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Time : Three Hours *Maximum Marks : 150*

(This paper contains 11 pages)

Read the following Instructions carefully :

(i) *This question paper consists of TWO Sections : 'A' and 'B'.*

(ii) *Section 'A' has TEN questions. Answer ALL questions in this Section.*

(iii) *Section 'B' has TWENTY questions. Answer any TEN questions in this Section.*

(iv) *Begin answer for this Section on a fresh page.*

(v) *Answers to questions in each Section should appear together in the same sequence in which they appear in the question paper.*

(vi) *There will be no negative marking.*

SECTION A

(100 *Marks*)

1. Write correct alphabet in capital against the question number : (29 × 1 = 29)

1.1 The age of the Siwalik Group is :
(A) Middle Oligocene to Early Miocene
(B) Middle Miocene to Early Pleistocene
(C) Late Pliocene to Early Pleistocene
(D) Early Pliocene to Late Pleistocene.

1.2 The term system in stratigraphy refers to a :
(A) Lithostratigraphic unit
(B) Biostratigraphic unit
(C) Chronostratigraphic unit
(D) Time Unit.

1.3 The Peninsular Gneissic Complex is dated as :
(A) 1600—1900 m.y.
(B) 2300—2600 m.y.
(C) 2600—2900 m.y.
(D) 3200—3500 m.y.

1.4 The most useful technique in dating potteries is :
(A) Fission track
(B) Uranium—Lead
(C) Potassium—Argon
(D) Carbon—14.

1.5 The group of organisms not significantly affected by Cretaceous/Tertiary extinction is :
(A) Plants
(B) Rudist bivalves
(C) Ammonites
(D) Dinosaurs.

1.6 Granitic magmas are formed in :
(A) Lower part of crust
(B) Lower part of mantle
(C) Upper part of crust
(D) Upper part of core

1.7 Body centered lattice has a cell content of :
(A) One atom
(B) Two atoms
(C) Three atoms
(D) Four atoms

1.8 Polymorphism in andalusite-kyanite-sillimanite is due to :
(A) Change in bond type
(B) Si—Al order-disorder
(C) Si—Al substitution
(D) Lattice defects

1.9 The mineral specularite is related to :

(A) Graphite
(B) Hematite
(C) Corundum
(D) Ilmenite.

1.10 Which of the followings form continuous solid solution series ?

(A) Calcite—dolomite
(B) Dolomite—magnesite
(C) Magnesite—siderite
(D) Siderite—calcite.

1.11 The maximum age of the ocean-floor is about :

(A) 100 m.y.
(B) 200 m.y.
(C) 300 m.y.
(D) 400 m.y.

1.12 If the maximum principal stress is vertical, the fault is :

(A) Normal
(B) Thrust
(C) Reverse
(D) Wrench

1.13 A fold with horizontal axial plane is known as :

(A) Upright
(B) Closed
(C) Recumbent
(D) Reclined

1.14 A rock with the mineral assemblage of orthoclase, nepheline, plagioclase, biotite and hornblende is known as :

(A) Diorite
(B) Syenite
(C) Granodiorite
(D) Nepheline—syenite

1.15 The commonly used unit of radioactivity in geological studies is :

(A) Curie
(B) Rad
(C) Roentgen
(D) Ergs.

1.16 In neutron logging the commonly used source is :

(A) Pu—Be
(B) U^{238}
(C) Co^{60}
(D) Gamma source

1.17 Isogonic lines are lines of equal :

(A) Intensity
(B) Declination
(C) Inclination (magnetic)
(D) Gravity

1.18 Gravity has maximum value at :
(A) Surface of the earth
(B) Mohorovicic discontinuity
(V) Core—mantle boundary
(D) Outer—inner core boundary

1.19 The correction always added to observed values in gravity survey is :
(A) Free-air
(B) Bouguer
(C) Isostatic
(D) Terrain

1.20 Maximum number of earthquakes occur in :
(A) Precambrian shield
(B) Himalaya—Hindukush range
(C) Circum—Pacific Belt
(D) Alpine range

1.21 A seismic wave passing through the inner core of the earth as P-wave is termed as :
(A) PKP
(B) PKIKP
(C) PKJKP
(D) P_cP

1.22 The magnetometer operating at liquid helium temperature is :
(A) Proton precession
(B) SQUID
(C) Fluxgate
(D) Schmidt vertical

1.23 The olivine rich layer of the earth is :
(A) Upper Crust
(B) Lower Crust
(C) Upper Mantle
(D) Lower Mantle

1.24 The highest radioactivity is observed in :
(A) Granite
(B) Basalt
(C) Charnockite
(D) Marble

1.25 A seismic wave showing retrograde elliptic particle motion is :
(A) Primary wave
(B) Secondary wave
(C) Rayleigh wave
(D) Love wave

1.26 The most useful and economic surface geophysical method for groundwater exploration is :
(A) Gravity
(B) Seismic
(C) Electrical resistivity
(D) Transient electromagnetic

1.27 Which of the following subsurface formation will show maximum electrical resistivity ?
(A) Clay bed
(B) Fine sand aquifer
(C) Coarse sand aquifer
(D) Gravel bed.

1.28 Fan shooting is most suitable for the delineation of :

(A) Syncline
(B) Anticline
(C) Fault zone
(D) Salt dome

1.29 Transmissibility of an aquifer can be expressed in :

(A) m^2/d
(B) m^3/d
(C) m/d
(D) m/s

2. Fill in the blanks : (8 × 2 = 16)

2.1 Plagioclase can show.....and.....superposed twinning.

2.2 The typical Lower Gondwana Flora includes.....and.....

2.3 The top and bottom of beds can be inferred by the presence of.....bedding and..... ripple marks.

2.4 Sulphide ores of copper are generally formed by.....and.....processes.

2.5 The main petroleum reservoir rock of Bombay High is.....and its geologic age is.....

2.6 The deep sea sediments are characterized by.....and.....

2.7 Very fine sand and silt particles produced by glacial erosion is termed as.....and the coarse unsorted deposits are known as.....

2.8 Optic axial plane of a biaxial mineral contains the vibration directions.....and.....

3. Match the following items on the left column with those on the right : (8 × 1 = 8)

1. Bornite	A. Oil
2. Vindhyan	B. Turbidity current
3. Gondwana	C. Tungsten
4. Scheelite	D. Diamond
5. Hornfels	E. Mature clastics
6. Graywacke	F. Contact metamorphism
7. Barail	G. Copper
8. Orthoquartzite	H. Coal.

4. Match the following items on the left column with those on the right :

1. CDP technique	A. Benioff zone
2. Airgun	B. Equatorial dipole
3. Induced polarisation	C. Regional gravity
4. Deep focus earthquake	D. Stacking
5. Isostasy	E. Marine seismic
6. Eotvos	F. Marine gravity
7. Isostatic filter	G. Airy
8. Electrical resistivity	H. Per cent frequency effect.

5. Fill in the blanks : (7 × 2 = 14)

5.1 Longitudinal and shear waves are called Body waves whereas Rayleigh and Love waves are known as Surface waves

5.2 Crust-mantle discontinuity is termed as Moho whereas mantle-core interface is known as Gutenberg

5.3 The temperature within the earth increases with depth and understood to be largely due to radioactive disintegration

5.4 Piezomagnetic effect arises from the distortion of .....and is produced by change in the rocks'.....

5.5 In neutron logging.....in the liquid is measured. It is therefore more suitable for measuring the porosity of the formation.

5.6 Ocean-continental convergent plate boundaries are characterized by.....and.....

5.7 Energy of the sun is due to Fusion reaction caused by the transformation of hydrogen into Helium

6. In a small area of Pacific Ocean five heatflow data were collected at different sites as follows : 1.85, 1.95, 2.05, 2.15 and 2.25 HFU. Calculate the sample mean and standard deviation of the data. Indicate if the mean is significantly higher/lower than the global heat flow of 1.65 HFU.
(Tabular t-value at 99% confidence is 4.60). (2 + 3 = 5)

7. From a rock sample, six typical fossils are recorded. Their known geologic ranges are as follows :

(a) Cretaceous to Pliocene
(b) Eocene to Pleistocene
(c) Palaeocene to Oligocene
(d) Palaeocene to Pliocene
(e) Eocene to Miocene
(f) Oligocene to Pleistocene.

Draw the range-chart and find the age of the sample. (3 + 2 = 5)

8. Electrical resistivity sounding is carried out in the field using Wenner arrangement and the following data set is recorded. Calculate apparent resistivity at the centre of the spread (AB). (5)

Spread Length (AB) = 30 m.
Potential difference at the measuring electrodes = 2 mV.
Current through electrodes (A, B) = 20 mA.

9. The piezometric heads in a confined aquifer separated by 121 m are 48.6 m and 47.5 m respectively. If the aquifer thickness is 30 m and transmissibility is 450 m²/d, compute the velocity and flow rates through the aquifer. (2 + 3 = 5)

10. Find the bulk modulus of elasticity (K) for the earth material from the following data :

V_p = 11420 m/s
V_S = 6360 m/s
ρ = 4680 kg/m³. (5)

SECTION B

(50 *Marks*)

(Answer any TEN questions in this Section)

11. Draw H. A, K, Q and AK type curves. Using only the letters a, b and c, as explained, give the sequence of formations for the above curves.

    a = clayey formation

    b = sandy clay bed

    c = pebble bed. (5)

12. A clean porous saturated sand has a resistivity of 9.6 ohm—m. Formation water resistivity is 0.4 ohm—m. Apply Archie's relation with a = 1 and m = 2 to find out the porosity. (5)

13. Write Maxwell's equations related to Faraday's and Ampere's laws for a homogenous isotropic medium. Explain the terms giving their units. (5)

14. A two-layer isolated prism having thicknesses 5 and 15 m respectively, overlies a basement. If the resistivity of the first and second layers are 50 and 10 ohm—m respectively, calculate the coefficient of anisotropy. (5)

15. Calculate the reflection and transmission coefficients (R and T) for a weathered basalt (V_1 = 2000 m/s, ρ_1 = 1900 kg/m³) overlying a massive basalt (V_2 = 3500 m/s, ρ_2 = 2300 kg/m³). (5)

16. In a seismic reflection survey, the average velocity of the dipping horizon is 4500 m/s. The frequency spectrum of the target lies in the range of 15—40 Hz. Assuming a maximum channel spacing of 50 m, calculate the dip of the horizon. (5)

17. Choose the (i) para- (ii) dia- (iii) ferro- (iv) ferri- and (v) anti ferri-magnetic substances from the list given below :

    (a) magnetite

    (b) hematite

    (c) pyroxene

    (d) quartz

    (e) iron-meteorite. (5 × 1 = 5)

18. (a) Show that the second vertical derivative will eliminate a plane regional gravity surface.

    (b) On a hill-top, the precession frequency of a proton precession magnetometer was observed to be 2 KHz. Compute the total magnetic field of the earth (F) at the hill-top. Given gyromagnetic ratio (G) = 0.267513/gamma-s. (3 + 2 = 5)

19. A spherical chromite deposit (ρ = 4 gm/cc) is having its center buried at a depth of 100 m below the ground surface. If the maximum gravity anomaly is 1.8 m gal above that area, compute the mass of the ore-body. Given, G = 6.673×10^{-11} $Nm^2 kg^{-2}$, density of rock-matrix = 2.67 gm/cc. (5)

20. (a) Groundwater head values at three wells A, B and C forming an equilateral triangle are 86, 90 and 88 m above msl. Draw the groundwater flow direction.

(b) Depth of average pre- and post-monsoon water table measured from a flat ground surface for an aquifer are 48 m and 45 m respectively. Compute the annual yield for this range of variation in the water-table. Given, Specific yield = 25%

Aquifer area = 10^4 m^2 (3 + 2 = 5)

21. (a) Give two reasons for calling Gallium as dispersed element.

(b) In a plutonic igneous rock the maximum number of major minerals present is five although the number of major elements in the crust is eight (O, Si, Al, Fe, Mg, Ca, Na, K). Give reasons. (2 + 3 = 5)

22. (a) In which section of Diopside the maximum value of extinction angle can be measured and why ?

(b) The length-fast quartz wedge is inserted at 45° position of the interference figure of an optically negative uniaxial mineral. Indicate the direction of movement of isochromatic rings in a diagram, and also show the length-fast direction of quartz-wedge. (2 + 3 = 5)

23. Draw a schematic section through a supergene sulphide enrichment zone of copper and label them. Indicate one typical copper ore mineral in each zone. (2 + 3 = 5)

24. Draw simple sketches showing the different types of plate movements. Indicate the resulting thickness of lithosphere and topographic features. (5)

25. Sketch a Bouma sequence, label its important features and write about its origin and environment of deposition. (5)

26. (a) What is the basis of classification of foraminifera into its suborders.

(b) Name four genera of larger benthic foraminifera which became extinct in Late Eocene times. (1 + 4 = 5)

27. On a free hand drawn map of India show the locations/distributions of the following items :

(a) A locality of marine Permo-carboniferous rocks in Peninsula.

(b) Godavari graben.

(c) Type area of Blaini Formation.

(d) A locality for Ediacarian Fauna.

(e) Nickeliferous laterite deposit. (5 × 1 = 5)

28. Classify the folds into different types based on the curvature properties of adjacent beds and show them on a $t' (= t_\alpha / t_o)$ Vs α -diagram. (3 + 2 = 5)

29. Write down the possible origin of the following symmetry elements and imposed fabric in metamorphic rocks :

(a) Axial (Planar).

(b) Axial (Linear).

(c) Orthorhombic.

(d) Monoclinic.

(e) Triclinic. $(5 \times 1 = 5)$

30. Name five principal types of aeolian sand dunes. Sketch each type indicating their morphology with respect to wind direction(s) producing it. (5)

(1)

1995

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Time : Three Hours *Maximum Marks: 150*

(This paper contains 14 pages)

courtesy: GATE Chairman Pandey.

Read the following instructions carefully:

(i) Write all the answers in the *answerbook*.

(ii) This question paper consists of two sections: A and B.

(iii) **Section A** has **NINE** questions. Answer **ALL** questions in this section.

(iv) **Section B** has **TWENTY** questions. Answer any **TEN** questions from this section. Strike off the answers which are not to be evaluated; else only the **first ten answers** will be considered. Answers to this section should start on a fresh page and should not be mixed with answers to **Section A**.

(v) Answers to questions and answers to the parts of a question should appear together in the same sequence in which they appear in the question paper.

(vi) In all questions of 5 marks, write clearly the important steps in your answer. These steps carry partial credit.

(vii) There will be no negative marking.

SECTION A
(100 MARKS)

1. Write the correct alphabet (only one) in capital against the question number in the answerbook:

(40 x 1 = 40)

1.1 Select the correct order of elements that occur in the earths's crust in decresing order of abundance.

A: Si, Al, Fe, Ca, Na
B: O, Si, Al, Fe, Ca
C: Si, O, Al, Ca, Mg
D: O, Si, Al, Ca, Fe

1.2 In the oceanic crust heat flow rate is maximum over:

A: coral reefs.
B: oceanic trenches.
C: seamounts.
D: mid-oceanic ridges. ✓

1.3 The source area from where material is derived to form a sedimentary rock is called:

A: peneplain.
B: phacolith.
C: pluton.
D: provenance.

1.4 The geophysical method best suited to prospect disseminated sulphide ore is:

A: electrical resistivity.
B: magnetic method.
C: induced Polarisation.
D: neutron logging.

1.5 Carbonatites are:

A: a primary source of diamonds.
B: rich in carbon in the form of graphite.
C: a source of carbonaceous sediments.
D: rich in CaCO3 in the form of calcite.

1.6 Sensitivity of a gravimeter is proportional to the:

A: time period of the spring.
B: square of the time period.
C: square-root of the time period.
D: none of the above.

1.7 A plain of eroded bedrock in an arid region developed between a mountain and a basin is known as:

A: pediment.
B: pediplain.
C: peniplain.
D: piedmont.

1.8 Marine hydrophones are of:

A: acceleration type.
B: displacement type.
C: velocity type.
D: pressure type.

1.9 Find the odd name out:

A: Ankleshwar
B: Porbandar
C: Digboi
D: Bassein

1.10 A large root under a mountain will give rise to a:

A: positive Bouguer anomaly.
B: zero Bouguer anomaly.
C: small negative Bouguer anomaly.
D: large negative Bouguer anomaly.

1.11 Commercial deposits of monazite in India occur in:

A: pegmatites.
B: river placers.
C: beach placers.
D: vein deposits.

1.12 Outer core of the earth causes a P-phase shadow zone starting at an angular distance (in degrees):

A: 100.
B: 103.✓
C: 112.
D: 116.

1.13 Coal deposits occurring in Bihar differ from those found in Assam in:

A: geologic age.
B: average calorific value.
C: average sulphur content.
D: all of the above.

1.14 Most widely used marine seismic energy source is:

A: Air gun.
B: Vapour choc.
C: Maxipulse.
D: Vibroseis.

1.15 The mineralogical composition of gondite is:

A: quartz - hypersthene - mica.
B: quartz - microcline - hornblende.
C: quartz - spessartite - rhodonite.
D: quartz - andalusite - psilomelane.

1.16 Density distribution inside the earth can be determined by using:

A: Adams-Williamson's equation.
B: Maxwell's equation.
C: Laplace's equation.
D: Green's equation.

1.17 The age in million years to the base of Cambrian, Triassic, Palaeocene and Pleistocene respectively are:

A: 600, 450, 65, 12
B: 500, 225, 70, 12
C: 570, 240, 65, 2
D: 570, 325, 65, 2

1.18 Earthquake shear wave velocity depends only on:

A: bulk modulus
B: shear modulus
C: bulk modulus and density
D: shear modulus and density.

1.19 Identify the chronostratigraphic units from the following list (Nos.1 to 9) which are arranged under the codes A to D. Select the correct code.

1. Member
2. Series
3. Era
4. Group
5. Bed
6. Zone
7. Stage
8. Formation
9. System

A: 2,7,9. B: 1,3,8. C: 4,5,6 D: 3,7,8.

1.20 Gravity at the centre of the earth is:

A: 980 gals.
B: 1068 gals.
C: 432 gals.
D : Zero.

1.21 At the temperature of 1000 degree C and pressure of 25 Kb the mineral phase that is stable in the mantle is:

A: spinel.
B: garnet.
C: plagioclase.
D: calcite.

1.22 Half life of U-238 is:

A: 4.5×10^9 years.
B: 7.1×10^8 years.
C: 1.4×10^{10} years.
D: 2.1×10^{11} years.

1.23 The composition of plagioclase in basalt is

A: albite.
B: labrodorite.
C: anorthite.
D: bytownite.

1.24 The present geomagnetic epoch is known as:

A: Gauss.
B: Matuyama.
C: Brunhes.
D: Gilbert.

1.25 The most direct evidence of mantle chemistry and mineralogy is provided by:

A: Chondrites.
B: Achondrites.
C: Ocean ridge basalts.
D: Ultramafic nodules.

1.26 P-wave velocity in uppermost mantle is around:

A: 6.5 km/s.
B: 8.1 km/s.
C: 9.3 km/s.
D: 10.0 km/s.

1.27 In plagioclase felspars the RI:

A: is maximum in andesine and decreases towards the Ab and An end members.
B: increases with increase in An content.
C: increases with increase in Ab content.
D: has no relationship with An content.

1.28 Porosity of the formation can be determined by:

A: Gamma-gamma log.
B: Microlog.
C: Neutron log.
D: Caliper log.

1.29 The properties used to determine rock structure rating include:

A: joint spacing.
B: weathering/alteration.
C: type of discontinuties.
D: all of the above.

1.30 The igneous texture that results due to the intergrowth of Na- and K- felspars is:

A: graphic.
B: myrmekitic.
C: perthitic.
D: ophitic.

1.31. The composition of pyrolusite is:

A: $MnSiO_3$.
B: $MnSiO_4$.
C: MnO_2.
D: $MnCO_3$.

1.32 Which of the following minerals crystallizes in monoclinic system ?:

A: Pigeonite.
B: Tourmaline.
C: Beryl.
D: Pyrite.

1.33 In an aquifer the ratio of volume of water that can be drained to the total volume of rock is termed as:

A: specific yield.
B: dynamic storage.
C: infiltration index.
D: specific retention.

1.34 Growth faults are common:

A: in deltaic environments.
B: close to transcurrent faults.
C: on continental slopes.
D: on either side of the mid-ocean ridges.

1.35 The normal lithostatic pressure and temperature gradient in stable continental regions are:

A: 500 bars/Km and 20 - 30 C/Km.
B: 250 bars/Km and 15 - 30 C/Km.
C: 250 bars/Km and 30 - 40 C/Km.
D: 1 Kb/Km and 40 - 50 C/Km.

1.36 Whole rock Rb/Sr isochron dates from a suite of metamorphosed rocks represent:

A: age of emplacement of the suite of rocks if the rocks are closed to Rb and Sr.
B: age of first metamorphic event in the area provided the rocks are open to Rb and Sr.
C: age of the last metamorphic event if the rocks are closed to Rb and Sr.
D: average age of the metamorphic events provided the rocks are closed to Rb and Sr.

1.37 The great thickness of sediments in a basin is due to:

A: accumulation of sediments in deep waters.
B: accumulation of sediments in deep inland troughs and rift valleys.
C: subsidence of the basin floor accompanying sedimentation.
D: sedimentation in foredeep of rising mountain chain.

1.38 Coal bearing strata are formed in cyclic sedimentary sequences because:

A: coal is formed in deltas showing coarsening upward.
B: of cyclic variation in climate and therefore input into the coal basins.
C: because of cyclic uplift and subsidence of coal bearing basins.
D: organic matter is always transported periodically.

1.39 Ophiolites are:

A: slices of ocean floor emplaced in tectonic thrust sheets.
B: pillow basalts formed in marginal marine basins.
C: pillow basalts associated with andesite formed in subduction zones.
D: serpentinised mafic and ultramafic rocks found in the Archaean greenschist belts.

1.40 Identify the planktonic foraminifera which is characteristic of the Cretaceous period:

A: Globotruncana.
B: Phylloceras.
C: Globorotalia.
D. Fusulina.

2. Match the terms given in set **A** with those given in set **B**. In the answerbook, write number-alphabet to form pairs. (10 x 1=10)

Set **A**	Set **B**
1. Uplifted basement	A. Ptilophyllum
2. Flysch	B. Low Temp. and pressure
3. Delta	C. Quartz
4. Petroleum caprock	D. Low Temp. and medium pressure
5. Greenschist facies	E. Eugeosynclinal sediment
6. Amphibolite facies	F. High Temp. and pressure
7. Gondwana	G. Gravity High
8. Piezoelectricity	H. Evaporite
9. Zeolite facies	I. Nappe
10. Crustal shortening	J. Upward coarsening of sediments.

3. Fill in the blanks with appropriate words :(Do not write the full sentence in the answerbook)
(1 mark per blank x 15 = 15)

3.1. Earthquake shear waves can not travel through _____ core of the earth.

3.2 The famous fossiliferous marine sequence in central part of India is known at _____ and is _____ in age.

3.3 Planetary motions around the sun are governed by _____laws.

3.4 Isotopic methods of distinction of geothermal water of meteoric origin from that of juvenile origin use O^{18}/O^{16} ratio and H^2/H^1 ratio.

3.5 Geiger-Muller counter responds primarily to_____ radiation.

3.6 The equipotential surface at mean sea level is called_____.

3.7 The optical indicatrix of a biaxial crystal is _____ and the optic axis lies in _____ plane.

3.8 Continental boundaries associated with subduction zones are _____ margins.

3.9 Deep oceanic sediments contain more of _____ and less of _____ minerals.

3.10 The number of alpha particles emitted by one gram of pure Radium (Ra 226) in one second is one _____.

3.11 The unit of magnetic intensity, 1 gamma is equal to _____ oersted.

4. Match the items of Set **A** with those of Set **B**: (In the answebook write number-alphabet to form a pair)
(10 x 1=10)

Set **A**	Set **B**
1. Curie point	A. Marine seismic survey
2. Latitude correction	B. Airy's hypothesis
3. Tripple junction	C. Thermoremanent magnetism
4. Sonobuoy	D. Earthquake intensity
5. Root formation	E. Subduction zone
6. Headwave	F. Electrical prospecting
7. Deep focus earthquake	G. Digital filtering
8. Apparent resistivity	H. Seismic refraction
9. Mercalli Scale	I. Plate Tectonics
10. Aliasing	J. Gravity Survey.

5 Give justification in brief for the following statements.

5.1 Short wave IR radiation centred at 1.4 and 1.9 micrometres with a band width of 0.2 micrometres is not used in remote sensing. (2)

5.2 Refraction of cleavage is often observed in folded strata. (2)

5.3 Base metal deposits are often found as veins and stockwork. (1)

6(a) An aquifer with an average thickness of 60 m and an areal extent of 200 hectares has a storage coefficient of $3x10^{-4}$ and a specific yield of 15 %. Estimate the available groundwater storage if the aquifer is unconfined and the groundwater table fluctuation is 17 m. (2)

(b) On a 1:25,000 scale topographic map, the measured distance between two road intersections is 47.2 mm. This distance on an aerial photograph is 94.3 mm. What is the scale of the photograph ? (1)

(c) The time period of a simple pendulum is 1 sec. at station A and 1.001 sec. at station B. If gravity at station A is 980 gals, what is the value of 'g' at station B ? (2)

7. In a seismic reflection survey the shot-detector distance is 200 m and depth of horizontal reflector is 100 m. Calculate the reflection travel time if the velocity in the medium is 3000 m/s. (5)

8 (a)Diurnal correction in a gravity survey is determined by multiple observations by the field gravimeter at the base. Can same be done by using a stationary gravimeter at the base station ? Justify your answer. (2)

(b) A proton precession magnetometer measures the total component of earth's magnetic field. Can it also measure vertical and horizontal fields ? Justify your answer. (2)

(c) Half-life of C-14 is 5600 years. In how many years will 5 micrograms of this isotope reduce to 1.25 micrograms ? (1)

$5 - 2.5 = 5600$

$2.5 = 1.W = 5600$

11200

9. An ore drive in an underground copper mine (Fig. 1)has been sampled using channel sampling. The length of each channel, the assay value of Cu (in %) in each channel sample and the location of each channel (distance in metres from one end of the drive) are given in Figure 1 (**see next page**). Compute the average grade of copper in the drive. (5)

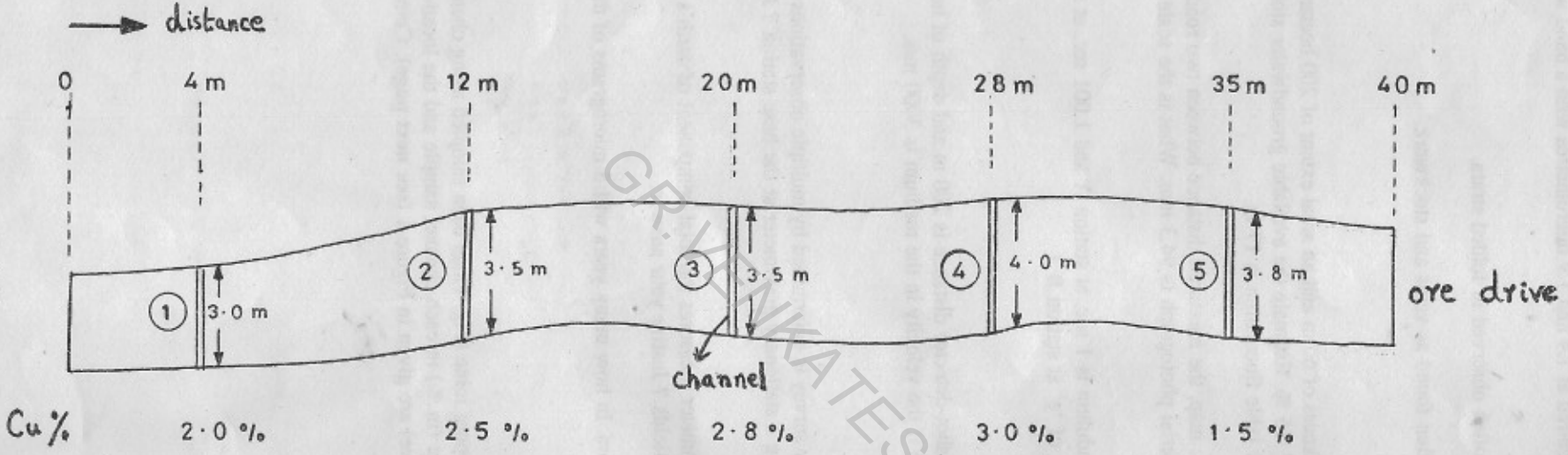

Fig. 1

SECTION B

(50 marks)

(Answer any **TEN** questions in this section)

10. What are dip isogons ? On a vertical section of a folded terrain show the construction of dip isogons. Draw figures to show the fundamental types of fold classes on the basis of the curvature of fold limbs. Plot a parallel fold on a $t' = t_\alpha/t_o$ vs α diagram. (5)

11. Figure 2 shows a sedimentary succession. Lithological details and sedimentary structures are described on the right. Identify the principal sedimentary environment and the three distinct sub-environments (marked I,II and III in Fig.2) and give in brief their mode of origin. (5)

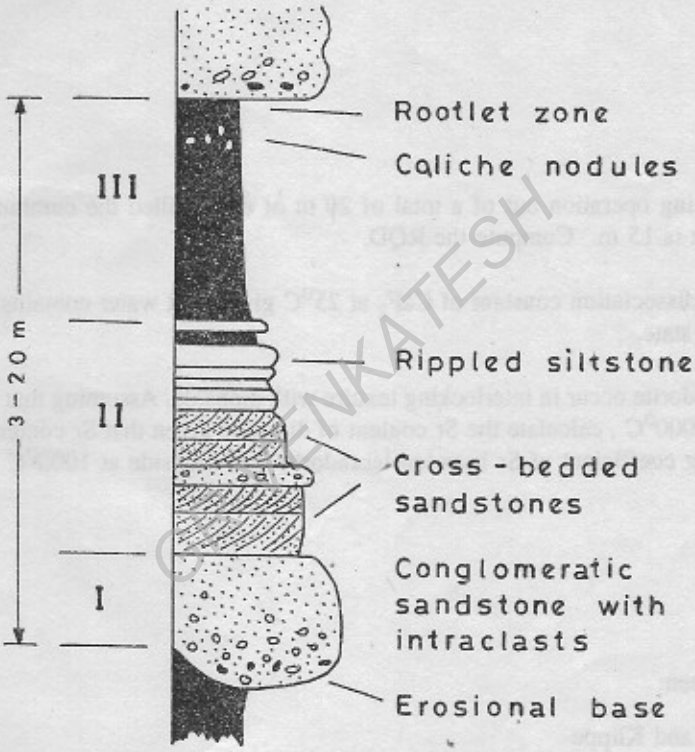

Fig. 2

12. Describe and illustrate three different structural modifications which are generally observed in the study of evolution of trilobites. (5)

13 (a) What are the most common ions used for assessing the quality of groundwater ? (2)

(b) Plot the average composition of seawater on Piper diagram. (3)

14. Calculate the structural formula of Olivine with respect to four oxygen atoms from the analysis given below:

Oxides	Mol.mass	Wt% oxides
SiO_2	60.9	39.41
FeO	71.85	16.46
MnO	70.94	0.21
MgO	40.32	43.27
CaO	56.08	0.23

(5)

15. Two vertical boreholes are located at the same elevation 500 m apart on an E-W line. The top of a coal seam is encountered in the western hole at 200 m and at 300 m in the eastern hole. The bedding makes an angle of 45 degrees with the axis of the core in both holes. Give a geometric or stereographic construction to obtain solutions for the strike and dip of the bed.

(5)

16 (a) In a core drilling operation out of a total of 20 m of core drilled the cummulative length of core pieces greater than 10 cm is 15 m. Compute the RQD. (1)

(b) Calculate the dissociation constant of CaF_2 at 25^oC given that water contains 0.00022 mol/kg of CaF_2 at 25^oC in dissolved state. (2)

(c) Grains of labradorite occur in interlocking texture with diopside. Assuming that the two minerals are formed in equilibrium at 1000^oC , calculate the Sr content of diopside given that Sr content of plagioclase is 200 ppm and the partitioning coefficient of Sr between labradorite and diopside at 1000^oC is K(lab/diop) = 2.25.

(2)

17. Differentiate between:

(a) Fenester and Klippe (2)
(b) Liquidus and solidus (2)
(c) Holotype and hypotype. (1)

18. Illustrate the following:

a. Petroleum traps associated with salt domes. (2)
b. The internal snowball structure of rotated pophyroclasts of garnet and its relation to the external fabric. (1)
c. Optical orientation diagram of diopside parallel to 010. (2)

19. Answer the following:

(a) The chemical composition of two rock types A and B are given below. Which rock contains more plagioclases ? Why?

	A	B
SiO_2	45.0	47.0
Al_2O_3	2.6	13.1
CaO	1.9	10.2
MgO	41.0	14.0
Na_2O	0.2	1.7
K_2O	0.12	0.08

(1)

(b) Give two reasons why coral reefs are not formed in oceans at greater depths. (2)

(c) Exsolution textures are often observed between pairs of ore minerals. Give reasons why all pairs of ore minerals do not show such texture. (2)

20. In a two layer horizontal interface, the respective seismic velocities of top and bottom layers are 1500 m/s and 2500 m/s. The depth of interface is 100 m. Calculate the intercept time on refraction time distance curve. (5)

21 (a) Give the names of three characteristics of a seismic reflection event which may indicate presence of hydrocarbon in a horizon. (3)

(b)Write the expression relating stacking velocity with reflection arrival time. (2)

22. A buried sphere is polarised by a vertical field in northern hemisphere. Draw sketches to show the nature of vertical and horizontal magnetic anomalies above the sphere. (5)

23 (a) Distinguish between Bouguer correction and Bouguer anomaly. (3)

(b) A Schmidt vertical magnetic balance is used in northern hemisphere. Can the same instrument be used in the southern hemisphere ? Explain. (2)

24. Using the expression for Bouguer correction calculate the correction in milligals for a station at a height 10 m above datum plane. Surface density is 2500 kg/ cubic metre. (5)

25 (a) Mention three uses of second derivative maps in interpretation of gravity and magnetic anomaly maps. (3)

(b) Explain how upward continuation acts as a smoothing filter. (2)

26 (a) Write down the geometrical factor for Wenner configuration for a given spacing. (2)

(b) "Mise-a-la-messe resistivity method is used to explore ore deposits which are not detected by surface geophysical methods". Is this statement correct? Justify your answer. (3)

27 (a) Name the parameters measured in TURAM method of electromagnetic prospecting. (2)

(b) Define Chargeability. (3)

28 (a) Name two applications of S.P. log. (2)

(b) Explain why the formation density determined by borehole gravity differs from that determined by gamma-gamma logging? (3)

29. In a two layer case a high velocity layer overlies a low velocity layer. Can seismic refraction and reflection surveys be conducted in this case? Explain. (5)

* END *

(2)

XP : Physical Sciences

Duration : Three hours

Maximum Marks : 150

This paper contains 30 pages.

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Courtesy : Chairman GATE, Roorkee.

Read the following instructions carefully.

1. Write all the answers in the answerbook.
2. This question paper contains SIX SECTIONS listed below:

SECTION CODE	SECTION	STARTING PAGE NO
S	Mathematics	3
M	Chemistry	6
E	Computational Science	11
F	Earth Sciences	18
I	Materials Science	22
T	Physics	25

3. Answer THREE sections only. Section **S** is COMPULSORY. Choose TWO others from the remaining sections.
4. Answer all questions in a Section. Each Section carries 50 marks.
5. Write SECTION CODES of the selected sections in the boxes provided on the cover page of the answerbook.
6. ANSWERS TO DIFFERENT SECTIONS SHOULD NOT BE MIXED WITH EACH OTHER.
7. Answers to questions and answers to different parts of a question should appear together.
8. In all questions of 5 or more marks write clearly the important steps in your answer. These steps carry partial credit.
9. Read the specific instructions given, if any, in the individual sections.
10. There will be no negative marking.

(F) EARTH SCIENCES

F1. In each of the subquestions below four alternatives are provided of which one is correct. Choose the correct alternative and write in your answerbook the letter A, B, C or D against the corresponding subquestion number. (25 x 1 = 25)

1.1 Which planet is farthest from the sun?

(A) usually Neptune, but sometimes Jupiter
(B) usually Pluto, but sometimes Neptune
(C) usually Neptune, but sometimes Mars
(D) usually Jupiter, but sometimes Neptune

1.2 Which is the most abundant type of fossil in the Precambrian?

(A) Trilobites (B) Gastropods
(C) Stromatolites (D) Ammonites

1.3 Porphyry deposits generally occur close to

(A) conservative plate margins (B) destructive plate margins
(C) triple junctions (D) transform faults

1.4 Which of the following represents the correct sequence from the oldest to the youngest?

(A) Talchir - Damuda - Panchet - Mahadev
(B) Talchir - Mahadev - Panchet - Damuda
(C) Damuda - Talcher - Mahadev - Panchet
(D) Panchet - Mahadev - Damuda - Talcher

1.5 Chromite deposits are usually associated with:

(A) Granites (B) Nepheline syenites
(C) Carbonatites (D) Peridotites

1.6 In a monoclinic crystal, one principal vibration direction is parallel to

(A) any one of the crystallographic axes (B) 'a' crystallographic axis
(C) 'b' crystallographic axis (D) 'c' crystallographic axis

1.7 A basalt undergoing low grade regional metamorphism will be transformed to

(A) garnet - plagioclase - diopside (B) cordierite - plagioclase - diopride
(C) hornblende - plagioclase (D) chlorite - actionolite - albite - Quartz

1.8 Fenitisation is associated with intrusions of

(A) Granite (B) Gabbro
(C) Nepheline syenite (D) Dolerite

1.9 The lowest layer of the earth's atmosphere is

(A) Troposphere (B) Stratosphere
(C) Mesosphere (D) Exosphere

1.10 An evidence of sea-floor spreading is:

(A) Marine gravity anomaly
(B) Earthquakes
(C) Paleomagnetism
(D) Geothermal flow

1.11 Scintillation counter responds primarily to :

(A) Alpha radiation
(B) Beta radiation
(C) Gamma radiation
(D) X - rays

1.12 Large deposits of marine manganese nodules are usually found in:

(A) Beach sands
(B) Continental shelf
(C) Coral reef
(D) Abyssal plane

1.13 Remnant magnetism acquired by slow-settling sedimentary particles is often of the type:

(A) Isothermal
(B) Viscous
(C) Detrital
(D) Chemical

1.14 Ninety-east ridge is situated in:

(A) Arabian sea
(B) Indonesian sea
(C) Indian ocean
(D) Bay of Bengal

1.15 Relationship of geometrical and gravitational flattening of the earth is given by

(A) Gauss' theorem
(B) Green's theorem
(C) Hayford's theorem
(D) Clairant's theorem

1.16 A reclined fold is one where the

(A) Trend of the axis and the axial plane are not the same
(B) Trend of the axis and the axial plane are not perpendicular to each other
(C) Trend of the axis and the axial plane are perpendicular to each other
(D) Axis is horizontal and the axial plane is vertical

1.17 Flysch is essentially

(A) Marine and dominantly argillaceous
(B) Estuarine and dominantly argillaceous
(C) Aeolian and arenaceous
(D) Fluvial and arenaceous

1.18 Hogbacks are characteristics of regions of

(A) Vertical resistant formations
(B) Inclined resistant formations
(C) Horizontal resistant formations
(D) Alluvial terrains

1.19 The structure of oil trap in Bombay High is

(A) A doubly plunging syncline
(B) An uniformly dipping bed
(C) A doubly plunging anticline
(D) An angular unconformity

1.20 Common-Depth-point (CDP) method is used in

(A) Seismic refraction (B) Seismic relection
(C) Well logging (D) Induced polarisation

1.21 An aquifluge is a formation which

(A) neither contains nor transmits water
(B) contains water but does not transport water
(C) contains and transmits water
(D) does not retain but transmits water.

1.22 Which one of the following can be a twin axis?

(A) Axis of binary symmetry (B) Axis of trigonal symmetry
(C) Axis of tetragonal symmetry (D) Axis of hexagonal symmetry

1.23 Water bodies are best recognised from images of band

(A) 4 (B) 5
(C) 6 (D) 7

1.24 Large S.P. anomalies are usually found over

(A) Oxides (B) Sulphides
(C) Carbonates (D) Coal

1.25 Taxodont hinges in lamellibranchs have

(A) Numerous teeth, more or less similar in form and size
(B) A few thick, sometimes grooved teeth
(C) A few teeth, non-uniform in size and shape
(D) One or more laminae or ridges instead of true teeth and hinge plate

F2.a) In a two-layer refraction survey, the velocities of upper and lower layers are 1000 m/s and 2000 m/s respectively. What is the value of the critical angle? (1)

b) Explain why the velocity of P waves shows a sharp fall at the core-mantle boundary. (2)

c) It is difficult to distinguish between petroleum and natural gas by electrical logs whereas velocity surveys like sonic logs can be useful. State the reason. (2)

F3.a) Explain why gravity increases from equator to pole. (2)

b) Bouguer anomaly usually shows strongly positive values over oceanic regions. State the reason. (1)

c) Draw figures to show electrode arrangements for current and potential electrodes in Wenner and Schlumberger configurations of resistivity survey. (2)

F4.a) Define : (i) specific yield of water and (ii) transmissibility coefficient of an aquifer. (2)

b) What is angular shear in a deformed rock? Calculate the quadratic elongation of a lineof 1 cm length which after deformation has a final length of 1.2 cm. (2)

c) If the principal stress σ_3 is vertical and σ_2 and σ_1 horizontal, what is the kind of fault that will be formed? (1)

F5.a) Migmatites are largely the result of three processes. Name any two. (2)

b) Describe the characteristic texture of Lamprophyres and Dolerites. (2)

c) Give Stoke's law mentioning what the different symbols stand for. (1)

F6.a) Distinguish optic sign and sign of elongation. (2)

b) Give the megascopic details of (i) Vitrain and (ii) Fusain (2)

c) Describe a saddle reef. (1)

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1998

GG : Geology & Geophysics

Duration : Three hours | Maximum marks : 150

This question paper contains 19 pages.

Read the following instructions carefully.

1. Write all the answers in the answer book only.
2. The question paper consists of **TWO SECTIONS** : **A** and **B**.
3. **Section A** has **NINE** questions. Answer **ALL** questions in this section.
4. **Section B** has **TWENTY** questions of which only **TEN** are to be answered. If more number of questions are attempted, score off the answers not to be evaluated; else the **First Ten** unscored answers will be evaluated.
5. Answers to **Section B** should start on a fresh page and should not be mixed with answers to **Section A.** Answers to questions 1 and 2 should be written in first two pages of the answer book, respectively.
6. Answers to questions and answers to parts of a question should appear together and should not be separated.
7. In all questions of 5 marks each, write clearly the important steps in your answer. These steps carry partial credit.
8. There will be no negative marking.

