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 Nor

(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