SECTION A

(100 Marks)

1. Write the correct alphabet (only one) in capital against the sub-question number in the answer book. (35 x 1 = 35)

1.1 The Archaean - Proterozoic boundary is fixed at

(A) 2300 Ma (B) 2500 Ma

(C) 2700 Ma (D) 2900 Ma

1.2 The horizontal component of the dip-slip of a fault is called

(A) horizontal slip (B) horizontal separation

(C) throw (D) heave

1.3 The average pH of sea-water is close to

(A) 7.2 (B) 7.6 (C) 8.0 (D) 8.4

1.4 The competency of a river is defined by the

(A) maximum amount of transported load

(B) maximum amount of suspended load

(C) maximum size of particles that can be transported

(D) maximum water velocity

1.5 Within the Earth's interior, the approximate depth at which the rocks have density close to the average density of Earth is close to

(A) 4000 km (B) 3000 km (C) 2000 km (D) 1000 km

1.6 In a deformed area, bedding (S_0) and axial plane schistosity (S_1), measured in a quartzite band, dip to the south, but the dip of S_0 is 82° and the dip of S_1 is 65°. This indicates that the quartzite band is the

(A) gently–dipping limb of an asymmetrical fold

(B) steeply–dipping limb of an asymmetrical fold

(C) normal limb of an overturned fold

(D) inverted limb of an overturned fold

1.7 A sedimentation unit in a sequence of clastic rocks is that thickness of sediments which was deposited

(A) at uniform chemical conditions

(B) under essentially constant physical conditions

(C) under essentially constant organic conditions

(D) at constant physical, chemical and organic conditions

1.8 Pyrolite is a hypothetical upper mantle rock consisting of peridotite and basalt in the ratio

(A) 1 : 3 (B) 1 : 2 (C) 2 : 1 (D) 3 : 1

1.9 An ore deposit formed during sedimentation in which the ore fluid was derived from a sub-marine volcanic source is termed

(A) sedimentary deposit (B) hydrothermal deposit

(C) epigenetic deposit (D) residual concentration deposit

1.10 The chemical formula for clinozoisite is

(A) $Ca_3 Al_2 Si_3 O_{12}$ (B) $3Ca\ Al_2\ Si_2\ O_8 \bullet CaCO_3$

(C) $Ca_2\ Al_3\ Si_3\ O_{12}\ (OH)$ (D) $CaAl_2\ Al_2\ Si_2\ O_{10}\ (OH)_2$

1.11 The earliest form of Cephalopod is

B

(A) Ammonites (B) Nautiloids

(C) Belemnites (D) Ceratites

1.12 In silicate minerals, the element that commonly occurs both in 4-fold and 6-fold coordinations is

A

(A) Ca (B) Mg (C) Fe (D) Al

1.13 Which of the following is the correct stratigraphic sequence beginning with the oldest first :

B

(A) Cheyair – Nallamalai – Papagni – Kistna

(B) Papagni – Cheyair – Nallamalai – Kistna

(C) Kistna – Nallamalai – Cheyair – Papagni

(D) Nallamalai – Cheyair – Kistna – Papagni

1.14 Folds formed by layer-parallel deformation are called

D

(A) buckle folds (B) bending folds

(C) parallel folds (D) similar folds

1.15 Orthopyroxene has two octahedral sites (M1 and M2), that are occupied with Fe^{2+} and Mg. But Fe^{2+} is strongly partitioned compared to Mg into the M2 site because

C

$M_1 > M_2$

(A) radius of Fe^{2+} < radius of Mg, and M1 site is larger than M2 site

(B) radius of Fe^{2+} > radius of Mg, and M1 site is smaller than M2 site

(C) radius of Fe^{2+} < radius of Mg, and M1 site is smaller than M2 site

(D) radius of Fe^{2+} > radius of Mg, and M1 site is larger than M2 site

1.16 The chemical composition of monazite is

C

(A) $Ca_5 (PO_4)_3$ (B) $Ca_5 (PO_4)_3 (F, Cl, OH)$

(C) (Ce, La, Y, Th) PO_4 (D) $Ca TiO_3$

1.17 The process of picking up and removal of loose rock fragments, sand and dust by wind is termed

A

(A) deflation (B) desertification (C) saltation (D) gelifluction

1.18 Kaolinization of felspar dominantly involves the process of

C

(A) oxidation (B) carbonation

(C) hydration (D) dehydration

1.19 Columnar joints in igneous rocks are formed due to

C

(A) diastrophic movement (B) chemical weathering

(C) thermal relaxation (D) pressure release

1.20 A cross-bedded sandstone comprises

(A) cohesive non-granular clasts (B) cohesive granular clasts

(C) non-cohesive granular clasts (D) non-cohesive non-granular clasts

1.21 A broad lobe of ice that terminates on open slopes beyond a mountain front is a

A

(A) piedmont glacier (B) valley glacier

(C) fjord glacier (D) cirque glacier

1.22 According to the classification of dip isogons, a flattened parallel fold belongs to

(A) IA (B) IB (C) IC (D) 2

1.23 The term "Green sand" signifies

A (A) unconsolidated glauconite-rich sands

(B) consolidated glauconite-rich sands

(C) sand-size particles of green quartz

(D) sand-size particles of hornblende

1.24 The pair of brachiopods that occur in Mesozoic rocks are

D

(A) Spirifer, Lingula (B) Productus, Lingula

(C) Rhynconella, Spirifer (D) Rhynconella, Productus

1.25 The group of silicate minerals with general formula $A_3B_2Si_3O_{12}$, where A and B are divalent and trivalent cations, is

$(SiO_4)_3$

D

SiO_3 SiO_4 SiO_2 SiO_4

(A) pyroxene (B) olivine (C) feldspar (D) garnet

1.26 The half-life of ^{14}C is

A

(A) 5730 years (B) 6250 years

(C) 8510 years (D) 10240 years

1.27 A point on a liquidus in a binary phase diagram involving pure phases is

A (A) invariant (B) isobaric invariant

(C) univariant (D) isobaric univariant

1.28 Fusilinids are important zonal fossils for

A (A) Eocene to Oligocene (B) Carboniferous to Permian

(C) Devonian to Carboniferous (D) Miocene to Pliocene

1.29 The term "blastoporphyric" refers to

(A) a volcanic rock

B (B) a metamorphosed igneous rock

(C) a deformed igneous rock

(D) an igneous rock formed due to anatexis of metamorphic rocks

1.30 In steriographic projection (radius = 15 cm), the normal to a crystal face and oriented 10^0 to the north azimuth should plot at a distance from the center equals to

(A) 1.47 cm (B) 1.31 cm (C) 1.85 cm (D) 2.46 cm

1.31 What is the basis for classifying Mesozoic Giant Dinosors into Saurischia and Ornithischia ?

(A) Character of pelvis (B) Nature of collar bones

(C) Presence / absence of wings (D) Nature of placenta

1.32 Pyroclastic deposits formed from clouds of ash that move out horizontally from a vent at high velocity following volcanic explosion is called

(A) Surge deposits (B) Ash fall deposits

(C) Ash flow deposits (D) Nuees ardentes

1.33 According to the IUGS classification, a leucocratic plutonic igneous rock containing 10 modal % quartz and plagioclase / (plagioclase + K-felspar) ratio at 45 is termed

(A) quartz monzonite (B) quartz monzodiorite

(C) monzonite (D) monzodiorite

1.34 In a metamorphic rock, the mineral assemblage – sillimanite + garnet + biotite + K-feldspar + quartz + ilmenite – indicates

(A) granulite facies conditions

(B) upper amphibolite facies conditions

(C) both granulite and upper amphibolite facies conditions

(D) middle and upper amphibolite facies conditions

1.35 Favourable condition for formation of Porphyry copper deposit is

(A) extremely low fO_2 condition of the initial magma

(B) high water content of the initial magma

(C) crystallization of magma at deep crustal level

(D) crystallization of magma at the Earth's surface

2. Write the correct alphabet (only one) in capital against the sub-question number in the answer book. (20 x 1 = 20)

2.1 Bodes law deals with

(A) Wind motion (B) Planetary bodies

(C) Ocean current (D) Internal constitution of earth

2.2 The lower mantle from a depth of 720 km to core boundary is termed as

(A) B layer (B) D layer (C) E layer (D) G layer

2.3 The temperature at stratopause is

(A) 0 °C (B) 20 °C (C) –65 °C (D) –140 °C

2.4 Wind that represents the balance between pressure gradient force and coriolis force is termed as

(A) Trade wind (B) Antitrade wind

(C) Tornado (D) Geostrophic wind

2.5 Oceanic zone extending from shoreline to a depth of 200 km and most populated with benthic organisms is

(A) Bathyl zone (B) Benioff zone

(C) Neritic zone (D) Phreatic zone

2.6 The number of spectral bands in Landsat Thematic Mapper Satellite is

(A) 3 (B) 4 (C) 6 (D) 7

2.7 Which one of the following physical properties has the widest range of values among rocks ?

(A) Density (B) Magnetic susceptibility
(C) Electrical resistivity (D) Seismic velocity

2.8 The polarity transition period of geomagnetic field for directional changes is about

(A) 500 – 1000 years (B) 1000 – 2500 years
(C) 3000 – 5000 years (D) 6000 – 8000 years

2.9 Eötvö's correction is required in

(A) Airborne electromagnetic survey (B) Airborne gravity survey
(C) Airborne magnetic survey (D) Airborne radioactive survey

2.10 The maximum value of Poisson's ratio for rocks is

(A) 0.25 (B) 0.50 (C) 1.00 (D) 2.00

2.11 The low velocity layer generally encountered in seismic prospecting is in the range

(A) 50 – 100 m/s (B) 100 – 200 m/s
(C) 250 – 1000 m/s (D) 1000 – 2500 m/s

2.12 Ground self potential due to an ore body originates due to

(A) Membrane potential (B) Liquid junction potential
(C) Electrokinetic potential (D) Oxidation-reduction potential

2.13 If ρ_t is longitudinal resistivity (parallel to plane of stratification) and ρ_m is transverse resistivity (normal to plane of stratification), then coefficient of anisotropy is

(A) ρ_m / ρ_t (B) ρ_t / ρ_m

(C) $(\rho_m / \rho_t)^{1/2}$ (D) $(\rho_t / \rho_m)^{1/2}$

2.14 Telluric currents are caused by

(A) Ionosphere current (B) Natural potential of earth

(C) Convection current in mantle (D) Convection current in outer core

2.15 In I.P. method, mho/m is the unit of measurement of

(A) Frequency effect (B) Delay time integral

(C) Chargeability (D) Metal factor

2.16 In AFMAG method, the range of frequencies used lies between

(A) 1 to 1000 Hz (B) 2 KHz to 10 KHz

(C) 20 KHz to 80 KHz (D) 1 MHz to 5 MHz

2.17 A measure of similarity between two data sets is given by

(A) Auto-correlation (B) Cross-correlation

(C) Convolution (D) Multiplexing

2.18 Find the odd one out among the following :

(A) Boomer (B) Doppler sonar

(C) Gyrocompass (D) Baringer INPUT System

2.19 Resistivity of the flushed zone is obtained by

(A) Normal log (B) Laterolog

(C) Induction log (D) Microlaterolog

2.20 'Tadpole plot' is a method of plotting data in

(A) Seismic reflection method (B) Magneto-telluric method

(C) Nuclear magnetic log (D) Dipmeter log

3. Match the terms given in set I with those given in set II. In the answer book, write number-alphabet to form pairs. (10 x 1 = 10)

Set I		Set II	
(1)	Hypsographic curve	(A)	Atmosphere
(2)	Magnetohydrodynamics	(B)	Gravity method
(3)	Spectral reflectance	(C)	Magnetic method
(4)	Gyromagnetic ratio	(D)	Seismic method
(5)	Astatisation	(E)	Inversion
(6)	Hydrogen Index	(F)	Remote sensing
(7)	Beaufort scale	(G)	Oceanography
(8)	Fission track	(H)	Neutron log
(9)	Eigenvector	(I)	Geomagnetic field
(10)	Bright spot	(J)	Geochronology

4. March the terms in set I with those in set II. In the answer book, write number - alphabet to form pairs. (10 x 1 = 10)

Set I		Set II	
(1)	Malanjkhand	(A)	Polymetallic sulfides
(2)	Sitampundi	(B)	Rhyolite
(3)	Jhamarkotra	(C)	Massifanorthosite
(4)	Madras	(D)	Muth quartzite
(5)	Chilka	(E)	Bagh beds
(6)	Kishengarh	(F)	Charnockite
(7)	Malani	(G)	Layered igneous complex
(8)	Spiti	(H)	Copper deposit
(9)	Narmada Valley	(I)	Phosphorite
(10)	Dariba	(J)	Nepheline syenite

5.

	Plagioclase	Olivine	Orthopyroxene
$K_{D, Sr}^{mineral-melt}$	1.80	0.01	0.02
$K_{D, Cr}^{mineral-melt}$	0.00	2.10	4.70

(K_D is the partition coefficient of elements)

(a) From the data given above, compare the compatibility / incompatibility relations of Sr and Cr in a melt coexisting with a solid comprising plagioclase, olivine and orthopyroxene in the proportion of 80, 15 and 5 by weight, respectively. (1)

(b) Calculate the Sr content of melt after 30% crystallisation of the solid (in a) for equilibrium crystallization and Rayleigh fractionation. (Assume Sr content in the initial melt to be 120 ppm). (2)

(c) From a consideration of typical rare earth element patterns for plagioclase separates, explain why massifanorthosites are likely to have formed under low f (O_2) conditions. (2)

6. (a) In a metamorphic rock characterised by granoblastic texture, a polygonal wollastonite grain is bordered by a rim of intergrown calcite and quartz. Write a balanced chemical reaction (with reactant(s) at left) for the metamorphic transformation. (1)

(b) Explain why euhedral quartz phenocrysts in rhyolites are often embayed along margins. (2)

(c) In igneous rocks, why do minerals like plagioclase show more frequent compositional zoning on or near rims compared to core portions of grains ? (Ignore difference in cooling rates). (2)

7. Study the geologic section given below (Fig. 1), and answer the following questions (in each case provide justification) :

(a) Which is the oldest rock ? (1)

(b) Which are the oldest and youngest basic flows ? (1)

(c) Which are basic sills ? (1)

(d) Explain why the youngest geologic event cannot be unambiguously ascertained. (2)

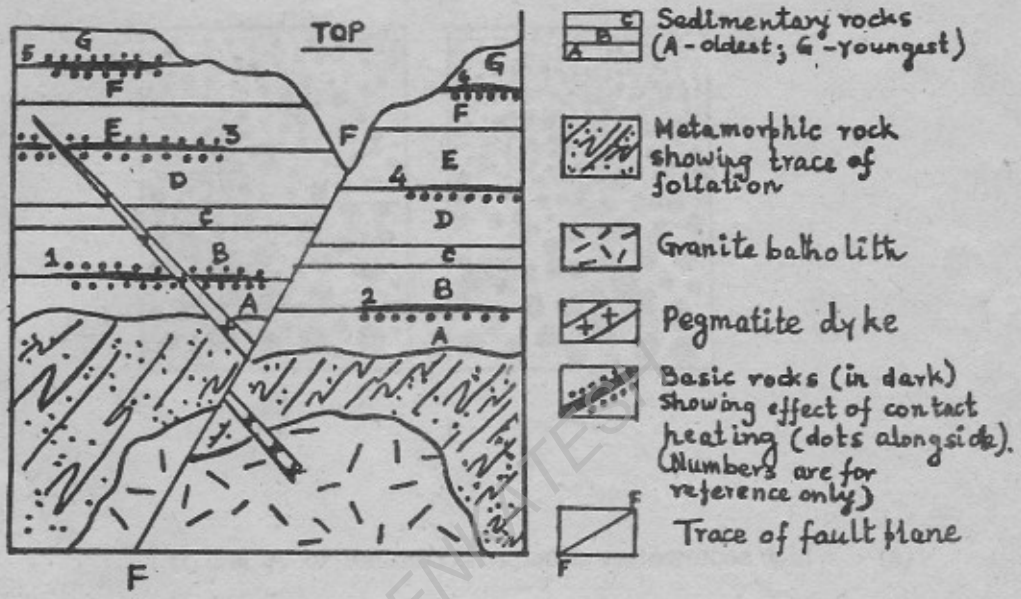


Fig. 1

8. (a) Why is longitudinal wave always faster than shear wave through a rock ? (2)

(b) Write the expressions for calculating water and hydrocarbon saturations used for formation evaluation and explain the terms involved. (3)

9. (a) Write the expression for Free-air anomaly and Bougner anomaly explaining the terms involved. (2)

(b) Name two instruments used in airborne magnetic survey, mentioning the fundamental principles of operations of these instruments (two sentences each). (2)

(c) Drawn the colinear dipole-dipole electrode arrangement used in electrical resistivity method and write the geometrical factor for this arrangement. (1)

SECTION B

(50 Marks)

10. Study the upright sectional views of sedimentary rocks given below (Fig. 2), and answer the following questions :

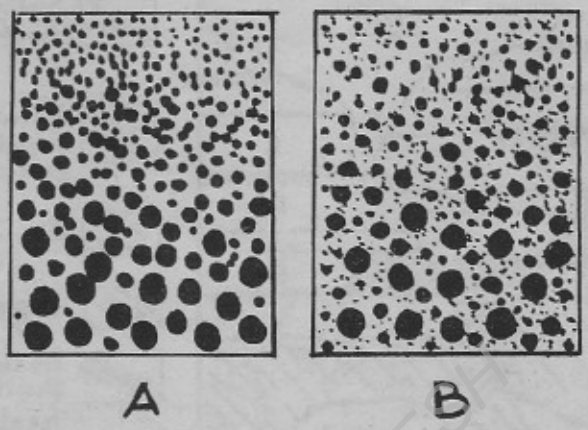


Fig. 2

(a) Which sedimentary structure is common to A and B ? (1)

(b) What are the essential commonality and difference in the two sequences from bottom to top ? (2)

(c) What are the possible geodynamic settings for sediment deposition in the two sequences ? (2)

11. (a) Arrange the following minerals in increasing order of resistance to chemical weathering : topaz, zircon, hypersthene, and ilmenite. (1)

(b) A granite contains 15 wt% Al_2O_3. What percentage of the granite must be removed in solution to leave a residual bauxite deposit containing 50 wt% Al_2O_3 ? (1)

(c) Discuss the role of different solubilities of Al_2O_3 and SiO_2 at varying pH in relation to bauxitization. (3)

12. (a) Distinguish between holohedral and hemihedral crystal forms. (1)

(b) Identify all crystal forms in the figure below (Fig. 3) (1)

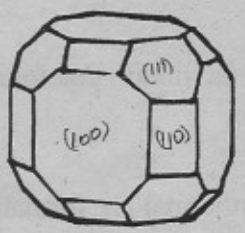


Fig. 3

(c) What is the zonal symbol for the two crystal faces having Miller indices (120) and (121) ? (1)

(d) What is Bragg equation ? (1)

(e) In practice, why do we assume the order of reflection to be 1 ? (1)

13. (a) In natural waters, hydrogen combines with both $^{16}0$ and $^{18}0$. Explain why $^{18}0$ / $^{16}0$ ratio decreases in water during evaporation. (assume kinetic energy of gases to be equal) (3)

(b) Why ∂D values in natural waters show a significantly larger variation compared to $\delta\,^{18}0$? (1)

(c) Calculate the residence time for Na (in myr) if its concentrations in ocean water and river water are 10,500 µg/g and 6.3 µg/g, respectively. (1)

14. (a) A mineral grain shows concentric rings of interference colours with the higher order colours towards the grain-centre. What inferences (at least two) can you make ? (2)

(b) Why does mottled extinction occur in certain minerals ? (2)

(c) Which is the most crucial criterion to distinguish the basal section of a green-coloured chlorite from that of a green hornblende in plane polarised light ? (1)

15. (a) Explain the reason for the occurrence of ore deposits of Ni, Cu, Co, PGE and the absence of those of Sn, W, Mo, Pb, Zn in mafic-ultramafic rocks. (2)

(b) How does boiling facilitate precipitation of sulfide minerals from hydrothermal fluids ? (2)

(c) In the context of hydrothermal ore formation, what is throttling ? (1)

16. (a) What are the fundamental laws of stratigraphy ? (1)

(b) What is an unconformity ? (1)

(c) What are the important kinds of unconformity ? (1)

(d) What causes unconformity ? (1)

(e) What is the mathematical expression for Reynold's number in relation to flow of ground water ? (1)

17. (a) Write the chemical formulae of the end-member components of magnetite and hematite solid solutions. (1)

(b) Write a stoichiometric reaction involving oxidation of magnetite to haematite. (1)

(c) At constant pressure-temperature conditions, explain how the stable assemblage haematite - magnetite will buffer the oxygen fugacity. (3)

18. (a) How can you derive the crystal structure of chalcopyrite from that of sphalersite ? (2)

(b) Consider a general formula of $A_8B_{16}O_{32}$ for 'normal' and 'inverse' spinel group of minerals. What are the essential differences in co-ordination and cation distribution over A and B sites in the above two groups ? (2)

(c) Define polytypism. (1)

19. (a) Can Mohr circle for strain with coordinates λ' and r' plot on the negative side of the origin ? Why ? (1)

(b) What is elongation or extension (e) ? What are its limiting values ? (2)

(c) In a body under stress, normal stress and shearing stress on a plane are +4 bar and −3 bar, respectively. What is the value of shearing stress on a plane normal to the earlier plane ? (1)

(d) What is the difference between Wulff net and Schmidt net ? (1)

20. (a) Write the expression for calculating the mass of ore reserves from gravity data if densities are known. Explain the terms involved. (3)

(b) Name the corrections that are applied to raw ground gravity data. Which correction is always added to the data ? (2)

21. (a) Draw the vertical and horizontal component magnetic anomalies due to vertically polarised buried sphere. (2)

(b) Draw a neat diagram and label it to show the phenomenon of membrane polarisation, as current is introduced into the ground. (1)

(c) Name the two methods of measuring ground self-potential. (2)

22. (a) Write the expression for calculating the fraction of induced current flowing between depths Z_1 and Z_2 due to two current electrodes placed on the surface of homogeneous earth at distance L apart. (2)

(b) If $Z_2 \rightarrow \infty$ and $L = 2Z_1$, what proportion of current will flow below the depth Z_1 for the above (a) case ? (2)

(c) If a layer of resistivity ρ_1 is underlain by a layer of resistivity ρ_2, what will be the reflection coefficient ? (1)

23. (a) If a layer of velocity 1500 m/s is underlain by a layer of velocity 2000 m/s at a depth of 100 m making an horizon interface, calculate the intercept time that will be produced on a time-distance curve. (3)

(b) List the factors that influence the 'move out' in a reflection survey. (2)

24. (a) How synthetic seismogram can be obtained for a shot impulse assuming a horizontal layering in the subsurface ? Give the mathematical expression only. (1)

(b) Draw and label the diagrams to show five techniques of seismic refraction survey. (3)

(c) Define 'headwave'. (1)

25. (a) Name the interactions that a gamma ray produces as it passes through a medium. (1)

(b) Give the energy ranges of each of the above interactions. (1)

(c) Derive the expression for half life of a radioactive element if the initial amount is N_0. (3)

26. (a) In airborne electromagnetic rotary field system, how are the transmitting and receiver units arranged ? (1)

(b) What is 'Skin depth' ? Give the mathematical expression. (2)

(c) For three layers of resistivities ρ_1, ρ_2 and ρ_3, draw diagrams to show.

i) Minimum type curve
ii) Maximum type curve
iii) Double ascending type curve, and
iv) Double descending type curve. (2)

27. (a) Write the expression for estimating apparent resistivity in the magneto-telluric method. How are the results plotted ? (2)

(b) What is the range of frequencies used in AMT ? (1)

(c) If an output impulse h (t) is known, name the digital process that is carried out to extract the input pulse f (t). Write the mathematical expression that represents this process. (2)

28. (a) Which log is used to estimate the value of formation water resistivity ? Write the expression for evaluating this resistivity. (2)

(b) Resistivity of a completely water saturated sand is 10 ohm meter and that of formation water is 0.4 ohm meter. What is the porosity of the formation ? (Use Archie's formula, taking cementation factor = 2) (3)

29. (a) Which log can help us in delineating gas-bearing and oil-bearing zones in a permeable formation ? (1)

(b) Write the two applications of Nuclear magnetic log. (2)

(c) What is a Borehole compensated log ? What parameter does it measure ? (2)

END

1999

M. Jayabalan

GG : Geology and Geophysics

Duration: Three hours | Maximum Marks: 150

This question paper contains 14 pages

Read the following instructions carefully

1 Write all the answers in the ANSWER BOOK only.

2 This question paper consists of **TWO SECTIONS: A** and **B**.

3 **Section A** has TWO questions. Question 1 has **THIRTYFIVE** subquestions and Question 2 has **TWENTY** subquestions. Answer all the sub-questions of both these questions on the pages of the answerbook specially marked with the respective numbers: QUESTION-1 and QUESTION-2.

4 **Section B** has **TWENTY** questions. Answer any **FIFTEEN** from this section. If more number of questions are attempted, score off the answers not to be evaluated. Otherwise only the **FIRST FIFTEEN** unscored answers will be considered.

5 Answers in **Section B** should start on a FRESH PAGE for each question. Score off blank pages, if any, between two answers.

6 Answers to questions and to parts of a question should appear together and should not be separated.

7 In answers to questions of **Section B** write down all important steps clearly.

8 There will be no negative marking.

SECTION A
(75 Marks)

1 Write the correct alphabet, i.e. A, B, C or D to indicate the correct answer in capital against the question number in the answer book.

$(35 \times 1 = 35$ marks)

1.1 Number of ^4He produced due to decay of ^{238}U to ^{206}Pb is

(A) 2 (B) 6 (C) 8 (D) 10

1.2 Which statement is true,

(A) The reaction $4Fe^{2+} \longrightarrow 4Fe^{3+} + 4e$ represents oxidation.
(B) In Darcy's equation dh/dl is known as hydraulic conductivity.
(C) The wavelength of visible light is 0.3 to 0.7 microns.
(D) The morphological adaptation in brachiopods living in areas of high sedimentation includes thin, flat valves.

1.3 The chemical composition of Jadeite is,

(A) $Na(AlSi_2O_6)H_2O$ (B) $NaAl(Si_2O_6)$
(C) $LiAl(Si_2O_6)$ (D) $Al_2(SiO_4)(OH,F)_2$

1.4 A silt loam has bulk density and particle density of 1.2 mg/m^3 and 2.6 mg/m^3 respectively. Its percentage of porespace is

(A) 0.46 (B) 5.38 (C) 46.15 (D) 53.8

1.5 If the watertable in an unconfined coastal aquifer is lowered by half meter, the salt water interface will rise,

(A) 2 meters (B) 4 meters (C) 20 meters (D) 40 meters

1.6 The specific resistance of water sample having conductivity of 3000 units is

(A) 333.3 ohm/cm (B) 3.33 ohm/cm (C) 33.3 ohm/cm (D) 0.003 ohm/cm

1.7 If centre of symmetry is added to $\bar{3}2/m$, the crystal class that results is,

(A) $\bar{3}m$ (B) $\bar{3}2/m$ (C) $\bar{3}2m$ (D) $\bar{3}mm$

1.8 A soft fibrous substance of brown to black colour, that accumulates in a bog environment where continual presence of water inhibits decay and oxidation of plant remain is known as

(A) Coal (B) Bitumen (C) Peat (D) Lignite

1.9 In Leucite - Silica binary system, incongruently melting intermediate compound is

(A) $KAlSi_3O_8$ (B) $KAlSi_2O_6$ (C) $NaAlSi_3O_8$ (D) $KAlSiO_4$

1.10 Two interfering folds having axial planes, axes and flow direction at right angle to each other will result in

(A) Type 1 interference pattern
(B) Type 2 interference pattern
(C) Type 3 interference pattern
(D) None of the above

1.11 Calc-alkaline basalts predominantly occur in

(A) subduction zones
(B) Mid oceanic ridges
(C) Transform fault zones
(D) Rift valleys

1.12 The boundary between Western Dharwar and Eastern Dharwar craton is demarcated by

(A) Closepet granite
(B) Nilgiri Charnockite
(C) Peninsular Gneiss
(D) Bababudhan Conglomerate

1.13 Palaeosols are

(A) ancient soils that developed upon a former landscape
(B) marine deposits resulted from sudden flush of water into the sea
(C) alluvial deposits at the place of meandering
(D) alluviums on the piedmont plain

1.14 Wollastonite does not appear in granulite facies because

(A) the temperature of metamorphism is too high
(B) the pressure of metamorphism is too high
(C) lack of water in the system
(D) unsuitable chemical composition

1.15 What is the range of orbital altitude for the Indian Remote Sensing Satellites?

(A) $< 1,000\ km$
(B) $700 - 900\ km$
(C) $5,000 - 10,000\ km$
(D) $> 10,000\ km$

1.16 From Sargipalli mine, Orissa, we get

(A) Pb and Zn (B) Coal (C) Pb, Cu and Ag (D) Chromite

1.17 In plastic body, the stress is proportional to

(A) strain (B) strain rate
(C) yield stress (D) none of the above

1.18 Oceanic magnetic anomaly pattern indicates

(A) sea-floor spreading away from the ridge
(B) eruption of lava with varying magnetite content
(C) homoclinal sequence of basaltic flows
(D) none of the above

1.19 The ash content in Tertiary coal compared to Gondwana coal is

(A) higher (B) equal (C) lower (D) variable

1.20 Asymmetric valley profile results from

(A) littoral current (B) presence of homoclinal strata
(C) glacial erosion (D) eolian activity

1.21 The reflection travel time curve is a

(A) parabola (B) hyperbola
(C) straight line (D) none of the above

1.22 Nyquist frequency is

(A) half the sampling frequency (B) twice the sampling frequency
(C) equal to the sampling frequency (D) none of the above

1.23 A gravity unit is equal to

(A) 10^{-5} gal (B) 10^{-3} gal (C) 10^{-4} gal (D) 10^{-2} gal

1.24 The second derivative is a measure of

(A) curvature (B) slope
(C) area (D) none of the above

1.25 The spacing between planets follows the

(A) Kepler's laws (B) Newton's laws
(C) Titius-Bode rule (D) none of the above

1.26 Optically pumped magnetometer measures

(A) total field
(B) vertical field
(C) horizontal field
(D) all of the above

1.27 Humble's formula is expressed as

(A) $\frac{1}{\phi^{2.15}}$ (B) $\frac{1}{\phi^2}$ (C) $\frac{0.62}{\phi^2}$ (D) $\frac{0.62}{\phi^{2.15}}$

1.28 Overvoltage is known as

(A) electrode polarization
(B) membrane polarization
(C) electrolytic polarization
(D) electrochemical polarization

1.29 Photoelectric absorption takes place in the energy range of

(A) > 200 Kev
(B) 100 Kev - 2 Mev
(C) > 1.02 Mev
(D) ≤ 200 Kev

1.30 Which log exhibits asymmetry at bed boundaries?

(A) Normal log (B) Lateral log (C) Latero log (D) Sonic log

1.31 Irrotational waves are known as

(A) S waves (B) P waves (C) Rayleigh waves (D) Love waves

1.32 d'Alembert's solution is the general solution for a,

(A) three dimensional wave equation
(B) two dimensional wave equation
(C) one dimensional wave equation
(D) none of the above

1.33 Streaming potential is known as

(A) mineralization potential
(B) electrokinetic potential
(C) diffusion potential
(D) electrochemical potential

1.34 Gravimeter is used to measure

(A) density
(B) change in 'g'
(C) specific gravity
(D) gravitational constant

1.35 Radiometric survey is carrried out

(A) only on land
(B) only in air
(C) both on land and in air
(D) none of the above

2 Write the correct alphabet (one only) in capital against the question number in the answer book. $(20 \times 2 = 40$ marks)

2.1 Poisson's ratio is expressed as

(A) $\frac{1}{2}\left[1 - \frac{1}{(V_P/V_S)^2-1}\right]$ (B) $\frac{1}{2}\left[\frac{1}{2} + \frac{1}{(V_P/V_S)^2-1}\right]$

(C) $\frac{(V_P/V_S)^2+1}{(V_P/V_S)^2-1}$ (D) $\left[\frac{1-(V_P/V_S)^2}{1+(V_P/V_S)^2}\right]^{\frac{1}{2}}$

2.2 Given the height (h) in cm, density (ρ) in gm/cc, the Bouguer correction in mgals is,

(A) $0.04192\rho h$ (B) $0.04192\rho h \times 10^{-2}$
(C) $0.4192\rho h$ (D) $0.04192\rho h \times 10^{-3}$

2.3 Amplitude and phase measurements are made in

(A) VLF and Fixed vertical loop methods
(B) AFMAG and VLF methods
(C) Slingram and Turam methods
(D) none of the above

2.4 Which of the following pairs are focussed logs?

(A) Lateral log and Laterolog (B) Induction log and Normal log
(C) Normal log and Lateral log (D) Laterolog and Induction log

2.5 NMO is expressed as

(A) $\frac{x^2}{2Vt_o^2}$ (B) $\frac{x}{2Vt_o}$ (C) $\frac{x^2}{2V^2t_o}$ (D) $\frac{x^2}{2V^2t_o^2}$

2.6 The reflection co-efficient across two media having resistivities $\rho_1 = 5\Omega m$ and $\rho_2 = 15\Omega m$ is

(A) 0.5 (B) 1.0 (C) 0.25 (D) 0.75

2.7 Which of the following pairs are used to measure the NRM of rocks?

(A) Flux Gate and Spinner magnetometers
(B) Astatic and Proton precession magnetometers
(C) SQUID and Spinner magnetometers
(D) SQUID and Flux Gate magnetometers

2.8 The correct ordering of minerals in the sequence dia, para, ferro and ferri magnetism is

(A) quartz, olivine, native iron, magnetite
(B) quartz, olivine, magnetite, native iron
(C) olivine, quartz, magnetite, native iron
(D) olivine, quartz, native iron, magnetite

2.9 The mass of the earth is $6 \times 10^{24} kg$ and that of the moon is $7.4 \times 10^{22} kg$. If the distance between the earth and the moon is $3.84 \times 10^{5} km$, the force exerted by the earth on the moon is

(A) 2.01×10^{20} Newton
(B) 20.1×10^{20} Newton
(C) 201×10^{20} Newton
(D) none of the above values

2.10 Burgess shale fauna are

(A) known for their outstanding preservation and include dominantly anthropodes
(B) known for their outstanding preservation and include foraminifera
(C) equivalent of Ediacarian fauna
(D) dominantly foraminifera

2.11 The half-life and λ of ^{87}Rb respectively are

(A) 4.88×10^{10} years and 14.2×10^{-11} year^{-1}
(B) 4.88×10^{10} years and 1.42×10^{-11} year^{-1}
(C) 4.88×10^{10} years and 1.24×10^{-11} year^{-1}
(D) 4.38×10^{10} years and 1.24×10^{-11} year^{-1}

2.12 The normal stress and shear stress on a plane oriented at 30^{o} to σ_2 (5000 psi) direction are respectively,

(A) 7500 psi, 4330.127 psi
(B) 7000 psi, 4230.127 psi
(C) 8000 psi, 4430.127 psi
(D) 8500 psi, 4530.127 psi

2.13 The triple junction consisting of TTT

(A) is stable if ab and ac form a straight line
(B) is stable if ac is parallel to the slip vector
(C) is stable if ab is right angle to bc
(D) is always unstable

2.14 Identify the correct sequence:

(A) MBT → MCT → ITSZ → HFF
(B) MCT → MBT → HFF → ITSZ
(C) Krol thrust → Krol nappe → Ramgarh thrust → Ramgarh nappe → Almora thrust → Almora nappe
(D) Krol nappe → Krol thrust → Ramgarh nappe → Ramgarh thrust → Almora nappe → Almora Thrust

2.15 If the angle between a line and the principal axis (X) of the strain ellipse having aspect ratio of 3.0 is 30 °, the angle is

(A) 45° (B) 75° (C) 35° (D) 60°

2.16 The internal buffering of fluid during metamorphism implies:

(A) the fluid is internally derived and maintains constant composition
(B) the fluid is externally derived and maintains constant composition
(C) the fluid composition is controlled by metamorphic reactions and varies with temperature
(D) the fluid composition is independent of metamorphic reactions

2.17 Cyprus type massive sulphide deposits are

(A) formed by hydrothermal emanation on the ocean floor
(B) related to hydrothermal fluid from granitoids
(C) formed due to liquid immiscibility in sulphide rich mafic magma
(D) related to basic lavas in intracratonic rifts

2.18 The weight percent of MgO and SiO_2 in forsterite is

(A) 57.3 and 42.7 (B) 42.7 and 57.3
(C) 40.7 and 59.3 (D) 49.7 and 50.3

2.19 Identify the property of pyrrhotite which distinguishes it from arsenopyrite.

(A) Higher reflectivity
(B) Pinkish-brown colour
(C) High bireflectance pleochroism
(D) Higher scratch hardness

2.20 The proportion of ^{40}K and ^{235}U has diminished so much through geological time in comparison with ^{238}U and ^{232}Th. This is because

(A) the volume percent of granite is much less compared with basalt
(B) half-life of ^{238}U is much less in comparison with ^{235}U
(C) ^{40}K and ^{235}U started decaying much later in comparison with ^{238}U and ^{232}Th
(D) The half life of ^{40}K and ^{235}U is much shorter in comparison with ^{238}U and ^{232}Th

SECTION B
(75 marks)

Answer any 15 questions. Each question carries 5 marks.

3 In the given geological map (Fig. 1) identify five (at least) geological events and arrange them in order of development. (5)

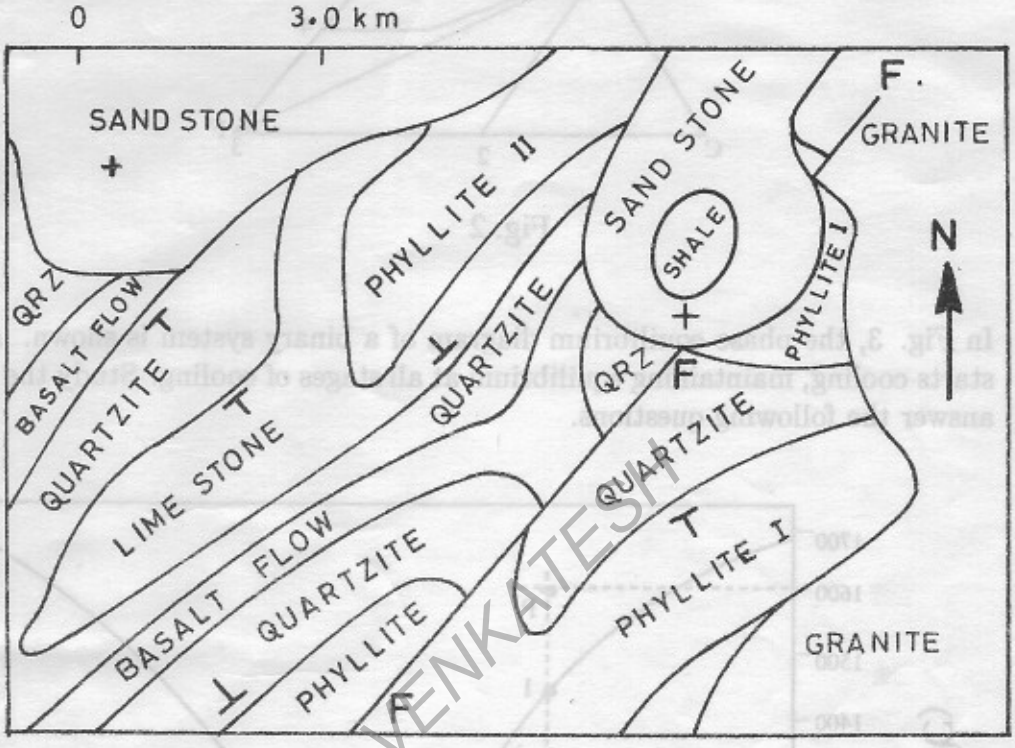


Fig. 1

4 With a neat free hand sketch, illustrate the four boundaries of the Indian plate. (5)

5 Match the following: (5)

(a) Delhi Supergroup	(1) Peninsular Gneiss
(b) Sakoli Group	(2) Banded Gneissic Complex
(c) Singhbhum Group	(3) Bastar granite gneiss
(d) Eastern Ghats Khondalites	(4) Tirodi gneiss
(e) Dharwar Supergroup	(5) Older Metamorphic gneiss

6 In pyroxene-granulite subfacies of a silica saturated rock, name the minerals represented by the points 1,2,3,4 and 5 in ACF diagram given in Fig. 2. (5)

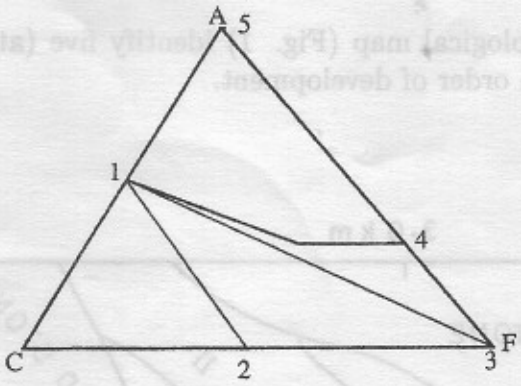


Fig. 2

7 In Fig. 3, the phase equilibrium diagram of a binary system is shown. A melt 'P' starts cooling, maintaining equilibrium at all stages of cooling. Study the figure and answer the following questions. (5)

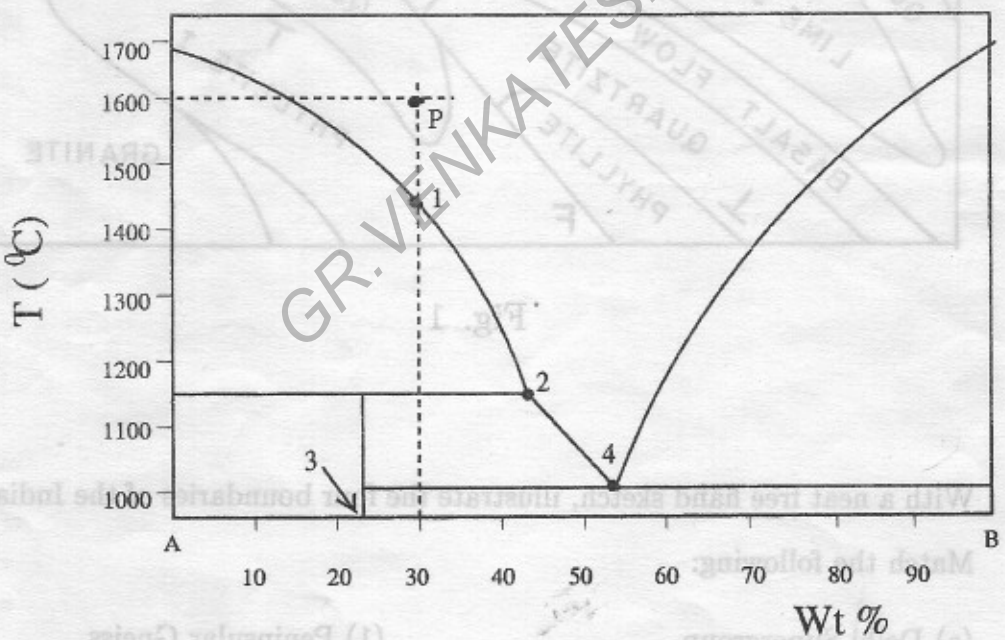


Fig. 3

(a) What happens between '1' and '2' ?
(b) What happens at '2'?
(c) What is '2' known as?
(d) What is '3'?
(e) Will the liquid reach point '4'? Justify your answer.

8 Optic orientation diagram of a crystal is shown in Fig.4. a,b and c are the crystallographic axes and X,Y and Z are the vibration directions. Study the figure and answer the following. (5)

(a) What is the system of crystallisation of the crystal?

(b) What type of extinction will be observed on section 100 and 010?

(c) What is the optic sign of the crystal?

(d) What is the crystallographic orientation of the optic axial plane?

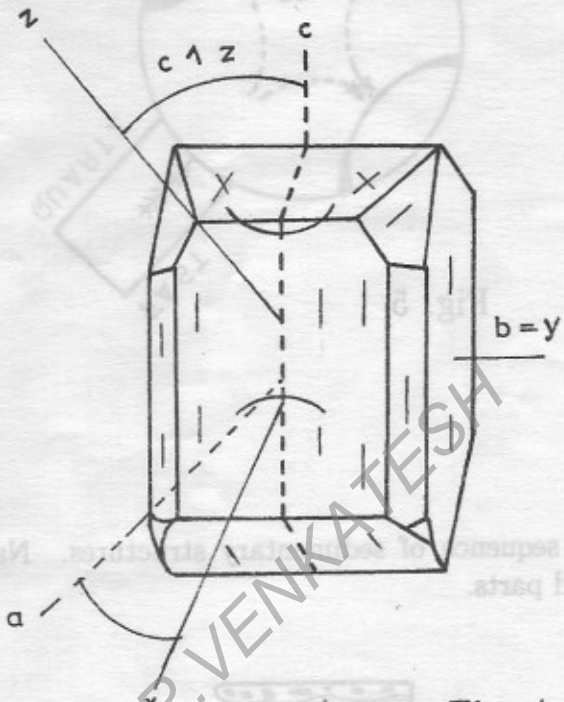


Fig. 4

9 Calculate the fraction of atoms remaining of $^{223}R_a$ ($T_{1/2}$ = 11 days) after a decay interval of 5 days. (5)

10 A centered interference figure of a mineral section is shown in Fig.5. Directions of movement of isochromatic rings on introduction of a length fast quartz wedge are shown. Comment on the behaviour and give reasons. (5)

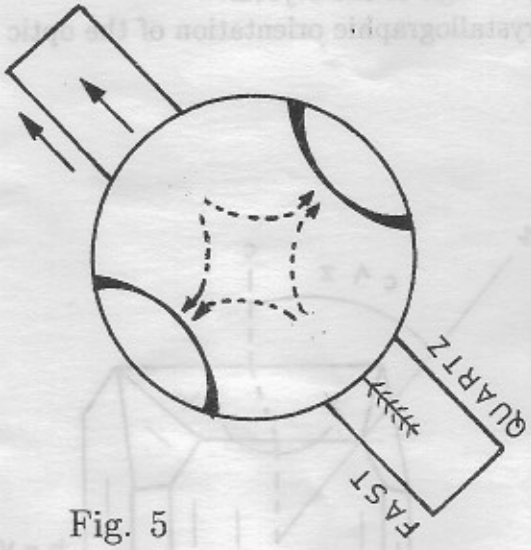


Fig. 5

11 Fig. 6 shows the sequence of sedimentary structures. Name the sequence and identify the labelled parts. (5)

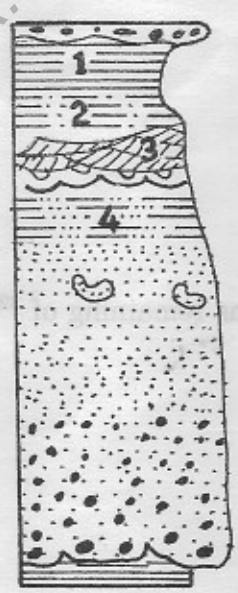


Fig. 6

12 How do you explain the formation of fine lamellae of ilmenite in the crystallographic plane of hematite? (5)

13 Convolve f(t) = 1,2,3 with g(t) = 4,5,6. (5)

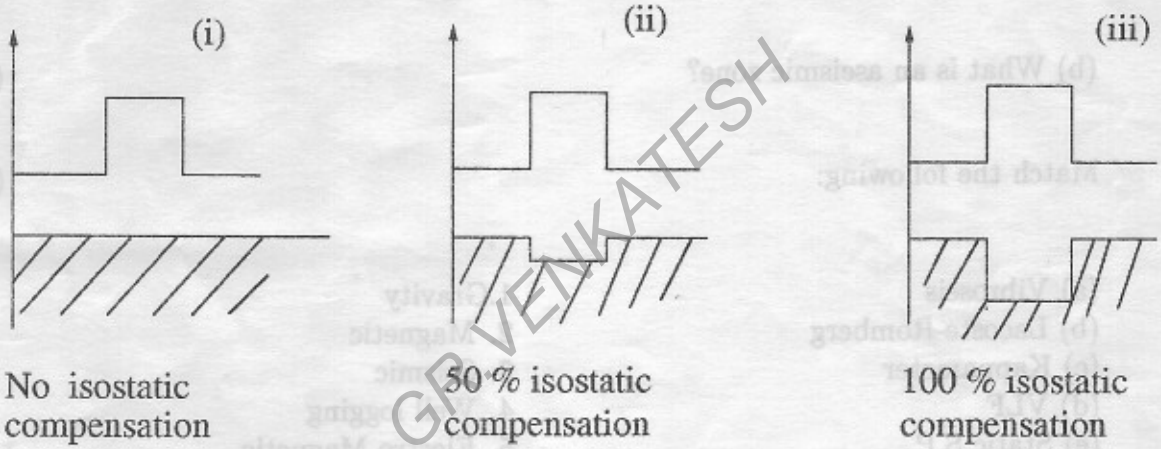
14 (a) Calculate the total magnetic field (F) and the horizontal component (H) of the earth's magnetic field, given the vertical component (Z) of the magnetic field as 10,000Y and inclination i=45°. (2)

(b) What are isogonic and isoclinic maps? (2)

(c) Does the magnetic equator coincide with the geomagnetic equator? (1)

15 (a) Write the expression for the vertical component of the gravity anomaly caused by a spherical body of radius R with density contrast $\delta\rho$ and its centre at a depth Z below the surface. (2)

(b) Draw sketches of the Bouguer anomaly expected for the following three cases. (3)



16 (a) Given the travel times through a formation, matrix and fluid as 50 msec, 30 msec and 70 msec respectively, $R_0 = 10\ \Omega$ m, $S_\omega = 50$ % and cementation factor = 2.0. Calculate the porosity, Formation factor, formation water resistivity and true resistivity of formation. (4)

(b) Define well log. (1)

17 (a) Calculate the thickness of the first layer in a two layer case, given the velocities $V_1 = 3$ km/sec, $V_2 = 5$ km/sec and cross over distance 200 m. (3)

(b) How do you determine the velocity of a layer, given the offset distances of geophones from the source and the travel times of the reflected wave from a common horizon at each geophone? (Assume dip to be zero). (2)

18 (a) Give three reasons for applying weathered zone correction. (3)

(b) How many fold CDP coverage is possible, given four receivers which are equally spaced and the shot spacing is equal to receiver spacing? (2)

19 (a) Name and draw the sketches of any three nonaxial dipole-dipole configuration. (3)

(b) What is the expression for law of refraction of current lines across the boundary between two media of different resistivities? Draw a sketch. (2)

20 (a) Draw a sketch showing the principle of electromagnetic induction in a conductor. (3)

(b) Write the mathematical expression for Faraday's law and Ampere's law. (2)

21 (a) Distinguish between (i) seismograph and seismoscope (ii) geomagnetic and dip poles. (4)

(b) What is an aseismic zone? (1)

22 Match the following: (5)

(a) Vibroseis	1.Gravity
(b) Lacoste-Romberg	2. Magnetic
(c) Kappameter	3. Seismic
(d) VLF	4. Well logging
(e) Static S.P.	5. Electro Magnetic

— END OF PAPER —

2000

GG: Geology & Geophysics

Duration: 3 hours | Maximum Marks: 150

17

This question paper contains pages

Read the following instructions carefully

1. All answers must be written only in the answer book provided.
2. This question paper contains **TWO SECTIONS: 'A' and 'B'.**
3. **Section A** consists of two questions of multiple choice type. Question 1 consists of **TWENTY FIVE** sub-questions of ONE mark each and Question 2 consists of **TWENTY FIVE** sub-questions of TWO marks each.
4. The answers to the multiple choice questions must be written only in the boxes provided in the first sheet of the answer book.
5. Answers to **Section B** should be started on a fresh page and should not be mixed with the answers to **Section A**. Question numbers must be written legibly and correctly in the answerbook.
6. Section B consists of **TWENTY** questions of **FIVE** marks each. **ANY FIFTEEN** out of them have to be answered. **If more number of questions are attempted, score off the answers not to be evaluated, else only the first fifteen answers will be considered.**
7. In all 5 mark questions, clearly show the important steps in your answers. These steps will carry partial credit.
8. There will be NO NEGATIVE marking.

SECTION A

(75 marks)

GG1. This question consists of 25 (Twenty Five) multiple choice sub-questions, each carrying one mark. For each sub-question (1.1 – 1.25), four alternatives (A, B, C and D) are given, out of which only one is correct. Write the correct answers in the boxes corresponding to the questions on the **FIRST** sheet of the answer book.

$(25 \times 1 = 25)$

(1.1) Which of the following minerals exhibits negative magnetic susceptibility?

(A). Pyroxene
(B). Quartz
(C). Olivine
(D). Biotite

(1.2) A primary wave reflected from the Gütenberg discontinuity is denoted as

(A). PcP
(B). PKP
(C). PKIKP
(D). PKiKP

(1.3) Find the odd one amongst the following:

(A). Telluric Method
(B). Gravity Method
(C). Magnetic Method
(D). Resistivity Method

(1.4) Moving source (horizontal loop) frequency domain E.M. method is known as

(A). Slingram
(B). Turam
(C). PEM
(D). Dip Angle

(1.5) The intensity of the Earth's magnetic field at the equator (in *gammas*) is

(A). 20000
(B). 30000
(C). 40000
(D). 50000

(1.6) The Bouguer anomaly over an isostatically compensated region is

(A). Zero
(B). Positive
(C). Negative
(D). Same as Isostatic Anomaly

(1.7) Which of the following is NOT applicable to Lacoste Romberg Gravimeter?

(A). Zero length spring
(B). Null instrument
(C). Stable Gravimeter
(D). Relative Gravity

(1.8) Chargeability is expressed in

(A). Volts
(B). Ohms
(C). Amperes
(D). Milliseconds

(1.9) Liquid junction potential is one-fifth of

(A). Shale Potential
(B). Streaming Potential
(C). Electrochemical Potential
(D). Mineralization Potential

(1.10) Bright spot is due to contrast in

(A). Velocity
(B). Acoustic Impedance
(C). Density
(D). Rigidity

(1.11) D.C. resistivity meter measures

(A). True Resistivity
(B). Apparent Resistivity
(C). Resistance
(D). Conductivity

(1.12) Porosity is determined by

(A). Normal log
(B). Lateral log
(C). Micro log
(D). Density log

(1.13) Which of the following is a vertically travelling coherent seismic noise?

(A). Ground Roll
(B). Cultural Noise
(C). Multiples
(D). Reflected Refractions

(1.14) Which of the following pairs of minerals exhibit exsolution texture?

(A). Pyrite-Pyrrhotite
(B). Pyrite-Chalcopyrite
(C). Sphalerite-Pyrrhotite
(D). Hematite-Magnetite

(1.15) Which of the following is due to replacement?

(A). Comb structure
(B). Cockade structure
(C). Colloform texture
(D). Caries texture.

(1.16) Which of the following parameters is NOT used in determining rock mass rating?

(A). joint spacing
(B). compressive strength
(C). slake durability index
(D). ground water condition

(1.17) Parallax observed in stereopairs is maximum in

(A). flat coastal regions
(B). plateau regions
(C). hilly terrains
(D). regions with rolling topography

(1.18) Anatexis is a process of

(A). partial melting of the continental crust
(B). generation of basaltic magmas in the mantle
(C). generation of tholeiitic magmas below mid-oceanic ridges
(D). generation of dry melts in the mantle

(1.19) Minute worm-like intergrowth of quartz in sodic plagioclase is called

(A). vitrophyric intergrowth
(B). graphic intergrowth
(C). myrmekitic intergrowth
(D). perthitic intergrowth

(1.20) Fenitisation observed around carbonatites results from

(A). alkali metasomatism
(B). injection of alkaline magmas
(C). carbonate alteration
(D). silicification

(1.21) Pore spaces in limestones formed by dissolution of shells are called

(A). interparticle porosity
(B). shelter porosity
(C). moldic porosity
(D). vuggy porosity.

(1.22) Dentition consisting of a series of similar alternating teeth and sockets in pelecypods is called

(A). taxodont dentition
(B). schizodont dentition
(C). isodont dentition
(D). dysodont dentition

(1.23) Glossopteris flora is characteristic of

(A). Damuda Group
(B). Mahadeva Group
(C). Rajmahal formation
(D). Jabalpur Group

(1.24) A bed is overturned if the dip of axial plane cleavage and the dip of the bed are in

(A). the same direction and the bed is steeper
(B). the same direction and the cleavage is steeper
(C). opposite directions and the bed is steeper
(D). opposite directions and the cleavage is steeper

(1.25) If a stream maintains the same course after upliftment in an area, it is referred to as

(A). consequent
(B). subsequent
(C). resequent
(D). antecedent

GG2. This question consists of 25 (Twenty Five) multiple choice sub-questions, each carrying two marks. For each sub-question (2.1 – 2.25), four alternatives (A, B, C and D) are given, out of which only one is correct. Write the correct answers in the boxes corresponding to the questions on the **SECOND** sheet of the answer book.

$(25 \times 2 = 50)$

(2.1) Migrator's equation relating true dip (θ) with apparent dip (θ_a) is

(A). $\tan\theta = \sin\theta_a$
(B). $\tan\theta_a = \sin\theta$
(C). $\tan\theta = \cos\theta_a$
(D). $\tan\theta_a = \cos\theta$

(2.2) Seismic phases which are recorded in the shadow zone are

(A). PcP
(B). PmP
(C). PKIKP
(D). PKKP

(2.3) Intensity of magnetization of a rock containing 10% magnetite (magnetic susceptibility=0.5) due to the Earth's magnetic field (0.6 oersteds) in c.g.s. units is

(A). 0.03
(B). 0.3
(C). 3
(D). 30

(2.4) Primary wave velocity is maximum in the

(A). Crust
(B). Upper Mantle
(C). Lower Mantle
(D). Inner Core

(2.5) Assuming a spherical homogeneous Earth, the gravity at a depth d is equal to that at a height h, when

(A). $h = d/2$
(B). $h = d$
(C). $h = 2d$
(D). $h = d^2$

(2.6) The combined elevation correction in gravity units for a station at a height of 10 metres above datum plane, for a surface density of 2000 kg/m^3, is

(A). 0.0224
(B). 0.224
(C). 2.24
(D). 22.4

(2.7) The potential at a distance r from a buried point source of current (I) in a medium with resistivity ρ is expressed as

(A). $\frac{I\rho}{2\pi r}$
(B). $\frac{I\rho r}{2\pi}$
(C). $\frac{I\rho r}{4\pi}$
(D). $\frac{I\rho}{4\pi r}$

(2.8) Given that water saturation of the uninvaded zone is S_w and water saturation of the flushed zone is S_{xo}, hydrocarbons are moveable when

(A). $S_{xo} < S_w$
(B). $S_{xo} = S_w$
(C). $S_{xo} > S_w$
(D). $S_{xo} = \sqrt{S_w}$

(2.9) Metal factor is expressed as

(A). $2\pi \times 10^5\ PFE/\rho_{dc}$
(B). $2\pi \times 10^5\ PFE/\rho_{ac}$
(C). $2\pi \times 10^5\ FE/\rho_{ac}$
(D). $2\pi \times 10^5\ FE/\rho_{dc}$.

(2.10) The Fourier Transform of a real and odd function is

(A). Imaginary and even
(B). Imaginary and odd
(C). Real and even
(D). Real and odd.

(2.11) How many types of 4 layer master curves exist for interpreting resistivity data?

(A). 4
(B). 6
(C). 8
(D). 10

(2.12) Ground roll with a wavelength of λ can be cancelled by a linear array of 5 geophones with a geophone spacing of D equal to

(A). $\lambda/5$
(B). $\lambda/4$
(C). $\lambda/3$
(D). $\lambda/2$

(2.13) Digital low-pass filters used in image processing are designed to

(A). increase spatial resolution
(B). emphasize local details
(C). emphasize regional features
(D). stretch the contrast of the image

(2.14) A grout curtain below a dam reduces piping by

(A). lowering the hydraulic gradient across the dam axis
(B). decreasing the hydrostatic head
(C). lowering pore-pressure beneath the dam
(D). increasing pore-pressure beneath the dam

(2.15) Tholeiitic basalt from which of the following settings has the highest potassium concentration?

(A). mid-oceanic ridges
(B). volcanic ocean islands
(C). island arcs
(D). back-arc basins

(2.16) Amongst CIPW normative minerals, which of the following pairs is incompatible?

(A). nepheline-albite
(B). hypersthene-nepheline
(C). hypersthene-quartz
(D). wollastonite-anorthite

(2.17) Garnet porphyroblasts with straight bands of inclusions at an angle to the external fabric indicate that the growth of the porphyroblasts was

(A). syn-tectonic
(B). pre-tectonic
(C). post-tectonic
(D). inter-tectonic

(2.18) Which of the following stratigraphic units is both underlain and overlain by basic flows?

(A). Lameta beds
(B). Bagh beds
(C). Kaladgi beds
(D). Cardita beaumonti beds

(2.19) Oxidation potential of the reaction, $H_2 \rightleftharpoons 2H^+ + 2e^-$, at 25 ^oC and at 1 atm pressure and unit activity of the reacting species is taken as

(A). 0.00 V
(B). 0.10 V
(C). 1.00 V
(D). 10.00 V

(2.20) The radius ratio of the cations to anions in a crystal is 1.0. If the anions are arranged in cubic closest packing around the cation, the coordination number of the cation is

(A). 4
(B). 6
(C). 8
(D). 12

(2.21) The association of serpentinites, radiolarian cherts and podiform chromites is found in

(A). mid-oceanic ridges

(B). layered igneous complexes

(C). continental rift zones

(D). suture zones

(2.22) Of the following macerals of coal, highest reflectance for a given rank of coal is exhibited by

(A). vitrinite

(B). inertinite

(C). exinite

(D). fusinite

(2.23) Migmatites are

(A). intimate mixtures of granitic and refractory metamorphic rocks indicating partial fusion

(B). rocks that result from alkali metasomatism

(C). rocks that form by lit-par-lit injection of basaltic magmas into granitic rocks

(D). metamorphic rocks that first form under upper greenschist facies conditions

(2.24) Given below is an outline of the Piper trilinear diagram (Fig. 1). The predominant species in the shaded area are

(A). Na-K bicarbonates

(B). Ca-Mg chlorides and sulphates

(C). Ca-Mg bicarbonates

(D). Na-K chlorides and sulphates

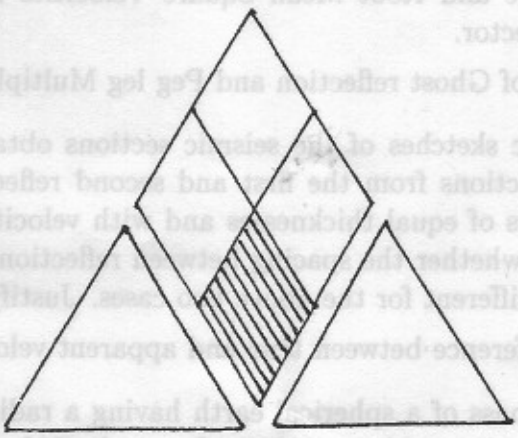


Fig. 1

(2.25) The Siwalik basin can be classified as a

(A). Back-arc basin

(B). Fore-arc basin

(C). Foreland basin

(D). Intracratonic basin

SECTION B

(75 marks)

This section consists of TWENTY questions of FIVE marks each. **ANY FIFTEEN** out of them have to be answered. If more number of questions are attempted, score off the answers not to be evaluated, else only the first fifteen unscored answers will be considered.

GG3. Draw schematic sketches for the following time domain functions and their Fourier Transforms.

(a) Rectangular function $\Pi(t) = \begin{cases} 1 & |t| \leq \frac{1}{2} \\ 0 & |t| > \frac{1}{2} \end{cases}$

(b) Fourier kernel $\frac{\sin at}{\pi t} = \frac{a}{\pi}\ \text{sinc}\ \frac{at}{\pi}$

(c) Dirac delta function $\delta(t) = 0, t \neq 0, \int_{-\infty}^{\infty} \delta(t)dt = 1$

(d) $\cos w_o t$

(e) $\sin w_o t$

GG4. (a) Assume a model with 2 horizontal layers with velocities $V_1 = 2km/s$ and $V_2 = 4km/s$, thicknesses h_1 and h_2 and zero offset two way travel times $t_{01} = 1s$ and $t_{02} = 2s$ to the first and second reflectors respectively. Calculate

(i). the thickness (h_2) of the second layer.

(ii). the Average and Root Mean Square Velocities for the ray path to the second reflector.

(b) Draw sketches of Ghost reflection and Peg leg Multiple.

GG5. (a) Draw schematic sketches of the seismic sections obtained at a geophone for zero offset reflections from the first and second reflectors of a model with 2 horizontal layers of equal thicknesses and with velocities (1) $V_1 < V_2$ and (2) $V_1 > V_2$. State whether the spacing between reflections in the seismic sections is constant or different for the above two cases. Justify your answer.

(b) Explain the difference between true and apparent velocities with a sketch.

GG6. (a) Calculate the mass of a spherical earth having a radius of 6370 km. Assume the absolute gravity on the earth's surface to be 980 gals.

(b) Name and write the expressions for the equations which are satisfied by gravity potential in free space and in a region containing a point mass with density ρ.

(c) What is the nature of Bouguer gravity over oceans?

GG7. (a) Define gyromagnetic ratio (γ_p). Calculate the total magnetic field, given the frequency of precession, $f = 2000\ hz$.

(b) Write the expression relating gravity potential (V) and magnetic potential (U). Derive the general expression for the vertical magnetic field from the gravity potential (V) at a distance (r) from the centre of a buried sphere having a radius (R), density (ρ) and mass (m). For the offset distances $x \neq 0$, assume $r = (x^2 + z^2)^{1/2}$, where z is the vertical depth to the centre of the sphere.

GG8. Given a 10 metre thick unit consisting of an alternating series of isotropic beds each 1 metre thick with resistivities alternating between 100 Ωm and 400 Ωm, calculate the transverse resistance, transverse resistivity, longitudinal conductance, longitudinal resistivity and the coefficient of anisotropy.

GG9. (a) Explain the principle of equivalence with a numerical example and a sketch.

(b) Draw a schematic sketch of the flow of electric current from source to sink across a horizontal layer boundary separating layers with resistivities (1) $\rho_1 < \rho_2$ and (2) $\rho_1 > \rho_2$.

GG10. (a) When does the dip angle become zero in parallel line dip angle EM surveying? Justify your answer.

(b) Draw a sketch depicting the variations in dip angle with depth of burial of a vertical sheet in dip angle E. M. surveys.

GG11. (a) A carbonate sample has a volume of 100 c.c. It contains 20 c.c. of pore space of which 10 c.c. is occupied by water. Given that the formation resistivity is 60 Ωm and the saturation exponent is 2, calculate the resistivity of formation water.

(b) What are positive and negative separations in Microlog curves? What do they indicate?

GG12. Match the following

A)	Cycle skipping	1)	Neutron log
B)	Electron density	2)	S. P. log
C)	Trumpet log	3)	Sonic log
D)	Formation water resistivity	4)	Gamma gamma log
E)	Hydrogen index	5)	Microlaterolog

GG13. (a) Give reason for the following:

(i). b-crystallographic axis is a possible twin axis in albite, but not in orthoclase.

(ii). In all clinopyroxenes, 100 sections give straight extinction.

(b) The stereogram of optical and crystallographic directions 'a' and 'c' of a mineral is given in Fig. 2. The plane of projection of the stereogram is normal to the vertical c-crystallographic axis. x, y and z are the three principal vibration directions. Optic axes are marked as OA and the optical axial plane as OAP. Find

(i). the system of crystallisation of the mineral.

(ii). optic sign of the mineral.

Give justification for your answer in each case.

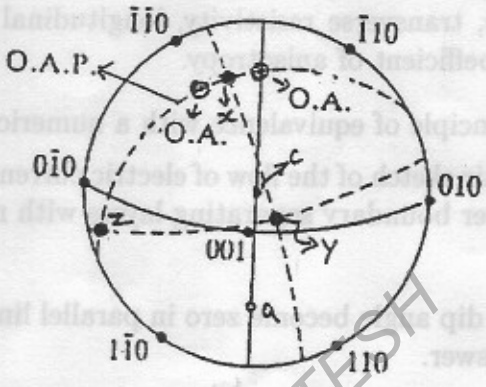


Fig-2

GG14. (a) The relative strength index of siphuncular tube is expressed by $\frac{h}{r}100$, where h is the wall thickness and r is the radius of the tube. It is found that the Mesozoic cephalopod Phylloceratida has a strength index of the order of 10-19, while Ammonitida has a significantly lower range of values of 3-6. What palaeoecological information can be drawn from this data?

(b) What are time-transgressive stratigraphic units?

GG15. With suitable illustrations wherever needed and a few explanatory sentences, distinguish between the following:

(a) internal structure of simple small current ripples and simple symmetric wave ripples.

(b) model of formation of planar and trough cross bedding.

(c) flaser and lenticular bedding.

GG16. (a) Differentiate between ridge-to-ridge transform faults and transcurrent faults giving suitable sketches.

(b) Figure 3 shows the apparent polar wandering curves obtained from rocks located on two segments of a single continent. The numbers on the figure indicate

the sequence of pole position obtained from rocks of simialr age in both segments of the continent. The chronological sequence is from 1 for the oldest rock to 11 for the youngest.

Interpret the apparent polar wandering curve.

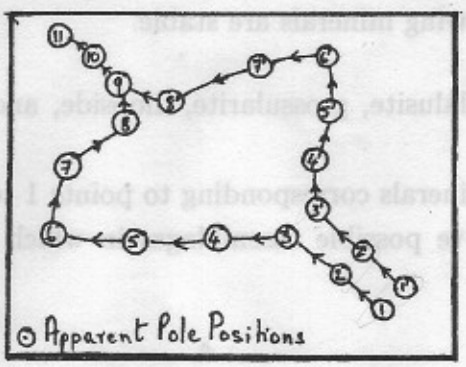


Fig. 3

GG17. (a) Figure 4 represents a P-T-X diagram of a bi-component system. How many degrees of freedom does the system possess,

(i). when crystals of B and melt coexist, such as on the surface EFGH?

(ii). at a point on the eutectic line, HG, when pressure is fixed (i.e. at an isobaric eutectic)?

(b) In the above bi-component system, if an invariant eutectic should occur, what phases must coexist?

(c) What is spinifex texture?

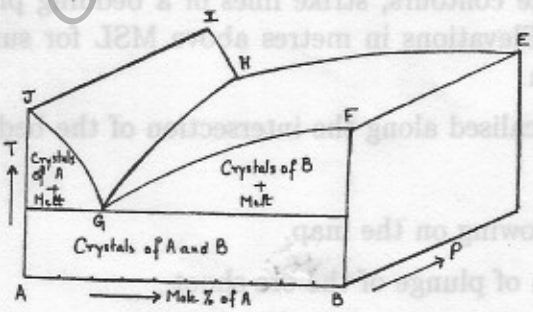


Fig-4

GG18. (a) Define specific yield of an aquifer.

(b) Distinguish between the storage coefficient of an unconfined aquifer and that of a confined aquifer.

(c) A confined aquifer covers a horizontal area of 500 km^2. The piezometric surface fluctuates above the top of the aquifer by 10 m. annually. The storage coefficient is 0.0009. Calculate,

(i). the expected available annual ground water storage in the aquifer.

(ii). the average yield per well per hour of 45 wells in the area which pump water 12 hours a day for 200 days in the year.

GG19. (a) What is an isograd in a metamorphic terrain?

(b) Given is the unlabelled ACF diagram (Fig. 5) of pyroxene hornfels facies in which the following minerals are stable.

Cordierite, andalusite, grossularite, diopside, anorthite, wollastonite and hypersthene.

(i). Identify minerals corresponding to points 1 to 7.

(ii). Mention five possible assemblages in which three of the given minerals co-exist.

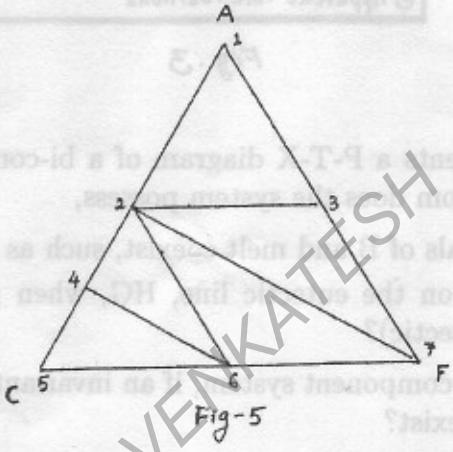


Fig-5

GG20. In figure 6. surface contours, strike lines of a bedding plane and those of a shear plane are given. Elevations in metres above MSL for surface contours and strike lines are also given.

An ore shoot is localised along the intersection of the bedding plane and the shear plane.

(a) Mark the following on the map.

(i). Direction of plunge of the ore shoot

(ii). Location of outcrop of the ore shoot

(b) Using the data available on the map, calcuate the angle of plunge of the ore shoot.

(Detach the LAST sheet, on which the figure is given, and attach to your answerbook.)

GG21. Given the relation

$$N = N_0 e^{-\lambda t}$$

Radius

where

N is the number of radionuclides of an element measured at time t,

N_0 is the number of radionuclides of the element at $t = 0$ and

λ is the decay constant;

(a) obtain an expression for D^*, the number of atoms of daughter elements at time t in terms of N, λ and t.

(b) Calculate the value of the decay constant, given that the half life of the radionuclide is 5×10^6 years.

(c) Calculate the age of the chemical system given that $\frac{D^*}{N} = 2.0$.

(d) If λ is well known and concentration of the radionuclide and the daughter are measured accurately in a rock, state two other conditions that are necessary to compute the age of the rock.

GG22. (a) In a fold, $t_0 = 2t_{60}$, where t_0 and t_{60} are orthogonal thicknesses measured at $\alpha = 0^o$ and 60^o respectively. What is the fold class as per Ramsay's classification?

(b) What type of interference pattern results when two folds with parallel axes and perpendicular axial planes are superposed?

(c) Draw a sketch of $\delta-$type porphyroclast and indicate the sense of shear.

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GG : Geology & Geophysics

Duration: Three hours | Maximum Marks: 150

This question paper contains 13 pages, please check whether all the pages are there

Read the following Instructions carefully.

1. This question paper contains **TWO SECTIONS: 'A'** and **'B'**

2. **Section A** consists of two questions of the multiple choice type. Question **1** consists of **TWENTY FIVE** sub-questions of ONE mark each and Question 2 consists of **TWENTY FIVE** sub-questions of TWO marks each.

3. Answer **Section A** only on the special machine-gradable **OBJECTIVE RESPONSE SHEET (ORS).** Questions of Section A will not be graded if answered anywhere else.

4. Answer problems of Section B in the answer-book.

5. Write your name, registration number and name of the Centre at the specified locations on the right half of the ORS for section A.

6. **Using a soft HB pencil darken the appropriate bubble under each digit of your registration number.**

7. **The Objective Response Sheet will be collected back after 120 minutes have expired from the start of the examination. In case you finish Section A before the expiry of 120 minutes, you may start answering Section B.**

8. Questions are of Section A to be answered by darkening the appropriate bubble (marked A,B,C, or D) using a soft HB pencil against the question number on the left-hand side of the **Objective Response Sheet.**

9. In case you wish to change an answer, erase the old answer completely using a good eraser.

10. There is no negative marking.

11. Section B consists of TWENTY questions of FIVE marks each. ANY FIFTEEN out of them have to be answered. If more number of questions are attempted, score off the answers not be evaluated, else only the first fifteen unscored answers will be considered strictly.

12. In all 5 mark questions, clearly show the steps.

SECTION A
(75 marks)

GG-1. This question consists of TWENTY FIVE sub-questions (1.1-1.25) of ONE MARK each. For each of the sub-questions, four possible answers (A,B,C and D) are given, out of which only one is correct. Answer each sub-question by darkening the appropriate bubble on the OBJECTIVE RESPONSE SHEET (ORS) using a soft HB pencil. Do not use the ORS for any rough work. You may like to use the Answer Book for any rough work, if needed.

(25 X 1 = 25)

(1.1) The Pleistocene epoch belongs to which of the following categories

(A). Chronostratigraphic
(B). Geochronologic
(C). Lithostratigraphic
(D). Biostratigraphic

(1.2) The species with limited geographic ranges is called

(A). Stenogeographic
(B). Eurygeographic
(C). Guide fossil
(D). Endemic

(1.3) In Trilobites when the suture line from the posterior end of the eye intersects the posterior margin, it is called

(A). Gonatoparian
(B). Proparian
(C). Anisomyarian
(D). Opisthoparian

(1.4) Which of the following is a marine deposit?

(A). Barakar Series
(B). Umaria Bed
(C). Rajmahal Series
(D). Raniganj Series

(1.5) What is a pycnocline?

(A). A zone of rapidly changing temperature
(B). A zone of rapidly changing density
(C). A zone of carbonate unsaturation
(D). A zone of rapidly depleting oxygen

(1.6) The relationship between X, Y and Z of deformed pebbles in a Conglomerate and the axial plane schistosity (S_1) is such that on S_1

(A) X and Z of pebbles always lie
(B) Only X of pebbles lie
(C) Y and Z of pebbles always lie
(D) X and Y of pebbles always lie
(Note that $X \geq Y \geq Z$)

(1.7) Pericline twinning is observed in

(A) Microcline
(B) Augite
(C) Andalusite
(D) Orthoclase

(1.8) An aquifluge is a formation which

(A). Neither contains nor transmits water
(B). Does not retain but transmits water
(C). Contains water but does not transport it
(D). Contains and transmits water

(1.9) When a thin section of a rock is studied in a petrological microscope how many times does double refraction take place from the light source to the eyepiece?

(A). Once
(B). Twice
(C). Thrice
(D). Four times

(1.10) In an area dip of uniformly dipping beds and the topographic slope are in the same direction, but beds are gentler. By walking down the slope, one encounters

(A). Gradually younger and younger beds
(B). Initially gradually older, then younger beds
(C). Initially gradually younger, then older beds
(D). Gradually older and older beds

(1.11). The Adams-Williamson equation is utilized for modelling the variation of the following with depth inside the earth

(A).Temperature variation
(B). Pressure variation
(C). Density variation
(D). Electrical properties

(1.12) A system representing a regional isostatic compensation is known as

(A). Vening Meinesz
(B). Pratt-Hayford
(C). Airy-Heiskanen
(D). Wadati

(1.13) A primary wave which gets refracted through the mantle and core is known as

(A). PKP
(B). PKIKP
(C). P_cP
(D). PP

(1.14) The primary circulation of air to low pressure areas causing it to flow nearly parallel to the isobars is due to

(A). Centrifugal force
(B). Pressure gradients
(C). Coriolis force
(D). Centripetal force

(1.15) Olivine undergoes phase changes to denser structures at pressures equivalent to depths of

(A). 200-250 kms and ~ 600 kms
(B). 390-450 kms and ~700 kms
(C). 600-680 kms and ~900 kms
(D). 700-790 kms and ~1100 kms

(1.16) One of the follwing methods is based on the electromagnetic transients

(A). MT
(B). CSAMT
(C). VLF
(D). LOTEM

(1.17) The order of resistivity of clay is

(A). 10 ohm metre
(B). 100 ohm metre
(C). 1000 ohm metre
(D). 5000 ohm metre

(1.18) The luminous displays observed prominently over north pole due to excitation of the ionized gases in the upper atmosphere is known as

(A). Meteors
(B). Photoluminescence
(C). Aurora Borealis
(D). Air glow

(1.19) A correction which needs to be subtracted from the travel times for the common-depth point recordings is known as

(A). Common-offset
(B). Static correction
(C). Normal Moveout
(D). Layer stripping

(1.20) A sequence of alluvium-sand-clay gives the following type of resistivity curve

(A). H- type
(B). A- type
(C). K- type
(D). Q- type

(1.21) Fjörds are characterized by

(A). An irregular glaciated coast
(B). A glaciated submerged coast
(C). An emergent coastline
(D). A smooth deltaic coast

(1.22) Which of the following rivers flows through a rift valley?

(A). Cauvery
(B). Krishna
(C). Narmada
(D). Brahmaputra

(1.23) The Stokes formula used for determination of particle size is

(A). $v = \frac{(\rho_s-\rho)g}{18\mu} \times d^2$

(B). $v = \frac{(\rho_s-\rho)g}{18\mu} \times d^{-1}$

(C). $v = \frac{(\rho_s-\rho)}{18\mu} \times d$

(D). $v = \frac{(\rho_s+\rho)g}{18\mu} \times d^{-1}$

(1.24) An ultramafic rock with olivine, phlogopite, magnesian garnet, pyroxene, chromite and perovskite is

(A). Harzburgite
(B). Websterite
(C). Kimberlite
(D). Vogesite

(1.25) Climbing ripple lamination develops due to

(A). Suspension fall out in a density flow
(B). Phased movements of water and suspended particles over a surface
(C). Tractional movement on bed surface
(D). Migration of antidunes

GG-2. This question consists of TWENTY FIVE sub-questions (2.1-2.25) of TWO marks each. For each of these sub-questions four possible answers (A,B,C and D) are given, out of which only one is correct . Answer each sub-question by darkening the appropriate bubble on the OBJECTIVE RESPONSE SHEET (ORS) using a soft HB pencil. Do not use the ORS for any rough work. You may like to use the Answer Book for any rough work if needed. (25 X 2 = 50)

(2.1) The Humboldt current is located in which of the following oceans

(A). Indian
(B). Atlantic
(C). Southern
(D). Pacific

(2.2) The flowering plants appeared on Earth in which of the following period

(A). Cretaceous
(B). Silurian
(C). Cambrian
(D). Permian

(2.3) Which of the following produces pearls?

(A). *Paradoxides*
(B). *Unio*
(C). *Pintada*
(D). *Ammonites*

(2.4) Which of the following is true for Atlantic type of continental margins?

(A). Divergent-Passive-Aseismic
(B). Divergent-Aseismic-Transform
(C). Convergent-Active-Seismic
(D). Transform-Active-Aseismic

(2.5) Choose the sequence correctly arranged in stratigraphic order

(A). Gondwana System-Subathu Series-Barail Series-Siwalik System
(B). Gondwana System-Cuddapah System-Subathu Series-Kuling System
(C). Zewan Beds-Vindhyan Supergroup-Lilang System-Talchir Boulder Bed
(D). Trichonopoly Stage-Papaghni Series-Umia Series-Tipam Sandstone

(2.6) A set of cylindrical upright folds is superposed by another set of non-coaxial folds. The axis of the superposed folds at any spot is determined by

(A). Fold dihedral angle of the first set of folds
(B). Fold dihedral angle of the superposed folds
(C). Intersection of axial planes of the two sets of folds
(D). Intersection of the limb of the first fold and the axial plane of the later folds.

(2.7) Shearing stress on any two perpendicular planes in a body under stress is

(A). Unequal in magnitude but of same sign
(B). Unequal in magnitude but of opposite sign
(C). Equal in magnitude but of opposite sign
(D). Equal in magnitude and of same sign

(2.8) Pyrrhotite and Sphalerite

(A). Are isomorphous
(B). Are isomorphous but do not form solid solution
(C). Are examples of polymorphism
(D). Are not isomorphous but form extensive solid solution

(2.9) Which following group of elements are concentrated to produce ore deposits in pegmatites?

(A). Be, Sn, Li, W
(B). Mo, Cu, Au, Be
(C). Au, Zn, Li
(D) Cu, Au, W

(2.10) Match the appropriate set of processes under which nickel ores form

(A). Magmatic crystallization; placer
(B). Liquid immiscibility; magmatic; hydrothermal; residual concentration
(C). Liquid immiscibility; hydrothermal; sedimentation; supergene enrichment
(D). Magmatic crystallization; liquid immiscibility in magmas;hydrothermal; sedimentation; residual concentration

(2.11) In CDP reflection profiling if the number of receivers is eight and the shot spacing is one then the coverage obtained is

(A).Two-fold
(B). Four-fold
(C). Eight-fold
(D). Ten-fold

(2.12) A continental heat flow province with a surface radioactive heat generation of 3 μWatt m^{-3} and a surface heat flow of $57x10^{-3}$ Watt m^{-2} for a 8 km slab thickness will have the reduced heat flow of

(A). $25x10^{-3}$ Watt m^{-2}
(B). $33x10^{-3}$ Watt m^{-2}
(C). $45x10^{-3}$ Watt m^{-2}
(D). $80x10^{-3}$ Watt m^{-2}

(2.13) If the Poisson's ratio of a typical rock is 0.3 then the ratio of the primary to secondary wave velocity will be

(A). $\sqrt{3}$
(B). $\sqrt{3.5}$
(C). $\sqrt{4}$
(D). $\sqrt{5}$

(2.14) The decay constant of ^{147}Sm is

(A). $7.00x10^{-11}y^{-1}$
(B). $6.54x10^{-12}y^{-1}$
(C). $7.44x10^{-12}y^{-1}$
(D). $8.24x10^{-12}y^{-1}$

(2.15) If a radioactive sample has a mean-life of ~8270 years then its half-life will be

(A). 4800 years
(B). 5731 years
(C). 6200 years
(D). 6800 years

(2.16) If the observed counting rate of a radioactive sample is $7.4x10^{4}$ counts per second, then the disintegration rate in Becquerel, assuming a counting efficiency of 20% will be (1 Becquerel = $2.703x10^{-11}$ Curie)

(A). $3.7x10^{4}$
(B). $3.7x10^{5}$
(C). $4.4x10^{5}$
(D). $3.7x10^{6}$

(2.17) If a planet revolves around the sun in a period of 8 years then its distance from the sun will be

(A). two times the earth's distance
(B). four times the earth's distance
(C). six times the earth's distance
(D). eight times the earth's distance

(2.18) A density log in a given region gave the density of the formation fluid and the rock matrix to be 950 kg/m^3 and 2540 kg/m^3 respectively. If the bulk density of the rock is 1950 kg/m^3 then the porosity percent will be

(A). 25
(B). 30
(C). 37
(D) 40

(2.19) If the density of a given layer within the earth's interior is 4900 kg/m^3 and the primary and shear wave velocities are 12 km/sec and 6.8 km/sec respectively then its bulk modulus will be (1 GPa = 10 kilobars)

(A). 103.5 GPa
(B). 203.5 GPa
(C). 350.6 GPa
(D). 400.5 GPa

(2.20) The conductivity of a rock sample is 2.7 Watts/m ^{0}C and the underground temperature in a region containing these rocks increase by 1 ^{0}C for 27 metres descent, then the heat lost per hour by a square kilometre in the region will be (1 kilowatt-hour = 8.601×10^6 calories)

(A). 3.6×10^7 Watt second
(B). 3.6×10^8 Watt second
(C). 5.9×10^8 Watt second
(D). 8.2×10^8 Watt second

(2.21) The scale of a vertical photograph is given by

(A). $\frac{\text{focal length}}{\text{camera height}}$

(B). $\frac{\text{camera height}}{\text{focal length}}$

(C). camera height x focal length

(D). magnification x camera height

(2.22) The solid solution between albite and anorthite in plagioclases can be best expressed by

(A). $2Na^{+} \rightarrow Ca^{2+}$
(B). $Na^{+} + Si^{4+} \rightarrow Ca^{2+} + Al^{3+}$
(C). $Ca^{2+} + Si^{4+} \rightarrow 2Na^{+} + Al^{3+}$
(D). $Na^{+} + Al^{3+} \rightarrow Si^{4+}$

(2.23) 1 Grossularite + 1 Quartz = 2 _____ + 1 Anorthite

(A). Diopside
(B). Pigeonite
(C). Wollastonite
(D). Hedenbergite

(2.24) Current ripples usually develop on bed surface by unidirectional flow, with grain size and stream power ranging from

(A). 0.1- 0.65 mm ; 10^{2}-10.8^{2} ergs/cm^{2}/sec
(B). 0.3 - 0.82 mm ; 10^{3}-10^{4} ergs/cm^{2}/sec
(C). 0.92 – 1.26 mm ; 10^{4} ergs/cm^{2}/sec
(D). 1.50 – 1.70 mm ; 10^{5}–10^{7} ergs/cm^{2}/sec

(2.25) Coal gas contains

(A). He, N_2, C_2H_4
(B). C_2H_4, CO_2, CH_4
(C). H_2, N_2, CO, CH_4
(D). H_2, N_2, C_2H_4, CH_4, CO

SECTION B

(75 Marks)

This section consists of TWENTY questions of FIVE marks each. ANY FIFTEEN out of these questions have to be answered on the Answer Book provided.

GG-3. (a) What is a paleosol? Describe in two lines.

(b) What is outwash ? Write in one sentence.

GG-4. (a) Name four magnetic epochs recognized for the Pliocene and Pleistocene.

(b) What is a concurrent range zone ? Write in one or two lines.

(c) What is the age of the base of the Pleistocene epoch ?

GG-5. (a) What is a thermohaline circulation? Write in two sentences.

(b) What is Carbonate Compensation Depth (CCD)? What is its average depth in the Indian Ocean?

GG-6. (a) Arrange the following in stratigraphic order
(i) Tipam Series
(ii) Barail Series
(iii) Disang Series
(iv) DupiTila Series

(b) What is the age of the Productus Shales ?

(c) What is the age of Fenestella Series of Kashmir ?

(d) What is the age of Neobolus Shales ?

GG-7. (a) Name the characteristic Lower Cambrian Trilobite genus.

(b) What is the stratigraphic range of graptolites ?

(c) Name the Dinosaurian bird.

(d) Is *Globigerina* a benthonic or a planktonic foraminifer ?

(e) In which epoch did Brachiopods have acme of their development?

GG-8. (a) In longitudinal strain the parameter λ is defined as $(l_1/l_o)^2$ where l_0 is the original length of a line and l_1 is the final length. Find the limits within which the value of λ may vary.

(b) Give two main differences between homogeneous and non-homogeneous deformations.

(c) On a vertical plane striking N 30° a lineation has a pitch of 25° from the south. Give the plunge amount and direction of the lineation.

GG-9. (a) Explain why some grains of augite show two sets of cleavage,while other grains show only one set of cleavage in a thin section.

(b) Extinction angle $z \wedge c$ measured in ten grains of augite varied from 9° to 38°. Explain.

(c) Indicate the crystallographic orientation of the section showing parallel extinction.

GG-10. (a) What information do the following provide in terms of environmental conditions ?

(i) Graded bedding

(ii) Herringbone crossbedding

(b) Sketch circles and indicate projections of axes (as B) and poles of axial planes (as A) for the following types of folds

(i) Recumbent fold

(ii) Reclined fold

(iii) Vertical fold

GG-11. (a) Why are E and W directions reversed in a clinometer?

(b) What are sheath folds?

(c) While working with a petrological microscope how are the vibration directions of the polarizer and analyzer determined?

(d) Write down the symmetry elements of the normal class of the monoclinic system?

GG-12. (a) How do you find the orthographic projection of a line on a plane on which it does not lie?

(b) Which is the most abundant metal in the earth's crust?

(c) What are chalcophile elements?

(d) State the Si:O ratios in pyroxenes and amphiboles.

GG13. (a) What will be the resistance of a 10 km long metallic cable of 2 mm diameter and if resistivity of the metallic conductor is 10^{-4} ohm metre?

(b) What will be the skin depth of magnetotelluric signal of 10^{-4} Hz penetrating a granitic body of 10,000 ohm metre resistivity?

GG-14. A pump test was conducted on a confined aquifer in an alluvial tract of 10 metre thickness at a discharge of 1540 litre/minute. A time drawdown plot gives 0.15 metre drawdown per cycle. Calculate the transmissivity and hydraulic conductivity.

GG-15. Water sample from a dug well has ^{32}Si activity of 0.016 dpm/10^3 litre and is at a distance of 20 km from the source. Estimate the flow velocity rate in m/yr (assuming the half-life of ^{32}Si to be 276 years and the ^{32}Si activity of rain water to be 0.28 dpm/10^3 litre).

GG-16. During an archeological survey a piece of wood from the ruins of an ancient dwelling in Assam was found to have a mass of 35 g and ^{14}C activity of 225 disintegrations per minute. Estimate the age of the archeological find if the half-life of ^{14}C is 5730 years and the wood of a living tree contains ^{14}C activity of 13.5 disintegrations per minute per gram.

GG-17. Compute the vertical component of gravity over a slab of infinite horizontal extent of density 2.5 gm/cc and thickness 500 metre located at a depth of 1 kilometre. What will be the value of gravity if the depth increases to 2 kilometre?

GG-18. Explain where would you expect to find exceptionally thick accumulation of sedimentary rocks.

GG-19. (a) What are the factors that control particle morphology?

(b) What is textural inversion? Cite two examples.

GG-20. (a) Define the term "particle size grading".

(b) What is the mechanism of inverse grading?

GG-21. (a) What is an estuary?

(b) What hypothesis can you suggest to explain the occurrence of thick estuarine accumulation in the sedimentary record?

GG-22. (a) What are Red Beds?

(b) How are Red Beds formed? During which geological period prolific development of Red Beds occurred?

(c) What significant information are obtained from studies of Red Beds?

"END OF THE QUESTION PAPER"

2002
GG : Geology and Geophysics

Duration : Three hours | Maximum Marks: 150

This question paper contains 14 pages. Please check whether all the pages are there.

Read the following instructions carefully.

1. All answers must be written in ENGLISH.
2. This question paper contains **TWO SECTIONS : 'A' and 'B'.**
3. **Section A** consists of two questions of multiple choice type. Question 1 consists of **TWENTY FIVE** sub-questions of ONE mark each and Question 2 consists of **TWENTY FIVE** sub-questions of TWO marks each.
4. Answer **Section A** only on the special machine-gradable **OBJECTIVE RESPONSE SHEET (ORS)**. Questions in Section A will not be graded if answered elsewhere.
5. Write your name, registration number and the name of the Centre at the specified locations on the right half of the **ORS** for Section A.
6. Using a HB pencil, darken the appropriate bubble under each digit of your registration number.
7. Questions in Section A are to be answered by darkening the appropriate bubble (marked A, B, C or D) using a HB pencil against the question number on the left hand side of the **ORS**. In case, you wish to change an answer, erase the old answer completely using a good soft eraser.
8. The **ORS** will be collected after 120 minutes from the start of the examination. In case you finish Section A before the expiry of 120 minutes, you may start answering Section B.
9. There will be NEGATIVE marking in Section A. For each wrong answer to 1- and 2-mark sub-questions, 0.25 and 0.5 marks will be deducted respectively. More than one answer marked against a question will be deemed as an incorrect response and will be negatively marked.
10. Answer questions in **Section B** in the answer book. Section B consists of TWENTY questions of FIVE marks each. ANY FIFTEEN out of them have to answered. If more number of questions are attempted , score off the answers not to be evaluated, else only the first fifteen unscored answers will be considered.
11. Answer for each question in Section B should be started on a fresh page. Question numbers must be written legibly and correctly in the answerbook.
12. In all 5 mark questions (Section B), clearly show the important steps in your answers. These intermediate steps will carry partial credit.

SECTION A
(75 Marks)

GG 1. This question consists of TWENTY FIVE sub-questions (1.1 – 1.25) of ONE MARK each. For each of the sub-questions, four alternatives (A,B,C and D) are given, out of which only one is correct. Answer each sub-question by darkening the appropriate bubble on the OBJECTIVE RESPONSE SHEET (ORS) using a soft HB pencil. Do not use the ORS for any rough work. You may use the Answer Book for any rough work, if needed. There will be NEGATIVE marking. For each wrong answer 0.25 mark will be deducted.

(25 X 1 = 25)

(1.1) A seismic phase refracted along the Mohorovicic discontinuity is denoted as
(A) Pn
(B) P*
(C) PmP
(D)PKP

(1.2) The velocity of the primary wave is minimum in the
(A) crust
(B) asthenosphere
(C) outer core
(D) inner core

(1.3) The axis through the Geomagnetic poles is inclined to the earth's axis at an angle of
(A) 7.5^0
(B) 9.5^0
(C) 11.5^0
(D) 13.5^0

(1.4) Which of the following gravity corrections is always positive?
(A) Free-Air
(B) Bouguer
(C) Latitude
(D) Terrain

(1.5) Intensity of an earthquake is a measure of it's
(A) magnitude
(B) destruction
(C) duration
(D) energy

(1.6) Which of the following shows near-linear variation with depth in the earth?
(A) Density
(B) Velocity
(C) Temperature
(D) Pressure

(1.7) Pratt's hypothesis explains isostasy by assuming
(A) blocks of equal density
(B) blocks of unequal density
(C) blocks of equal thickness
(D) blocks of unequal weight

(1.8) Which amongst the following is the fastest moving plate ?
(A) Nazca
(B) Eurasian
(C) African
(D) North American

(1.9) A typical value of the SP of a massive sulphide ore is
(A) 10 millivolts
(B) 100 millivolts
(C) 1000 millivolts
(D) 10000 millivolts

(1.10) Which amongst the following is NOT a natural source method
(A) AFMAG
(B) TURAM
(C) MT
(D) Telluric

(1.11) The surface wave magnitude (Ms) of the major earthquake which occurred on 26th January 2001 in Gujarat is
(A) 6.9
(B) 7.4
(C) 7.9
(D) 8.4

(1.12) From the minerals listed below identify the one which is most susceptible to weathering:
(A) Augite
(B) Muscovite
(C) Hornblende
(D) Olivine

(1.13) The diameter of a sand grain is 1 mm. In ϕ grade it is equivalent to
(A) –1
(B) 0
(C) 1
(D) 2

(1.14) Breccia and conglomerate differ in
(A) size of the clasts
(B) shape of the clasts
(C) cementing material
(D) environment of deposition

(1.15) Which of the following is a wind-blown deposit ?
(A) Till
(B) Bajada
(C) Varve
(D) Loess

(1.16) The reservoir rock in Bombay High oilfield is
(A) sandstone – shale alternations
(B) sandstone
(C) shale
(D) limestone

(1.17) Choose the youngest stratigraphic unit from the following:
(A) Semri Group
(B) Tal Formation
(C) Delhi Super Group
(D) Iron Ore Group

(1.18) The tails of the barchan dunes are pointed towards
(A) downwind direction
(B) upwind direction
(C) normal to the wind direction
(D) oblique to the wind direction

(1.19) Yellow pleochroic haloes are commonly seen in
(A) muscovite
(B) biotite
(C) cordierite
(D) orthoclase

(1.20) An igneous texture showing meshwork of feldspar laths with gaps filled by glass is known as
(A) seriate
(B) intersertal
(C) intergranular
(D) trachytic

(1.21) The hydrostatic head in a well penetrating a confined aquifer will be
(A) at the top of the aquifer
(B) below the top of the aquifer
(C) above the top of the aquifer
(D) independent of the top of the aquifer

(1.22) The diagnostic assemblage of granulite facies in metabasites is
(A) clinopyroxene-plagioclase-epidote
(B) clinopyroxene-plagioclase-hornblende
(C) clinopyroxene-hornblende-epidote
(D) clinopyroxe-orthopyroxene-plagioclase

(1.23) Vitrinite reflectance
(A) increases with rank of coal
(B) decreases with rank of coal
(C) increases with grade of coal
(D) decreases with grade of coal

(1.24) Pillow structure in volcanic rocks forms due to
(A) high volatile content of lava
(B) low volatile content of lava
(C) under-water eruption of lava
(D) sub-aerial eruption of lava

(1.25) The chemical composition of lepidolite is
(A) $LiAlSi_2O_6$
(B) $KLi_2AlSi_4O_{10}(OH)_2$
(C) $NaLi_2AlSi_4O_{10}(OH)_2$
(D) $LiAlSiO_4$

GG 2. This question consists of TWENTY FIVE sub-questions (2.1 – 2.25) of TWO MARKS each. For each of the sub-questions, four alternatives (A,B,C and D) are given, out of which only one is correct. Answer each sub-question by darkening the appropriate bubble on the OBJECTIVE RESPONSE SHEET (ORS) using a soft HB pencil. Do not use the ORS for any rough work. You may use the Answer Book for any rough work, if needed. There will be NEGATIVE marking. For each wrong answer 0.5 mark will be deducted.

(25 X 2 = 50)

(2.1) The theoretical value of gravity on the surface of the earth at 45^0 latitude is
(A) 978.6 gals
(B) 979.6 gals
(C) 980.6 gals
(D) 981.6 gals

(2.2) Magnetic anomaly is symmetrical and independent of the strike of the body at latitudes of
(A) 0^0
(B) 45^0
(C) 90^0
(D) All latitudes

(2.3) If a primary wave is incident on the Gutenberg discontinuity at an angle of 30^0 to the normal, the angle at which it is refracted into the core is about
(A) 7^0
(B) 17^0
(C) 27^0
(D) 37^0

(2.4) The magnetic field one earth radius above the north pole compared to the field at the pole is
(A) one eighth
(B) one quarter
(C) half
(D) the same

(2.5) Given the difference in arrival times of S and P waves recorded at a station to be 10 seconds, Vp= 6.5km/s and Vs=3.6 km/s, the epicentral distance is
(A) 20 km
(B) 40 km
(C) 80 km
(D) 120 km

(2.6) The paleolatitude of a rock sample with remanent magnetic inclination of 30^0 is
(A) 6^0
(B) 16^0
(C) 26^0
(D) 36^0

(2.7) The depth to the center of a buried spherical mass giving rise to a gravity anomaly with a half width of 20 m is
(A) 13m
(B) 26m
(C) 39m
(D) 54m

(2.8) Pick the correct pair amongst the following

(A) Magnetite	Paramagnetic
(B) Haematite	Ferromagnetic
(C) Quartz	Paramagnetic
(D) Gypsum	Diamagnetic

(2.9) Refraction of current flow lines obey the law given by
(A) $\rho_1 \tan\theta_1 = \rho_2 \tan\theta_2$
(B) $\rho_2 \tan\theta_1 = \rho_1 \tan\theta_2$
(C) $\rho_1 \sin\theta_1 = \rho_2 \sin\theta_2$
(D) $\rho_2 \sin\theta_1 = \rho_1 \sin\theta_2$

(2.10) The half-life of carbon-14 is 5700 years. What fraction of the original C-14 would still be present in an archaeological artifact which is 17,100 years old ?
(A) 1/3
(B) 2/3
(C) 1/4
(D) 1/8

(2.11) A rock sample contains 3 genera of trilobites whose stratigraphic ranges are Cambrian to Permian, Silurian to Permian and Ordovician to Silurian respectively. The age of the rock sample is,
(A) Cambrian to Permian
(B) Ordovician to Permian
(C) Ordovician
(D) Silurian

(2.12) Below the surface zone in the ocean there is a marked decrease in temperature and increase in salinity with depth. The density of water below the surface zone
(A) remains the same
(B) decreases with depth
(C) increases with depth
(D) varies independently

(2.13) Pick the correct combination of geologic period and corresponding most useful index fossils:
(A) Cambrian: Ammonites
(B) Triassic: Planktonic foraminifera
(C) Cretaceous: Trilobites
(D) Ordovician: Graptolites

(2.14) The most characteristic feature of carbonate cementation in continental environment is
(A) drusy fabric
(B) acicular fabric
(C) mineralogically aragonite
(D) high Mg/Ca ratio

(2.15) Choose the correct combination of sedimentary basin type and its example:
(A) Interior: Cuddapah
(B) Subduction: Pranhita-Godavari
(C) Foreland: Bombay offshore
(D) Pull Apart: Siwalik

(2.16) The silica content in alkali syenites is lower than that in other syenites because the former contains
(A) low amount of quartz
(B) significant amount of feldspathoids
(C) large amount of anorthitic plagioclase
(D) large amount of olivine

(2.17) In a coastal aquifer the elevation of water table above sea level is 2 metres. If the density of fresh water is 1 and that of saline water is 1.025, at what depth below sea level will the fresh-saline interface occur?
(A) 10 m
(B) 20 m
(C) 40 m
(D) 80 m

(2.18) Which of the following statements is true ?
(A) Kyanite is more stable than sillimanite in areas of low geothermal gradient
(B) Kyanite is more stable than sillimanite in areas of high geothermal gradient
(C) Kyanite is the high temperature polymorph of sillimanite
(D) Sillimanite is the high pressure polymorph of kyanite

(2.19) Choose the correct statement
(A) Pentlandite is an oxide mineral of nickel
(B) Wolframite is a silicate mineral of tungsten
(C) Chalcocite has the composition Cu_2S
(D) Cuprite has the composition CuO

(2.20) Which of the following statements is true in reflected light microscopy?
(A) Covellite does not show bireflectance
(B) Pyrite shows bireflectance
(C) Chalcopyrite shows higher reflectance than pyrite
(D) Sphalerite shows lower reflectance than galena

(2.21) In a fold if the curvature of the inner arc is lower than that of the outer arc, then the dip isogons
(A) converge towards the inner arc
(B) diverge towards the inner arc
(C) remain parallel
(D) may converge or diverge

(2.22) Choose the correct pair of orogeny and age
(A) Pan-African orogeny: 1000 Ma
(B) Grenville orogeny: 500 Ma
(C) Hercynian orogeny: 300 Ma
(D) Alpine orogeny: 400 Ma

(2.23) In the Hermann-Manguin system of notations, if we add mirror planes perpendicular to each of the rotation axes of 422, the resulting crystal class is:
(A) 4/m2/m2/m which falls in Cubic system
(B) 4/m2/m2/m which falls in Tetragonal system
(C) 4mm which falls in Tetragonal system
(D) 4/m which falls in Tetragonal system

(2.24) Pore-water pressure accelerates landslides through which of the following mechanisms?
(A) It decreases effective normal stress and decreases shear strength
(B) It increases effective normal stress and decreases shear strength
(C) It increases effective normal stress and increases shear strength
(D) It increases density of rock mass

(2.25) Name the missing product in the following reaction:
3Anorthite = 2Kyanite + _____ + Quartz
(A) Grossularite
(B) Wollastonite
(C) Labradorite
(D) Diopside

SECTION B
(75 marks)

This section consists of TWENTY questions of FIVE marks each. ANY FIFTEEN out of them have to be answered. If more number of questions are attempted, score off the answers not to be evaluated, else only the first fifteen unscored answers will be considered.

GG3. Sketch the following sedimentary structures and explain the processes of their formation:

(i) Current crescent (show current direction) (3)

(ii) Load cast. (2)

GG4. (a) What explanations are given for the function of complex suture in ammonites ? (2)

(b) Foraminiferal assemblages of three beds A, B and C (from bottom to top) are given below. Interpret the depositional environment and justify your answer. (3)

C *Haplophragmoides, Trochammina*

B *Nummulites, Discocyclina, Rotalia, Quinqueloculina*

A *Bolivina, Uvigerina, Lenticulina, Globigerina*

GG5. (a) An elongate mineral grain shows first-order gray interference colour under microscope. When a gypsum plate is inserted such that its fast-ray is parallel to the length of the mineral, the interference colour changes to second order green. Answer the following:

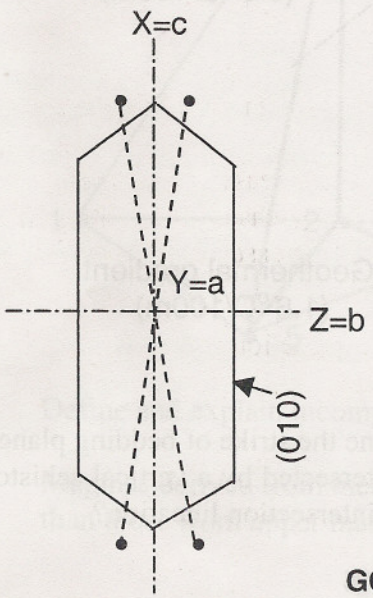
(i) Why did the interference colour change to green? (2)

(ii) What is the sign of elongation of the mineral? (1)

(b) In the following diagram optic orientation on the (100) section of a crystal is shown; X, Y and Z are the vibration directions. Answer the following:

(i) What is the crystal system to which the crystal belong? (1)

(ii) What is the optic sign of the crystal? (1)



GG6.(a) A sequence of sandstone is cored for 2 m drilled length. The recovered core measurements (in cm) are given below. Compute the core loss and RQD (Rock Quality Designation) of the drilled sequence. Which category of rock quality classification does it belong to? (3)

9.5	12.5	14.4	10.5
16.8	14.8	10.5	9.6
15.4	11.5	8.8	8.4
17.0	14.5	8.1	11.7

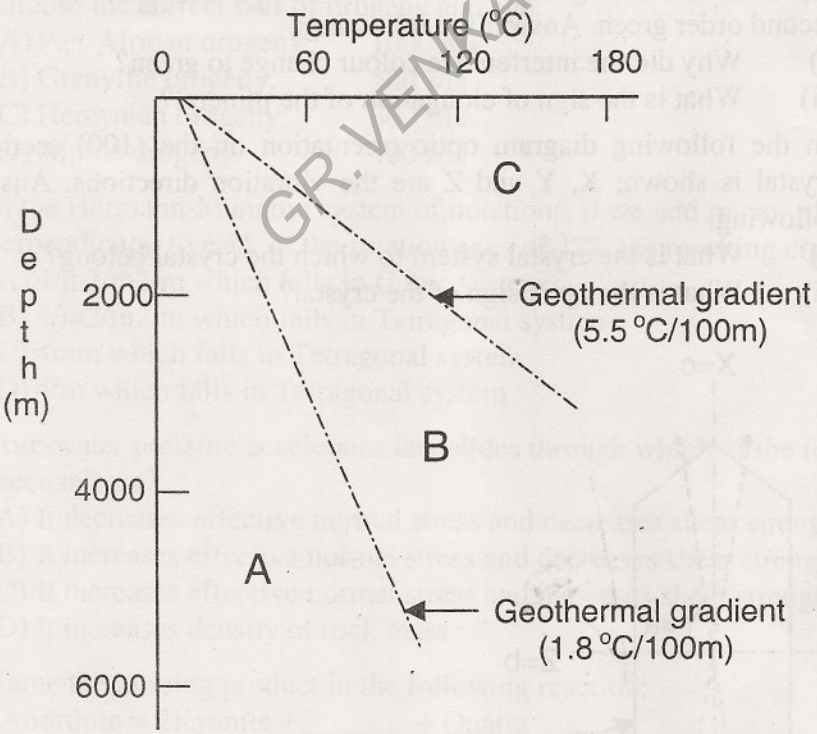
(b) A confined aquifer has a thickness of 5 m and hydraulic conductivity of 4 m/day. Calculate the ground-water flow through an aquifer section of 2 km length under a hydraulic gradient of 2 m/km. (2)

GG7. (a) Give geological age of the following stratigraphic units: (3)

(i) *Syringothyris* Limestone
(ii) Subathu Formation
(iii) Bagh Beds

(b) Two geothermal gradients are drawn in the following depth vs temperature diagram. Three zones A, B and C are marked. Giving reasons for your answer indicate the zone where, (2)

(i) petroleum is most likely to form and be trapped
(ii) petroleum may form but not trapped



GG8. (a) In a deformed sedimentary terrane the strike of bedding plane is N-S and dip is 45° towards west. It is intersected by a vertical schistosity striking E-W. What is the plunge of the intersection lineation? (1)

(b) Draw a schematic two-dimensional diagram to show coaxial folding. Show the axial traces of the two generations of folds. (2)

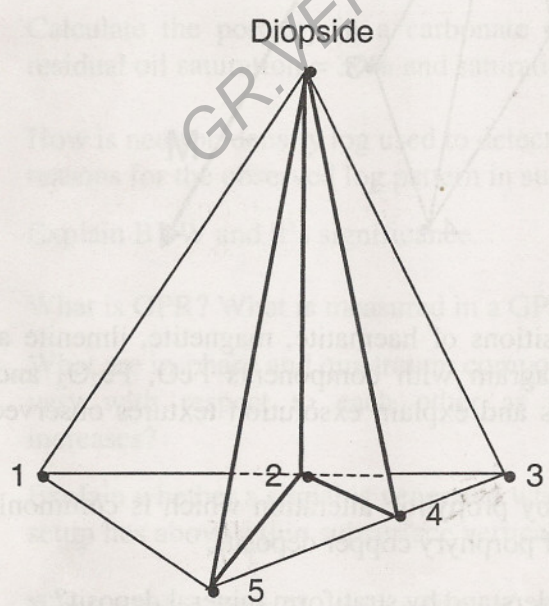
(c) In the coaxial fold drawn by you, show where you will get the following minor-fold interference structures: (2)
(i) S on Z
(ii) Z on S

GG9. (a) For the reaction $Mg_2SiO_4 + SiO_2 = 2MgSiO_3$, the thermodynamic data at 1bar and 298°K are: ΔH_r = -7200 J/mole; ΔS_r = -1.00 J/deg.mole and ΔV_r = -0.40 J/bar. Assuming that these values are constant over the crustal range of pressures and temperatures, explain why quartz and forsterite do not coexist in crustal rocks. (2)

(b) What do you understand by chondrite normalisation of rare earth elements? What is the advantage of such normalisation? (2)

(c) Define ionic potential. (1)

GG10. (a) In the diagram of basalt tetrahedron given below the end-members of the base of the tetrahedron are forsterite, quartz and nepheline. Answer the following: (3)
(i) Identify minerals corresponding to points 1 to 5
(ii) What is the plane of silica saturation?
(iii) What is the plane of silica undersaturation?



(b) Define and explain incompatible element in partial melting. (1)

(c) Magmas derived from melted crustal rocks have higher $^{87}Sr/^{86}Sr$ ratios than those from upper mantle source. Explain why. (1)

GG11. (a) What do you understand by external buffering of fluid during metamorphism? (1)

(b) In AFM projection from muscovite, give the justification for subtracting $3K_2O$ from Al_2O_3 for calculation of "A" component. (1)

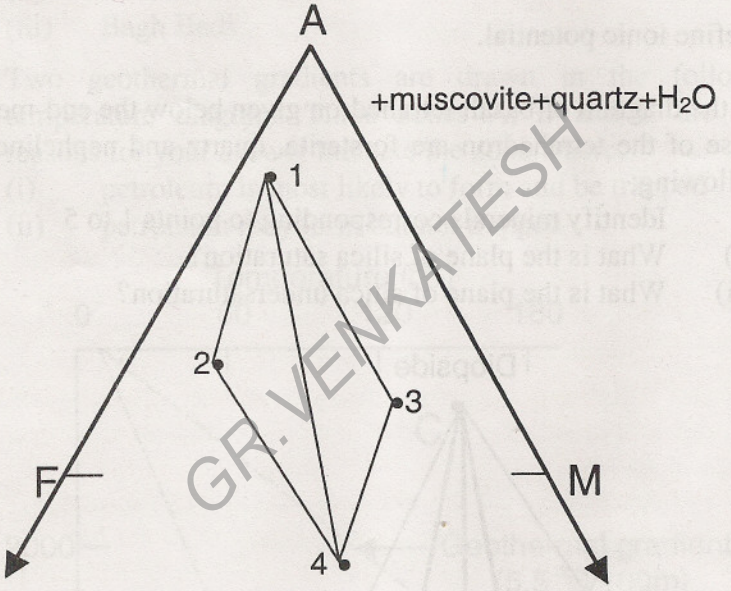
(c) Given below is the unlabelled AFM diagram of staurolite zone rocks in which the following AFM minerals are stable

Chlorite, Biotite, Staurolite, Garnet

(i) Identify the minerals corresponding to points 1 to 4 (1)

(ii) Mention two possible assemblages in which three of the four AFM minerals coexist. (1)

(iii) Which are the AFM minerals which have reacted to form staurolite? (1)



GG12. (a) Plot the compositions of haematite, magnetite, ilmenite and ulvospinel on a ternary diagram with components FeO, Fe_2O_3 and TiO_2. Show relevant tie-lines and explain exsolution textures observed between the minerals. (3)

(b) What is meant by propylitic alteration which is commonly observed in the outer zone of porphyry copper deposits. (1)

(c) What do you understand by stratiform mineral deposit? (1)

GG13. (a) Draw the fault plane solution (beach ball) for each of the following inclined faults:
(i) Strike slip fault (ii) Thrust fault and (iii) Normal fault (3)

(c) Calculate the geometric factor for a Schlumberger configuration. (2)

GG21. (a) Why is interpretation of magnetic anomalies more complex than gravity anomalies? Give four reasons. (2)

(b) Explain upward continuation and it's utility. (2)

(c) What is Konigsberger ratio? (1)

GG22. (a) Prove that the maximum gravity anomaly of a horizontal cylinder is larger than that due to a sphere having the same radius, depth and density as the cylinder. (3)

(b) What is the latitude correction for a gravity survey at the poles?. (1)

(c) Why is an unstable gravitymeter so called? (1)

'END OF QUESTION PAPER'

2003

GG : Geology and Geophysics

Duration: Three Hours | Maximum Marks: 150

Read the following instructions carefully

1. This question paper contains 90 objective questions. Q.1 – 30 carry one mark each and Q.31 – 90 carry two marks each.
2. Answer all the questions.
3. Questions must be answered on special machine gradable **O**bjective **R**esponse **S**heet (**ORS**) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left side of the **ORS.** Each question has only one correct answer. In case you wish to change an answer, erase the old answer completely using a good soft eraser.
4. There will be **NEGATIVE** marking. For each wrong answer **0.25** mark from Q.1 – 30 and **0.5** mark from Q.31 – 90 will be deducted. More than one answer marked against a question will be deemed as an incorrect response and will be negatively marked.
5. Write your registration number, name and name of the Centre at the specified locations on the right half of the **ORS**.
6. Using HB pencil, darken the appropriate bubble under the letters corresponding to your paper code.
7. Using HB pencil, darken the appropriate bubble under each digit of your registration number.
8. No charts or tables are provided in the examination hall.
9. Use the blank pages given at the end of the question paper for rough work.
10. Choose the **closest** numerical answer among the choices given.
11. This question paper contains 20 pages. Please report if there is any discrepancy.

Q.1 – 30 carry one mark each

Q.1 The approximate distances to the planets from the sun follow the

(A) Kepler's law (B) Titus-Bode's law
(C) Newton's law (D) Poisson's law

Q.2 The Gutenberg discontinuity occurs below the surface of the earth at a depth of

(A) 35 km (B) 2500 km (C) 2900 km (D) 5120 km

Q.3 The condensation of the earth and other planets was completed approximately

(A) 1.6 billion years ago (B) 2.6 billion years ago
(C) 3.6 billion years ago (D) 4.6 billion years ago

Q.4 The height of the stratopause above the surface of the earth is about

(A) 10 km (B) 30 km (C) 50 km (D) 80 km

Q.5 Airy's hypothesis explains the mechanism of compensation of mountain areas by assuming crustal blocks of

(A) equal density (B) unequal density
(C) equal thickness (D) equal depth

Q.6 The zone of increasing density of ocean-water with depth is termed as

(A) thermocline (B) halocline (C) geocline (D) pycnocline

Q.7 The presence of ophiolite suite of rocks on the continental crust has been observed in

(A) rift zones (B) orogenic belts
(C) flood basalts (D) sedimentary basins

Q.8 The value of P-wave velocity is highest

(A) at the centre of the earth (B) in the upper crust
(C) just below the Moho (D) at the base of lower mantle

Q.9 A majority of deep-focus earthquakes are located in

(A) Alpine – Himalayan zone (B) western margin of Pacific Ocean
(C) Mid-Atlantic ridge (D) eastern margin of Pacific Ocean

Q.10 From the following order of radioactive isotopes choose the correct one with decreasing half-life

(A) K^{40}, Rb^{87}, Sm^{147}, U^{235} (B) Rb^{87}, K^{40}, U^{235}, Sm^{147}
(C) U^{235}, K^{40}, Rb^{87}, Sm^{147} (D) Sm^{147}, Rb^{87}, K^{40}, U^{235}

Q.11 An environmental effect of global warming is

(A) increase in global albedo
(B) breakdown of gas-hydrates
(C) decrease in precipitation
(D) fall in sea-level

Q.12 Which one of the following magnetometers is NOT used for measuring natural remanent magnetization?

(A) Cryogenic magnetometer
(B) Spinner magnetometer
(C) Astatic magnetometer
(D) Rubidium vapour magnetometer

Q.13 The most characteristic metamorphic rocks in subduction zones belong to one of the following metamorphic facies

(A) greenschist facies
(B) almandine-amphibolite facies
(C) blueschist facies
(D) granulite facies

Q.14 The device used for measuring marine geothermal gradient is

(A) Bullard probe
(B) Needle probe
(C) Ewing probe
(D) Lee-Beck probe

Q.15 The most important magnetite deposit in India occurring as Banded Magnetite Quartzite is located in

(A) Kudremukh
(B) Noamundi
(C) Bailadila
(D) Meghataburu

Q.16 A sandstone containing < 15% matrix and > 25% feldspar is classified as

(A) quartz arenite
(B) arkosic arenite
(C) arkosic wacke
(D) quartz wacke

Q.17 The range of present denudation rate for major drainage basins is

(A) 1 – 10 cm / 1000 years
(B) 10 – 100 cm / 1000 years
(C) 100 – 500 cm / 1000 years
(D) 500 – 1000 cm / 1000 years

Q.18 When did the multi-cellular life evolve?

(A) Archaean (B) Proterozoic (C) Palaeozoic (D) Mesozoic

Q.19 The Mesozoic era ranges between

(A) 400 – 600 Ma
(B) 275 – 325 Ma
(C) 65 – 225 Ma
(D) 30 – 200 Ma

Q.20 The lower Palaeozoic sequence in the Indian subcontinent occurs in

(A) The Himalayas
(B) Rajasthan
(C) Kutch
(D) Thiruchirapalli

Q.21 During fractional crystallization of a basaltic magma due to early crystallization of pyroxene and plagioclase, the remaining liquid is enriched in

(A) potash and soda (B) soda and silica
(C) silica and potash (D) potash, soda and silica

Q.22 The mineral having two hardnesses is

(A) Quartz (B) Tourmaline
(C) Olivine (D) Kyanite

Q.23 During the transformation of organic matter to petroleum the temperature in the "oil window" is about

(A) $< 50\ ^{o}C$ (B) $50 - 150\ ^{o}C$
(C) $150 - 250\ ^{o}C$ (D) $250 - 350\ ^{o}C$

Q.24 A horizontal bed is folded in a manner that the axial plane of the fold is vertical and strikes N-S. If it is a non-plunging fold, the amount of dip of the bed in the hinge zone of the fold is

(A) 0^{o} (B) $30^{o} - 50^{o}$ (C) $50^{o} - 70^{o}$ (D) 90^{o}

Q.25 If the resistivity of intermediate layer is less than that of the overlying and the underlying layers in a three-layer case, the field resistivity curve is of the type

(A) A-type (B) K-type (C) H-type (D) Q-type

Q.26 The hydraulic conductivity of an aquifer is expressed as

(A) m / day (B) m^2 / day (C) m^3 / day (D) poise

Q.27 Ore minerals usually associated with chalcopyrite deposits are

(A) bornite, cuprite, covellite (B) hematite, magnetite, siderite
(C) bauxite, limonite, goethite (D) mica, columbite, cassiterite

Q.28 The geophysical method used for estimating the reserves of ore deposits is

(A) gravity (B) magnetic
(C) self potential (D) electromagnetic

Q.29 Electrode polarisation is one of the causes of

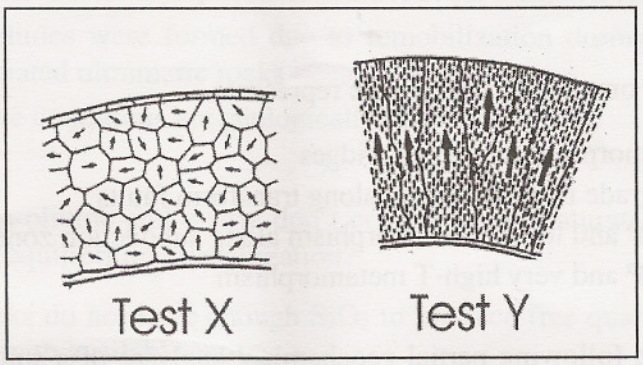
(A) shale potential (B) magnetic flux
(C) induced polarization (D) electromagnetic induction

Q.30 In a.c. resistivity meter, the frequency of current introduced into the ground is

(A) 100 Hz (B) 50 Hz (C) 25 Hz (D) 10 Hz

Q.31 – 90 carry two marks each

Q.31 The wall microstructure of two foraminiferal tests X and Y are shown below. The arrows indicate the optic-axis orientation of calcite crystals. Identify the wall types of X and Y



(A) X is porcellaneous and Y is hyaline
(B) X is agglutinated and Y is porcellaneous
(C) X is microgranular and Y is agglutinated
(D) X is hyaline and Y is porcellaneous

Q.32 Interference figure in a polarizing microscope forms

(A) below the microscope
(B) on the microscope stage
(C) on the top of the objective lens
(D) in-between objective lens and eye piece

Q.33 Which one of the following sets of structures is useful in deciphering the sense of shearing in a ductile shear zone?

(A) Vein arrays, syntaxial veins and boudins
(B) Symmetrical folds, hinge lines of folds and axial plane foliation in folds
(C) Crenulation foliation, spaced cleavage and axial plane foliation
(D) Extensional crenulation foliation, S-C mylonitic foliation and mica-fish

Q.34 The following sequence of facies develops from bottom to top during slowing down of a high velocity stream

(A) Gravel → Plane-laminated medium sand → Trough cross-bedded sand → Planar cross-bedded sand → Cross-laminated fine sand → Plane-laminated fine sand

(B) Plane-laminated medium sand → Gravel → Planar cross-bedded sand → Trough cross-bedded sand → Plane-laminated fine sand → Cross-laminated fine sand

(C) Gravel → Plane-laminated medium sand → Planar cross-bedded sand → Trough cross-bedded sand → Plane-laminated fine sand → Cross-laminated fine sand

(D) Gravel → Planar cross-bedded sand → Cross-laminated fine sand → Trough cross-bedded sand → Plane-laminated medium sand → Plane-laminated fine sand

Q.35 Which of the following is NOT a potential geobarometer?

(A) almandine + rutile = ilmenite + aluminosilicate + quartz
(B) anorthite = grossularite + aluminosilicate + quartz
(C) almandine + phlogopite = pyrope + annite
(D) cordierite = garnet + aluminosilicate + quartz

Q.36 The garnet + omphacite assemblage represents

(A) metamorphism at oceanic ridges
(B) low grade metamorphism along transform faults
(C) high-P and low-T metamorphism along subduction zones
(D) high-P and very high-T metamorphism

Q.37 Which of the following partial geochemical analyses of a suite of granitoids indicate their peraluminous character?

(A) Al_2O_3 – 15.68%, CaO – 6.23%, Na_2O – 4.52%, K_2O – 4.67%
(B) Al_2O_3 – 10.82%, CaO – 0.87%, Na_2O – 1.45%, K_2O – 3.25%
(C) Al_2O_3 – 12.62%, CaO – 4.45%, Na_2O – 3.75%, K_2O – 4.20%
(D) Al_2O_3 – 8.68%, CaO – 6.51%, Na_2O – 1.38%, K_2O – 3.19%

Q.38 A garnet has the composition $Fe_{1.5}$ $Mg_{0.9}$ $Mn_{0.45}$ $CaO_{0.15}$ Al_2 Si_3 O_{12}. The mole percentages of grossular, almandine, spessartine and pyrope components in this garnet are

(A) 10, 30, 20 and 40%, respectively
(B) 5, 15, 35 and 55%, respectively
(C) 50, 30, 15 and 5%, respectively
(D) 5, 50, 15 and 30%, respectively

Q.39 On the magnetic polarity time scale, the correct chronological order from older to younger of the polarity epochs is

(A) Matuyama normal → Gauss reversed → Gilbert normal → Brunhes reversed
(B) Gilbert normal → Gauss reversed → Matuyama normal → Brunhes reversed
(C) Matuyama reversed → Gauss normal → Gilbert reversed → Brunhes normal
(D) Gilbert reversed → Gauss normal → Matuyama reversed → Brunhes normal

Q.40 The correct order of the volcanic activities in India from older to younger is

(A) Greenstone Belt → Rajmahal Trap → Dras Volcanics → Deccan Traps
(B) Rajmahal Trap → Dras Volcanics → Deccan Traps → Greenstone Belt
(C) Greenstone Belt → Dras Volcanics → Rajmahal Trap → Deccan Traps
(D) Deccan Traps → Rajmahal Trap → Greenstone Belt → Dras Volcanics

Q.41 In a chromitite layer, pyrrhotite, pentlandite and chalcopyrite are present in the interstitial spaces between chromite crystals. Which of the following ore genesis is possible for the above sulphide assemblage?

(A) The sulphides were formed by hydrothermal cavity filling processes

(B) The sulphides were crystallised from the residual melt after formation of chromite

(C) The sulphides were formed due to remobilization during serpentinization of the associated ultramafic rocks

(D) The above conditions are geologically not viable

Q.42 Why magnesium-olivine and quartz don't coexist in oversaturated igneous rocks that have undergone equilibrium crystallization?

(A) Such rocks do not have enough SiO_2 to produce free quartz after formation of silicates with available cations

(B) Magnesium-olivine reacts with excess silica to form pyroxene enstatite

(C) The existence of the mineral pair, olivine plus quartz, requires the additional formation of a feldspathoid such as nepheline

(D) At high temperature there is a solid solution relationship between SiO_2 and Mg_2SiO_4

Q.43 A plate margin is characterized by the following features

i highest variation in gravity values
ii highest heat flow
iii high pressure / low temperature metamorphism
iv intense seismic activity

The above plate margin may be

(A) divergent plate margin (B) transform plate margin
(C) convergent plate margin (D) collision-type plate margin

Q.44 Which of the following statements are correct?

P Landsat TM satellite has 7 bands
Q In standard FCC the forest covers show red tones
R The visible spectral range in electromagnetic radiation is between 1μm to 3μm
S Sun-synchronous satellites have equatorial orbital planes

(A) P, S (B) P, Q, R (C) Q, R, S (D) P, Q

Q.45 The average interstitial velocity of groundwater through the pores of an aquifer can be estimated using the formula

(A) $v = KH / \phi$ (B) $v = K\phi / H$
(C) $v = H / K\phi$ (D) $v = H\phi / K$

where, v is velocity through pore spaces; K is hydraulic conductivity; H is hydraulic gradient and ϕ is effective porosity in fraction

Q.46 An excavation for an underground power house in a highly jointed granitic terrain has an arch-type roof, vertical walls and flat floor. It trends N-S and the orientations of three equally spaced joint sets across the cavity are as follows

i N 10° / 20° E
ii N 0° / 60° E
iii N 5° / 90° E

To provide stability to the power house against the rock falls within the cavity, most intense treatment will be provided on the

(A) eastern wall
(B) floor
(C) western wall and roof
(D) floor and eastern wall

Q.47 A multinational company has drilled two exploratory vertical boreholes P and Q. Borehole Q is located at an elevation of 350 m at a map distance of 1000 m due E from borehole P at 0 m. A N-S striking copper lode is encountered between 200 m and 400 m in borehole P and between 1550 m and 1750 m in borehole Q below the ground surface

Dip and thickness of the copper lode between the boreholes are

(A) Dip - 45°E, thickness – about 140 m
(B) Dip - 45°W, thickness – about 140 m
(C) Dip - 45°E, thickness – 200 m
(D) Dip - 45°W, thickness – 200 m

Q.48 Two sources of energy driving oil into a well are: (i) gas dissolved in oil and (ii) water. Choose the correct statement

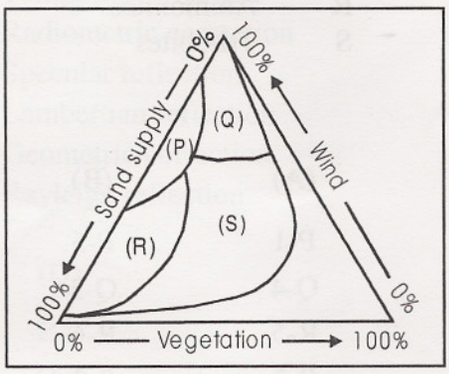
(A) In dissolved-gas drive the production rate increases as the pressure gradient declines
(B) In dissolved-gas drive the reservoir energy is replenished by shutting the well
(C) In water-drive there is a sharp decline of reservoir pressure
(D) In water-drive the reservoir energy is replenished by shutting the well

Q.49 Vitrinite of the organic matter, extracted from a source rock, has an average reflectivity of 3.2%. It represents a thermal maturity of the source rock in

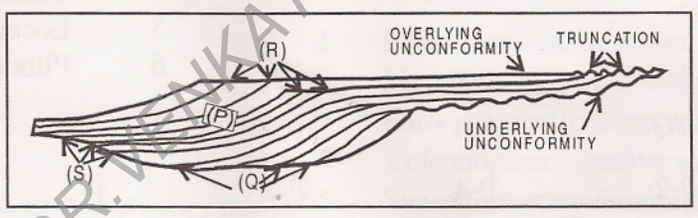
(A) diagenetic stage
(B) catagenetic stage of peak oil generation
(C) catagenetic stage of only wet gas generation
(D) metagenetic stage of dry gas generation

Q.50 According to Hack (1941), fields of stability of dune forms (P, Q, R and S) can be shown on a triangular diagram given below. The end members are wind effectiveness, vegetative cover and sand supply. The fields of transverse dune (td), barchans (ba), longitudinal dunes (ld), parabolic dunes (pd) and whaleback dunes (wd) are as follows

(A)	(B)	(C)	(D)
P - wd	P - ba	P - td	P - ld
Q - td	Q - ld	Q - ba	Q - pd
R - ld	R - td	R - wd	R - bd
S - ba	S - pd	S - ld	S - td



Q.51 Identify the correct seismic stratigraphic terminations P, Q, R and S within the following idealized seismic sequence



(A)	(B)	(C)	(D)
P- Onlap	P- Downlap	P- Toplap	P- Offlap
Q- Toplap	Q- Onlap	Q- Offlap	Q- Downlap
R- Downlap	R- Offlap	R- Onlap	R- Toplap
S- Offlap	S- Toplap	S- Downlap	S- Onlap

Q. 52 – 56 are "Matching" exercises. Choose the correct one from among the alternatives A, B, C and D

Q.52

	Fossil group		Age of extinction
P	Archaeocyatha	1	Ordovician
Q	Conodonts	2	Permian
R	Ammonites	3	Triassic
S	Trilobites	4	Eocene
		5	Cambrian
		6	Cretaceous

(A)	(B)	(C)	(D)
P-1	P-5	P-2	P-3
Q-4	Q-3	Q-6	Q-2
R-5	R-6	R-3	R-4
S-3	S-2	S-1	S-5

Q.53

	Stratigraphic units		Age
P	Tal Formation	1	PreCambrian
Q	Uttatur Formation	2	Cambrian
R	Sylhet Formation	3	Jurassic
S	Patcham Formation	4	Cretaceous
		5	Eocene
		6	Pliocene

(A)	(B)	(C)	(D)
P-2	P-4	P-2	P-5
Q-4	Q-5	Q-3	Q-4
R-5	R-6	R-5	R-3
S-3	S-2	S-1	S-6

Q.54

	Geomorphic Processes		Landforms
P	Glacial	1	Point bar
Q	Fluvial	2	Barchan
R	Aeolian	3	Esker
S	Marine	4	Sinkholes
		5	Cusp
		6	Pahoehoe

(A)	(B)	(C)	(D)
P-5	P-3	P-4	P-3
Q-2	Q-1	Q-3	Q-4
R-1	R-2	R-6	R-5
S-3	S-5	S-1	S-2

Q.55 Select the correct associations of the following groups of items of remote sensing studies

	Group I		Group II
P	Reflection from smooth surface	1	Temporal correction
Q	Reflection from rough surface	2	Radiometric correction
R	Correction for sun's elevation	3	Specular reflection
S	Correction for earth's rotation	4	Lambertian reflection
		5	Geometric correction
		6	Rayleigh reflection

(A)	(B)	(C)	(D)
P-6	P- 4	P-3	P-4
Q-3	Q-6	Q-4	Q-3
R-1	R-5	R-2	R-1
S-2	S-1	S-5	S-2

Q.56

	Mineral deposits		Most probable origin
P	Agucha	1	Late magmatic injection
Q	Malanjkhand	2	Magmatic hydrothermal
R	Bailadilla	3	Early magmatic segregation
S	Khetri	4	Volcanogenic massive sulphide
		5	Synsedimentary remobilized
		6	Metamorphosed sedimentary rock

(A)	(B)	(C)	(D)
P-4	P-3	P-2	P-1
Q-2	Q-1	Q-6	Q-3
R-6	R-2	R-1	R-4
S-5	S-4	S-3	S-2

Q.57 For the cordierite breakdown reaction :

3 cordierite = 2 garnet + 4 sillimanite + 5 quartz

ΔS°_{r} and ΔV°_{r} are – 0.0984 kJ/K and –15.973 kJ/kbar respectively. If equilibrium pressure at 25 °C is 3.6 kbar, then what is the equilibrium pressure at 650 °C?

(A) 5.5 kbar (B) 6.5 kbar (C) 7.5 kbar (D) 8.5 kbar

Q.58 A sequence of fossiliferous limestone is folded into an asymmetrical non-plunging overturned fold trending N-S whose limbs contain stretched and fragmented belemnite fossils. The two limbs dip at angles of 20° and 50° respectively towards west. A strain analysis of these fossils at many localities of the fold shows that their original average length was 2.0 cm. After the strain determination, the values of final lengths at locations X, Y and Z are as follows

X-on the limb dipping at 20°	5.0 cm
Y-on the limb dipping at 50°	8.0 cm
Z-along the hinge line	2.2 cm

Which one of the following values of elongation is correct?

(A) 200% at location X
(B) 300% at location Y
(C) 100% at location Z
(D) All values of elongation are wrongly calculated

Q.59 Four molluscan shells across a stratigraphic succession are found to differ in their oxygen isotopic composition. The difference in $\delta^{18}O$ values of the shells could be due to

P salinity variation in the habitat
Q difference in temperature of the ambient water
R diagenetic alteration
S oxygen isotopic variation in the sea-water

Choose the right combination from the following

(A) P, Q (B) Q, S (C) P, Q, S (D) P, Q, R, S

Q.60 The favourable environments for the formation of coal include

P Coastal marshy land
Q Freshwater inland basin
R Aeolian environment
S Coastal beaches

(A) P and Q
(B) P, Q and R
(C) Q and R
(D) R and S

Q.61 The value of g, the acceleration due to gravity, is maximum at the

(A) equator (B) north magnetic pole
(C) crust mantle boundary (D) mantle core boundary

Q.62 The output (in volts) of a geophone planted in the earth is proportional to

(A) strain (B) ground displacement
(C) ground velocity (D) ground acceleration

Q.63 Autocorrelation is the convolution of a time series

(A) with itself (B) with its reverse
(C) with its reciprocal (D) with its square

Q.64 For any function (of time), the time duration, Δt and the spectral bandwidth, Δw are related to each other as

(A) $\Delta t \Delta w = 1$ (B) $\Delta t \Delta w \geq 1$
(C) $\Delta t \Delta w \geq 2\pi$ (D) $\Delta t \Delta w \leq 2\pi$

Q.65 The Maxwell's equation, div $\mathbf{D} = \rho$ is the differential form of

(A) Faraday's Law (B) Coulomb's law
(C) Gauss's law (D) Darcy's law

Q.66 Carbon – 14 method is useful for dating events younger than

(A) 10 Ma (B) 1 Ma (C) 0.1 Ma (D) 0.01 Ma

Q.67 The coefficient of anisotropy of a layered medium is

(A) r (B) 1/r (C) $\sqrt{r}$ (D) $\sqrt{1/r}$

where r = longitudinal conductance / transverse resistance

Q.68 Fluid filled porous sedimentary rocks are

(A) electronic conductors (B) electrolytic conductors
(C) semi-conductors (D) super conductors

Q.69 Which one of the following minerals has the maximum diagnostic response to logging tools?

(A) Coal (B) Sulphide (C) Magnetite (D) Monazite

Q.70 The stress regime at the mid-ocean ridges is tensional in character. This is supported by earthquakes due to

(A) normal faulting (B) strike slip faulting
(C) high angle reverse faulting (D) opening of rift at the ridge crest

Q.71 In Turam method, the measurement is made of

(A) amplitude ratio and phase difference
(B) amplitude
(C) orientation of plane of polarization
(D) real and imaginary components

Q.72 The porosity of a reservoir rock can be obtained from

(A) Sonic, Density and Gamma Ray logs
(B) Sonic, Density and Caliper logs
(C) Gamma Ray, Neutron and Resistivity logs
(D) Density, Neutron and Sonic logs

Q.73 Which one of the following statements is wrong?

(A) In linear stretching, the operation is done on individual pixels without affecting the neighbourhood pixels
(B) Laplacian filter is a type of directional filter
(C) A multispectral classification is an irreversible process of data compression
(D) The useful range of orbital altitude for sun-synchronous low earth orbit is constrained by earth's atmosphere and van Allen belts

Q.74 Which one of the following statements is correct?

(A) Proton precession magnetometer gives the vertical component of the magnetic field
(B) Vertical derivative can be used to locate edges of shallow magnetic bodies
(C) Diamagnetic bodies are weakly magnetic with positive susceptibility
(D) For a vertically polarised spherical body, the horizontal component of magnetic anomaly is symmetrical with positive peak value over the center of the body

Q.75 One of the important contributions made by Maxwell in the theoretical investigation of electromagnetic phenomenon was

(A) the concept of ether
(B) the proof of transverse nature of light waves
(C) the addition of displacement current term in Ampere's law
(D) the suggestion of a method of measuring velocity of light

Q.76 The gravity and magnetic fields have the following properties

P Gravity field follows inverse square law, while magnetic field follows inverse cube law
Q Both fields are derivable from a scalar potential
R The source of gravity field is a scalar quantity, while that of magnetic field is a vector
S Both fields are governed by scalar Laplace's equation

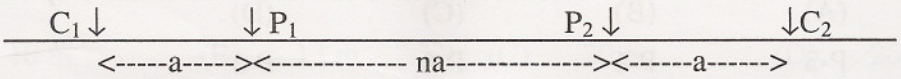
The two correct properties are

(A) P, S (B) P, R (C) Q, R (D) R, S

Q.77 The SI units of the terms (i) current density, (ii) magnetic field, (iii) electrical permittivity and (iv) magnetic permeability are respectively

(A) Ampere/m^2, Ampere/m, Farad/m, Henry/m
(B) Ampere/m^2, Oersted, Mho/m, Weber/m^2
(C) Ampere, Oersted, Farad/m, Henry/m
(D) Weber/m, Henry/m, Ampere/m, Farad/m

Q.78 In the following diagram, C_1 C_2 and P_1 P_2 are current and potential electrodes respectively, a is mutual separation of electrodes and n is an integer



The above diagram represents one of the electrode arrays stated below in the left column and the corresponding formula for computing apparent resistivity is given in the right column

P	Pole – pole array	1	$2\pi n(n+1)a$ V/I
Q	Dipole – dipole array	2	$4\pi na$ V/I
R	Schlumberger array	3	$2\pi na$ V/I
S	Radial dipole array	4	$\pi (n+1)(n+2) a$ V/I

The correct combination is

(A) P-3 (B) Q-1 (C) S-2 (D) R-4

Q.79 The logs used for measuring (i) free fluid index and (ii) resistivity of the flushed zone in a reservoir formation are

P Normal Resistivity log
Q Nuclear Magnetic log
R Microlaterolog
S Neutron log

The correct combination is

(A) P, Q (B) Q, R (C) R, S (D) S, P

Q. 80-81 are "Matching Exercises". Choose the correct one from among the alternatives A, B, C and D.

Q.80

	Group 1		Group 2
P	Ricker pulse	1	Signal processing
Q	Dar Zarrouk parameter	2	Gravimeter
R	Aliasing	3	Potential theory
S	Astatisation	4	Resistivity
		5	Zero phase wavelet
		6	Magnetic susceptibility

(A)	(B)	(C)	(D)
P-3	P-1	P-6	P-5
Q-6	Q-3	Q-5	Q-4
R-4	R-5	R-3	R-1
S-5	S-3	S-4	S-2

Q.81

	Group 1		Group 2
P	Ground control points	1	Density slicing
Q	Euclidean distance algorithm	2	Median filter
R	Variance-covariance matrix	3	Sobel filter
S	Non-linear filter	4	Geometrical rectification
		5	Supervised classification
		6	Principal component analysis

(A)	(B)	(C)	(D)
P-5	P-4	P-3	P-6
Q-6	Q-5	Q-1	Q-4
R-1	R-6	R-4	R-3
S-3	S-2	S-5	S-2

Q.82 A seismic recording unit uses a 16 bit A – D converter with one sign bit. It also uses binary gain ranging amplifiers. The dynamic range available with such a system is

(A) 90 dB (B) 96 dB (C) 180 dB (D) 192 dB

Q.83 A CDP seismic survey is conducted using a 192 channel recording system, with shot spacing of 50 m and geophone group spacing of 25 m. The number of folds covered in this survey are

(A) 48 (B) 72 (C) 96 (D) 192

Q.84 A primary wave with a period of 1 second has a displacement of 1.0 micron. It produces an acceleration of nearly

(A) 40 mgal (B) 4 mgal (C) 0.4 mgal (D) 0.04 mgal

Q.85 In a magnetic survey, base station readings were recorded as follows

Time	8 hrs 00 min	9 hrs 00 min
Reading	34284.5 nT	34290.5 nT

The magnetic anomaly at a field station, where the reading of 34255.8 nT was observed at 8 hrs 12 min, after diurnal correction, will be

(A) 29.9 nT (B) –29.9 nT (C) 28.7 nT (D) –28.7 nT

Q.86 An estimate of the depth to the center of a buried spherical body, which shows a peak value of 200 mgal over the center of the body, and half of this value at a distance of 20 m from the center on either side along a profile, is

(A) 10 m (B) 13 m (C) 20 m (D) 26 m

Q.87 Taking a representative value of 25 W $m^{-1}K^{-1}$ for the thermal conductivity of crustal rocks and a temperature gradient of 30 °C/km, the corresponding heat flow value in Wm^{-2} will be approximately

(A) 750 (B) 75 (C) 7.5 (D) 0.75

Q.88 From an IP survey, following data were obtained
Apparent resistivity at 0.1 Hz = 30 Ωm
Apparent resistivity at 1.0 Hz = 20 Ωm

The metal factor of the ore body (in mho/m) will be of the order of

(A) 10^2 (B) 10^3 (C) 10^4 (D) 10^5

Q.89 The skin depth of electromagnetic wave of frequency 400 Hz in a medium of resistivity 1.6×10^3 Ωm will be

(A) 500 m (B) 1 km (C) 1.5 km (D) 2 km

Q.90 The resistivity of a compact formation, fully saturated with brine solution of 0.4 Ωm resistivity, is 10 Ωm. Assuming cementation factor = 2 in the Archie's formula, calculate the porosity of the formation

(A) 10% (B) 20% (C) 30% (D) 40%

End of the question paper

M. Jayabalan

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2004

GG : Geology and Geophysics

Duration: Three Hours | Maximum Marks: 150

Read the following instructions carefully

1. This question paper contains 90 objective questions. Q.1-30 carry one mark each and Q.31-90 carry two marks each.

2. Answer al the questions.

3. Questions must be answered on special machine gradable **O**bjective **R**esponse **S**heet (**ORS**) by darkening the appropriate bubble (marked A. B, C, D) using HB pencil against the question number on the left hand side of the ORS. Each question has only one correct answer. In case you wish to change an answer, erase the old answer completely using a good soft eraser.

4. There will be **NEGATIVE** marking. For each wrong answer **0.25** mark from Q.1-30 and **0.5** mark from Q.31-90 will be deducted. More than one answer marked against a question will be deemed as an incorrect response and will be negatively marked.

5. Write your registration number, name and name of the Centre at the specified locations on the right half of the **ORS**.

6. Using HB pencil, darken the appropriate bubble under each digit of your registration number.

7. Using HB pencil, darken the appropriate bubble under the letters corresponding to your paper code.

8. No charts or tables are provided in the examination hall.

9. Use the blank pages given at the end of the question paper for rough work.

10. Choose the **closest** numerical answer among the choices given.

11. This question paper contains **28** pages. Please report if there is any discrepancy.

Q. 1 – 30 carry one mark each

Q.1 The generalized chemical composition of mica is

(A) $X_2\ Y_{4-6}\ Z_8\ O_{20}\ (OH,F)_4$

(B) $X_{4-6}\ Y_2\ Z_8\ O_{20}\ (OH,F)_4$

(C) $X\ Y_{4-6}\ Z_8\ O_{20}\ (OH,F)_4$

(D) $X_2\ Y_{4-6}\ Z_6\ O_{20}\ (OH,F)_4$

Q.2 Point group $\bar{4}2m$ belongs to

(A) Isometric

(B) Tetragonal

(C) Orthorhombic

(D) Monoclinic

Q.3 The K_{eq} for H_2O at normal room temperature is

(A) $(a_{H2O}\ a_{OH-})/\ a_{H+}$

(B) $(a_{H+}\ a_{OH-})/\ a_{H2O}$

(C) $(a_{H+}\ a_{H2O})/\ a_{OH-}$

(D) $(a_{OH-}\ a_{H2O})$

Q.4 A toposheet has a number of 48 K/5. It indicates its scale as

(A) 1:50,000

(B) 1:25,000

(C) 1:10,000

(D) 1:5000

Q.5 A magnetite bearing layered rock is exposed in an area. It has a very low dip and has near horizontal attitude. Its dip is measured accurately by

(A) Clinometer compass
(B) Brunton compass
(C) Photogrammatrically
(D) Theodolite based elevation method

Q.6 The best estimate of porosity of a subsurface sandstones is made by

(A) micro resistivity log
(B) formation density log
(C) acoustic log
(D) neutron gamma log

Q.7 Below an alluvium covered plain area, a thick vertical bed of barite deposit occurs at shallow depth. The geophysical method used to delineate the barite deposit is

(A) electrical
(B) magnetic
(C) seismic
(D) gravity

Q.8 In which of the following oil fields coal bed is the petroleum reservoir rock?

(A) Panna
(B) Kalol
(C) Lakwa
(D) Narimanan

Q.9 Folded lenses of petroleum bearing sandstone are found enclosed in the shales. They form

(A) structural traps
(B) stratigraphic traps
(C) combination traps
(D) kinetic traps

Q.10 In an open valley covered with thick pile of low strength sediments, the most suitable dam is

(A) Arch dam
(B) Buttress dam
(C) Earth dam
(D) Gravity dam

Q.11 Choose the correct statement from the following.

(A) Remote sensing system operates mainly in the ultraviolet part of the electromagnetic spectrum
(B) The primary source of the electromagnetic radiation for a passive remote sensing system is the Earth's magnetic field
(C) Landsat MSS obtain data at four wave bands
(D) In the visible part of the electromagnetic spectrum, high reflectivity of the cloud indicates low water content.

Q.12 The stratigraphic range of benthic foraminifera is

(A) Permian to Recent
(B) Eocene to Recent
(C) Cambrian to Recent
(D) Precambrian to Recent

Q.13 Which of the following features is related to glaciation?

(A) Karst topography
(B) Cirques
(C) Graded beds
(D) Atolls

Q.14 Which of the following is an intensive thermodynamic variable?

(A) Enthalpy
(B) Entropy
(C) Volume
(D) Mineral composition

Q.15 A metamorphic rock containing the assemblage glaucophane + epidote + phengite + paragonite belongs to

(A) blueschist facies
(B) greenschist facies
(C) amphibolite facies
(D) zeolite facies

Q.16 Ni-Cu sulfide deposits in mafic- ultramafic rocks are formed by the process of

(A) hydrothermal fluid activity
(B) liquid immiscibility
(C) magmatic segregation
(D) residual Concentration

Q.17 The layer of charged particles trapped by the earth's magnetic field is known as

(A) Ionosphere
(B) Van Allen Radiation Belt
(C) Solar Wind
(D) Magnetotail

Q.18 Clairaut's theorem relates the sum of geometrical and gravitational flattening to the

(A) equatorial force of gravity
(B) equatorial centrifugal force
(C) ratio of equatorial force of gravity and equatorial centrifugal force
(D) ratio of equatorial centrifugal force to equatorial force of gravity

Q.19 The physical property used in magnetic prospecting is

(A) magnetic induction
(B) magnetic permeability
(C) magnetic susceptibility
(D) magnetic potential

Q.20 A volcanic rock acquires magnetism during solidification of lava. This magnetism is due to

(A) thermoremnant magnetization
(B) detrital remnant magnetization
(C) chemical remnant magnetization
(D) paramagnetism

Q.21 Geoid is an equipotential surface coinciding with the

(A) topography
(B) ocean bottom
(C) reference spheroid
(D) mean sea level

Q.22 The best method for prospecting for disseminated sulphide ore bodies is

(A) Self-potential
(B) Gravity
(C) Induced polarization
(D) Electromagnetic method

Q.23 PKIKP is a seismic body (primary) wave which travels through the

(A) upper mantle
(B) upper mantle and lower mantle
(C) mantle, outer core and inner core
(D) mantle and outer core

Q.24 At the mantle core boundary the modulus rigidity is

(A) zero
(B) same as in the mantle
(C) twice that of the mantle
(D) thrice that of the mantle

V. Rajkumar

Q.25 Earthquakes associated with visible deformation of the Earth's crust and faulting are known as

(A) volcanic earthquakes

(B) tectonic earthquakes

(C) plutonic earthquakes

(D) deep focus earthquakes

Q.26 The Fo-Di-Ab plane in the normative basalt tetrahedron is known as

(A) plane of critical undersaturation

(B) plane of critical saturation

(C) plane of critical superesaturation

(D) plane of saturation

Q.27 Which one of the following is the chaacteristic Lower Gondwana flora?

(A) *Ptilophyllum*

(B) *Glossopteris*

(C) *Palmoxylon*

(D) *Baragwanthia*

Q.28 Which of the following is a Coriolis force-driven ocean current?

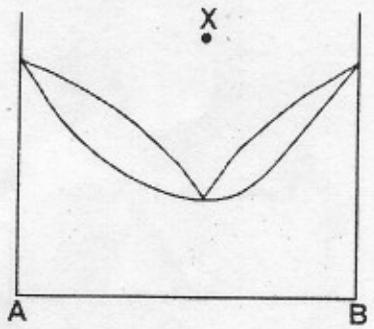
(A) Tsunamis

(B) Ekman Spiral

(C) Humboldt Current

(D) Agulhas Current

Q.29 The figure below is a system showing partial solid solution of crystals A and B. Assuming equilibrium between the crystals and the melt, what is the composition of the last crystal formed just prior to complete solidification of melt 'X'?



(A) $A_{30}B_{70}$

(B) Pure A

(C) Same as 'X'

(D) Pure B

Q.30 The rock mass in an area is faulted. The fault surface shows slickensides. If the rake of slickensides is zero degree, then the fault is a

(A) gravity fault

(B) thrust fault

(C) strike-slip fault

(D) growth fault

Q.31- 90 carry two marks each

Q.31 If a two fold axis of symmetry in a crystal intersects a plane perpendicular to it, it generates

(A) six fold symmetry

(B) three fold symmetry

(C) twin axis

(D) centre of symmetry

Q.32 A groundwater sample has the following composition, expressed in molality. Ca = 0.00584; Mg = 0.0016; HCO_3 = 0.00475; SO_4 = 0.00518. From the choices given below, choose its correct ionic strength.

(A) 0.0173

(B) 0.0205

(C) 0.0225

(D) 0.0276

Q.33 The hydrogen ion activity of seawater for pH 8.3 is

(A) 5.0×10^{-9}

(B) 2.2×10^{-5}

(C) 8.0×10^{-5}

(D) 9.0×10^{-5}

Q.34 If the decay constant of an isotope is 1.55125×10^{-10}/y, then its half-life is

(A) 2.47×10^{5} years

(B) 4.46×10^{9} years

(C) 5.45×10^{9} years

(D) 8.21×10^{9} years

Q.35 Match the elements of List I with those of List II

List I	List II
P Sonic log	1 total magnetic field
Q Satellite borne gravity survey	2 compensating network
R Proton precession magnetometer	3 sea surface variations
S Slingram method	4 subsurface cavity

Choose the correct answer from the following

(A)	(B)	(C)	(D)
P-4	P-2	P-4	P-1
Q-3	Q-4	Q-3	Q-2
R-2	R-3	R-1	R-3
S-1	S-1	S-2	S-4

Q.36 A horizontal hard bed rock is covered uniformly by alluvium in an area. Seismic refraction investigations indicate that the "critical distance" is 300 m from the shot point. The seismic wave velocities in the alluvium and the bed rock are 1000 m/s and 2000 m/s, respectively. The depth of the bed rock below the alluvium is about

(A) 86.6 m

(B) 150.0 m

(C) 173.2 m

(D) 300.0 m

Q.37 Match the following volcanic activities (List I) with their corresponding stratigraphic ages (List II).

List I	List II
P Sylhet trap	1 Jurassic
Q Rajmahal trap	2 Eocene
R Deccan trap	3 Proterozoic
S Malani rhyolite	4 Cretaceous

Choose the answer from the following choices.

(A)	(B)	(C)	(D)
P-4	P-2	P-4	P-2
Q-1	Q-1	Q-2	Q-4
R-3	R-4	R-4	R-1
S-2	S-3	S-1	S-3

Q.38 A seismic facies of a sedimentary basin is characterized by widespread "high amplitude" and "high continuity reflections". It indicates

(A) fluvial environment

(B) littoral environment

(C) neritic environment

(D) deep sea environment

Q.39 Microresistivity investigations of a zone encountered in a well indicate the resistivity of flushed zone as 9.4 ohm m. The resistivity of the mud filtrate is 5 ohm m. The formation factor for this zone is

(A) 0.88

(B) 1.88

(C) 2.88

(D) 3.20

Q.40 A petroleum reservoir has pressure 162 kg/cm^2. At the reservoir temperature, if its petroleum has a bubble point pressure of 140 kg/ cm^2, then the reservoir contains

(A) oil
(B) oil and water
(C) free gas
(D) oil, free gas and water

Q.41 Match the physical laws (List I) with their mathematical expressions (List II)

List I	List II
P Faraday's law	1 $\vec{J} = \sigma \vec{E}$
Q Ampere's law	2 $\nabla . \vec{B} = 0$
R Coulomb's law	3 $\nabla \times \vec{E} = - \partial \vec{B} / \partial t$
S Ohm's law	4 $\nabla \times \vec{H} = \vec{J} + \partial \vec{D} / \partial t$

Choose the correct answer from the following

(A)	(B)	(C)	(D)
P-2	P-3	P-3	P-4
Q-3	Q-4	Q-4	Q-1
R-1	R-2	R-1	R-2
S-2	S-1	S-2	S-3

Q.42 A rock mass has three sets of joints at a given place. The average number of joints per cubic meter of rock is 12. The RQD of this rock mass is about

RQD = %

(A) 75.4

(B) 80.1

(C) 85.3

(D) 90.4

Q.43 A hill face runs east-west and slopes at an angle of 35° N. Which one of the following joints is prone to cause landslides?

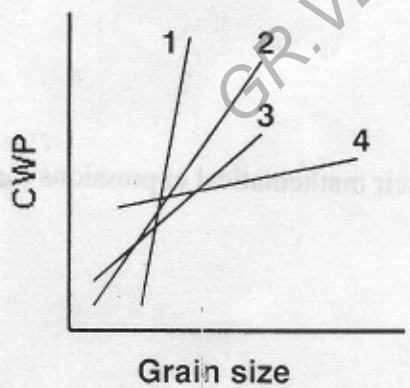
(A) Joints dipping 25° towards N 10° E

(B) Joints dipping 35° due south

(C) Joints dipping 50° due north

(D) Joints dipping 50° due east

Q.44 For four sandstone samples 1,2,3 and 4, the following figure shows the plot of grain size and cumulative weight percentage (CWP) of grains.



The poorest sorting of sediment is exhibited by the sample number

(A) 1

(B) 2

(C) 3

(D) 4

Q.45 Match the localities in List I with their corresponding mineral deposits in List II

List I	List II
P Malanjkhand	1 Barite-Asbestos
Q Pulivendla	2 Lead-Zinc
R Ambaji-Deri	3 Kyanite
S Lapsaburu	4 Copper-Molybdenum

Choose the correct answer from the following

(A)	(B)	(C)	(D)
P-3	P-4	P-4	P-2
Q-1	Q-1	Q-3	Q-1
R-2	R-2	R-1	R-3
S-4	S-3	S-2	S-4

Q.46 Based on the IUGS System of igneous rock classification, match the rock types (List I) with the percent of minerals (List II).

List I	List II
P Harzburgite	1 10% Ol, 50% Opx, 40% Cpx
Q Websterite	2 60% Ol, 30% Opx, 10% Cpx
R Wehrlite	3 60% Ol. 15% Opx, 25% Cpx
S Lherzolite	4 60% Ol, 10% Opx, 30% Cpx

Choose the answer from the following.

(A)	(B)	(C)	(D)
P-2	P-2	P-1	P-4
Q-1	Q-1	Q-2	Q-3
R-4	R-3	R-4	R-1
S-3	S-4	S-3	S-2

Q.47 Which of the following has the correct stratigraphic order from the oldest to the youngest?

(A) Neobolus Shales – Erinpura Granite- Kamlial Series- Kioto limestone- Barakar Series

(B) Erinpura Granite- Neobolus Shales- Barakar Series- Kioto limestone- Kamlial Series

(C) Kioto limestone -Barakar Series- Kamlial Series- Erinpura Granite- Neobolus Shales

(D) Neobolus Shales- Kamlial Series -Kioto limestone- Erinpura Granite – Barakar Series

Q.48 Which of the following planktonic foraminifera is a well established monsoon proxy?

(A) *Globorotalia truncatulinoides*

(B) *Globigerinoides sacculifer*

(C) *Globigerina bulloides*

(D) *Orbulina universa*

Q.49 Indicate the incorrect statement in the following.

(A) The electrode configuration which measures the curvature of potential is radial dipole.

(B) The average density of the Earth is 5.52×10^3 kg/m^3.

(C) S wave is a seismic body wave that can not travel through a liquid.

(D) At least four seismograph stations are needed to locate the epicenter of an earthquake.

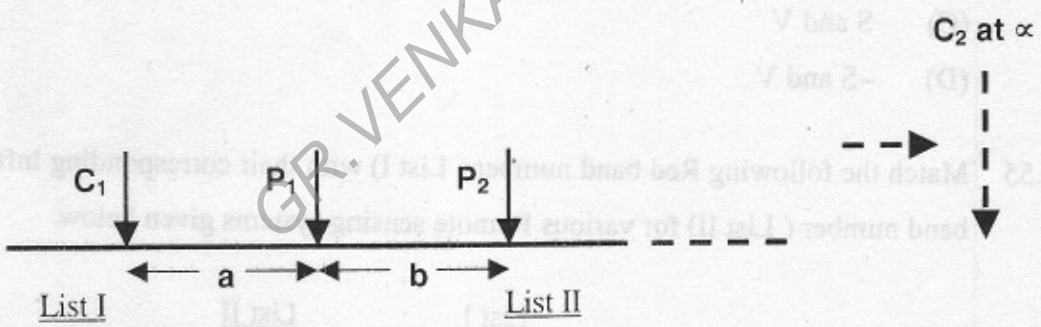
Q.50 Which of the following is a characteristic tropical planktonic foraminiferal assemblage?

(A) *Globigerinoides sacculifer, Gs. ruber, Globorotalia menardii, Orbulina universa*
(B) *Globigerina bulloides, Orbulina universa, Globorotalia truncatulinoides, Neogloboquadrina pachyderma*
(C) *Neogloboquadrina pachyderma, Globigerina nepenthes, G. bulloides, Orbulina universa*
(D) *Orbulina universa, Globigerina bulloides, Globigerinoides sacculifer, Globorotalia truncatulinoides*

Q.51 During prograde metamorphism of basic rocks, the greenschist → amphibolite facies transition is marked by

(A) decrease in anorthitic plagioclase and increase in actinolite
(B) increase in anorthitic plagioclase and decrease in actinolite
(C) decrease in anorthitic plagioclase as well as in actinolite
(D) increase in anorthitic plagioclase as well as in actinolite

Q.52 The diagram given below represents one of the electrode arrays (List I). Here, C_2 is placed at $\propto$ and b= a. The corresponding formula for computing apparent resistivity is given in List II. Match the electrode array (List I) with the corresponding formulae (List II) for computing apparent resistivity.



List I

P Pole-dipole

Q Half-Wenner

R Half- Schlumberger

S Three-electrode

List II

1 $2\prod a^2 \frac{\Delta V}{I}$

2 $2\prod a \frac{\Delta V}{I}$

3 $\prod a \frac{\Delta V}{I}$

4 $4\prod a \frac{\Delta V}{I}$

Choose the correct answer from the following

(A) Q-4
(B) R-2
(C) P-3
(D) S-1

Q.53 The data on entropy (S) and volume (V) of kyanite and sillimanite are furnished in the table below. Choose the correct slope of the reaction kyanite = sillimanite on a P-T diagram.

Mineral	S($J.K^{-1}$)	V (cm^3)
Kyanite	83.74	44.09
Sillimanite	96.11	49.90

(A) 0.047 $bar.K^{-1}$

(B) 4.047 $bar.K^{-1}$

(C) 21.29 $bar.K^{-1}$

(D) 212.9 $bar.K^{-1}$

Q.54 The first partial derivative of Gibbs free energy of a pure crystalline phase with respect to (i) temperature (at constant pressure) and (ii) pressure (at constant temperature) are

(A) S and –V

(B) –S and –V

(C) S and V

(D) –S and V

Q.55 Match the following Red band number (List I) with their corresponding Infrared band number (List II) for various Remote sensing systems given below.

Remote Sensing Systems	List I Red band No.	List II Infrared band No.
P Landsat MSS (1-3)	5	2
Q Landsat TM	3	3
R SPOT	2	4
S NOAA	1	7

Choose the correct Red band –Infra red band No. combination from the following

(A)	(B)	(C)	(D)
5 & 7	5 & 2	5 & 7	5 & 3
3 & 4	3 & 7	3 & 3	3 & 4
2 & 3	2 & 4	2 & 2	2 & 2
1 & 2	1 & 3	1 & 4	1 & 7

Q.56 On thermodynamic rationale, an ideal geobarometer is a mineralogical reaction for Which dP/dT approaches

(A) infinity

(B) zero

(C) one

(D) minus one

Q.57 Vp is the velocity of the P wave in a medium for which 'a' and 'b' are empirical constants. The density of the medium is

(A) $\rho = a+bVp$

(B) $\rho = aVp+bVp^2$

(C) $\rho = aVp^2+b$

(D) $\rho = a+b/Vp^2$

Q.58 Four VLF transmitters W, X,Y and Z are operating at frequencies of 10,15, 20 and 25 kHz respectively. The maximum ground penetration is due to

(A) transmitter Z

(B) transmitter Y

(C) transmitter X

(D) transmitter W

Q.59 If the distance between a nuclear material and the detector is 'd' then the radiation count rate will be proportional to

(A) d^2

(B) $1/d^2$

(C) $1/d^3$

(D) $1/d^4$

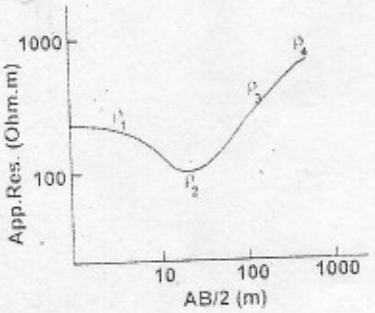
Q.60 The EM response of a conducting spherical body, when located in three contrasting hosts of resistivities 500, 700 and 1000 ohm m, will be

(A) maximum in 500 ohm m host
(B) maximum in 700 ohm m host
(C) maximum in 1000 ohm m host
(D) is zero in all the hosts

Q.61 Hammer's chart is used for

(A) free air correction for gravity
(B) gravity interpretation
(C) resistivity data interpretation
(D) terrain correction

Q.62 Plot between apparent resistivity and half electrode spacing is given below



The above curve is of

(A) K type
(B) Q type
(C) HQ type
(D) HA type

Q.63 Match the following magnetostratigraphic events (List I) with their corresponding ages (List II)

List I Events	List II Ages (Ma)
P Jaramillo top	1 0.984
Q Kaena base	2 3.127
R Mammoth top	3 3.221
S Cochiti top	4 4.033

Choose the correct answer from the following

(A)	(B)	(C)	(D)
P-1	P-1	P-2	P-3
Q-2	Q-4	Q-3	Q-4
R-3	R-3	R-4	R-2
S-4	S-2	S-1	S-1

Q.64 If the measured heat flow for a continental heat flow province is 57×10^{-3} W/m^2 and the reduced heat flow is 33×10^{-3} Wm^2, then the surface radioactive heat generation for a slab of 7.5 km thickness will be

(A) 0.9 μ W/m^3

(B) 1.2 μ W/m^3

(C) 2.2 μ W/m^3

(D) 3.2 μ W/m^3

Q.65 Two horizontal layers of resistivities of 100 ohm m and 200 ohm m and of thickness 10 m each are stacked in a single homogenous isotropic layer. The coefficient of anisotropy for the above will be

(A) 0.96

(B) 1.06

(C) 2.06

(D) 3.06

Q.66 In a two layer case, if 'x' is shot detector separation, 'V' is the velocity of the P wave in the upper layer and t_o is the two-way normal incidence travel time. In such a case the Normal Move Out (NMO) correction for a single horizontal reflecting interface is

(A) $\Delta t_n \approx x/2V^2t_o$

(B) $\Delta t_n \approx x^2/2V^2t_o$

(C) $\Delta t_n \approx x^2t_o/2V^2$

(D) $\Delta t_n \approx xt_o/2V^2$

Q.67 Match the items in List I with those of List II

List I	List II
P Vibroseis	1 dipping plane correction
Q Geophone	2 hydraulic vibrator
R Common-depth-point	3 moving coil electromagnetic type
S Dip moveout	4 roll-along shooting

Choose the correct answer from the following

(A)	(B)	(C)	(D)
P-1	P-2	P-3	P-2
Q-2	Q-1	Q-1	Q-3
R-3	R-3	R-2	R-4
S-4	S-4	S-4	S-1

Q.68 Match the following Petroleum Fields (List I) with their corresponding reservoir rocks (List II).

List I	List II
P Rudrasagar	1 Limestone
Q Bombay High	2 Shale
R Borehola	3 Sandstone
S Indrora	4 Igneous rock

Choose the correct answer from the following

(A)	(B)	(C)	(D)
P-2	P-3	P-4	P-3
Q-1	Q-1	Q-3	Q-1
R-4	R-3	R-1	R-4
S-3	S-4	S-2	S-2

Q.69 A sequence of hydrocarbon bearing sandstone, calcareous shale, coal and water bearing sandstone is encountered in a well. A zone of this sequence in the well profile, indicates a very high electrical resistivity, low gamma count and very high caliper reading. This zone corresponds to

(A) calcareous shale
(B) hydrocarbon bearing sandstone
(C) fresh water bearing sandstone
(D) coal

Q.70 Match the entries in List I with those in List II

List I	List II
P Lacoste- Romberg gravimeter	1 groundwater
Q Island arcs	2 zero length spring
R Adams-Williamson equation	3 strong seismic activity and deep focus earthquakes
S Tritium	4 density models

Choose the correct answer from the following

(A)	(B)	(C)	(D)
P-2	P-2	P-2	P-4
Q-3	Q-3	Q-4	Q-3
R-1	R-4	R-3	R-2
S-4	S-1	S-1	S-1

Q.71 In a well, the following logs were taken.

P sonic log
Q resistivity log
R self-potential log
S density log

For the demarcation of the sand-shale boundary, the right combination of logs is

(A) P,Q
(B) Q,R
(C) R,S
(D) S,P

Q.72 The specific radiocarbon activity of a wood sample is 5.25 dpm/gm of carbon. The specific activity of NBS oxalic acid standard is 13.37 dpm/gm of carbon. The age of the wood sample will be

(A) 5305 years
(B) 6350 years
(C) 7305 years
(D) 7500 years

Q.73 Indicate the incorrect statement in the following.

(A) The removal of mass between datum plane and observation station is known as Bouger correction.

(B) The upward continuation of gravity data increases resolution as well as amplitude.

(C) For a given current electrode separation, the signal strength (potential difference) will be more for Wenner array.

(D) The skin depth is the depth at which the electromagnetic signal amplitude is reduced by 1/e and phase rotates by 1 radian of the surface value.

Q.74 Indicate the correct statement in the following.

(A) Induced polarization method works on the principle of ionic conduction

(B) The displacement current part in electromagnetic wave equation can not be neglected at low frequencies

(C) The coefficient of anisotropy in electrical prospecting varies between 1.0 and 1.2

(D) VLF method is based on the electromagnetic transients

Q.75 Match the following features in List I with the fossils in List II

List I	List II
P Opisthoparian	1 Cephalopoda
Q Micropygous	2 Gastropoda
R Ceratitic suture	3 Trilobite suture
S Spire	4 Pygidium

Choose the answer from the following

(A)	(B)	(C)	(D)
P-4	P-3	P-3	P-2
Q-2	Q-4	Q-1	Q-1
R-1	R-1	R-4	R-4
S-3	S-2	S-2	S-3

Q.76 A hydrocarbon bearing formation has true electrical resistivity of 50 ohm m. The resistivity of formation water is 1.5 ohm m. The formation factor (F) of the formation is 4.1. The percent hydrocarbon saturation of the formation is

(A) 60
(B) 65
(C) 70
(D) 75

Q.77 If the primary wave velocity in a given material is twice the shear wave velocity, then its Poisson's ratio will approximately be

(A) 0.30
(B) 0.33
(C) 0.40
(D) 0.45

Q.78 Assuming an average crustal density of 2.8×10^3 kg/m^3 and the gravitational constant to be 6.67×10^{-11} m^3/kg.s^2, the Bouger correction per metre of elevation will be

(A) 0.82×10^{-6} m/s^2
(B) 0.95×10^{-6} m/s^2
(C) 1.17×10^{-6} m/s^2
(D) 2.15×10^{-6} m/s^2

Q.79 If the energy released by an earthquake is 7×10^9 kWh, then its magnitude would be

(A) 6.75
(B) 7.75
(C) 8.75
(D) 9.0

Q.80 The value of 'g' varies from the equator to the poles by about

(A) 5.2 gals

(B) 6.3 gals

(C) 7.1 gals

(D) 8.5 gals

Q.81 If at particular depth, the primary wave velocity is 11.5 km/s, shear wave velocity is 6.5 km/s and the density is 5.0×10^3 kg/m^3, then the bulk modulus of the rock at that depth will be

(A) 2.5×10^{11} N/m^2

(B) 3.0×10^{11} N/m^2

(C) 3.5×10^{11} N/m^2

(D) 3.8×10^{11} N/m^2

Q.82 Match the entries in List I with those in List II

List I	List II
P BABI	1 Chondrite
Q SMOW	2 LVZ
R Mantle	3 Oxygen and hydrogen isotopes
S CHUR	4 Sr isotope ratio

Choose the correct answer from the following

(A)	(B)	(C)	(D)
P-1	P-3	P-4	P-2
Q-2	Q-1	Q-3	Q-4
R-3	R-4	R-2	R-1
S-2	S-3	S-1	S-4

Q.83 The hydraulic conductivity of a 8m thick aquifer is 4.72×10^{-6} m/s. Its transmissivity is

(A) 37.76×10^{-6} m^2/s

(B) 37.76×10^{-5} m^2/s

(C) 37.76×10^{-4} m^2/s

(D) 37.76×10^{-3} m^2/s

Q.84 The correct descending order of weatherability of minerals in question is

(A) Muscovite→ Na-plagioclase→ Ca-plagioclase→ Quartz
(B) Na-plagioclase→ Ca-plagioclase→ Quartz→ Muscovite
(C) Ca-plagioclase→ Muscovite→ Na-plagioclase→ Quartz
(D) Ca-plagioclase→ Na-plagioclase→ Muscovite→ Quartz

Q.85 Match the following engineering structures (List I) to their corresponding features (List II).

List I	List II
P Pressure tunnel	1 Water conductor system
Q Gravity dam	2 Competent rocks
R Retaining wall	3 Weep holes
S Buttress dam	4 Deck

Choose the correct answer from the following.

(A)	(B)	(C)	(D)
P-1	P-2	P-1	P-3
Q-2	Q-3	Q-2	Q-1
R-3	R-4	R-4	R-2
S-4	S-1	S-3	S-4

Q.86 Match the tectonic setting in List I with their corresponding associates in List II

List I	List II
P Subduction zone	1 Salt domes
Q Spreading centre	2 Diamondiferous kimberlite
R Intracontinental rift	3 Porphyry copper
S Passive continental margin	4 Black smoker

Choose the correct answer from the following

(A)	(B)	(C)	(D)
P-3	P-2	P-3	P-4
Q-2	Q-3	Q-4	Q-3
R-4	R-4	R-2	R-2
S-1	S-1	S-1	S-1

Q.87 The sulfur isotopic composition of chalcopyrite ($\delta^{34}S_{Cp}$) in a hydrothermal Pb-Zn sulfide deposit formed at 330°C is 5.595 ‰. The galena–chalcopyrite sulphur isotopic thermometric expression is given by

$$T\,(K) = \left(\frac{-0.58x10^{6}}{\Delta_{Gn-Cp}}\right)^{1/2}$$

The equilibrium S-isotopic composition of galena ($\delta^{34}S_{Gn}$) is

(A) – 4.2 ‰

(B) – 1.2 ‰

(C) +1.2 ‰

(D) + 4.2 ‰

Q.88 The mean grain size of a sand sample is 8^{-1} mm. In Φ (phi) scale this grain size is

(A) 0.125

(B) 2.000

(C) 3.000

(D) 4.000

Q.89 Which of the following can not be used as a shear sense indicator?

(A) Mica fish

(B) V-pull aparts

(C) Φ-type porphyroclasts

(D) Quartz c-axis LPO (lattice preferred orientation) pattern

Q.90 Plane strain is indicated by

(A) $\lambda_1 > \lambda_2 = 0 > \lambda_3$

(B) $\lambda_1 \leq \lambda_2 = 1.0 \leq \lambda_3$

(C) $\lambda_1 \geq \lambda_2 = 1.0 \geq \lambda_3$

(D) $\lambda_1 > \lambda_2 = 1.0 > \lambda_3$

End of the question paper

2005
GG : Geology and Geophysics

Duration : Three Hours | Maximum Marks :150

Read the following instructions carefully.

1. This question paper contains all objective questions. Q.1 to Q.30 carry **one** mark each and Q.31 to Q.80 carry **two** marks each. Q. 81 to Q. 85 each contains part "a" and "b". In these questions, parts "a" as well as "b" carry **two** marks each.

2. Answer all the questions.

3. Questions must be answered on special machine gradable **O**bjective **R**esponse **S**heet (**ORS**) by darkening the appropriate bubble (marked A, B, C, D) against the question number on the left hand side of the **ORS,** using **HB** pencil. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely using a good soft eraser.

4. There will be **NEGATIVE** marking. In Q.1 to Q.30, **0.25** mark will be deducted for each wrong answer and in Q.31 to Q.80, **0.5** mark will be deducted for each wrong answer. In Q.81 to Q.85, for the part "a", **0.5** mark will be deducted for a wrong answer. Marks for correct answers to part "b" of Q.81 to Q.85 will be given only if the answer to the corresponding part "a" is correct. However, there is no negative marking for part "b" of Q. 81 to Q.85. More than one answer bubbled against a question will be deemed as an incorrect response.

5. Write your registration number, name and name of the Centre at the specified locations on the right half of the **ORS**.

6. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.

7. Calculator is allowed in the examination hall.

8. Charts, graph sheets or tables are not allowed.

9. Use the blank pages given at the end of the question paper for rough work.

10. This question paper contains **24** printed pages including pages for rough work. Please check all pages and report, if there is any discrepancy.

Q. 1 – Q. 30 carry one mark each.

Q.1 The direction of motion of blocks on either side of a transform fault is

(A) diagonal to the ridge axis
(B) parallel to the ridge axis
(C) same as the direction of the ridge offset
(D) opposite to the direction of the ridge offset

Q.2 In igneous rocks, when plagioclase grains are enclosed by pyroxene, the texture is termed as

(A) ophitic
(B) porphyritic
(C) graphic
(D) myrmekitic

Q.3 In terms of generation of petroleum, a possible source rock is of no importance even if it contains sufficient amount of kerogen of type

(A) I
(B) II
(C) III
(D) IV

Q.4 Electrical conductivity of quartz arenite, saturated with water of given salinity

(A) remains same with increasing temperature
(B) decreases with increasing temperature
(C) increases with increasing temperature
(D) may vary randomly with increasing temperature

Q.5 A thermodynamic closed system refers to

(A) transfer of mass but not energy
(B) transfer of both energy and mass
(C) transfer of energy but not mass
(D) transfer of neither mass nor energy

Q.6 GPS is used as

(A) gravity profiling system
(B) ground penetrating system
(C) gas prospecting system
(D) geographic location system

Q.7 The neutral pH of pure water at 300°C is

(A) equal to 7.0
(B) less than 7.0
(C) more than 7.0
(D) more than 7.5

Q.8 The magnetic anomaly at the crest of mid-oceanic ridges is

(A) positive
(B) negative
(C) varies from positive to negative
(D) zero

Q.9 Porphyry copper deposits are characteristically associated with

(A) divergent boundaries
(B) subduction zones
(C) continent-continent collisional zones
(D) transform faults

Q.10 Seismic reflection surveys deal with the recording of signals of

(A) high frequency and later arrivals
(B) high frequency and first arrivals
(C) low frequency and later arrivals
(D) low frequency and first arrivals

Q.11 Which of the following is NOT found in a typical ophiolite suite?

(A) Hydrothermally altered pillow basalt
(B) Serpentinized ultramafic rocks
(C) Pelagic sediments
(D) Reefal limestone

Q.12 A 'clay-core' is an essential part of

(A) Arch dam
(B) Buttress dam
(C) Gravity dam
(D) Earth dam

Q.13 Polar flattening is defined as the

(A) ratio of equatorial to polar radii of the Earth
(B) ratio of polar to equatorial radii
(C) difference of equatorial and polar radii divided by equatorial radius
(D) difference of equatorial and polar radii divided by polar radius

Q.14 Amongst the following logs, which one gives the best estimate of TOC (total organic carbon)?

(A) gamma log
(B) acoustic log
(C) induction log
(D) caliper log

Q.15 In coastal aquifer affected by saltwater intrusion, depth of the interface is defined by

(A) Stock's law
(B) Ghyben-Herzberg principle
(C) Jacob's equation
(D) Darcy's law

Q.16 The Mesozoic-Cenozoic boundary is placed at

(A) 45 Ma
(B) 75 Ma
(C) 65 Ma
(D) 105 Ma

Q.17 Plucking, abrasion and ablation are terms related to

(A) rivers
(B) glaciers
(C) oceans
(D) wind

Q.18 Which of the following is an Upper Gondwana plant fossil?

(A) *Glossopteris*
(B) *Gangamopteris*
(C) *Vertebraria*
(D) *Otozamites*

Q.19 Sum of deviations from mean of a variable is

(A) zero
(B) one
(C) equal to range
(D) half of range

Q.20 The most abundant element in the Earth's crust is

(A) Al
(B) Fe
(C) O
(D) Si

Q.21 The usual temperature range of granulite facies metamorphism is

(A) 400-600°C
(B) 500-700°C
(C) 700-900°C
(D) 900-1200°C

Q.22 The coordination number of Ca with oxygen in the perovskite structure is

(A) 4
(B) 6
(C) 8
(D) 12

Q.23 Most of the world's oil source rocks belong to

(A) Mesozoic
(B) Paleozoic
(C) Cenozoic
(D) Proterozoic

Q.24 A sedimentary basin accumulates huge thickness of sediments if

(A) subsidence rate is fast and sedimentation rate is slow
(B) subsidence rate is fast and sedimentation rate is fast
(C) subsidence rate is slow and sedimentation rate is fast
(D) subsidence rate is slow and sedimentation rate is slow

Q.25 Vertical component of the Earth's magnetic field will be maximum at

(A) geomagnetic equator
(B) geographic equator
(C) geographic poles
(D) geomagnetic poles

Q.26 The basins formed in the continent-continent collisional settings are known as

(A) trench-slope basins
(B) peripheral foreland basins
(C) rift basins
(D) pull-apart basins

Q.27 Due to denudation, mountains are reduced to low relief landform, which is termed as

(A) mesa
(B) peneplain
(C) table mountain
(D) karst

Q.28 Which one of the following coal/lignite deposits is of Permian age?

(A) Makum (Assam)
(B) Palana (Rajasthan)
(C) Jharia (Jharkhand)
(D) Neyveli (Tamil Nadu)

Q.29 The mineral assemblage omphacite + pyrope-rich garnet belongs to

(A) blueschist facies
(B) eclogite facies
(C) granulite facies
(D) pyroxene hornfels facies

Q.30 With increase in API gravity of oil in a reservoir, the seismic wave velocity

(A) increases
(B) decreases
(C) does not change
(D) varies erratically

Q. 31 to Q. 80 carry two marks each

Q.31 Which one of the following rocks is the most compactable?

(A) Sandstone
(B) Shale
(C) Conglomerate
(D) Limestone

Q.32 'Bright spots' are associated with

(A) zones of very high gravity and magnetic anomalies
(B) zones of very high electrical current density in subsurface
(C) interfaces between gas and underlying oil/water layers
(D) zones of very high radioactivity

Q.33 Progradation of sediments in coastal margins is best indicated by

(A) onlap
(B) toplap
(C) downlap
(D) concordance

Q.34 Resistivity of a water sample having a conductivity of 4000 μmho/cm is

(A) 250 Ω.cm
(B) 400 Ω.cm
(C) 2500 Ω.cm
(D) 25 Ω.cm

Q.35 Planar cross-beds in horizontal bedded sandstone indicate the following paleo-current directions in a locality.
N5°, N350°, N5°, N10°, N355°, N5°, N355°, N345°, N355°, N15°
The mean paleo-current direction at the locality is

(A) N15°
(B) N180°
(C) N355°
(D) N360°

Q.36 Volume of a sample of sandstone is 200 cc. The volume of the solid mass of this sample is 140 cc. The volume of isolated unconnected pore spaces in the sample is estimated as 20 cc. The percent effective porosity of the sandstone is

(A) 10
(B) 20
(C) 28
(D) 30

Q.37 Which of the following is not a method of radiometric dating?

(A) U– Pb
(B) Ar–Ar
(C) Pb–Pb
(D) Rb–Rb

Q.38 Choose the mineral that contains iron in both bivalent and trivalent oxidation states from the following.

(A) Goethite
(B) Hematite
(C) Magnetite
(D) Siderite

Q.39 The magnitude of SP anomaly over a massive sulfide ore body is

(A) a few millivolts
(B) a few tens of millivolts
(C) a few hundreds of millivolts
(D) a few volts

Q.40 Prof. Kaul took 64 gm of a radiometric sample for gamma ray spectroscopy at 20.00 Hr. Next morning he returned to the laboratory at 08.00 Hr and found that only 1 gm of the radioactive material was left. The half-life of radioactive sample is

(A) 2.00 hours
(B) 2.50 hours
(C) 4.00 hours
(D) 5.33 hours

Q.41 Choose the correct mineral pair that has minimum hardness–maximum specific gravity combination from the following.

(A) Calcite–quartz
(B) Gypsum–barite
(C) Orthoclase–calcite
(D) Quartz–topaz

Q.42 On a stereoplot the bedding plane plots as a straight line passing through the center. The bed is

(A) vertical
(B) horizontal
(C) steeply dipping
(D) gently dipping

Q.43 Basins with thick piles of sediments are characterized by

(A) positive gravity and low magnetic anomalies
(B) negative gravity and low magnetic anomalies
(C) positive gravity and high magnetic anomalies
(D) negative gravity and high magnetic anomalies

Q.44 Which one of the following physical properties of rocks changes abruptly in the presence of ground water?

(A) Seismic velocity
(B) Electrical resistivity
(C) Density
(D) Magnetic susceptibility

Q.45 The combination of geophysical methods most suitable for exploration of chromite deposits is

(A) radiometric and electrical methods
(B) magnetic and electrical methods
(C) gravity and magnetic methods
(D) gravity and electrical methods

Q.46 A uranium deposit is exposed on the surface. The emitted α particles can travel in air up to

(A) 20 cm
(B) 1 meter
(C) 10 meter
(D) 100 meter

Q.47 Fluxgate magnetometer can measure

(A) only the horizontal component of magnetic field (H)
(B) only the vertical component of magnetic field (V)
(C) only total magnetic field (F)
(D) any component as well as total magnetic field

Q.48 Most of the sulfide minerals are electrically conductive. However, there is an exception to this. Choose the exception from the following

(A) Galena (PbS)
(B) Sphalerite (ZnS)
(C) Pyrite (FeS_2)
(D) Chalcopyrite ($CuFeS_2$)

Q.49 According to the Darcy's law, hydraulic conductivity is defined as ('i' being the hydraulic gradient)

(A) K= -Q/iA
(B) K= -iA/Q
(C) K= -i/AQ
(D) K= AQ/i

Q.50 Match the following and choose the correct combination

Group I (Parent rock)	Group-II (Metamorphic equivalent)
P. Shale	1. Amphibolite
Q. Limestone	2. Quartzite
R. Sandstone	3. Mica schist
S. Basalt	4. Marble
	5. Gondite
	6. Acid charnockite

(A)	(B)	(C)	(D)
P-3	P-1	P-1	P-3
Q-4	Q-4	Q-4	Q-4
R-2	R-2	R-2	R-5
S-1	S-3	S-5	S-6

Q.51 Which of the following statements is correct?

(A) Geometry of reflection time-distance curve is a parabola
(B) Earth acts as a high pass filter
(C) Convolution in time domain is equal to multiplication in frequency domain
(D) Critical distance is more than the cross-over distance

Q.52 If the solubility product of $CaSO_4.2H_2O$ is $10^{-4.36}$, and stability constant of $CaSO_4^o$ (uncharged dissolved species) is $10^{2.23}$, then the activity of $CaSO_4^o$ in pure water is

(A) $10^{-2.13}$
(B) $10^{-6.59}$
(C) $10^{2.23}$
(D) $10^{-1.13}$

Q.53 Choose the correct normative mineral assemblage in igneous rocks from the following

(A) quartz + hypersthene + albite
(B) nepheline + olivine + quartz
(C) quartz + nepheline + olivine
(D) olivine + quartz + anorthite

Q.54 In an alluvium-covered area, a seismic reflection survey was carried out to investigate the attitude of sandstone beds striking N-S. Two geophones A and B were located at distances 50 meter each towards east and west of the shot point respectively. The travel time of seismic waves at geophone A and B are 100 and 150 msec respectively from the dipping sandstone surface. If the velocity of seismic wave in alluvium is 1000 m/sec, then the dip of the sandstone bed is

(A) 30° due West
(B) 30° due East
(C) 45° due West
(D) 45° due East

Q.55 Choose the phosphatic-walled microfossil from the following.

(A) Conodont
(B) Bryozoa
(C) Diatoms
(D) Dinoflagellate

Q.56 In a two-layer case, seismic wave velocities V_1 and V_2 are 2000 and 3000 m/sec respectively and the thickness of top horizontal layer h_1 is 100 m. The normal move out (NMO) correction for a geophone placed at 50 m away from the shot point will be

(A) $\frac{25}{2}$ msec
(B) $\frac{25}{4}$ msec
(C) $\frac{25}{8}$ msec
(D) $\frac{25}{12}$ msec

Q.57 Dominance of the Banded Iron Formations in the Precambrian time is due to

(A) greater concentration of iron
(B) high P_{N2} in the atmosphere
(C) low P_{CO2} in the atmosphere
(D) high P_{CO2} in the atmosphere

Q.58 A time series having 'n' samples is convolved with a filter function of length 'm'. The length of resultant signal is

(A) n + m
(B) n - m
(C) n + m -1
(D) nm

Q.59 In a flow regime, the 'bedforms' formed with increasing current velocity are

(A) dunes – ripples – plane beds – antidunes
(B) ripples – dunes – plane beds – antidunes
(C) antidunes – dunes – ripples – plane beds
(D) plane beds – ripples – dunes – antidunes

Q.60 Analog seismic reflection data is band-passed between frequencies 20–50 Hz. These data were digitized for storing in digital form, for further processing. What should be the maximum sampling interval to avoid aliasing?

(A) 5 msec
(B) 10 msec
(C) 15 msec
(D) 20 msec

Q.61 Which one of the following rocks has the highest tensile strength?

(A) Granite
(B) Sandstone
(C) Slate
(D) Marble

Q.62 Electrical potential at a distance 'r' from a single current electrode placed on the ground is given by $V = \frac{\rho I}{2\pi r}$. The expression for apparent resistivity for the Schlumberger array in terms of electric field over homogeneous half-space will be

(A) $\rho_a = \pi r^2 \frac{E}{I}$

(B) $\rho_a = 2\pi r^2 \frac{E}{I}$

(C) $\rho_a = 3\pi r^2 \frac{E}{I}$

(D) $\rho_a = 4\pi r^2 \frac{E}{I}$

Q.63 Cell parameters of the Orthorhombic system correspond to

(A) $a \neq b \neq c, \alpha = \beta = \gamma = 90^0$

(B) $a = b \neq c, \alpha = \beta = \gamma = 90^0$

(C) $a = b = c, \alpha = \beta = \gamma = 90^0$

(D) $a \neq b \neq c, \alpha = \gamma = 90^0, \beta \neq 90^0$

Q.64 Which of the following resistivity sounding curves is not possible to draw?

(A) KQ type
(B) KH type
(C) HK type
(D) QK type

Q.65 What is degree of freedom in P-T space for the following metamorphic reaction in KFMASH system?
Staurolite + muscovite + quartz = kyanite + biotite + H_2O

(A) 0
(B) 1
(C) 2
(D) 3

Q.66 Resistivity variation in a 3-layer sequence with thicknesses 'h_1' and 'h_2' is $\rho_1 > \rho_2 < \rho_3$. If the top two layers are merged to form a single homogeneous layer of resistivity ρ_e and thickness 'h_e', then

(A) $h_e < h_1 + h_2$
(B) $h_e = h_1 + h_2$
(C) $h_e > h_1 + h_2$
(D) $h_e = h_2/h_1$

Q.67 Which of the following macerals in a given coal sample shows the highest reflectance?

(A) Vitrinite
(B) Liptinite
(C) Exinite
(D) Inertinite

Q.68 Which of the following statements is NOT true for EM prospecting?

(A) Frequency of primary and secondary fields remain same
(B) Primary source of MT field lies fairly outside the Earth
(C) Very low frequency EM method has large depth of exploration
(D) Transient EM method is free from primary field interference at receiver coil

Q.69 Branching ratio is encountered in the

(A) Rb-Sr system
(B) Sm-Nd system
(C) U-Th-Pb system
(D) K-Ar system

Q.70 In any time varying magnetic field if we put a closed loop then an induced emf is generated in the loop. Which of the following expressions deals with the above phenomenon?

(A) $\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$

(B) $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

(C) $\nabla . \vec{D} = \rho$

(D) $\nabla . \vec{B} = 0$

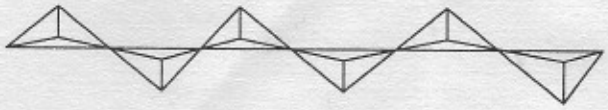
Q.71 A shale sample contains organic matter characterized by TOC of 2 %. The kerogen in it is of type II. The vitrinite in the organic matter of this shale shows average reflectance of 3 %. Under such conditions the shale has acquired maturity to reach the generation stage of

(A) oil only
(B) oil and wet gas only
(C) dry gas only
(D) wet gas only

Q.72 Which of the following is the correct statement?

(A) AFMAG method uses 5 – 50 kHz frequency range
(B) Very low frequency (VLF) method uses 1 – 1000 Hz frequency range
(C) Magnetotelluric method uses 10^{-5} – 1 Hz frequency range
(D) Controlled source EM methods use 100 kHz – 1 MHz frequency range

Q.73 The figure shown below represents sharing of oxygen between neighboring SiO_4 tetrahedra in a silicate structure. The silicate mineral is



(A) Biotite
(B) Garnet
(C) Diopside
(D) Orthoclase

Q.74 Which of the following pairs of statements is correct for upward continuation of gravity anomaly?
(i) High frequency anomaly filtered out
(ii) Low frequency anomaly filtered out
(iii) Magnitude of gravity anomaly increases as compared to the anomaly at the surface
(iv) Magnitude of gravity anomaly decreases as compared to the anomaly at the surface

(A) (i) and (ii)
(B) (ii) and (iii)
(C) (i) and (iii)
(D) (i) and (iv)

Q.75 Match the following stratigraphic units (Group 1) with their corresponding ages (Group 2).

Group 1	Group 2
P. Sirbu Shale	1. Neoproterozoic
Q. Muth Quartzite	2. Quaternary
R. Kantkote Sandstone	3. Paleozoic
S. Kopili Shale	4. Tertiary
	5. Mesozoic
	6. Paleoproterozoic

(A)	(B)	(C)	(D)
P-1	P-6	P-3	P-1
Q-6	Q-1	Q-1	Q-3
R-3	R-5	R-5	R-5
S-4	S-4	S-4	S-4

Q.76 The maximum amplitude of variation in acceleration due to gravity 'g' due to tidal effect is

(A) 0.3 Gal
(B) 0.03 Gal
(C) 0.3 mGal
(D) 0.03 mGal

Q.77 Which of the following is a texturally immature but mineralogically matured sandstone?

(A) Arkose
(B) Quartz wacke
(C) Lithic wacke
(D) Quartz arenite

Q.78 Which of the following is the correct statement?

(A) Gas and oil contact is assessed by Induction log
(B) Density is determined by Gamma-Gamma log
(C) Sand and shale boundary is demarcated by Micro log
(D) Cavity is located by self-potential log

Common Data Questions

Common Data for Questions 79, 80:
An undersaturated petroleum-bearing sandstone is characterized by the following parameters. (i) Area =100 sq km, (ii) average 'pay' thickness = 10 m, (iii) average porosity = 20%,

(iv) average water saturation = 30%, (v) depth of occurrence of the sandstone = 1530–1500 m, (vi) electrical resistivities of the zones between 1530–1510 and 1510–1500 meters are 20 and 100 Ω.m respectively, (vii) FVF = 1.1, (viii) specific gravity of petroleum = 0.9.

Q.79 Which of the following is correct?

(A) Free gas occurs in the upper 10 m of the sandstone
(B) Free gas and oil occur in the upper 10 m of the sandstone
(C) Condensate and relatively fresh water occur in upper 10 m of the sandstone
(D) Oil occurs in the upper 10 m of the sandstone

Q.80 The 'in place' geological reserve of petroleum in million tonnes in the pool is about

(A) 60
(B) 80
(C) 100
(D) 114

Linked Answer Questions: Q.81a to Q.85b carry two marks each

Statement for Linked Answer Questions 81a & 81b:

CO_2 dissolves in water to produce carbonic acid.

Q.81a The equilibrium constant $\left(K_{CO_2}\right)$ for CO_2 dissolution reaction is expressed as

(A) $K_{CO_2} = \dfrac{a_{H_2}}{a_{H_2CO_3}}$

(B) $K_{CO_2} = \dfrac{a_{H^+} a_{CO_3^{-2}}}{a_{H_2CO_3}}$

(C) $K_{CO_2} = \dfrac{a_{H_2CO_3}}{P_{CO_2} a_{H_2O}}$

(D) $K_{CO_2} = \dfrac{a_{CO_2} a_{H_2CO_3}}{a_{H_2O}}$

Q.81b In the above case if $a_{H_2CO_3} = 10^{-2.004}$; $K_{CO_2} = 10^{-1.47}$, then the partial pressure of CO_2 is

(A) $10^{-0.534}$
(B) $10^{-3.474}$
(C) $10^{-2.47}$
(D) $10^{-1.47}$

Statement for Linked Answer Questions 82a & 82b:

The value of acceleration due to gravity 'g' is maximum at the

Q.82a

(A) Conrad discontinuity
(B) Mohorovicic discontinuity
(C) Gutenberg discontinuity
(D) Lehman discontinuity

Q.82b The body wave reflected from this discontinuity is

(A) PKiKP
(B) PcP
(C) PmP
(D) Pn

Statement for Linked Answer Questions 83a & 83 b:

A horizontal bedded, thick and compact sandstone is overlain by alluvium in a flat area. Based on seismic refraction investigation in the area, the usual travel time-distance plot was prepared. It shows two straight lines- the one passing through origin, has slope of 5×10^{-4} sec/m and the other intercepting the travel-time axis has a slope 25×10^{-5} sec/m.

Q.83a The velocities V_1 & V_2 (in m/sec) of seismic wave in the alluvium and the sandstone respectively are

(A) 2000 m/sec and 4000 m/sec
(B) 4000 m/sec and 2000 m/sec
(C) 500 m/sec and 250 m/sec
(D) 250 m/sec and 500 m/sec

Q.83b If from the shot point, the critical distance (d_c) where the direct and refracted rays reach at the same time, is 400 m, the thickness of alluvium above sandstone is about

(A) 115 m
(B) 131 m
(C) 340 m
(D) 640 m

Statement for Linked Answer Questions 84a & 84b:

In the Earth's upper mantle

Q.84a The rock commonly believed to exist is
(A) lamprophyre
(B) eclogite
(C) garnet peridotite
(D) kimberlite

Q.84b Mineralogy of the above rock can be represented by the assemblage
(A) olivine + orthopyroxene + clinopyroxene + garnet
(B) olivine + plagioclase + clinopyroxene
(C) olivine + orthopyroxene + plagioclase + garnet
(D) olivine + spinel + orthopyroxene + clinopyroxene

Statement for Linked Answer Questions 85a & 85b:

In an orogenic belt, the principal stress axes are oriented in the following manner

(i) σ_1 is horizontal (E-W)

(ii) σ_2 is horizontal (N-S)

(iii) σ_3 is vertical

where $\sigma_1 > \sigma_2 > \sigma_3$

Q.85a Such an orientation of the stress axes can produce

(A) N-S striking thrust
(B) N-S striking gravity fault
(C) E-W striking thrust
(D) N-S striking gravity fault

Q.85b Regional metamorphism related to the above deformational regime is characterized by

(A) isobaric cooling path
(B) cooling path with minor decompression
(C) anti-clockwise PT path
(D) clockwise PT path

***** END OF THE QUESTION PAPER *****

SPACE FOR ROUGH WORK

2006

GG: Geology & Geophysics

Duration : Three Hours | Maximum Marks :150

Read the following instructions carefully.

1. This question paper contains all objective questions. Q.1 to Q.20 carry **one** mark each and Q.21 to Q.85 carry **two** marks each.
2. Answer all the questions.
3. Questions must be answered on **O**bjective **R**esponse **S**heet (**ORS**) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the **ORS**. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely.
4. Wrong answers will carry NEGATIVE marks. In Q.1 to Q.20, **0.25** mark will be deducted for each wrong answer. In Q.21 to Q.76, Q.78, Q.80, Q.82 and in Q.84 **0.5** mark will be deducted for each wrong answer. However, there is no negative marking in Q.77, Q.79, Q.81, Q.83 and in Q.85. More than one answer bubbled against a question will be taken as an incorrect response.
5. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the **ORS**.
6. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
7. Calculator is allowed in the examination hall.
8. Charts, graph sheets or tables are NOT allowed in the examination hall.
9. Rough work can be done on the question paper itself. Additionally blank pages are given at the end of the question paper for rough work.
10. This question paper contains **20** printed pages including pages for rough work. Please check all pages and report, if there is any discrepancy.

Q. 1 – Q. 20 carry one mark each.

Q.1 Compared with the Earth, which one of the following statements is true for the planet Mars?

(A) It has less number of moons
(B) It is less dense
(C) It is closer to the Sun
(D) It has shorter length of days

Q.2 The volcanic equivalent of gabbro is

(A) basalt (B) dacite (C) rhyodacite (D) rhyolite

Q.3 The Coriolis effect

(A) remains constant throughout the globe
(B) changes with longitude
(C) is zero at the equator and maximum at the poles
(D) is minimum at the poles and maximum at the equator

Q.4 At which discontinuity the isostatic compensation of excess or deficiency of mass occurs?

(A) Conrad discontinuity
(B) Gutenberg discontinuity
(C) Lehman discontinuity
(D) Mohorovicic discontinuity

Q.5 Magnetic stripes in the oceanic crust are due to

(A) sea floor spreading
(B) continental drift
(C) polar wandering
(D) geomagnetic field variation from equator to pole

Q.6 Which one of the following sedimentary deposits is associated with glaciers?

(A) Dune (B) Fanglomerate (C) Moraine (D) Point bar

Q.7 Chromite ores in mafic-ultramafic rocks are formed by

(A) metamorphic processes
(B) magmatic processes
(C) hydrothermal processes
(D) weathering process

Q.8 The stable state of a geochemical system refers to the configuration with

(A) minimum possible entropy
(B) maximum possible entropy
(C) minimum possible Gibbs free energy
(D) maximum possible Gibbs free energy

Q.9 A vertical dipping barite deposit below a soil cover of 50 meters can be delineated by

(A) Gravity method
(B) Magnetic method
(C) Radioactive method
(D) Self-potential method

Q.10 Age of the reservoir that accounts for the maximum production of petroleum in the Bombay High is

(A) Jurassic (B) Miocene (C) Pleistocene (D) Triassic

Q.11 Which one of the following is a silicate mineral?

(A) Barite (B) Calcite (C) Dolomite (D) Quartz

Q.12 The warmest period in the Earth's history was

(A) Cretaceous (B) Miocene (C) Oligocene (D) Pleistocene

Q.13 The type of orogeny involving oceanic crust on one side and continental crust on the other, is known as

(A) Acadian
(B) Andean
(C) Himalayan
(D) Island-arc

Q.14 The Earth's core is believed to be composed of

(A) solid Fe + Ni alloys
(B) liquid Fe + Ni alloys
(C) partially liquid and partially solid Fe + Ni alloys
(D) solid Fe + Co alloys

Q.15 The horizontal component of dip slip fault is termed as

(A) hade (B) heave (C) plunge (D) throw

Q.16 The array used to map simultaneously the lateral and vertical variations in electrical conductivity is

(A) Multi-electrode Axial dipole array
(B) Schlumberger array
(C) Two-electrode array
(D) Wenner array

Q.17 The terms fluxgate, proton precession and optical pumping are used to describe various

(A) gravimeters
(B) magnetometers
(C) resistivitymeters
(D) seismographs

Q.18 Ground roll, the main source of noise in seismic survey, is composed of

(A) Love waves
(B) P-waves
(C) Rayleigh waves
(D) S-wave

Q.19 The process of mechanical disintegration and/or chemical decomposition along with transportation by a natural agent at surface conditions, is known as

(A) denudation (B) erosion (C) exfoliation (D) weathering

Q.20 Which one of the following is related to destructive plate margins?

(A) Guyots
(B) Mid-oceanic ridges
(C) Transcurrent faults
(D) Trenches

Q. 21 to Q. 75 carry two marks each.

Q.21 Match localities in Group I with their corresponding mineral deposits in Group II

Group I	Group II
P. Zawar	1. Chromite
Q. Hutti	2. Magnesite
R. Sukinda	3. Lead-Zinc
S. Almora	4. Gold

(A)	(B)	(C)	(D)
P-1	P-3	P-4	P-3
Q-2	Q-2	Q-2	Q-4
R-4	R-4	R-3	R-1
S-3	S-1	S-1	S-2

Q.22 The ore mineral characterized by light yellow color, high reflectivity and high polishing hardness is

(A) Chalcopyrite
(B) Galena
(C) Pyrite
(D) Sphalerite

Q.23 Consider a hydrothermal zinc deposit containing 5 million tonnes of ore with an average grade of 2 per cent zinc. A typical ore forming fluid contains 500 ppm zinc. Assuming the fluid density of 1000 $kg.m^{-3}$, the volume of fluid required to form the ore deposit is

(A) 2×10^6 m^3
(B) 2×10^7 m^3
(C) 2×10^8 m^3
(D) 2×10^{10} m^3

Q.24 Match the localities in Group I with the associated rock types in Group II

	Group I	Group II
P.	Dharwar Craton	1. Eclogites
Q.	Gondwana Basin	2. Carbonatite
R.	Sung Valley	3. Greenstone
S.	Tso-Morari Crystallines	4. Lamprophyre

(A)	(B)	(C)	(D)
P-2	P-3	P-2	P-3
Q-1	Q-4	Q-1	Q-1
R-3	R-2	R-4	R-2
S-4	S-1	S-3	S-4

Q.25 Rock 'X' is thrust over rock 'Y'. Subsequently, rock 'Y' is exposed to surface in the midst of rock 'X' by erosion. The exposure of rock surrounded by rock 'X' forms

(A) inlier
(B) klippe
(C) outlier
(D) window

Q.26 Melting in mantle is NOT caused by

(A) addition of water
(B) decrease in pressure
(C) increase in pressure
(D) increase in temperature

Q.27 Formation of ilmenite lamellae in magnetite is explained by

(A) only oxidation
(B) only exsolution
(C) exsolution followed by oxidation
(D) oxidation followed by exsolution

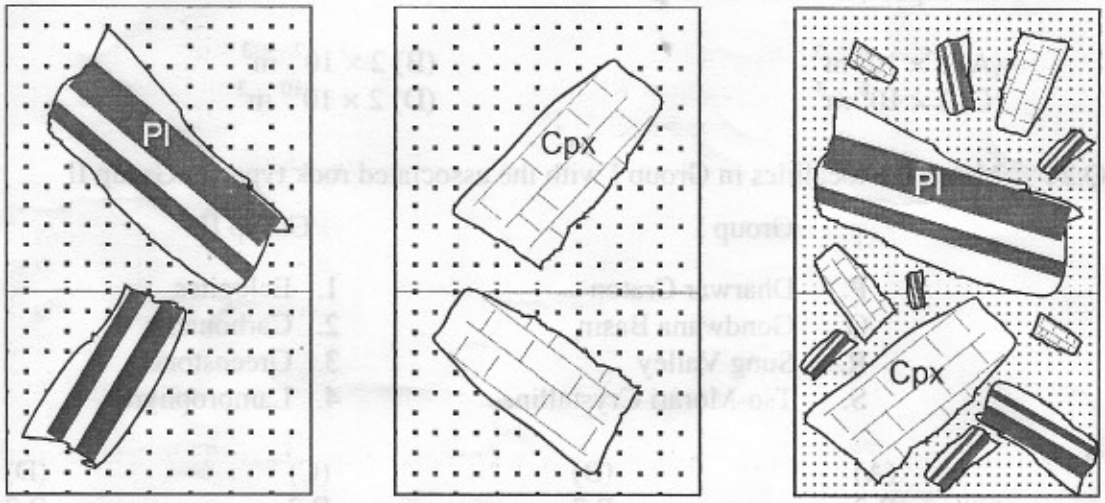
Q.28 The second sillimanite isograd is marked by

(A) absence of muscovite and presence of sillimanite
(B) absence of both muscovite and sillimanite
(C) presence of both muscovite and sillimanite
(D) presence of muscovite and absence of sillimanite

Q.29 The standard Gibbs free energy change of a reaction can be written as

(A) $\Delta G_r^o = RP \ln K$
(B) $\Delta G_r^o = -RP \ln K$
(C) $\Delta G_r^o = RT \ln K$
(D) $\Delta G_r^o = -RT \ln K$

Q.30 Schematic sketches illustrating photomicrographs of three basaltic samples (X, Y, Z), containing anorthite rich plagioclase (Pl) and diopside (Cpx) phenocrysts are shown below.



Crystallization behavior of these basalts is explained in the diopside – anorthite system which has an eutectic at a composition of anorthite 42 (wt %). Correct combination of melt composition for the three basalts is

(A) X:M < 42, Y:M > 42, Z:M = 42 (B) X:M = 42, Y:M > 42, Z:M < 42
(C) X:M < 42, Y:M = 42, Z:M > 42 (D) X:M > 42, Y:M < 42, Z:M = 42

Q.31 Anticlockwise P-T-t paths are characterized by

(A) attainment of P_{max} before T_{max}
(B) attainment of T_{max} before P_{max}
(C) attainment of P_{max} and T_{max} at the same time
(D) subduction zone metamorphism

Q.32 The thermometric expression pertaining to oxygen isotope fractionation between quartz (qtz) and water (w) is given by $10^3 \ln \alpha_{qtz-w} = \left\{3.13\times10^6 (T)^{-2}\right\} - 2.94$. If the analyzed $\delta^{18}O$ value of hydrothermal quartz is 12 ‰, and isotope equilibrium temperature is 250°C, the $\delta^{18}O$ value of water is

(A) 3.5 ‰ (B) 4.5 ‰ (C) 5.2 ‰ (D) 6.2 ‰

Q.33 Which one of the following sedimentary environments is characterized by evaporites?

(A) Anastomosing channels (B) Crevasse splay
(C) Marsh (D) Sabkha

Q.34 Match the sedimentary process in Group I with the associated sedimentary structures in Group II

Group I	Group II
P. Dessication	1. Stylolite
Q. Migration of Ripples	2. Current Crescent
R. Pressure Solution	3. Cross-beds
S. Scouring	4. Sun-cracks

(A)	(B)	(C)	(D)
P-4	P-3	P-4	P-3
Q-3	Q-4	Q-1	Q-1
R-1	R-2	R-2	R-2
S-2	S-1	S-3	S-4

Q.35 A bivalvia has small simple teeth near the edge of the valve. This kind of dentition is known as

(A) Dysodont
(B) Pachydont
(C) Palaeotaxodont
(D) Schizodont

Q.36 Which one of the following foraminifera is characterized by uniserial chamber arrangement?

(A) *Bolivina* (B) *Cibicides* (C) *Elphidium* (D) *Nodosaria*

Q.37 The foraminiferal assemblage of a core sample dominantly consists of *Uvigerina, Lenticulina, Bulimina, Globigerina* and *Globorotalia*. The paleoenvironment indicated by the assemblage is

(A) outer shelf
(B) estuarine
(C) coastal – inner shelf
(D) terrestrial

Q.38 The youngest marine record overlying the Precambrian strata in Himalaya is

(A) Haimanta Group
(B) Kasauli Formation
(C) Siwalik Group
(D) Subathu Formation

Q.39 The Gondwana sedimentation in India is characterized by

P. swampy environment
Q. glacial climate
R. marine intercalations
S. trap flows

Which one of the following combinations is true for the Upper Gondwana?

(A) Q, R (B) R, S (C) P, S (D) P, Q

Q.40 Which one of the following statements is true about the boundaries of lithostratigraphic units?

(A) They are of the same age in all parts of the basin
(B) They can also be time – transgressive
(C) They must coincide with chronostratigraphic boundaries
(D) They are defined by the stratigraphic ranges of fossils

Q.41 The transgressive system tract and highstand system tract are separated by

(A) transgressive surface
(B) lowstand system tract
(C) sequence boundary
(D) maximum flooding surface

Q.42 Which one of the following oil fields is producing petroleum from 'shales'?

(A) Ankaleshwar (B) Borehola (C) Indrora (D) Narimanam

Q.43 If the oil window zone occurs between 1.0 to 2.5 km, the geothermal gradient of the sedimentary basin is about

(A) 1° C / 100m
(B) 2° C / 100m
(C) 6° C / 100m
(D) 20° C / 100m

Q.44 The GIS function which deals with the transport of resources from one location to another, is known as

(A) Contiguity Function
(B) Network Function
(C) Proximity Function
(D) Spread Function

Q.45 A sandstone aquifer has hydraulic conductivity of 30 m/d and its transmissivity is 150 m^2/d. Its average thickness is

(A) 5.0 m (B) 9.0 m (C) 22.5 m (D) 450 m

Q.46 During the processing of seismic data, the slantness of reflection paths is removed by

(A) elevation correction
(B) normal moveout correction
(C) dip moveout correction
(D) automatic static correction

Q.47 The output of a geophone is proportional to ground

(A) displacement (B) velocity (C) acceleration (D) strain

Q.48 At a sampling interval of 4.0 ms, a signal is observed to alias as a 75 Hz frequency. The actual frequency of the observed signal is

(A) 125 Hz (B) 150 Hz (C) 175 Hz (D) 200 Hz

Q.49 In seismic reflection prospecting, random noise is removed by geophone grouping and

(A) deconvolution
(B) f-k filtering
(C) Wiener filtering
(D) stacking

Q.50 Which one of the following seismic features indicates presence of hydrocarbon but NOT the lithological boundary?

(A) chaotic reflections
(B) dim spot
(C) flat spot
(D) polarity reversal

Q.51 A sandstone unit is characterized by porosity 10% and water saturation 50%. The P-wave velocity in its matrix is 5000 m/s. Assuming the P-wave velocity in oil and water as 1280 m/s and 1500 m/s respectively, the P-wave velocity (m/s) in sandstone unit is

(A) 3550 (B) 3650 (C) 3960 (D) 4200

Q.52 In an earthquake affected area, the focal mechanism solution suggests a near vertical plunge of T-axis. It indicates

(A) a normal fault
(B) a strike slip fault
(C) an oblique fault with appreciable dip slip component
(D) a thrust fault

Q.53 The moment magnitude of the great Chilean earthquake of May 1960 was calculated to be 9.5. Its seismic moment in Nm (Newton meter) is

(A) 2.0×10^{23} (B) 2.5×10^{23} (C) 2.0×10^{30} (D) 3.0×10^{30}

Q.54 In well logging, the thermal neutron tool detects neutrons having energy of about

(A) 10000 eV (B) 100 eV (C) 0.025 eV (D) 0.0001 eV

Q.55 A well is drilled with saline water base mud. The electrical resistivity of about 5 m thick sandstone encountered in the well, is determined by

(A) normal resistivity log
(B) lateral resistivity log
(C) micro resistivity log
(D) laterolog

Q.56 'Skip cycle phenomenon' is associated with

(A) Gamma logging
(B) Induction logging
(C) S.P. logging
(D) Sonic logging

Q.57 Total magnetic field at the Earth's equator is

(A) 10000 nT (B) 30000 nT (C) 50000 nT (D) 70000 nT

Q.58 Gamma is a unit of magnetic field. It is equivalent to

(A) Gauss (B) Nano-Tesla (C) Oersted (D) Tesla

Q.59 Which one of the following statements is NOT correct?

(A) Eotvos correction is applied for airborne and shipborne gravity survey
(B) Free-air and Bouguer corrections are always opposite in nature
(C) Lacoste-Romberg gravimeter is a stable gravimeter
(D) Terrain correction is always positive for land gravity survey

Q.60 Ohm.Ampere/meter is the unit of

(A) magnetic flux density (B) magnetic field intensity
(C) electric current density (D) electric field intensity

Q.61 The magnitude of resultant field (combination of primary and secondary magnetic fields) in electromagnetic prospecting is

(A) more than the primary field
(B) less than the primary field
(C) equal to the primary field
(D) equal to the secondary field

Q.62 Match the methodologies from Group I with the parameters they measure in Group II

Group I	Group II
P. TURAM method	1. dip angle
Q. Slingram method	2. electric and magnetic field components
R. Magnetotelluric method	3. amplitude ratio and phase difference
S. VLF method	4. real and imaginary component of secondary field

(A) P-3, Q-4, R-2, S-1 (B) P-2, Q-4, R-3, S-1
(C) P-1, Q-2, R-3, S-4 (D) P-3, Q-1, R-4, S-2

Q.63 An EM wave travels vertically downward in a homogeneous medium of 100 meters skin depth. At a depth of 200 meters, what is the amplitude of the EM wave measured as percent of wave amplitude at the Earth's surface?

(A) 13.53 (B) 18.39 (C) 36.78 (D) 50

Q.64 Which one of the following equations holds good for an irrotational vector quantity $\vec{P}$?

(A) $\nabla \times \vec{P} = \vec{P}$ (B) $\nabla \times \vec{P} = 1.0$
(C) $\nabla \times \vec{P} = 0$ (D) $\nabla \times \vec{P} = |\vec{P}|$

Q.65 Solution of Laplace equation ($\nabla^2 V=0$) in spherical coordinate system assuming spherical symmetry with 'a' and 'b' as constants, is

(A) $V=-ar+b$ (B) $V=-\frac{a}{r}+b$

(C) $V=-\frac{a}{r^2}+b$ (D) $V=-\frac{a}{r^3}+b$

Q.66 In a laboratory experiment, resistivities are measured as 100, 100 and 121 ohm.m in three perpendicular directions of a cubical rock sample of 10 cm length. What is the coefficient of anisotropy of the sample?

(A) 0.82 (B) 0.90 (C) 1.10 (D) 1.21

Q.67 Which one of the following curve types shows both 'equivalence' and 'suppression' problems in resistivity data interpretation?

(A) HK-type (B) KH-type (C) HQ-type (D) QH-type

Q.68 Compton scattering takes place when the energy of gamma rays is

(A) greater than 2 MeV
(B) 200 KeV to 2 MeV
(C) 10 KeV to 200 KeV
(D) less than 10 KeV

Q.69 If 'J' is a $N\times M$ rectangular Jacobian matrix ($N > M$), then the generalized least square inverse of matrix 'J' is

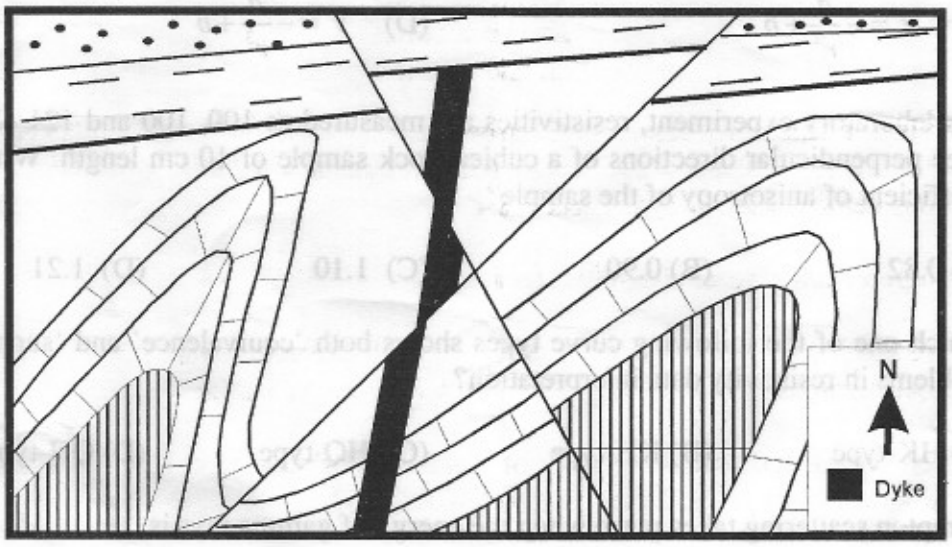
(A) $\left(J^T J\right)^{-1}$ (B) $\left(J J^T\right)^{-1}$ (C) $\left(J^T J\right)^{-1} J^T$ (D) $J^T\left(J J^T\right)^{-1}$

Q.70 In linearized geophysical inverse problems, Marquardt parameter (λ) is added on the diagonal element of a square matrix before finding its inverse. Such operation

(A) makes the solution stable
(B) increases resolution
(C) reduces non-uniqueness
(D) gives the unique solution

Common Data Questions

Common Data for Questions 71, 72, 73: Geological map of an area is given below in the standard format. Based on this, attempt questions 71, 72 and 73.



Q.71 The map indicates which type of unconformity?

(A) Angular unconformity (B) Disconformity
(C) Nonconformity (D) Paraconformity

Q.72 The nature of the conjugate set of faults is

(A) normal fault (B) reverse faults
(C) strike-slip fault (D) thrust

Q.73 The correct sequence (oldest to youngest) of geological events is

(A) Faulting → folding → dyke intrusion → unconformity
(B) Folding → dyke intrusion → unconformity → faulting
(C) Folding → faulting → dyke intrusion→ unconformity
(D) Faulting → folding → unconformity → dyke intrusions

Common Data for Questions 74, 75: To measure the gravity across the Atlantic Ocean, a ship sails from USA to Europe in the East direction at 30°N latitude with a speed of 10 knots in calm water condition. The mean sea level is taken as the datum plane.

Q.74 The magnitude of the Eotvos correction is

(A) –65.0 mgal (B) 0.0 mgal (C) +32.5 mgal (D) +65.0 mgal

Q.75 The magnitude of Free-air correction is

(A) –5.30 mgal (B) 0.0 mgal (C) +2.65 mgal (D) +5.3 mgal

Linked Answer Questions: Q.76 to Q.85 carry two marks each.

Statement for Linked Answer Questions 76 & 77: Some of the conditions for the formation of sandstones are listed below

P. ultramafic source rock
Q. prolonged weathering
R. quick burial
S. arid climate

Modal analysis of a sandstone sample is given below
(i) Quartz = 59.1% (ii) feldspar = 29.7% (iii) rock fragments = 0.2%
(iv) ferruginous cement = 2.5% (v) matrix = 8.4%

Q.76 Petrographically the sandstone is classified as

(A) Arkose
(B) Feldspathic wacke
(C) Quartz arenite
(D) Quartz wacke

Q.77 Which one of the following pairs of combinations (amongst P, Q, R and S) holds good for the class of sandstone interpreted in Q.76?

(A) P, Q (B) Q, R (C) R, S (D) P, S

Statement for Linked Answer Questions 78 & 79: Some igneous and metamorphic rocks were discovered, described and named from Indian localities.

Q.78 Which one of the following rocks was NOT discovered from India?

(A) Anorthosite (B) Charnockite (C) Gondite (D) Khondalite

Q.79 Characteristic mineralogical and geochemical features of the correct rock in Q.78 is dominantly

(A) sodic plagioclase and positive Eu anomaly
(B) sodic plagioclase and negative Eu anomaly
(C) calcic plagioclase and negative Eu anomaly
(D) calcic plagioclase and positive Eu anomaly

Statement for Linked Answer Questions 80 & 81: A petroleum reservoir is characterized by the following parameters
(i) Area = 100 sq.km, (ii) thickness of pay zone = 15 meter, (iii) porosity = 20%,
(iv) water saturation = 25%, (v) API gravity (Degree) of oil = 25°,
(vi) Formation volume factor of oil = 1.1, (vii) recovery factor = 30%

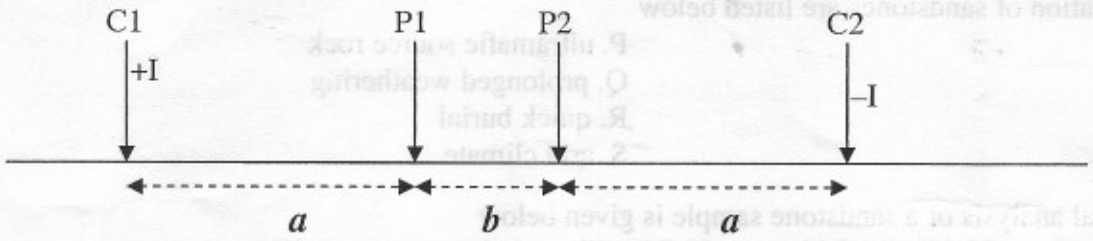
Q.80 The specific gravity of oil is about

(A) 0.80 (B) 0.85 (C) 0.90 (D) 0.95

Q.81 The recoverable oil reserve in MMT is about

(A) 55 (B) 155 (C) 355 (D) 550

Statement for Linked Answer Questions 82 & 83: Four electrode configuration given below is used in a resistivity survey (C1, C2 and P1, P2 are current and potential electrodes respectively) on a horizontal surface.



Q.82 The geometrical factor for such an array is

(A) $\frac{b}{a(a+b)}$ (B) $\frac{a(a+b)}{b}$

(C) $\pi\frac{a(a+b)}{b}$ (D) $2\pi\frac{a(a+b)}{b}$

Q.83 Distances 'a' and 'b' in the above configuration are 1000 meters and 50 meters respectively. If 2 ampere current flow gives 100 μV potential difference over an inhomogeneous earth mass, then the apparent resistivity is

(A) 3.3 Ωm (B) 33 Ωm (C) 330 Ωm (D) 3300 Ωm

Statement for Linked Answer Questions 84 & 85: The Young's modulus (E), density of rock (ρ) and Poisson's ratio (σ) are used to determine shear wave velocity (β) in a rock.

Q.84 Which one of the following expressions is correct?

(A) $\beta=\sqrt{\frac{E}{\rho(1+\sigma)}}$ (B) $\beta=\sqrt{\frac{E}{2\rho(1+\sigma)}}$

(C) $\beta=\sqrt{\frac{E}{2\rho(1-\sigma)}}$ (D) $\beta=\sqrt{\frac{E}{\rho(1-\sigma)}}$

Q.85 If the shear wave velocity and density are 3600 m/s and 2.7 gm/cc respectively and Poisson's ratio is assumed to be 0.25, the value of Young's modulus (E) in GPa is

(A) 26.24 (B) 43.74 (C) 52.49 (D) 87.48

END OF THE QUESTION PAPER

2007
GG: Geology & Geophysics

Duration : Three Hours | Maximum Marks :150

Read the following instructions carefully.

1. This question paper contains 85 objective type questions. Q.1 to Q.20 carry **one** mark each and Q.21 to Q.85 carry **two** marks each.

2. Attempt all the questions.

3. Questions must be answered on **O**bjective **R**esponse **S**heet (**ORS**) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the **ORS**. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely.

4. Wrong answers will carry NEGATIVE marks. In Q.1 to Q.20, **0.25** mark will be deducted for each wrong answer. In Q.21 to Q.76, Q.78, Q.80, Q.82 and in Q.84, **0.5** mark will be deducted for each wrong answer. However, there is no negative marking in Q.77, Q.79, Q.81, Q.83 and in Q.85. More than one answer bubbled against a question will be taken as an incorrect response. Unattempted questions will not carry any marks.

5. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the **ORS**.

6. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.

7. Calculator is allowed in the examination hall.

8. Charts, graph sheets or tables are NOT allowed in the examination hall.

9. Rough work can be done on the question paper itself. Additionally blank pages are given at the end of the question paper for rough work.

10. This question paper contains **20** printed pages including pages for rough work. Please check all pages and report, if there is any discrepancy.

Q. 1 – Q. 20 carry one mark each.

Q.1 The maximum curvature of a cylindrically folded surface occurs at the

(A) axial plane (B) fold axis (C) hinge (D) limb

Q.2 The plutonic equivalent of rhyolite is

(A) diorite (B) granite (C) granodiorite (D) monzonite

Q.3 At a pressure of 14 kb and temperature of 600 °C, basalt would metamorphose to

(A) amphibolite (B) eclogite (C) greenschist (D) mafic granulite

Q.4 Which is the most abundant sediment in the deep sea?

(A) Clay (B) Pebble (C) Sand (D) Silt

Q.5 Which of the following is an ore mineral of iron?

(A) Manganite (B) Magnesite (C) Malachite (D) Magnetite

Q.6 "Bajada" is

(A) an arid region landform (B) a fluvial landform
(C) a glacial landform (D) an oceanic landform

Q.7 Which of the following does NOT lie within the Dharwar craton?

(A) Bababudan Group (B) Closepet granite
(C) Khairagarh volcanics (D) Kolar schist belt

Q.8 In which of the following oil and gas fields is limestone the reservoir rock?

(A) Bombay High (B) Cambay basin
(C) Cauvery basin (D) Krishna-Godavari basin

Q.9 In remote sensing, DTM is an abbreviation for

(A) Day Time Mapping (B) Digital Triangulation Model
(C) Digital Transverse Meridian (D) Digital Terrain Model

Q.10 Which is the most abundant element in the solar system?

(A) Hydrogen (B) Iron (C) Oxygen (D) Silicon

Q.11 Latitude correction applied for gravity data reduction is maximum at the latitude of

(A) 0° (B) 30° (C) 45° (D) 60°

Q.12 The ratio of the Earth's total magnetic field at the Equator to that at the North Pole is

(A) $\frac{1}{3}$ (B) $\frac{1}{2}$ (C) $\frac{2}{3}$ (D) $\frac{3}{4}$

Q.13 The apparent resistivity type curve recorded over the following three layer section (top - dry soil; middle - saturated aquifer; bottom - bed rock) is

(A) A-Type (B) H-Type (C) K-Type (D) Q-Type

Q.14 Self-potential method is used in geophysical prospecting of ore deposits predominantly containing

(A) chalcopyrite (B) chromite (C) ilmenite (D) magnetite

Q.15 Deep earthquakes are associated with

(A) mid-oceanic ridges
(B) rift zones
(C) subduction zones
(D) transform faults

Q.16 The average P-wave velocity in the continental crust is

(A) 3.5 km/s (B) 4.5 km/s (C) 5.5 km/s (D) 6.5 km/s

Q.17 The amplitude of ground motion generated by an earthquake of magnitude 8 is greater than that of an earthquake of magnitude 5 by a factor of

(A) 3 (B) 100 (C) 300 (D) 1000

Q.18 A P-wave is NOT a

(A) dilatational wave
(B) irrotational wave
(C) longitudinal wave
(D) rotational wave

Q.19 Low velocity zone (LVZ) occurs globally at the base of the

(A) asthenosphere (B) crust (C) lithosphere (D) outer core

Q.20 The fastest spreading divergent plate boundary is the

(A) Carlsberg ridge
(B) Central-Indian ridge
(C) East Pacific rise
(D) Mid-Atlantic ridge

Q. 21 to Q. 75 carry two marks each.

Q.21 An open fold may appear to be isoclinal when viewed in a section

(A) at a low angle to the fold axis
(B) at 45° to the fold axis
(C) perpendicular to the fold axis
(D) parallel to the axial plane

Q.22 Glaucophane is a dense mineral because

(A) Na occurs in the 'A' site while Al is in the octahedral site
(B) Na occurs in the 'A' site while Al is in the tetrahedral site
(C) Na occurs in the 'M4' site while Al is in the octahedral site
(D) Na occurs in the 'M4' site while Al is in the tetrahedral site

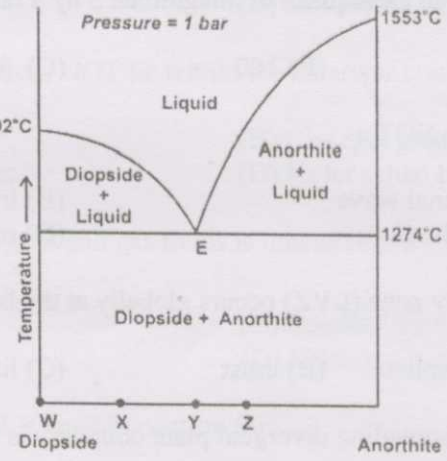
Q.23 When a hydrous fluid infiltrates a rock containing the assemblage wollastonite + calcite + quartz at a fixed pressure and temperature, the modal proportion of

(A) calcite will increase at the expense of quartz and wollastonite
(B) wollastonite will increase at the expense of quartz and calcite
(C) quartz will increase at the expense of calcite and wollastonite
(D) calcite and quartz will increase at the expense of wollastonite

Q.24 Which of the following represents a correct magmatic fractionation sequence?

(A) Basalt → Andesite → Dacite → Phonolite
(B) Basalt → Andesite → Trachyte → Rhyolite
(C) Basalt → Mugearite → Dacite → Rhyolite
(D) Basalt → Mugearite → Trachyte → Phonolite

Q.25 In the following figure, four rocks (W, X, Y and Z) undergo fractional melting. Which rock will require the highest temperature for complete melting? (Rock Y is of eutectic composition)



(A) W
(B) X
(C) Y
(D) Z

Q.26 Which is the most common type of porosity in sandstone?

(A) Mouldic (B) Intraparticle (C) Interparticle (D) Shelter

Q.27 Which of the following features is NOT a 'tool mark'?

(A) Chevron mark (B) Groove cast (C) Load cast (D) Prod mark

Q.28 Match the following :

Group I	Group II
P. Lead	1. Magmatic
Q. Aluminium	2. Pegmatitic
R. Chromite	3. Residual
S. Muscovite	4. Hydrothermal

(A) P - 2, Q - 1, R - 3, S - 4 (B) P - 4, Q - 3, R - 1, S - 2
(C) P - 3, Q - 4, R - 2, S - 1 (D) P - 3, Q - 4, R - 2, S - 1

Q.29 State the nature of the following reaction :

$$Si^{4+} + 4H_2O \leftrightarrow H_4SiO_4 + 4H^+$$

(A) hydration (B) hydrolysis (C) oxidation (D) reduction

Q.30 Match the ionic species in Group I with their representative concentrations (ppm) in Group II, as found in meteoric water at 6 °C.

Group I	Group II
P. Na^+	1. 2.4
Q. Mg^{2+}	2. 23.0
R. Ca^{2+}	3. 1.0
S. K^+	4. 5.1

(A) P - 2, Q - 1, R - 4, S - 3 (B) P - 1, Q - 2, R - 3, S - 4
(C) P - 4, Q - 3, R - 2, S - 1 (D) P - 3, Q - 4, R- 1, S - 2

Q.31 Which of the following properties does NOT affect the permeability of sandstone?

(A) Pore size (B) Tortuosity of pores
(C) Sorting (D) Mineralogy of framework grains

Q.32 Which of the following macerals has the lowest H/C ratio?

(A) Alginite (B) Fusinite (C) Resinite (D) Sporinite

Q.33 The paleoenvironmental condition indicated by the foraminiferal assemblage, *Ammonia – Cibicides – Quinqueloculina* is

(A) abyssal (B) bathyal (C) non-marine (D) shelf

Q.34 Match the bivalves in Group I with the dentitions in Group II.

Group I	Group II
P. *Nucula*	1. Desmodont
Q. *Spondylus*	2. Pachydont
R. *Mytilus*	3. Dysodont
S. *Mya*	4. Taxodont
	5. Isodont
	6. Schizodont

(A) P - 4, Q - 5, R - 3, S - 1
(B) P - 4, Q - 1, R - 3, S - 2
(C) P - 6, Q - 5, R - 1, S - 3
(D) P - 6, Q - 5, R - 3, S - 2

Q.35 Match the following stratigraphic units in Group I with their corresponding ages in Group II.

Group I	Group II
P. Katrol Formation	1. Paleozoic
Q. Po Formation	2. Archean
R. Kheinjua Formation	3. Proterozoic
S. Dhokpathan Formation	4. Mesozoic
	5. Quaternary
	6. Tertiary

(A) P – 6, Q – 1, R – 3, S – 5
(B) P – 4, Q – 6, R – 2, S – 1
(C) P – 1, Q – 4, R – 1, S – 6
(D) P – 4, Q – 1, R – 3, S – 6

Q.36 Match the minerals in Group I with their respective silicate structures in Group II.

Group I	Group II
P. Olivine	1. Nesosilicate
Q. Quartz	2. Sorosilicate
R. Epidote	3. Inosilicate
S. Biotite	4. Phyllosilicate
	5. Cyclosilicate
	6. Tectosilicate

(A) P – 1, Q – 2, R – 5, S – 4
(B) P – 1, Q – 6, R – 2, S – 4
(C) P – 3, Q – 6, R – 4, S – 2
(D) P – 4, Q – 5, R – 6, S – 1

Q.37 Match the following:

Group I	Group II
P. Moyar-Bhavani Shear Zone	1. Eastern Ghats Mobile Belt
Q. Kui-Chitraseni Shear Zone	2. Southern Granulite Terrain
R. Nagavalli-Vamsadhara Shear Zone	3. Western Dharwar Craton
S. Jabanahalli Shear Zone	4. Aravalli-Delhi fold belt
	5. Singhbhum Craton
	6. Bhandara Craton

(A) P – 1, Q – 2, R – 5, S – 4
(B) P – 6, Q – 5, R – 2, S – 4
(C) P – 4, Q – 2, R – 6, S – 1
(D) P – 2, Q – 4, R – 1, S – 3

Q.38 Which is the correct sequence of occurrence of the following thrusts in the Himalayan mountain belt along a south to north traverse?

(A) Krol Thrust – Ramgarh Thrust – Almora Thrust - ITSZ
(B) Ramgarh Thrust – Krol Thrust – Almora Thrust - ITSZ
(C) Krol Thrust – Almora Thrust – Ramgarh Thrust - ITSZ
(D) Almora Thrust – Ramgarh Thrust – ITSZ – Krol Thrust

Q.39 Which of the following triple junctions is ALWAYS stable? (R = ridge; T = trench; F = transform fault)

(A) F-F-F (B) R-R-R (C) T-R-F (D) T-T-T

Q.40 Match the following:

Group I	Group II
P. Nickpoints	1. Karst topography
Q. Pediplains	2. Paleosols
R. Duricrust	3. Moraine
S. Yardangs	4. Rejuvenation
	5. Desert
	6. Abrasion

(A) P – 1, Q – 2, R – 5, S – 4
(B) P – 4, Q – 5, R – 2, S – 6
(C) P – 6, Q – 5, R – 2, S – 3
(D) P – 5, Q – 3, R – 1, S – 2

Q.41 A straight, steep mountain front, with little penetration of the alluvial fans into the range suggests the following:

(A) wind erosion
(B) slow uplift along an active fault
(C) rapid uplift along an active fault
(D) the presence of ancient inactive fault

Q.42 At a fixed temperature, find the concentration (mole/litre) of ferric ion in solution if

i) solubility product of ferric hydroxide $K = 10^{-38.6}$

ii) ionisation product of water $K_w = 10^{-14.2}$

iii) pH = 7

(A) 10^{-17} (B) 10^{-7} (C) 10^{+7} (D) 10^{+17}

Q.43 A basaltic lava flow is found to have a $^{87}Sr/^{86}Sr$ ratio of 0.720, and a $^{87}Rb/^{86}Sr$ ratio of 0.750. If the initial $^{87}Sr/^{86}Sr$ value is determined to be 0.704, what is the age of the flow? (assume $\lambda = 1.42 \times 10^{-11}$ year^{-1}).

(A) 2.5×10^9 years (B) 1.5×10^9 years (C) 2.5×10^6 years (D) 1.5×10^6 years

Q.44 What are the normal (σ_n) and shear (τ) stresses acting on a plane that makes an angle of 30° with the maximum principal compressive stress (σ_1) direction? Given $\sigma_1 = 10$ kb and $\sigma_2 = 5$ kb.

(A) $\sigma_n = 5.25$ kb; $\tau = 1.17$ kb (B) $\sigma_n = 6.25$ kb; $\tau = 2.17$ kb
(C) $\sigma_n = 7.25$ kb; $\tau = 3.17$ kb (D) $\sigma_n = 8.25$ kb; $\tau = 4.17$ kb

Q.45 Quartz can be optically distinguished from nepheline based on

(A) relief (B) birefringence
(C) optic sign (D) extinction angle

Q.46 The Poisson's ratio of a rock with P- and S- wave velocities in the ratio of $\sqrt{3}$: 1 is

(A) 0.20 (B) 0.25 (C) 0.30 (D) 0.35

Q.47 A seismic reflection segment after migration

(A) shallows and steepens
(B) deepens and steepens
(C) lengthens and deepens
(D) shortens and deepens

Q.48 The coverage obtained for a 12 geophone CDP profile with shot spacing equal to twice the geophone spacing is

(A) 3-fold (B) 6-fold (C) 12-fold (D) 24-fold

Q.49 A P-wave incident on a horizontal interface between two layers at an angle of 30° generates a reflected S-wave. What is the angle of reflection of the S-wave? (The P- and S- wave velocities in the top layer are 4 km/s and 2.5 km/s respectively).

(A) 12° (B) 14° (C) 16° (D) 18°

Q.50 The decimal number 27 is represented in binary form as

(A) 11101 (B) 11001 (C) 10111 (D) 11011

Q.51 A salt dome is characterized by

(A) low velocity and low density
(B) low velocity and high density
(C) high velocity and low density
(D) high velocity and high density

Q.52 Convolving two sampled signals $f(n) = \{1,1,2,2\}$ with $g(n) = \{3,2,1\}$ results in a function $x(n)$ equal to

(A) {1, 3, 7, 9, 10, 6} (B) {3, 5, 9, 11, 6, 2}
(C) {3, 9, 6, 11, 2, 2} (D) {3, 5, 9, 6, 11, 5}

Q.53 The correct sequence in which the following EM methods should be arranged in order of their increasing depth of investigation is

P – Very Low Frequency method
Q – Magnetotelluric method
R – Ground Penetrating Radar method
S – Slingram method

(A) P < R < S < Q (B) S < R < P < Q (C) R < P < S < Q (D) P < R < Q < S

Q.54 Which of the following is measured in the time domain Induced Polarization method?

(A) Transient decay of electric potential
(B) Electric current injected into the ground
(C) Electric potential and injected current
(D) DC resistance only

Q.55 In magnetotelluric method, EM source field is

(A) a plane wave source (B) a spherical wave source
(C) a cylindrical wave source (D) an elliptical wave source

Q.56 In magnetotelluric method, phase angle derived from measured data over a homogeneous medium is

(A) 0° (B) 30° (C) 45° (D) 90°

Q.57 For a fixed electrode spacing, arrange the following electrode configurations in the order of their increasing depth of investigation.

P – Schlumberger; Q – Wenner; R – Three electrodes; S – Two electrodes

(A) P < Q < S < R (B) P < R < S < Q (C) P < R < Q < S (D) P < Q < R < S

Q.58 The correct expression relating the gravitational (U) and magnetic (W) potentials is (G - universal gravitational constant, ρ - density, I - intensity of magnetization and α - the direction of magnetization)

(A) $W = -\frac{I}{G\rho}\frac{\partial U}{\partial \alpha}$ (B) $W = -\frac{\rho}{GI}\frac{\partial U}{\partial \alpha}$

(C) $U = -\frac{\rho}{GI}\frac{\partial W}{\partial \alpha}$ (D) $U = -\frac{I}{G\rho}\frac{\partial W}{\partial \alpha}$

Q.59 Magnetic survey was conducted from 8:00 A.M. to 12:00 noon and the following observations were recorded.

Station No	1 (Base)	2	3	4	5	1 (Base)
Time	8:00	9:00	10:00	11:00	12:00	12:00
Total field (γ)	45500	45650	45750	45850	45850	45700

Which station shows the maximum anomaly after linear drift correction?

(A) 2 (B) 3 (C) 4 (D) 5

Q.60 At 45°N latitude, a spherical body having a radius 500 m, density 3.5 g/cc and magnetic susceptibility 5.0×10^{11} CGS unit, lies at a depth of 1.0 km. Assuming present day magnetic field, which statement is true if measurements are made along an E-W profile?

(A) Both gravity and total magnetic field anomalies are symmetric
(B) Gravity anomaly is symmetric and total magnetic field anomaly is asymmetric
(C) Total magnetic field anomaly is symmetric and gravity anomaly is asymmetric
(D) Both gravity and total magnetic field anomalies are asymmetric

Q.61 Match the following:

Group I	Group II
P. Paramagnetic	1. Cobalt
Q Diamagnetic	2. Ilmenite
R. Ferromagnetic	3. Pyroxene
S. Antiferromagnetic	4. Quartz

(A) P - 2, Q - 3, R - 1, S - 4 (B) P - 1, Q - 3, R - 2, S - 4
(C) P - 4, Q - 2, R - 1, S - 3 (D) P - 3, Q - 4, R - 1, S - 2

Q.62 The difference in gravity measurements aboard two ships sailing towards each other in opposite directions (E-W) with a constant speed of 10 knots is 130 mgals at the crossing point of both the ships. At what latitude are the ships sailing?

(A) 15° (B) 30° (C) 45° (D) 60°

Q.63 After decaying through 7 half-life periods, the original amount of radioactive substance that reduces to an amount of $\frac{1}{64}$ g, is

(A) 0.25 g (B) 0.50 g (C) 1.0 g (D) 2.0 g

Q.64 Number of atoms and disintegration constants of the parent (N_1, λ_1) and daughter (N_2, λ_2) radio-nuclides respectively in secular equilibrium are related as

(A) $\frac{N_1}{N_2} = \frac{\lambda_2}{\lambda_1}$ (B) $\frac{N_1}{N_2} = \frac{\lambda_1}{\lambda_2}$

(C) $\frac{N_1}{\lambda_1} = \frac{\lambda_2}{N_2}$ (D) $\frac{N_1\lambda_1}{N_2} = \frac{N_2\lambda_2}{N_1}$

Q.65 What is the volume (%) of shale in a shaly-sand bed exhibiting a pseudo-static SP of –44 mV? (static SP for clean sand = –55 mV)

(A) 10 (B) 20 (C) 30 (D) 40

Q.66 If the saturation exponent in Archie's equation is 2, the bulk resistivity of 50% water saturated formation increases in comparison to that of a fully water saturated formation by a factor of

(A) 4 (B) 8 (C) 16 (D) 32

Q.67 Determination of formation porosity using neutron logging is based on

(A) chlorine index (B) hydrogen index
(C) neutron activation index (D) oxygen index

Q.68 Which combination of logs is used to identify a gas zone based on the characteristic shape of the derived porosity plots?

(A) Sonic and density (B) Resistivity and density
(C) Density and neutron (D) Sonic and neutron

Q.69 Inverse solution for an underdetermined problem can be constructed by

(A) minimum norm inversion (B) least square inversion
(C) regularized least square inversion (D) Marquardt inversion

Q.70 Primary field source used in Slingram EM method is a

(A) small circular loop (B) large rectangular loop
(C) long grounded wire (D) long vertical transmitter

Common Data Questions

Common Data for Questions 71,72,73:

A P-wave generated from a surface source is incident at an angle of 15° on the horizontal interface between two 100 m thick layers with velocities $V_1 = 2$ km/s and $V_2 = 4$ km/s for the first and second layers respectively.

Q.71 The crossover distance (metres) for a head wave from the interface between the two layers is

(A) 326 (B) 336 (C) 346 (D) 356

Q.72 A reflection from the base of the second layer is recorded at an offset (source-receiver) distance (metres) of

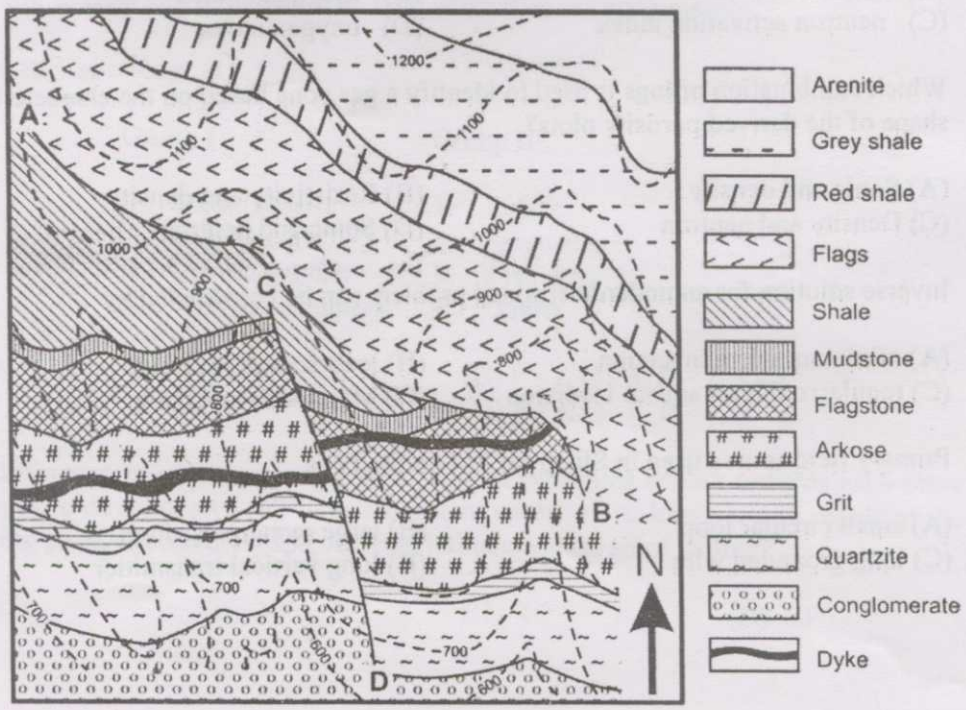
(A) 160 (B) 165 (C) 170 (D) 175

Q.73 The total travel time (ms) taken for the P-wave generated at the surface to reach the detector after reflection from the base of the second layer is

(A) 152 (B) 157 (C) 162 (D) 167

Common Data for Questions 74, 75:

The figure below represents the geological map of an area. Based on the map, attempt questions 74 and 75. Contours depicted are in metres.



Q.74 What is the nature of the discontinuity AB?

(A) Fault
(B) Disconformity
(C) Paraconformity
(D) Angular unconformity

Q.75 The discontinuity CD represents a

(A) normal fault
(B) reverse fault
(C) strike-slip fault
(D) strike fault

Linked Answer Questions: Q.76 to Q.85 carry two marks each.

Statement for Linked Answer Questions 76 & 77:

The discontinuities within the earth are marked by changes in velocity and density of the medium.

Q.76 The velocity discontinuity within the earth at which the density of the medium is closest to the average density of the earth, is

(A) Conrad (B) Gutenberg (C) Lehmann (D) Mohorovicic

Q.77 The change in P-wave velocity across the above discontinuity is

(A) 1.7 km/s (B) 3.7 km/s (C) 5.7 km/s (D) 7.7 km/s

Statement for Linked Answer Questions 78 & 79:

In electromagnetic method of geophysical prospecting, the depth of investigation (skin depth), is a function of the physical property of the medium and frequency of the source field.

Q.78 A homogeneous medium is represented by the electrical conductivity 'σ' and magnetic permeability 'μ'. If the angular frequency of the source field is ω, then the expression for the skin depth 'δ' is:

(A) $\delta = \sqrt{\frac{\omega\mu\sigma}{2}}$ (B) $\delta = \sqrt{\frac{2\sigma}{\omega\mu}}$ (C) $\delta = \sqrt{\frac{1}{2\omega\mu\sigma}}$ (D) $\delta = \sqrt{\frac{2}{\omega\mu\sigma}}$

Q.79 The frequency of the EM source required to achieve a depth of investigation of 1 km in a medium of electrical resistivity of 4.0 Ωm and magnetic permeability of $4\pi\times10^{-7}$ H/m is

(A) 1 Hz (B) 10 Hz (C) 100 Hz (D) 1000 Hz

Statement for Linked Answer Questions 80 & 81:

Paleocurrent data for a sedimentary succession is as follows:

N 20 E, N 25 E, N 30 E, N 15 E, S 20 W, S 25 W, S 30 W, S 15 W, N 25 E, S 25 W

Q.80 The rose diagram generated from the paleocurrent data is

(A) bimodal - bipolar
(B) polymodal
(C) trimodal
(D) unimodal

Q.81 Which environment of deposition can explain the above paleocurrent data?

(A) Alluvial fan (B) Deep marine (C) Fluvial (D) Tidal flat

Statement for Linked Answer Questions 82 & 83:

A garnet peridotite contains 60% olivine, 25% orthopyroxene, 10% clinopyroxene and 5% garnet. The K_D values for the element **cerium** during melting for each mineral are as follows: olivine = 0.001; orthopyroxene = 0.003; clinopyroxene = 0.1; garnet = 0.02.

Q.82 During melting of the garnet peridotite, the bulk distribution coefficient of cerium is

(A) 0.0124 (B) 0.1240 (C) 8.0650 (D) 83.3300

Q.83 The extent of **equilibrium** partial melting required to double the concentration of cerium in the melt compared to the source is

(A) 5% (B) 20% (C) 35% (D) 50%

Statement for Linked Answer Questions 84 & 85:

A dipping limestone bed with a true width of 5 metres shows an apparent width of 10 metres on a horizontal surface.

Q.84 Calculate the true dip of the limestone bed.

(A) 70° (B) 50° (C) 30° (D) 10°

Q.85 At what horizontal distance (metres) from the exposed upper surface of the bed should a vertical drill hole be made so as to intersect the top of the bed at a depth of 100 metres?

(A) 73.2 (B) 173.2 (C) 273.2 (D) 373.2

END OF THE QUESTION PAPER

GG : GEOLOGY AND GEOPHYSICS

Duration : Three Hours *Maximum Marks* :150

Read the following instructions carefully

1. This question paper contains **16** printed pages including pages for rough work. Please check all pages and report discrepancy, if any.

2. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the ORS.

3. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.

4. All the questions in this question paper are of objective type.

5. Questions must be answered on **O**bjective **R**esponse **S**heet (**ORS**) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer**. In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.

6. Questions 1 through 20 are 1-mark questions and questions 21 through 85 are 2-mark questions.

7. Questions 71 through 73 is one set of common data questions, questions 74 and 75 is another pair of common data questions. The question pairs (76, 77), (78, 79), (80, 81), (82, 83) and (84, 85) are questions with linked answers. The answer to the second question of the above pairs will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.

8. Un-attempted questions will carry zero marks.

9. **NEGATIVE MARKING**: For Q.1 to Q.20, ***0.25*** mark will be deducted for each wrong answer. For Q.21 to Q.75, ***0.5*** mark will be deducted for each wrong answer. For the pairs of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.76, Q.78, Q.80, Q.82 and Q.84, ***0.5*** mark will be deducted for each wrong answer. There is no negative marking for Q.77, Q.79, Q.81, Q.83 and Q.85.

10. Calculator **without data connectivity** is allowed in the examination hall.

11. Charts, graph sheets and tables are NOT allowed in the examination hall.

12. Rough work can be done on the question paper itself. Additional blank pages are given at the end of the question paper for rough work.

Q. 1 – Q. 20 carry one mark each.

Q.1 The planet having density less than 1.0 gm/cm^3 is

(A) Jupiter (B) Neptune (C) Saturn (D) Uranus

Q.2 Which mineral in a metamorphic rock indicates high grade metamorphism?

(A) Chlorite (B) Muscovite (C) Serpentine (D) Sillimanite

Q.3 Which of the following landforms is formed by organisms?

(A) Atoll (B) Drumlins (C) Outwash (D) Point bar

Q.4 The age of the sandstone reservoir in Cambay basin is

(A) Cretaceous (B) Eocene (C) Holocene (D) Jurassic

Q.5 Due to *Coriolis* effect, the ocean currents will be deflected towards the right in

(A) Antarctica (B) Equator
(C) Southern Hemisphere (D) Northern Hemisphere

Q.6 The age of the Precambrian – Cambrian boundary (in million years) is close to

(A) 250 (B) 550
(C) 1550 (D) 2550

Q.7 Which of the following minerals is harder than a knife blade?

(A) Calcite (B) Fluorite (C) Gypsum (D) Quartz

Q.8 Choose a Proterozoic stratigraphic unit from the following

(A) Cuddapah Super Group (B) Dharwar Super Group
(C) Gondwana Super Group (D) Iron Ore Group

Q.9 The correct pair of naturally occurring fissile isotope of Uranium is

(A) U^{236} and U^{237} (B) U^{235} and U^{236} (C) U^{235} and U^{238} (D) U^{236} and U^{238}

Q.10 In the plate tectonic theory, the "ring of fire" around the Pacific ocean is related to

(A) convergent plate boundary (B) divergent plate boundary
(C) hot spots (D) transform fault

Q.11 The shear wave is

(A) longitudinal (B) dilatational (C) irrotational (D) equivoluminal

Q.12 The liquid used in the sensor of a Proton Precession Magnetometer should be rich in

(A) carbon (B) hydrogen (C) nitrogen (D) oxygen

Q.13 The dominant process of heat transport in the lithosphere is

(A) advection (B) conduction (C) convection (D) radiation

Q.14 The shape of a vertical electric sounding curve over a three layer sequence comprising moist soil (top), fresh water saturated coarse sand (middle) and clay (bottom) is

(A) A - type (B) H - type (C) K - type (D) Q - type

Q.15 The geophysical method that provided a convincing evidence of sea floor spreading is

(A) gravity (B) magnetic (C) electric (D) seismic

Q.16 The difference in the gravity value (in mgal) between the equator and pole is close to

(A) 3786 (B) 4586 (C) 5186 (D) 5986

Q.17 With respect to the Earth-Moon axis, the tidal deformation of the Earth produced by the Moon has the shape of

(A) oblate ellipse (B) oblate ellipsoid (C) prolate ellipse (D) prolate ellipsoid

Q.18 A successful combination of geophysical methods for exploration of kimberlite pipe is

(A) gravity and radiometric
(B) magnetic and electromagnetic
(C) radiometric and magnetic
(D) radiometric and seismic

Q.19 Liquid outer core is evidenced by shadow zone for direct P-wave in the epicentral distance of

(A) 92°-132°
(B) 92°-142°
(C) 102°-132°
(D) 102°-142°

Q.20 Rift valleys are bounded by

(A) normal faults (B) reverse faults (C) strike-slip faults (D) transform faults

Q. 21 to Q.75 carry two marks each.

Q.21 The composition of a sandstone is as follows:
Quartz: 55%, Feldspar: 25%, Rock fragments: 1% and Matrix: 19%

Petrographically, the sandstone is classified as

(A) arkose
(B) arkosic wacke
(C) lithic arenite
(D) quartz wacke

Q.22 Match the sedimentary structures in Group I with the geological processes in Group II.

Group I	Group II
P. Load casts	1. Turbulent scour
Q. Cross bedding	2. Melting ice
R. Flutes	3. Soft sediment deformation
S. Dropstones	4. Biogenic
	5. Migration of mega ripples

(A)	(B)	(C)	(D)
P – 3	P – 2	P – 3	P – 1
Q – 2	Q – 1	Q – 5	Q – 4
R – 1	R – 5	R – 1	R – 5
S – 4	S – 4	S – 2	S – 2

Q.23 The phyllodes developed in echinoids to

(A) increase efficiency in food collection
(B) protect it from sinking in muddy substratum
(C) burrow deep into the sediments
(D) protect it from predators

Q.24 Two rock samples, P and Q, are characterized by the following well-preserved fossil assemblages:
P: abundance of planktonic foraminifera and radiolaria
Q: abundance of spore, pollen and vertebrate fossils

Which of the following statements is true about the palaeoenvironmental conditions of the rocks?

(A) P is estuarine and Q is deep marine
(B) P is inter-tidal and Q is terrestrial
(C) P is terrestrial and Q is shallow marine
(D) P is deep marine and Q is terrestrial

Q.25 The evidence of Turonian marine transgression in Peninsular India is

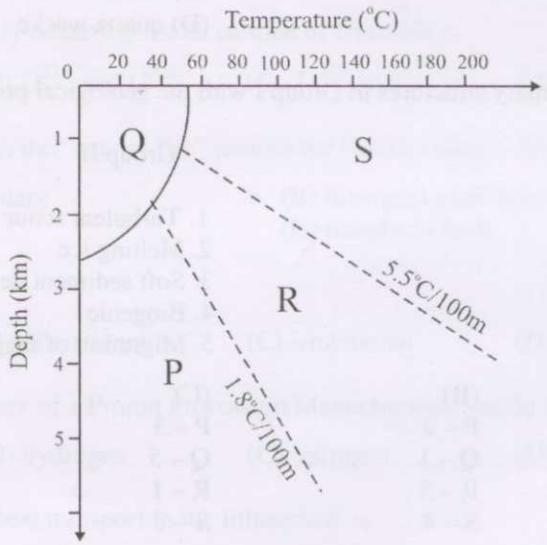
(A) Bagh Beds
(B) Niniyur Formation
(C) Patcham Formation
(D) Umaria Marine Bed

Q.26 Match the stratigraphic units of India with their age:

Stratigraphic Units	Age
P. Sargur Schist	1. Oligocene
Q. Kopili Shales	2. Eocene
R. Damuda Group	3. Permian
S. Kolhan Group	4. Carboniferous
	5. Proterozoic
	6. Archaean

(A)	(B)	(C)	(D)
P – 5	P – 4	P – 6	P – 6
Q – 3	Q – 3	Q – 1	Q – 2
R – 4	R – 1	R – 2	R – 3
S – 1	S – 5	S – 5	S – 5

Q.27 In the following depth – temperature profile the broken lines indicate geothermal gradients. The zone in which oil and gas are likely to be generated and trapped is



(A) P
(B) Q
(C) R
(D) S

Q.28 If a horizontal mirror plane is added to a pyramid having three-fold symmetry, the resultant symmetry of the *c*-axis will be

(A) 3m
(B) $\overline{3}$
(C) $\overline{6}$
(D) 6/m

Q.29 Dodecahedron and trapezohedron faces are observed in

(A) beryl (B) chalcopyrite (C) fluorite (D) garnet

Q.30 The crystal system of biotite is

(A) hexagonal (B) monoclinic (C) orthorhombic (D) tetragonal

Q.31 The {0001} section of a uniaxial mineral can be distinguished from an isotropic mineral in thin section by

(A) extinction angle (B) pleochroism (C) relief (D) interference figure

Q.32 Match the landforms in Group I with geomorphic processes in Group II

Group I	Group II
P. Paired terrace	1. Glacial erosion
Q. Cirque	2. Glacial deposition
R. Barchan	3. River rejuvenation
S. Kames	4. Wind erosion
	5. Wind deposition

(A)	(B)	(C)	(D)
P – 4	P – 2	P – 3	P – 3
Q – 2	Q – 3	Q – 2	Q – 1
R – 5	R – 4	R – 5	R – 5
S – 3	S – 1	S – 4	S – 2

Q.33 Match the ore/mineral deposits in Group I with genetic processes in Group II

Group I	Group II
P. Kyanite	1. Chemical sedimentation
Q. Laterite	2. Chemical weathering
R. Banded iron ore	3. Metamorphic
S. Platinum	4. Magmatic

(A)	(B)	(C)	(D)
P – 2	P – 3	P – 4	P – 3
Q – 1	Q – 2	Q – 3	Q – 2
R – 3	R – 1	R – 2	R – 4
S – 4	S – 4	S – 1	S – 1

Q.34 The scale of an aerial photograph acquired from a height of 5000 m using a camera having focal length of 200 mm, is

(A) 1 : 5000 (B) 1 : 20000 (C) 1 : 40000 (D) 1 : 60000

Q.35 The ratio of axial stress to corresponding axial strain for elastic material is known as

(A) Bulk modulus (B) Poisson's ratio (C) Shear modulus (D) Young's modulus

Q.36 An x-ray beam of wavelength $\lambda = 1.541$ Å is incident on a cubic crystal having lattice spacing of 4 Å. What will be its 2θ value (where θ is the glancing angle) on x-ray diffractogram?

(A) 11.10° (B) 20.10° (C) 22.20° (D) 44.20°

Q.37 The dip slip of a fault is 200 m and the dip amount is 30°. The throw of the fault (m) is

(A) 300 (B) 200 (C) 100 (D) 50

Q.38 Which of the following modes of origin applies to snowball garnet?

(A) Pre-tectonic (B) Syn-tectonic (C) Post-tectonic (D) Contact metamorphic

Q.39 Rocks of which of the following facies form under low geothermal gradient?

(A) Blueschist (B) Granulite
(C) Hornblende hornfels (D) Sanidinite

Q.40 Which of the following statements is/are true for porosity of sandstone?

P. Porosity increases with sorting of grains.
Q. Porosity decreases with sorting of grains.
R. Porosity decreases with shale content.
S. Porosity increases with shale content.

(A) Q (B) P, S (C) P, R (D) S

Q.41 On crystallization of anorthite, Sr concentration in the magma will

(A) decrease (B) increase
(C) increase and then decrease (D) remain constant

Q.42 If the solubility product of gypsum is $10^{-4.36}$, the solubility (mol/litre) of gypsum in an ideal aqueous solution will be

(A) $10^{-9.72}$ (B) $10^{-4.36}$ (C) $10^{-2.18}$ (D) $10^{-1.09}$

Q.43 What is the age of the lignite deposit of Neyveli?

(A) Eocence (B) Miocene (C) Oligocene (D) Permian

Q.44 Find the correct match of mineral pair in Group I with the corresponding crystallization behaviour in Group II

Group I	Group II
P. Silica – K feldspar	1. Solid solution
Q. Albite – Anorthite	2. Peritectic
R. Forsterite – Silica	3. Eutectic

(A)	(B)	(C)	(D)
P – 3	P – 1	P – 2	P – 3
Q – 1	Q – 2	Q – 1	Q – 2
R – 2	R – 3	R – 3	R – 1

Q.45 An igneous rock with 50% olivine, 25% orthopyroxene and 25% clinopyroxene by mode will be called

(A) dunite (B) harzburgite (C) lherzolite (D) wehrlite

Q.46 In a gravity survey, if the observation point lies below the datum plane, then for gravity data reduction

(A) Free-air and Bouguer corrections are positive
(B) Free-air correction is positive and Bouguer correction is negative
(C) Free-air correction is negative and Bouguer correction is positive
(D) Free-air and Bouguer corrections are negative

Q.47 If the Earth's magnetic field at the north pole is 60,000 γ and the radius of Earth is R, at what height above the north pole will its magnitude be 30,000 γ ?

(A) 0.26 R (B) 0.52 R (C) 0.78 R (D) 1.04 R

Q.48 Match the apparent resistivity type curves observed on the surface in Group I with the subsurface resistivity variations in Group II

Group I	Group II
P. AK-Type	1. $\rho_1 < \rho_2 > \rho_3 > \rho_4$
Q. HK-Type	2. $\rho_1 > \rho_2 < \rho_3 > \rho_4$
R. KQ-Type	3. $\rho_1 > \rho_2 < \rho_3 < \rho_4$
S. HA-Type	4. $\rho_1 < \rho_2 < \rho_3 < \rho_4$
	5. $\rho_1 < \rho_2 > \rho_3 < \rho_4$
	6. $\rho_1 < \rho_2 < \rho_3 > \rho_4$

(A)	(B)	(C)	(D)
P – 2	P – 3	P – 4	P – 6
Q – 4	Q – 4	Q – 5	Q – 2
R – 1	R – 2	R – 6	R – 1
S – 3	S – 6	S – 1	S – 3

Q.49 The plane wave electromagnetic field traveling vertically downward in a homogeneous half-space of resistivity 500 Ωm varies with depth 'z' as,

$$H_y(z) = H_0 e^{-0.5z} \{\cos(\omega t - 0.5z) + i \sin(\omega t - 0.5z)\}$$

What is the frequency (in Hz) of the primary field given $\mu = \mu_0 = 4\pi \times 10^{-7}$ h/m?

(A) 7.16×10^7 (B) 5.16×10^7 (C) 3.16×10^7 (D) 1.16×10^7

Q.50 Wenner survey is performed over a homogeneous ground of resistivity 200 Ωm. For the current electrode spacing of 60 m, 100 mA current flow is recorded. What will be the magnitude of potential difference (in mV) between potential electrodes?

(A) 53.0 (B) 159.2 (C) 477.7 (D) 1433.1

Q.51 Potential Difference (PD) and Gradient of Potential Difference (GPD) are measured along a profile over a massive sulfide body in self-potential survey. Which of the following statements is correct for the anomalies over the center of the body?

(A) PD is positive and GPD is positive
(B) PD is positive and GPD is zero
(C) PD is negative and GPD is negative
(D) PD is negative and GPD is zero

Q.52 Match the phase differences between the quantities of induction phenomena (Group I) with the amount of phase difference in Group II

Group I	Group II
P. Secondary field with respect to primary field	1. leads by 90°
Q. Inphase component of secondary field with respect to primary field	2. lags by 90°
R. Quadrature component of secondary field with respect to primary field	3. lags between 90° - 180°
S. Quadrature component of secondary field with respect to inphase component of secondary field	4. lags by 180°

(A)	(B)	(C)	(D)
P- 4	P- 1	P- 2	P- 3
Q- 1	Q- 2	Q- 3	Q- 4
R- 3	R- 4	R- 1	R- 2
S- 2	S- 3	S- 4	S- 1

Q.53 Which of the following combinations of electromagnetic field components is measured in magnetotelluric method?

(A) E_x, E_y, H_x, H_y, H_z (B) E_x, E_y, E_z, H_x, H_z
(C) E_x, E_y, E_z, H_y, H_z (D) E_x, E_z, H_x, H_y, H_z

Q.54 Which form of partial differential equation is used for the interpretation of electromagnetic anomalies in geophysical prospecting?

(A) Diffusion equation (B) Laplace's equation
(C) Poisson's equation (D) Wave equation

Q.55 A radioactive substance decays to one third of its original value in 6 hours time. What is the half-life (in hours) of the substance?

(A) 3.58 (B) 3.78 (C) 3.98 (D) 4.18

Q.56 The relation between magnetic latitude (θ) and the magnetic inclination (i) is

(A) $2 \tan i = \tan \theta$ (B) $\tan i = 2 \tan \theta$ (C) $\tan i = 2 \tan^2 \theta$ (D) $2 \tan i = \cos \theta$

Q.57 To derive magnetic field from gravity field, the Poisson's relation can be used only when the direction of magnetization is

(A) horizontal (0°) (B) 45° (C) 60° (D) vertical (90°)

Q.58 Fourier analysis matches the signal by a series of sinusoids. Each member of the series fits an exact number of

(A) one-fourth wavelength (B) one-third wavelength
(C) half-wavelength (D) one wavelength

Q.59 Compton scattering is the physical basis of

(A) Neutron - Gamma logging (B) Neutron - thermal neutron logging
(C) Natural Gamma logging (D) Gamma - Gamma logging

Q.60 If the P-wave velocity is twice that of S-wave velocity in a medium, the Poisson's ratio of the material is

(A) 0.50 (B) 0.33 (C) 0.25 (D) 0.12

Q.61 The Lame's coefficient (λ) can be written in terms of compressibility of the material (β) and Poisson's ratio (σ) as

(A) $\lambda = \dfrac{3\sigma}{(1+\sigma)\beta}$ (B) $\lambda = \dfrac{(1+\sigma)}{3\sigma\beta}$

(C) $\lambda = \dfrac{\sigma}{(1+\sigma)(1-2\sigma)\beta}$ (D) $\lambda = \dfrac{3(1-2\sigma)}{\beta}$

Q.62 The amplitude of seismic wave varies due to spherical spreading as a function of

(A) radius of sphere
(B) 1 / (radius of sphere)
(C) (radius of sphere)^2
(D) 1 / (radius of sphere)^2

Q.63 If f is the frequency of seismic wave and v is its velocity, the relation between absorption coefficient (α) and quality factor (Q) is

(A) $\alpha = \dfrac{\pi f}{Qv}$ (B) $\alpha = \dfrac{Qf}{\pi v}$ (C) $\alpha = \dfrac{Qv}{\pi f}$ (D) $\alpha = \dfrac{\pi Q}{vf}$

Q.64 In marine seismic surveys, the maximum depth d (in feet) at which the bubble will break is related to the charge weight W (in pounds) by the relation

(A) $d = 3.8\ W$ (B) $d = 3.8\ W^{1/2}$ (C) $d = 3.8\ W^{1/3}$ (D) $d = 3.8\ W^{1/4}$

Q.65 Considering noise problem (reverberation) in marine seismic work, the frequencies for higher harmonics are expressed by $f_n = \dfrac{(2n-1)V_w}{4d_w}$, where f_n - frequency of nth harmonic , V_w - velocity of sound in water and d_w - water depth. The fundamental frequency in terms of the reciprocal of one - way travel time is

(A) one - fourth (B) one - third (C) one - half (D) three - fourth

Q.66 In a linear inverse problem having rectangular system matrix that is rank deficient, the inverse solution is

(A) unique solution
(B) least square solution
(C) minimum norm solution
(D) minimum norm least square solution

Q.67 In a linear inverse problem having eigenvalues 100, 10, 1, 0.1, 0.01, 0.001, the highest condition number of the system matrix is

(A) 100000 (B) 10000 (C) 1000 (D) 100

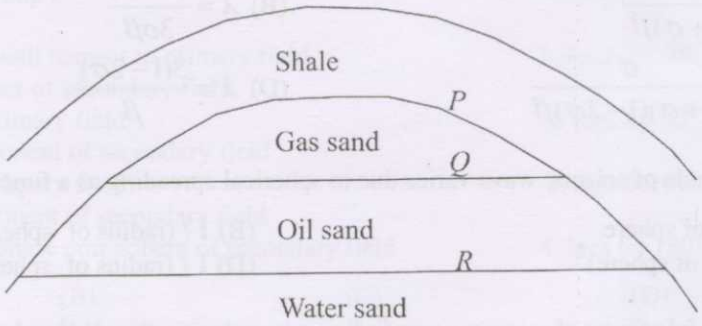
Q.68 A combination of radioactive logging to detect chlorine in a formation is

(A) Neutron-thermal neutron log and Gamma-Gamma log
(B) Neutron-epithermal neutron log and Neutron-Gamma log
(C) Neutron-Gamma log and Gamma-Gamma log
(D) Neutron-epithermal neutron log and Gamma-Gamma log

Q.69 In electrical logging, the measured resistivity of flushed zone is 19.2 Ωm, the resistivity of mud-filtrate is 1.33 Ωm and the computed value of residual oil saturation in flushed zone is 20%. The value of formation resistivity factor is

(A) 8.50 (B) 8.85 (C) 9.11 (D) 9.24

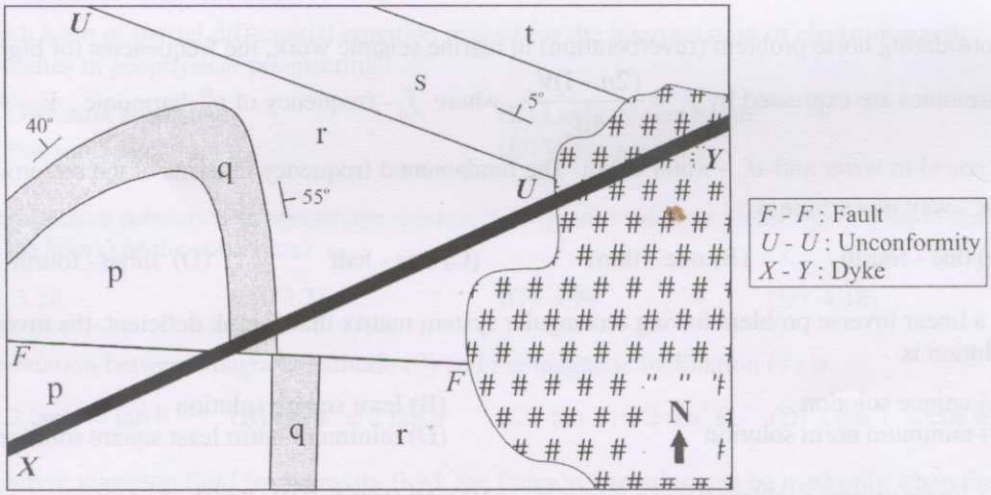
Q.70 In a seismic reflection survey, lithological boundaries P (Shale and Gas sand), Q (Gas sand and Oil sand) and R (Oil sand and Water sand) computed on the basis of reflection coefficients are shown in figure. Which is the correct sequence of reflection coefficients at these boundaries?



(A) P (- 0.30), Q (+ 0.20), R (+ 0.03)
(B) P (- 0.30), Q (+ 0.03), R (+ 0.20)
(C) P (+ 0.20), Q (- 0.30), R (+ 0.03)
(D) P (+ 0.20), Q (+ 0.03), R (- 0.30)

Common Data Questions

Common Data for Questions 71, 72 and 73: The following geological map shows exposures of sedimentary beds p, q, r, s, t and a batholith (hatched) in a flat terrain.



Q.71 The fold seen in the area is

(A) a synform plunging northerly
(B) a synform plunging southerly
(C) an antiform plunging northerly
(D) an antiform plunging southerly

Q.72 If the fault dips 70° southerly, it is a

(A) normal fault with southern upthrown block
(B) right lateral strike-slip fault
(C) reverse fault with northern upthrown block
(D) reverse fault with southern upthrown block

Q.73 The intrusion of dyke took place

(A) after deposition of beds 's' and 't'
(B) before deposition of beds 's' and 't'
(C) before faulting
(D) before folding

Common Data for Questions 74 and 75: Two sampled data sets are given as: $X(n) = \{1, 2, -1, 3\}$ and $Y(n) = \{1, -1, 2, \frac{1}{2}\}$

Q.74 The cross-correlation between these two time series for zero lag is

(A) $-\frac{3}{2}$ (B) $\frac{5}{2}$

(C) 2 (D) 3

Q.75 The convolution of the data sets results in a time series

(A) $\{1, 1, \frac{11}{2}, -4, \frac{17}{2}, -1, 1\}$ (B) $\{-1, 1, -4, \frac{17}{2}, \frac{1}{2}, -1, 1\}$

(C) $\{1, 1, -1, \frac{17}{2}, -4, \frac{11}{2}, \frac{3}{2}\}$ (D) $\{1, -1, \frac{5}{2}, -4, \frac{17}{2}, 2, 1\}$

Linked Answer Questions: Q.76 to Q.85 carry two marks each.

Statement for Linked Answer Questions 76 and 77: A mineral assemblage consists of fayalite, ferrosilite and quartz in equilibrium.

Q.76 The number of components in the system is

(A) 4 (B) 3 (C) 2 (D) 1

Q.77 The degree of freedom of the mineral assemblage in P-T space is

(A) 1 (B) 2 (C) 3 (D) 4

Statement for Linked Answer Questions 78 and 79: The Fe - O bond length in haematite is 2.05 Å and the ionic radius of anion is 1.32 Å.

Q.78 The correct pair of radius ratio and coordination number is

(A) 0.220 and 3 (B) 0.380 and 4 (C) 0.553 and 6 (D) 0.770 and 8

Q.79 The electrostatic valency of the cation is

(A) 0.25 (B) 0.5 (C) 1.0 (D) 3.0

Statement for Linked Answer Questions 80 and 81: The gravity anomaly along a profile over a spherical ore body shows a maximum anomaly of 12 mgal at the centre and a value of 6 mgal at a distance of 3600 m from the centre. The density contrast between the ore mass with the surrounding rocks is 0.4 gm/cm^3.

Q.80 The computed depth (in m) to the centre of the spherical mass is

(A) 2340 (B) 2940 (C) 3780 (D) 4680

Q.81 The computed radius (in m) of the spherical mass is

(A) 1965 (B) 2865 (C) 3250 (D) 3685

Statement for Linked Answer Questions 82 and 83: A P-wave generated from a surface source is incident at an angle of 30° on a horizontal interface and refracted at an angle of 50° into the second layer. The velocity in the first medium is 3.5 km/s. Densities in the first and second layer are 2.3 gm/cm^3 and 2.5 gm/cm^3, respectively.

Q.82 The velocity (in km/s) in the second layer is

(A) 5.36 (B) 4.86 (C) 4.55 (D) 4.15

Q.83 The reflection coefficient for the ratio of reflected and incident P-wave amplitudes at normal incidence is

(A) 0.32 (B) 0.28 (C) 0.25 (D) 0.21

Statement for Linked Answer Questions 84 and 85: Two students were assigned the same 3-layer Schlumberger resistivity sounding data for interpretation. They interpreted different model parameters. First student interpreted resistivities $\rho_1 = 10\ \Omega m$, $\rho_2 = 50\ \Omega m$, $\rho_3 = 10\ \Omega m$, thicknesses $h_1 = 50$ m and $h_2 = 10$ m.

Q.84 Which combination of ρ_2 and h_2 interpreted by the second student is correct according to the principle of equivalence?

(A) $\rho_2 = 25\ \Omega m$ and $h_2 = 5$ m
(B) $\rho_2 = 25\ \Omega m$ and $h_2 = 20$ m
(C) $\rho_2 = 100\ \Omega m$ and $h_2 = 20$ m
(D) $\rho_2 = 100\ \Omega m$ and $h_2 = 40$ m

Q.85 Transverse resistance and longitudinal conductance calculated by the second student for the second layer is

(A) 4000 Ωm^2, 0.4 mho
(B) 2000 Ωm^2, 0.2 mho
(C) 500 Ωm^2, 0.8 mho
(D) 125 Ωm^2, 0.2 mho

END OF THE QUESTION PAPER

GG : GEOLOGY AND GEOPHYSICS

Duration : Three Hours *Maximum Marks* : 100

Read the following instructions carefully :

1. This question paper contains **24** printed pages including pages for rough work. Please check all pages and report discrepancy, if any.
2. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the **O**ptical **R**esponse **S**heet (**ORS**)
3. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
4. All questions in this paper are of objective type.
5. Questions must be answered on **O**ptical **R**esponse **S**heet (**ORS**) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer**. In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as an incorrect response.
6. The paper consists of two parts: Part A and Part B. Part A is common to both Geology and Geophysics candidates. Part B contains two sections: Section 1 (Geology) and Section 2 (Geophysics). Geology candidates will attempt questions in Section 1 only. Geophysics candidates will attempt questions in Section 2 only. Correctly darken the bubble (in the ORS) corresponding to the section attempted by you.
7. There are a total of 60 questions carrying 100 marks. Part A consists of 20 questions; all are 1-mark questions. Each of the sections (Section 1 & Section 2) in Part B consists of 40 questions; all are 2-mark questions.
8. Questions 51 through 56 (3 pairs) are common data questions and question pairs (57, 58) and (59, 60) are linked answer questions. The answer to the second question of the above 2 pairs depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. Un-attempted questions will carry zero marks.
10. Wrong answers will carry NEGATIVE marks. For Q.1 to Q.20, ⅓ mark will be deducted for each wrong answer. For Q. 21 to Q. 56, ⅔ mark will be deducted for each wrong answer. The question pairs (Q.57, Q.58), and (Q.59, Q.60) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair i.e. for Q.57 and Q.59, ⅔ mark will be deducted for each wrong answer. There is no negative marking for Q.58 and Q.60.
11. Calculator (without data connectivity) is allowed in the examination hall.
12. Charts, graph sheets or tables are NOT allowed in the examination hall.
13. Rough work can be done on the question paper itself. Additionally, blank pages are given at the end of the question paper for rough work.

PART A: COMMON TO BOTH GEOLOGY AND GEOPHYSICS CANDIDATES

Q. 1 – Q. 20 carry one mark each.

Q.1 The Gutenberg discontinuity is located at a depth of around

(A) 35 km
(B) 150 km
(C) 2900 km
(D) 5000 km

Q.2 What is the age of the "Barail Series" ?

(A) Jurassic
(B) Paleocene
(C) Oligocene
(D) Miocene

Q.3 Thermohaline circulation in the oceans is driven by

(A) only salinity gradients
(B) both temperature and salinity gradients
(C) only temperature gradients
(D) only density difference

Q.4 Which one of the following minerals cannot be used as an abrasive ?

(A) Garnet
(B) Corundum
(C) Quartz
(D) Gypsum

Q.5 Which one of the following lakes is interpreted to be of meteoritic impact origin ?

(A) Lonar Lake
(B) Chilka Lake
(C) Kolleru Lake
(D) Pulicat Lake

Q.6 Which of the following geomorphic features is **not** related to desert environments ?

(A) yardang
(B) bajada
(C) hamada
(D) esker

Q.7 Which of the following is located closest to the Ninety-East Ridge ?

(A) Bombay High
(B) Lakshwadweep Islands
(C) Andaman and Nicobar Islands
(D) Maldives

Q.8 LPG (Liquefied Petroleum Gas) consists mainly of

(A) propane and butane

(B) methane and ethane

(C) methane and butane

(D) ethane and propane

Q.9 Who proposed the principle "the present is the key to the past" ?

(A) Carl von Linnaeus (B) James Hutton

(C) William Smith (D) Alcide d'Orbigny

Q.10 Of the following, which is an ore of nickel ?

(A) Pentlandite (B) Cinnabar

(C) Cassiterite (D) Scheelite

Q.11 Over a three layered earth, comprising of top dry soil followed by saturated weathered layer and hard rock basement, a resistivity sounding experiment is performed. The obtained VES curve is

(A) K-type (B) A-type

(C) H-type (D) Q-type

Q.12 The logging tool for direct determination of permeability is

(A) induction (B) litho-density

(C) sonic (D) NMR

Q.13 Which of the following parameters is uniquely resolved by residual gravity anomaly data ?

(A) lateral density contrast

(B) excess/deficit mass

(C) absolute density

(D) geometric dimensions of geophysical model

Q.14 Crude oil density, in degree API (American Petroleum Institute), is a measure of viscosity. The value of 10 API is of

(A) water (B) heavy crude

(C) average crude (D) light crude

Q.15 For perfectly conducting medium, skin depth (m) is

(A) 10^5 (B) 100

(C) 10 (D) 0

Q.16 If a planet revolves around the Sun with a period of 8 years, then its distance from the Sun would be (in terms of distance between Earth and Sun)

(A) two times (B) four times

(C) six times (D) eight times

Q.17 A vast majority of earthquake sources are often linked to

(A) inner core

(B) outer core

(C) brittle part of the earth's crust

(D) molten part of earth's mantle

Q.18 In paleomagnetism, detrital magnetization is an important process for study of

(A) sedimentary rocks

(B) metamorphic rocks

(C) basic igneous rocks

(D) acidic igneous rocks

Q.19 A Geiger-Muller counter is used for measuring

(A) gamma radiation

(B) alpha particles

(C) beta particles

(D) both alpha and beta particles

Q.20 The presence of crustal root beneath a mountain chain can be best explained by

(A) Pratt's model

(B) Airy's model

(C) Vening Meinesz model

(D) Plume model

END OF PART A

PART B (SECTION 1): FOR GEOLOGY CANDIDATES ONLY

Q. 21 to Q. 60 carry two marks each.

Q.21 Which one of the following is a typical Lower Gondwana plant assemblage ?

(A) *Glossopteris, Ptilophyllum, Nilssonia, Bucklandia*

(B) *Glossopteris, Gangamopteris, Schizoneura, Sphenophyllum*

(C) *Gangamopteris, Lycopodites, Brachyphyllum, Nilssonia*

(D) *Vertebraria, Alethopteris, Otozamites, Glossopteris*

Q.22 Which of the following is not correct for a Pelecypod shell ?

(A) Pedicle is present.

(B) Pallial sinus, if present, is on the posterior side.

(C) Lunule is towards anterior.

(D) Both the valves have teeth and sockets.

Q.23 Match the following:

Group I	Group II
P. Muschelkalk	1. Cambrian
Q. Katrol Formation	2. Miocene
R. Uttatur Stage	3. Middle Triassic
S. Baripada beds	4. Cretaceous
	5. Pleistocene
	6. Late Jurassic

(A) P-3, Q-6, R-5, S-1 (B) P-1, Q-2, R-3, S-4

(C) P-3, Q-6, R-4, S-2 (D) P-6, Q-3, R-1, S-2

Q.24 Match the following:

Group I	Group II
P. Pelagic	1. Open ocean
Q. Pycnocline	2. Cold sphere
R. Psychrosphere	3. North Atlantic
S. Humboldt Current	4. Density
	5. Thermocline
	6. East Pacific

(A) P-1, Q-4, R-3, S-6 (B) P-6, Q-2, R-1, S-5

(C) P-5, Q-6, R-1, S-3 (D) P-1, Q-4, R-2, S-6

Q.25 Match the following:

Group I	Group II
P. *Globigerina bulloides*	1. Lower Cambrian
Q. *Olenellus*	2. Echinodermata
R. Ambulacrum	3. Graptolites
S. Nema	4. Upwelling
	5. Coelenterata
	6. Silurian

(A) P-1, Q-6, R-2, S-5
(B) P-5, Q-6, R-2, S-3
(C) P-4, Q-1, R-2, S-3
(D) P-2, Q-4, R-5, S-6

Q.26 Dinosaurs can be distinguished from the other Mesozoic reptiles by

(A) Large size
(B) Carnivorous habit
(C) Erect stance
(D) Sprawling stance

Q.27 Which of the following is a polar planktic formanifer ?

(A) *Globigerenoides rubber*
(B) *Neogloboquadrina pachyderma*
(C) *Globorotalia menardii*
(D) *Orbulina universa*

Q.28 Which one of the following mass-wasting processes is designated as a slow flowage type ?

(A) Mudflow (B) Solifluction (C) Slump (D) Rockslide

Q.29 Which of the following accurately describes the rock 'phonolite' ?

(A) Undersaturated ultramafic volcanic rock
(B) Undersaturated mafic plutonic rock
(C) Undersaturated ultrabasic volcanic rock
(D) Intermediate alkaline plutonic rock

Q.30 Match the assemblages in Group I with the corresponding metamorphic facies in Group II :

Group I	Group II
P. Albite-jadeite-glaucophane-lawsonite	1. Greenschist
Q. Garnet-orthopyroxene-clinopyroxene-plagioclase	2. Blueschist
R. Garnet-muscovite-biotite-sillimanite-quartz	3. Granulite
S. Albite-chlorite-epidote-actinolite	4. Amphibolite
	5. Zeolite
	6. Prehnite-pumpellyite

(A) P-1, Q-6, R-2, S-5
(B) P-5, Q-1, R-3, S-4
(C) P-2, Q-3, R-4, S-1
(D) P-3, Q-2, R-1, S-6

Q.31 When underplated by mafic magmas, and with no erosion, lower crustal rocks will experience _____ during metamorphism.

(A) isobaric heating followed by isothermal decompression
(B) isothermal compression followed by isobaric heating
(C) isobaric heating followed by isothermal compression
(D) isobaric heating-cooling trajectory

Q.32 Match the minerals in Group I with their characteristic optical properties in Group II :

Group I	Group II
P. Biotite	1. Uniaxial negative
Q. Sodalite	2. Mottled extinction
R. Nepheline	3. Uniaxial positive
S. Quartz	4. Isotropic, low relief
	5. Isotropic, high relief
	6. Biaxial negative

(A) P-5, Q-1, R-3, S-6
(B) P-6, Q-2, R-5, S-1
(C) P-3, Q-2, R-4, S-5
(D) P-2, Q-4, R-1, S-3

Q.33 A single slice of rock bound by thrust faults on all sides is called a

(A) horse
(B) pop-up structure
(C) duplex
(D) graben

Q.34 A strike-slip dip fault strikes 30°N, and dips 45°SE. The net slip of the fault plunges

(A) 30° towards 45°N
(B) 0° towards 30°N
(C) 45° towards 120°N
(D) 90° towards 30°N

Q.35 The boundary between the Indian and Eurasian plates is the

(A) Main Central Thrust
(B) Main Boundary Thrust
(C) South Tibetan Detachment Zone
(D) Indus-Tsangpo Suture Zone

Q.36 Plagioclase feldspars belong to the _____ crystal system.

(A) Triclinic (B) Monoclinic
(C) Orthorhombic (D) Rhombic

Q.37 The plane by which twinned crystals are united is called the

(A) mirror plane (B) twin plane
(C) glide plane (D) composition plane

Q.38 In satellite remote-sensing, the spectral bands near 1.4 μm and 1.9 μm are avoided because of

(A) absorption due to H_2O and CO_2 in the atmosphere
(B) absorption due to ozone layer in the atmosphere
(C) absorption due to nitrogen in the atmosphere
(D) absorption by vegetation

Q.39 Formation of chromitite from a basaltic magma can be explained by

(A) liquid immiscibility (B) assimilation
(C) magma mixing (D) Soret effect

Q.40 Match the following economic deposits in Group I with their places of occurrences in Group II :

Group I	Group II
P. Bauxite	1. Naliya
Q. Phosphorite	2. Maldeota
R. Magnesite	3. Pahalgam
S. Barite	4. Salem
	5. Mangampeta
	6. Belgaum

(A) P-1, Q-2, R-4, S-5 (B) P-2, Q-3, R-4, S-6
(C) P-3, Q-1, R-6, S-5 (D) P-6, Q-2, R-4, S-5

Q.41 What is the host rock for sulphide mineralization in Rampura-Agucha belt ?

(A) Graphitic mica schist

(B) Garnetiferous mica schist

(C) Graphitic biotite-sillimanite gneiss

(D) Garnetiferous sillimanite-feldspar gneiss

Q.42 Which of the following is the correct order of decreasing permeability ?

(A) silty sandstone > siltstone > sandstone > pebbly sandstone

(B) siltstone > silty sandstone > sandstone > pebbly sandstone

(C) pebbly sandstone > sandstone > silty sandstone > siltstone

(D) pebbly sandstone > sandstone > siltstone > silty sandstone

Q.43 Which of the following varieties of coal has the least H/C ratio ?

(A) peat (B) lignite

(C) bituminous (D) anthracite

Q.44 What is the age of the reservoir rock in the Cambay basin ?

(A) Eocene (B) Oligocene

(C) Miocene (D) Paleocene

Q.45 Which one of the following can be considered the best cap rock for oil and gas traps ?

(A) chert (B) evaporite

(C) sandstone (D) shale

Q.46 A negative Eu anomaly will develop in a fractionating magma following separation of

(A) garnet (B) olivine

(C) plagioclase (D) orthopyroxene

Q.47 In which of the following islands is the Mid-oceanic ridge exposed above sea-level ?

(A) Japan (B) Seychelles

(C) Hawaii (D) Iceland

Q.48 _____ dams are constructed where the foundation rock is strong.

(A) Gravity (B) Arch

(C) Buttress (D) Earth

Q.49 Which type of cross-bedding is a definite indicator of tidal currents ?

(A) epsilon cross-bedding (B) herring-bone cross-bedding

(C) hummocky cross-bedding (D) trough cross-bedding

Q.50 Which type of sedimentary basin is formed close to continent-continent collisional settings ?

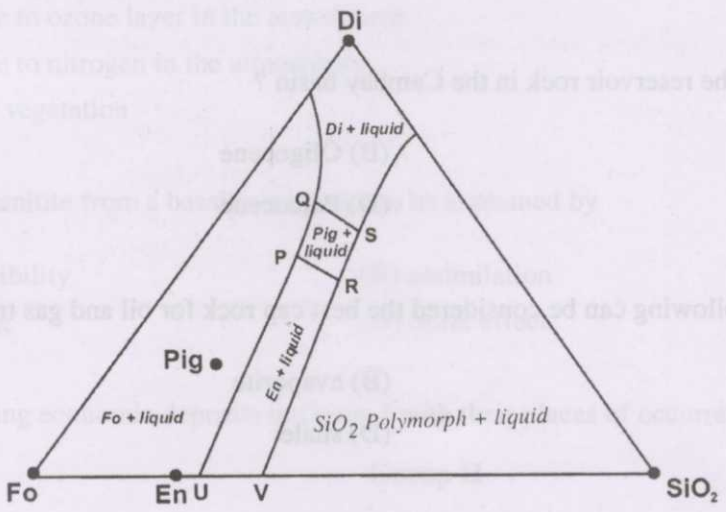
(A) Fore-arc basin (B) Peripheral foreland basin

(C) Back-arc basin (D) Retro-arc foreland basin

Common Data Questions

Common Data for Questions 51 and 52 :

A rock contains 65% forsterite (Fo), 27% enstatite (En) and 8% pigeonite (Pig) and its melting relationships at 1 bar can be represented by the figure given below:



Q.51 The name of the rock is

(A) Lherzolite (B) Harzburgite

(C) Wehrlite (D) Dunite

Q.52 On partially melting this rock, the first melt will have the composition of point

(A) P (B) Q

(C) R (D) S

Common Data for Questions 53 and 54:

An unfossiliferous sedimentary succession is characterized by the following features –

(i) sandstone-shale alternation, with sheet-like geometry of the sandstone beds; (ii) the sandstones exhibit graded bedding; (iii) erosional structures under the sandstone beds; (iv) convolute lamination, and (v) ripple marks on the sandstone beds.

Q.53 Which depositional environment is indicated for the above sedimentary succession ?

(A) Fluvial (B) Eolian

(C) Intertidal (D) Deep marine

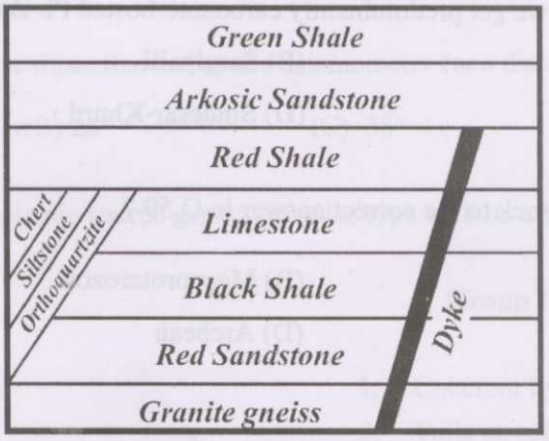
Q.54 What type of paleocurrent pattern is expected from the erosional structures in the succession ?

(A) Unimodal (B) Bimodal

(C) Bimodal - bipolar (D) Polymodal

Common Data for Questions 55 and 56:

Examine the given geological section, which contains sedimentary successions interrupted by a dyke, and which contains no tectonic discontinuities.



Q.55 How many unconformities can be identified in the section ?

(A) 3 (B) 4

(C) 5 (D) 6

Q.56 Which of the following contacts is a nonconformity ?

(A) Granite gneiss – Red Sandstone

(B) Black Shale – Limestone

(C) Limestone – Red Shale

(D) Red Shale – Arkosic Sandstone

Linked Answer Questions

Statement for Linked Answer Questions 57 and 58:

Microfossils may have different test composition.

Q.57 Which of the following is a siliceous microfossil group ?

(A) Conodonts (B) Radiolaria

(C) Dinoflagellates (D) Foraminifera

Q.58 What is the preferred microhabitat of the microfossil group that is the correct answer in Q.57?

(A) Benthic (B) Planktic

(C) Nektic (D) Nektobenthic

Statement for Linked Answer Questions 59 and 60:

Pb-Zn sulphide deposits can form in different types of host rocks.

Q.59 Of the following, where do we get predominantly carbonate-hosted Pb-Zn sulphide deposits ?

(A) Mochia – Zawar (B) Sargipalli

(C) Pur – Banera (D) Sindesar-Khurd

Q.60 What is the age of the host rock to the correct answer in Q.59 ?

(A) Neoproterozoic (B) Mesoproterozoic

(C) Paleoproterozoic (D) Archean

END OF SECTION 1 OF PART B

PART B (SECTION 2): FOR GEOPHYSICS CANDIDATES ONLY

Q. 21 to Q. 60 carry two marks each.

Q.21 Match the following functions in time-domain with their fourier spectra :

Group I	Group II
P. $\Pi(t)=\begin{cases}1,-1/2\le t\le 1/2\\0,t<-1/2 \text{ and } t>1/2\end{cases}$	1. 1
Q. Dirac delta function, $\delta(t)$	2. $\frac{\sin(\pi f)}{f}$, where f is frequency
R. $x(t)=e^{-\lvert t\rvert}$	3. $\frac{2}{1+4\pi^2 f^2}$, where f is frequency
S. $\Lambda(t)=\begin{cases}1+t,-1<t<0\\1-t,0<t<1\\0,otherwise\end{cases}$	4. $\frac{\sin^2(\pi f)}{f^2}$, where f is frequency

(A) P-2, Q-3, R-1, S-4 (B) P-1, Q-3, R-2, S-4
(C) P-1, Q-4, R-2, S-3 (D) P-2, Q-1, R-3, S-4

Q.22 The teleseismic rays are those that arrive at a seismometer for a distance greater than

(A) 18° (B) 28° (C) 38° (D) 48°

Q.23 Match the following seismic source generated noise type with its appearance on the seismogram :

Group I	Group II
P. Reverberation	1. Coherent hyperbolic events
Q. Multiples	2. Tails on reflected events
R. Guided waves	3. Events paralleling first breaks
S. Diffractions	4. Reflections at even time intervals after the primary reflections

(A) P-1, Q-3, R-2, S-4 (B) P-3, Q-4, R-2, S-1
(C) P-2, Q-4, R-3, S-1 (D) P-4, Q-1, R-3, S-2

Q.24 Which is the parameter for measuring the size of the earthquake that does not need an instrumental record ?

(A) Richter Magnitude (B) Intensity
(C) Moment (D) M_W

Q.25 The standard form of wave equation for propagation of cubical dilatation (θ) is

$$\rho \frac{\partial^2 \theta}{\partial t^2} = (\lambda + 2\mu)\nabla^2 \theta .$$

The compressional wave velocity is given by

(A) $\sqrt{\frac{2\lambda + \mu}{\rho}}$ (B) $\sqrt{\frac{\lambda + 2\mu}{2\rho}}$ (C) $\sqrt{\frac{\lambda + \mu}{\rho}}$ (D) $\sqrt{\frac{\lambda + 2\mu}{\rho}}$

Q.26 PKIKP is a seismic body wave which travels through

(A) upper mantle

(B) upper and lower mantle

(C) mantle, outer core and inner core

(D) mantle and outer core

Q.27 A seismic signal is recorded in a frequency band, 50-100 Hz. The sampling interval (ms) to avoid aliasing would be

(A) 5 (B) 10 (C) 15 (D) 20

Q.28 The minimum appreciable amplitude recorded by a seismometer is 0.2 mm and the maximum one is 20.0 cm, then the dynamic range in dB is

(A) 80 (B) 60 (C) 40 (D) 20

Q.29 Match the following:

Group I	Group II
P. Primary wave	1. Propagate along surface of the medium
Q. Secondary wave	2. Particle motion is orthogonal to direction of propagation
R. Rayleigh wave	3. Particle motion describes a retrograde ellipse
S. Love wave	4. Particle motion in the direction of propagation

(A) P-3, Q-4, R-1, S-2 (B) P-1, Q-4, R-2, S-3

(C) P-1, Q-3, R-2, S-4 (D) P-4, Q-2, R-3, S-1

Q.30 Which of the following is a minimum-phase wavelet ? The first value in each case is at time zero.

(A) {–2, 5, –2} (B) {–2, 5, 2}

(C) {6, –1, –2} (D) {3, 4, –4}

Q.31 In a gas zone, true porosity ϕ_t, neutron log ϕ_n and density derived porosity ϕ_d are related as

(A) $\phi_n < \phi_d > \phi_t$ (B) $\phi_n > \phi_d > \phi_t$

(C) $\phi_n > \phi_d = \phi_t$ (D) $\phi_n < \phi_d = \phi_t$

Q.32 Identify the equation for formation water resistivity (Rw_e) estimation from SP log, wherein *SSP*, *K(T)* and R_{mfe} are respectively static SP, temperature dependent coefficient and mudfiltrate resistivity.

(A) $SSP = - Rw_e \log(\frac{K(T)}{Rmf_e})$

(B) $SSP = -K(T) \log(\frac{Rw_e}{Rmf_e})$

(C) $SSP = - Rmf_e \log(\frac{K(T)}{Rw_e})$

(D) $SSP = -K(T) \log(\frac{Rmf_e}{Rw_e})$

Q.33 Gamma ray detected in density log is

(A) natural gamma present in the formation

(B) gamma ray from epithermal neutron source

(C) gamma ray scattered from the formation

(D) gamma ray emitted from neutron capture reaction

Q.34 In Turam method, one measures the reduced field ratio of the amplitude and of the phase difference between the two coils. In the absence of subsurface conducting body, the response is characterized as

(A) the successive reduced field ratio is equal to 1.0 and phase difference is 0°

(B) the successive reduced field ratio is equal to 1.0 and phase difference is 45°

(C) the successive reduced field ratio is equal to 0.5 and phase difference is 90°

(D) the successive reduced field ratio is equal to 0.5 and phase difference is 60°

Q.35 Electric field ($\vec{E}$) through a polarizable dielectric medium with polarization vector ($\vec{P}$), electric susceptibility (χ_e) and dielectric permittivity (ε_0). The electric displacement vector ($\vec{D}$) for the medium can be written as

(A) $\vec{D} = \varepsilon_0 (1 + \chi_e)$
(B) $\vec{D} = \varepsilon_0 \vec{E} - \vec{P}$
(C) $\vec{D} = \varepsilon_0 \vec{E} + \chi_e$
(D) $\vec{D} = \varepsilon_0 \vec{E} + \vec{P}$

Q.36 Using different electrodes configuration , maximum depth of investigation is achieved in

(A) Schlumberger
(B) dipole
(C) tri-electrodes
(D) Wenner

Q.37 Relevant differential equation to study low frequency electromagnetic prospecting for a conducting target can be written in the form of

(A) Wave equation
(B) Laplace's equation
(C) Helmholtz equation
(D) Poisson's equation

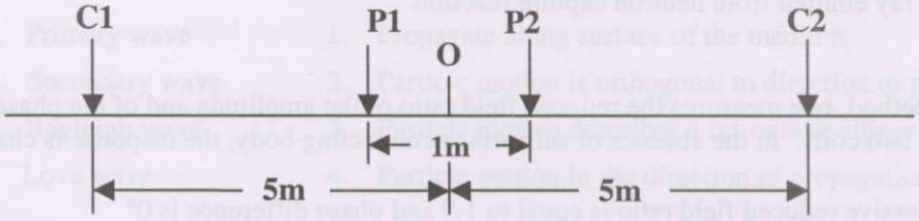
Q.38 In a layered medium, if the basement is perfectly conducting, magnetotelluric phase response asymptotically approaches to

(A) 0°
(B) 45°
(C) 60°
(D) 90°

Q.39 Magnetotelluric spectral impedance can be defined as

(A) the ratio of the spatial spectrum from mutually orthogonal horizontal components of the electric and magnetic field
(B) the ratio of the spatial spectrum of the vertical component to the horizontal component of magnetic field
(C) the ratio of the spatial spectrum of the vertical component to the horizontal component of electric magnetic field
(D) the ratio of the spatial spectrum of the two horizontal components of electric field

Q.40 Following four electrodes array: P1, P2 are measuring electrodes and C1, C2 are current electrodes used in resistivity measurement. Inter-electrode separation is also shown in figure.



The above electrode configuration is

(A) radial dipole
(B) parallel dipole
(C) Schlumberger
(D) Wenner

Q.41 In DC resistivity method, direct filter coefficients are used to compute

(A) apparent resistivity data from resistivity transform

(B) resistivity transform from apparent resistivity data

(C) apparent resistivity from measured potential difference

(D) apparent resistivity from one electrode configuration to other electrode configuration

Q.42 A counting rate of 15,100 counts per minute is recorded by a radiation counter having a dead time of 300 μsec. The count rate (counts per minute) in the absence of dead time would be

(A) 13,333 (B) 14,333 (C) 15,333 (D) 16,333

Q.43 The output of a linear and invariant system for a unit input is {3, 1}. Then what would be the output for an input {–2, 1} ?

(A) {–6, 1, 1} (B) {–1, 1, 6} (C) {–1, 6, 1} (D) {1, –1, 6}

Q.44 Geophysical inverse problems are described by

(A) Fredholm's integral equation of first kind

(B) Fredholm's integral equation of second kind

(C) Volterra's equation of second kind

(D) Legendre equation

Q.45 Spot the ANN method from the following :

(A) Singular value decomposition

(B) Monte-Carlo technique

(C) Ridge regression procedure

(D) Back propagation technique

Q.46 The concept of resolving kernel is used in

(A) Tikhonov's regularization method

(B) Ridge regression method

(C) Backus-Gilbert method

(D) Simulated annealing method

Q.47 For underwater gravity measurements, the following correction is needed :

(A) Prey correction

(B) Free-air correction

(C) Bouguer correction

(D) Isostatic correction

Q.48 The source of magnetic anomalies extend up to

(A) upper mantle

(B) core-mantle boundary

(C) lower mantle

(D) Curie-point isotherm

Q.49 In magnetic prospecting scalar magnetometers are used. Then, the prime assumption involved in magnetic data acquisition is

(A) remnant magnetization is predominant

(B) both remnant and induced magnetization are responsible

(C) induced magnetization plays a dominant role

(D) only diamagnetic sources are responsible

Q.50 Source of main geomagnetic field is best represented by

(A) a system of electric currents at core-mantle boundary

(B) a system of dipoles, quadrupoles, octupoles and multipoles

(C) an inclined geomagnetic dipole at center of earth

(D) a system of currents in the ionosphere

Common Data Questions

Common Data for Questions 51 and 52:

In a resistivity sounding experiment using Schlumberger configuration the apparent resistivity function asymptotically approaches a sloping straight line of slope 45° with abscissa.

Q.51 From the above data it can be inferred that the basement is

(A) Perfectly conducting

(B) Relatively resistive

(C) Relatively conducting

(D) Perfectly resistive

Q.52 If the intercept at $\rho_a = 1$ ohm-m is 5 and resistivity of top layer is 10 ohm-m, then the depth of basement is

(A) 50.0 m
(B) 5.0 m
(C) 2.0 m
(D) 0.5 m

Common Data for Questions 53 and 54:

In a seismic refraction experiment involving a two-layered earth of P-wave velocities, 3 km/sec and 4.5 km/sec the delay time is found to be 49.69 m sec.

Q.53 From the above data, the depth to the interface is given by

(A) 150 m
(B) 120 m
(C) 100 m
(D) 50 m

Q.54 Using the above depth, the computed critical distance (m) would be

(A) 151.20
(B) 178.88
(C) 221.67
(D) 169.87

Common Data for Questions 55 and 56:

The peak gravity anomaly over a 2-D line mass of circular cross-section (horizontal cylinder) of density contrast 500 kg/m^3 is 1.674 mgal. The anomaly decreases to 0.837 m gal at a distance of 500 m along a principal profile. The universal gravitation constant, $G = 6.6667 \times 10^{-11}$ m^3 sec^{-2}kg^{-1}.

Q.55 The depth (m) to center of line mass and radius (m) of the horizontal cylinder are

(A) 500, 199.80
(B) 200, 150.93
(C) 200, 100.33
(D) 100, 60.37

Q.56 Hence compute the excess mass per unit length (kg/m) of the line mass

(A) 11.0×10^7
(B) 9.0×10^7
(C) 6.27×10^7
(D) 3.67×10^7

Linked Answer Questions

Statement for Linked Answer Questions 57 and 58:

Resistivity log recorded using normal device with measuring electrode, M, is situated close to the current electrode, A, in logging device placed in borehole. A constant current, I, injected from current electrode into the formation.

Q.57 If the spacing between A and M is r, and the potential difference ΔV is measured between the measuring electrode, M and remotely placed surface electrode. Then the expression for the apparent resistivity can be written as

(A) $\rho_a = \frac{2\pi r}{I}\Delta V$

(B) $\rho_a = \frac{4\pi r^2}{I}\Delta V$

(C) $\rho_a = \frac{2\pi r^2}{I}\Delta V$

(D) $\rho_a = \frac{4\pi r}{I}\Delta V$

Q.58 If r = 0.40 m ; I = 0.02 amp ; $\Delta V = 0.04$ volt, then the measured apparent resistivity will be

(A) 1 Ωm

(B) 5 Ωm

(C) 10 Ωm

(D) 20 Ωm

Statement for Linked Answer Questions 59 and 60:

Given the wavelets, a={3, –2} and b={1, –2}

Q.59 The cross-correlation, φ_{ab}, is given by

(A) {–6, 7, –2}

(B) {–6, 10, –12}

(C) {–4, –11, –6}

(D) {–6, 11, –4}

Q.60 The inverse of wavelet 'a', W_a^{-1} is given by

(A) {4/3, 16/9, 17/7, 64/81}

(B) {1/3, 2/9, 4/27, 8/81}

(C) {4/9, 1/3, 64/81, 16/27}

(D) {16/27, 64/81, 4/9, 1/3}

END OF THE QUESTION PAPER

GG : GEOLOGY AND GEOPHYSICS

Duration : Three Hours *Maximum Marks* :100

Read the following instructions carefully.

1. This question paper contains **24** pages including blank pages for rough work. Please check all pages and report discrepancy, if any.

2. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the **Optical Response Sheet (ORS)**.

3. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.

4. All questions in this paper are of objective type.

5. Questions must be answered on the **ORS** by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **For each question darken the bubble of the correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as an incorrect response.

6. There are a total of 65 questions carrying 100 marks.

7. Apart from General Aptitude (GA), the question paper consists of two parts: Part A and Part B. Part A is common to both Geology and Geophysics candidates. Part B contains two sections: Section 1 (Geology) and Section 2 (Geophysics). Geology candidates will attempt questions in Section 1 only. Geophysics candidates will attempt questions in Section 2 only. Correctly darken the bubble (in the ORS) corresponding to the section attempted by you.

8. Part A consists of 25 questions; all will carry 1-mark each. Each of the sections (Section 1 & Section 2) in Part B consists of 30 questions; all will carry 2-marks each.

9. Questions Q.48 – Q.51 (2 pairs) are common data questions and question pairs (Q.52, Q.53) and (Q.54, Q.55) are linked answer questions. The answer to the second question of the linked answer questions pair depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.

10. Questions Q.56 – Q.65 belong to General Aptitude (GA). Questions Q.56 – Q.60 will carry 1-mark each, and questions Q.61 – Q.65 will carry 2-marks each. The GA questions will begin on a fresh page starting from page **15**.

11. Un-attempted questions will carry zero marks.

12. Wrong answers will carry NEGATIVE marks. For Q.1 – Q.25 and Q.56 – Q.60, ⅓ mark will be deducted for each wrong answer. For Q.26 – Q.51 and Q.61 – Q.65, ⅔ mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53), and (Q.54, Q.55) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair i.e. for Q.52 and Q.54, ⅓ mark will be deducted for each wrong answer. There is no negative marking for Q.53 and Q.55.

13. Calculator (without data connectivity) is allowed in the examination hall.

14. Charts, graph sheets or tables are NOT allowed in the examination hall.

15. Rough work can be done on the question paper itself. Additionally, blank pages are provided at the end of the question paper for rough work.

PART A: COMMON TO BOTH GEOLOGY AND GEOPHYSICS CANDIDATES

Q.1 – Q.25 carry one mark each.

Q.1 Earth's dipole field originates mainly from

(A) mantle (B) outer core (C) inner core (D) crust

Q.2 Sunspots are regions of

(A) high pressure
(B) low magnetic field
(C) high temperature
(D) high magnetic field

Q.3 The electrical conduction mechanism in sedimentary rocks is usually

(A) pyroelectric (B) electronic (C) electrolytic (D) dielectric

Q.4 The unit of electrical resistivity is

(A) Ohm (B) Ohm-m (C) Ohm-m^2 (D) Ohm-m^{-1}

Q.5 Outcrop pattern parallel to topographic contours signifies

(A) horizontal beds
(B) vertical beds
(C) inclined beds
(D) folded beds

Q.6 A rock with equal modal contents of quartz, plagioclase and orthoclase is known as

(A) diorite (B) gabbro (C) granite (D) syenite

Q.7 The main factors in soil-forming processes are

(A) bedrock and time only
(B) topography and bedrock only
(C) climate, time and topography only
(D) climate, topography, bedrock and time

Q.8 Glacial drift refers to the

(A) movement of glaciers
(B) interglacial intervals
(C) erosional landforms produced by glaciers
(D) sediments deposited by glaciers

Q.9 Sand dunes are long ridges whose alignment is

(A) always parallel to the prevailing wind direction
(B) always perpendicular to the prevailing wind direction
(C) either parallel or perpendicular to the prevailing wind direction
(D) not related to the prevailing wind direction

Q.10 The oldest rocks in India are

(A) more than 3 billion years old
(B) between 2.5 and 3 billion years old
(C) between 2 and 2.5 billion years old
(D) less than 2 billion years old

Q.11 The sequential placement of geological events, as determined by their position in the rock record, is known as

(A) relative dating
(B) correlation
(C) absolute dating
(D) uniformitarianism

Q.12 Time equivalence of rock units in different areas can be established primarily by considering similarity in

(A) lithology
(B) fossil assemblages
(C) sedimentary structures
(D) mineral assemblages

Q.13 Which of the following volcanic events has been suggested as a major cause of the extinction of dinosaurs?

(A) Panjal volcanism
(B) Deccan volcanism
(C) Rajmahal volcanism
(D) Malani volcanism

Q.14 Bode's law expresses the approximate distance between

(A) earth and other planets
(B) moon and sun
(C) planets and sun
(D) moon and earth

Q.15 India's northward drift from Gondwanaland is believed to have started approximately (in million years ago, Ma)

(A) 50 Ma (B) 150 Ma (C) 300 Ma (D) 400 Ma

Q.16 Which of the following instruments contains piezoelectric material?

(A) hydrophone
(B) geophone
(C) gravimeter
(D) magnetometer

Q.17 If the average crustal thickness is 35 km and the height of a mountain is 5 km above mean sea level, the crustal thickness based on Airy's model beneath the mountain will be approximately

(A) 35 km (B) 40 km (C) 50 km (D) 70 km

Q.18 The equipotential surface over which the gravitational field has equal value is known as

(A) geoid
(B) spheroid
(C) ellipsoid
(D) mean sea level

Q.19 The angle between the present geographic north and geomagnetic north is

(A) 1.5° (B) 7.5° (C) 11.5° (D) 23.5°

Q.20 Among the following, the best reconnaissance method for determining basement configuration of sedimentary basins is

(A) gravity method
(B) self potential method
(C) seismic method
(D) electromagnetic method

Q.21 Cooling of basaltic lava under water will lead to the formation of

(A) lava tunnel
(B) pillow structure
(C) columnar jointing
(D) cumulus texture

Q.22 What rock would you expect to find at the base of a typical oceanic plate?

(A) Basalt (B) Diorite (C) Gabbro (D) Peridotite

Q.23 Major coal deposits of India are found in the

(A) Cuddapah Supergroup
(B) Vindhyan Supergroup
(C) Gondwana Supergroup
(D) Dharwar Supergroup

Q.24 Which of the following is a product of residual weathering process?

(A) Placer gold
(B) Banded iron ore
(C) Bauxite
(D) Porphyry copper

Q.25 Choose the correct combination of ore and location of its deposit.

(A) Uranium – Jaduguda
(B) Lead – Khetri
(C) Gold – Panna
(D) Iron – Malanjkhand

END OF PART A

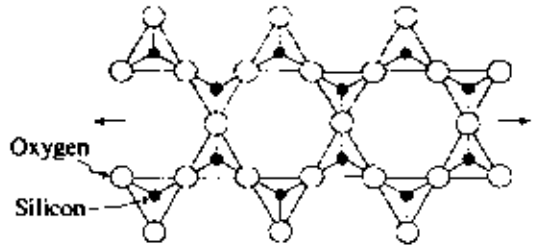
PART B (SECTION 1): FOR GEOLOGY CANDIDATES ONLY

Q.26 – Q.55 carry two marks each.

Q.26 The age of the oldest rocks in present-day ocean basins is

(A) Devonian (B) Jurassic (C) Eocene (D) Permian

Q.27 Silicon to oxygen ratio in the following silicate structure is



(A) 1 : 2 (B) 2 : 5 (C) 4 : 11 (D) 1 : 3

Q.28 Direct precipitation of uraninite from a mineralizing solution containing UO_2^{2+} ions can take place due to

(A) increase in Eh
(B) decrease in Eh
(C) increase in pH
(D) decrease in pH

Q.29 Match the optical properties in **Group I** with appropriate minerals in **Group II.**

Group I	**Group II**
P. Twinkling	1. Quartz
Q. Pleochroic haloes	2. Nepheline
R. Anomalous interference colour	3. Calcite
S. Uniaxial positive	4. Chlorite
	5. Biotite

(A) P – 4, Q – 5, R – 3, S – 2
(B) P – 3, Q – 4, R – 5, S – 2
(C) P – 3, Q – 5, R – 4, S – 1
(D) P – 3, Q – 4, R – 5, S – 1

Q.30 Wall-rock alteration producing epidote, albite and chlorite around an ore body is called

(A) argillic alteration
(B) propylitic alteration
(C) potassic-silicate alteration
(D) sericite alteration

Q.31 Match the textures/structures in **Group I** with appropriate processes in **Group II**.

Group I	**Group II**
P. Cumulus texture	1. Cavity filling
Q. Spinifex texture	2. Gravity settling
R. Oriented intergrowth	3. Annealing
S. Comb structure	4. Quenching
	5. Coherent exsolution

(A) P – 2, Q – 4, R – 5, S – 1
(B) P – 3, Q – 1, R – 2, S – 5
(C) P – 1, Q – 5, R – 4, S – 3
(D) P – 2, Q – 5, R – 4, S – 1

Q.32 An area shows linear erosional depression, sag pond, spring and offset stream along with sub-horizontal slickensides. The prominent structure indicated by these features is

(A) strike-slip fault
(B) horst and graben
(C) klippe
(D) nappe

Q.33 Match the ore types in **Group I** with appropriate path-finder elements in **Group II**.

Group I	**Group II**
P. Porphyry Cu ore	1. As
Q. Vein type Au ore	2. Hg
R. Pb-Zn-Ag ores	3. Cr
	4. Mo
	5. Ni

(A) P – 4, Q – 1, R – 2
(B) P – 3, Q – 2, R – 1
(C) P – 4, Q – 3, R – 5
(D) P – 5, Q – 4, R – 2

Q.34 Match the nature of mass movements listed in **Group I** with the evidences listed in **Group II**.

Group I	**Group II**
P. Creep	1.Tounge-shaped mass movement
Q. Earth flow	2. Curved tree trunks
R. Slump	3. Scree formation at the base
	4. Curved surface of rupture

(A) P-2, Q-1, R-4
(B) P-1, Q-3, R-4
(C) P-4, Q-2, R-1
(D) P-4, Q-3, R-2

Q.35 Which of the following metamorphic facies is characterized by the pyrope rich garnet + omphacite assemblage?

(A) Blueschist
(B) Eclogite
(C) Greenschist
(D) Granulite

Q.36 Match the gemstones in **Group I** with corresponding minerals in **Group II**.

Group I	**Group II**
P. Peridote	1. Beryl
Q. Emerald	2. Feldspar
R. Amazonite	3. Corundum
S. Ruby	4. Olivine

(A) P-4, Q-1, R-2, S-3
(B) P-1, Q-3, R-2, S-4
(C) P-2, Q-4, R-1, S-3
(D) P-3, Q-4, R-1, S-2

Q.37 Which of the following statements is **NOT** correct with regard to a perched water table?

(A) It is within an area where a local aquiclude occurs within a larger aquifer
(B) It lies above the main water table
(C) It is found in the main zone of saturation
(D) It is occasionally associated with springs

Q.38 The spatial resolution of IRS LISS-III multi-spectral sensor for Near Infra-Red (NIR) band is

(A) 5.8 m × 5.8 m (B) 23.5 m × 23.5 m (C) 70 m × 70 m (D) 72.5 m × 72.5 m

Q.39 Which of the following combinations of extinction events and extinct organisms is **NOT** correct?

(A) Cretaceous end – Dinosaurs
(B) Triassic end – Conodonts
(C) Permian end – Trilobites
(D) Miocene end – Ammonites

Q.40 In India, marine fossiliferous rocks of lower Paleozoic age are mainly found in the

(A) Gondwana
(B) Higher Himalaya
(C) Outer Himalaya
(D) Tethys Himalaya

Q.41 Which of the following pairs of rock formations and characteristic fossils is correct?

(A) Raniganj – *Elephas*
(B) Pinjor – *Titanosaurus*
(C) Lameta – *Glossopteris*
(D) Subathu – *Nummulites*

Q.42 Which of the following groups of rock formations is **NOT** arranged from older to younger?

(A) Uttatur – Trichinopoly – Ariyalur – Niniyur
(B) Patcham – Katrol – Chari – Umia
(C) Talchir – Damuda – Panchet – Mahadev
(D) Semri – Kaimur – Rewa –Bhander

Q.43 Choose the correct combination of geological agents and associated features.

(A) River – Spit
(B) Glacier – Yardang
(C) Longshore current – Esker
(D) Wind – Ventifact

Q.44 A sedimentary sequence dominated by large scale (5-10 m thick) cross beds, well-sorted and well-rounded quartz-rich sand with no fine matrix is most likely to be a

(A) deltaic deposit
(B) lagoonal deposit
(C) eolian deposit
(D) outer shelf deposit

Q.45 An invertebrate in which the plane of symmetry bisects the shell through the mid-point of the hinge is a

(A) Pelecypod (B) Brachiopod (C) Gastropod (D) Caphalopod

Q.46 The oldest mammals and birds are known, respectively, from

(A) Cretaceous and Paleocene
(B) Silurian and Devonian
(C) Triassic and Jurassic
(D) Oligocene and Miocene

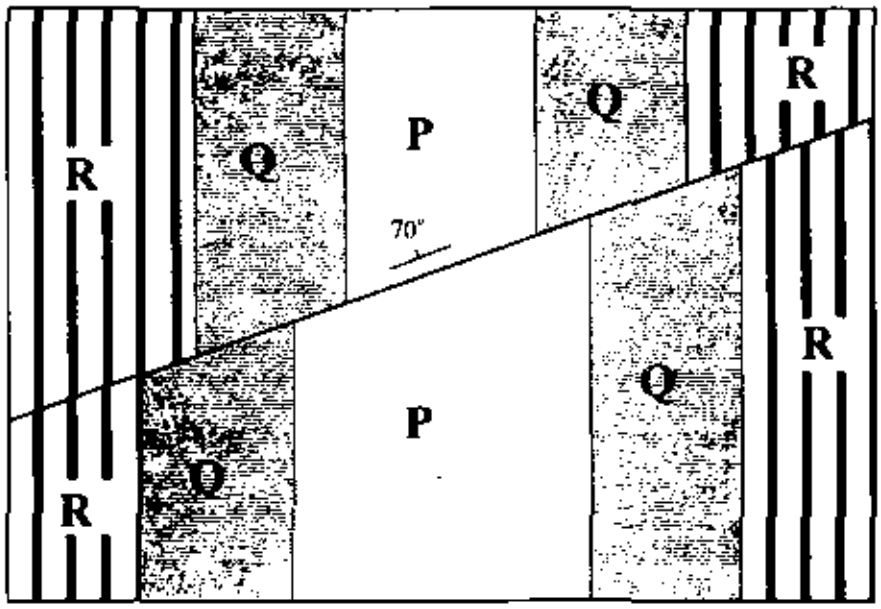
Q.47 Allochems in a limestone consist of

(A) micrite only
(B) spar only
(C) ooids only
(D) bioclasts and ooids

Common Data Questions

Common Data for Questions 48 and 49:

The following geological map exposes three beds, of which the bed P is the oldest and the bed R the youngest.



Q.48 What type of structure does the map depict?

(A) Faulted anticline (B) Folded strike-slip fault
(C) Faulted syncline (D) Folded normal fault

Q.49 Why is bed P wider in the area south of fault?

(A) Erosion has removed most of bed P to the north of fault
(B) Folding has caused thinning of bed P to the north of fault
(C) Deeper level of bed P is exposed due to faulting and erosion to the south of fault
(D) Bed P had a variable thickness prior to faulting

Common Data for Questions 50 and 51:

A sequence of shale and limestone is intruded by an igneous pluton. Metasomatic interaction between the pluton and the country rocks involves introduction of Si and Al into dolomitic limestone.

Q.50 Which pair of rock types best describes the products of metamorphism in the contact aureole?

(A) Slate and schist
(B) Schist and hornfels
(C) Schist and skarn
(D) Hornfels and skarn

Q.51 The mineral which is **NOT** expected in assemblages in the metamorphosed dolomitic limestone is

(A) grossular
(B) anorthite
(C) diopside
(D) andalusite

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

A pluton of iron-poor basic magma containing trace concentrations of Ni, Rb, Sr and V undergoes crystallization upon cooling.

Q.52 The first mineral to crystallize will be

(A) augite (B) hornblende (C) olivine (D) oligoclase

Q.53 The trace element that will be preferentially incorporated in the correct mineral in Q. 52 is

(A) Ni (B) Rb (C) Sr (D) V

Linked Answer Questions 54 and 55:

Q.54 Silica-undersaturated minerals are

(A) nepheline and albite
(B) olivine and enstatite
(C) leucite and orthoclase
(D) olivine and leucite

Q.55 The Hermann-Mauguin symbols of crystallographic notation for the correct minerals in Q. 54 are

(A) 2/m2/m2/m and 4/m
(B) 2/m2/m2/m for both
(C) 4/m and 2/m
(D) 6 and $\bar{1}$

END OF SECTION 1 OF PART B

PART B (SECTION 2): FOR GEOPHYSICS CANDIDATES ONLY

Q.26 – Q.55 carry two marks each.

Q.26 The gravity value measured at the base of a 10 m tall building is 40 mGal. The value at the top of the building ignoring its mass is close to

(A) 20 mGal (B) 37 mGal (C) 40 mGal (D) 43 mGal

Q.27 Upward continuation technique filters _____ wavelength anomalies and _____ their amplitudes.

(A) short, reduces
(B) long, enhances
(C) long, reduces
(D) short, enhances

Q.28 The relative intensities of induced and remanent magnetization are commonly expressed in terms of

(A) susceptibility
(B) gyromagnetic ratio
(C) Poisson's ratio
(D) Königsberger ratio

Q.29 In electrical resistivity method, which among the following is correct with reference to Geometric Factor (GF)?

(A) GF varies for profiling and remains constant for sounding
(B) GF remains constant for both profiling and sounding
(C) GF remains constant for profiling and varies for sounding
(D) GF varies for both profiling and sounding

Q.30 If in a magnetic dipole 'm' represents poles of equal strength and 'l' represents the distance between the two poles, then the magnetic moment of dipole is

(A) lm (B) $\frac{l}{m}$ (C) $2lm$ (D) $\frac{lm}{2}$

Q.31 Energy in radioactive decay with respect to time follows

(A) normal distribution
(B) Poisson distribution
(C) chi-squared distribution
(D) binomial distribution

Q.32 The logging technique that uses non-conductive drilling fluids is

(A) SP logging
(B) Resistivity logging
(C) Induction logging
(D) Radiometric logging

Q.33 Unguided random-walk inversion technique signifies

(A) Genetic algorithm
(B) Simulated annealing
(C) Monte Carlo inversion
(D) Metropolis algorithm

Q.34 The compressional wave velocity V_p within a solid with adiabatic bulk modulus K_s, rigidity modulus G and density ρ is given by

(A) $V_p = \sqrt{\frac{K_s + (5/3)G}{\rho}}$ (B) $V_p = \sqrt{\frac{K_s + (2/3)G}{\rho}}$

(C) $V_p = \sqrt{\frac{K_s + (1/3)G}{\rho}}$ (D) $V_p = \sqrt{\frac{K_s + (4/3)G}{\rho}}$

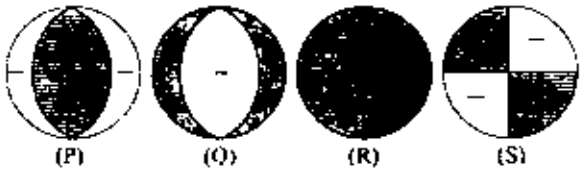
Q.35 The number of independent elements of the 4th order stiffness tensor required to characterize general elastic media is

(A) 2 (B) 21 (C) 36 (D) 81

Q.36 The seismic energy released in an earthquake of magnitude M_s = 7.0 is about _____ times that released in an earthquake of M_s = 6.0.

(A) 10 (B) 32 (C) 64 (D) 100

Q.37 In the figure given below "–" represents dilatation and "+" represents compression. The fault plane solution of an earthquake with strike-slip mechanism is represented by



(A) P (B) Q (C) R (D) S

Q.38 The anelastic attenuation of seismic energy depends on

(A) quality factor
(B) particle acceleration
(C) stress drop
(D) particle velocity

Q.39 The seismic wave travelling in low velocity layer and critically incident at the discontinuity between low and high velocity layers

(A) will be diffracted
(B) will be reflected
(C) will propagate along the discontinuity
(D) will be absorbed

Q.40 An input signal {-1,1,0,2}, after passing through a delay operator z, will be

(A) $-z^2 + z^3 + 2z^5$
(B) {0, –1, 1, 0, 2}
(C) {0, 2, 0, 1, –1}
(D) $-z + z^2 + 2z^4$

Q.41 If m represents the number of model parameters, d the number of data points and p the rank of matrix to be inverted, then which of the following defines an underdetermined system?

(A) $m < d$ and $p = d$
(B) $m > d$ and $p = d$
(C) $m = d$ and $p = d$
(D) $m < d$ and $p \neq d$

Q.42 A unit amplitude of an electromagnetic wave at thrice the skin-depth will be reduced to

(A) $-3e$ (B) $\frac{3}{e}$ (C) $\frac{e}{3}$ (D) e^{-3}

Q.43 The Hilbert transform of a function $f(t)$ is denoted by $H(f(t))$. If $f(t) = \sin t$, then $H\{H(f(t))\}$ is

(A) $-\sin t$ (B) $-\cos t$ (C) $\sin t$ (D) $\cos t$

Q.44 The rectangular function $\pi(t)$ is defined as $\pi(t) = 1 \quad |t| \leq 1/2$
$= 0 \quad |t| > 1/2$

The convolution of $\pi(t)$ with itself will be

(A) a triangular function $\Lambda(t)$
(B) $\pi(t)$ again
(C) a unit-step function u(t)
(D) a delta function $\delta(t)$

Q.45 Given $A = e^{-y}(\cos x \mathbf{a}_x - \sin x \mathbf{a}_y)$, where $\mathbf{a}_x$ and $\mathbf{a}_y$ denote the unit vectors in x- and y-directions, respectively. Then $\nabla \cdot (\nabla \times A)$ is equal to

(A) e^{-y} (B) 0 (C) $e^{-y}(\cos x)$ (D) $e^{-y}(\sin x)$

Q.46 Match the items in **Group I** with those in **Group II**.

Group I	**Group II**
P. Convolution in time domain	1. $\frac{1}{2\Delta t}$
Q. Nyquist frequency	2. Flat spectrum
R. Aliasing	3. Multiplication in frequency domain
S. White noise	4. Frequency folding
	5. Autocorrelation function

(A) P-3, Q-1, R-4, S-2
(B) P-2, Q-1, R-5, S-4
(C) P-3, Q-1, R-2, S-1
(D) P-2, Q-4, R-1, S-5

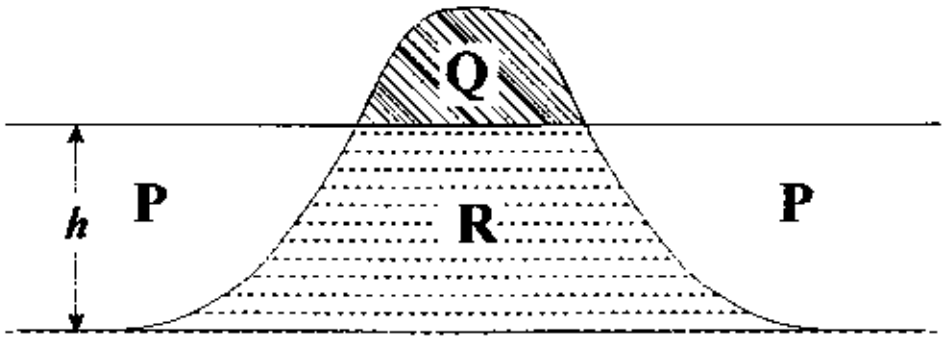
Q.47 In magnetic materials, the relation between magnetic permeability μ and susceptibility κ (in SI units) is

(A) $\mu = 1/\kappa$
(B) $\mu = 1 - \kappa$
(C) $\mu = 1 + \kappa$
(D) $\mu = 1 - 2\pi\kappa$

Common Data Questions

Common Data for Questions 48 and 49:

The terrain correction in gravity method accounts for topographic relief in the vicinity of the observation point. The Bouguer slab assumes the topography around the observation point to be flat. In the figure below, the Bouguer slab thickness is h and the hollow portion **P** lies within the Bouguer slab. **Q** and **R** are parts of the topography.



Q.48 In the region **P**, the terrain correction is

(A) half of that in **R**
(B) negative
(C) zero
(D) positive

Q.49 In the region **Q**, the terrain correction is required to account for

(A) hollow portion **P**
(B) reduced gravity due to excess mass in portion **Q**
(C) increased gravity due to excess mass in portion **Q**
(D) over-correction of Bouguer slab

Common Data for Questions 50 and 51:

For an input x_n, the output of a digital filter y_n is given by $y_n = 1.5x_n - 2x_{n-1} + 2.5y_{n-2}$.

Q.50 The order of the digital filter is

(A) 4 (B) 3 (C) 2 (D) 1

Q.51 The transfer function of the digital filter is

(A) $\frac{y_n}{x_n} = \frac{1.5 - 2z}{1 - 2.5z}$
(B) $\frac{y_n}{x_n} = \frac{1.5 - 2z}{1 - 2.5z^2}$
(C) $\frac{y_n}{x_n} = \frac{1 - 2.5z^2}{1.5 - 2z}$
(D) $\frac{y_n}{x_n} = \frac{1.5 - 2z}{1 + 2.5z^2}$

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

In a two-layer earth model, the values of seismic velocity and density of first and second layers, respectively, are $V_{p1} = 4000$ m/s, $\rho_1 = 2500$ Kg/ m^3, and $V_{p2} = 4500$ m/s, $\rho_2 = 2600$ Kg/ m^3.

Q.52 The acoustic impedance of the first layer in SI units at normal incidence is

(A) 10^3 (B) 10^4 (C) 10^5 (D) 10^7

Q.53 The transmission coefficient for a wave at normal incidence at the boundary of first and second layer is

(A) 0.46 (B) 0.58 (C) 0.92 (D) 1.07

Statement for Linked Answer Questions 54 and 55:

Consider a magnetotelluric (MT) field set up. A plane electromagnetic wave with a time dependence factor $e^{-i\omega t}$ is travelling vertically downwards (z-direction) into the Earth with an angular frequency ω. The electric field is polarized in the x-direction (strike).

Q.54 The electromagnetic field components considered in this mode are

(A) E_x, H_y and H_z (B) E_z, H_x and H_z (C) E_x, H_y and E_z (D) E_y, H_x and H_z

Q.55 Which of the following equations represents the above mode?

(A) $E_x = \dfrac{-1}{i\omega\mu}\dfrac{\partial H_y}{\partial z}$ (B) $H_x = \dfrac{-1}{i\omega\mu}\dfrac{\partial E_y}{\partial z}$ (C) $H_y = \dfrac{1}{i\omega\mu}\dfrac{\partial E_y}{\partial z}$ (D) $H_y = \dfrac{1}{i\omega\mu}\dfrac{\partial E_x}{\partial z}$

END OF SECTION 2 OF PART B

General Aptitude (GA) Questions

Q.56 – Q.60 carry one mark each.

Q.56 *Choose the most appropriate word from the options given below to complete the following sentence:*
His rather casual remarks on politics _____ his lack of seriousness about the subject.

(A) masked
(B) belied
(C) betrayed
(D) suppressed

Q.57 *Which of the following options is the closest in meaning to the word below:*
Circuitous

(A) cyclic
(B) indirect
(C) confusing
(D) crooked

Q.58 *Choose the most appropriate word from the options given below to complete the following sentence:*
If we manage to _____ our natural resources, we would leave a better planet for our children.

(A) uphold
(B) restrain
(C) cherish
(D) conserve

Q.59 25 persons are in a room. 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is:

(A) 2 (B) 17 (C) 13 (D) 3

Q.60 *The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.*
Unemployed : Worker

(A) fallow : land
(B) unaware : sleeper
(C) wit : jester
(D) renovated : house

Q.61 – Q.65 carry two marks each.

Q.61 If 137 + 276 = 435 how much is 731 + 672?

(A) 534 (B) 1403 (C) 1623 (D) 1513

Q.62 Hari (H), Gita (G), Irfan (I) and Saira (S) are siblings (i.e. brothers and sisters). All were born on 1st January. The age difference between any two successive siblings (that is born one after another) is less than 3 years. Given the following facts:

i. Hari's age + Gita's age > Irfan's age + Saira's age.
ii. The age difference between Gita and Saira is 1 year. However, Gita is not the oldest and Saira is not the youngest.
iii. There are no twins.

In what order were they born (oldest first)?

(A) HSIG (B) SGHI (C) IGSH (D) IHSG

Q.63 **Modern warfare has changed from large scale clashes of armies to suppression of civilian populations. Chemical agents that do their work silently appear to be suited to such warfare; and regretfully, there exist people in military establishments who think that chemical agents are useful tools for their cause.**

Which of the following statements best sums up the meaning of the above passage:

(A) Modern warfare has resulted in civil strife.
(B) Chemical agents are useful in modern warfare.
(C) Use of chemical agents in warfare would be undesirable.
(D) People in military establishments like to use chemical agents in war.

Q.64 5 skilled workers can build a wall in 20 days; 8 semi-skilled workers can build a wall in 25 days; 10 unskilled workers can build a wall in 30 days. If a team has 2 skilled, 6 semi-skilled and 5 unskilled workers, how long will it take to build the wall?

(A) 20 days (B) 18 days (C) 16 days (D) 15 days

Q.65 Given digits 2, 2, 3, 3, 3, 4, 4, 4, 4 how many distinct 4 digit numbers greater than 3000 can be formed?

(A) 50 (B) 51 (C) 52 (D) 54

END OF THE QUESTION PAPER

Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work

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SEAL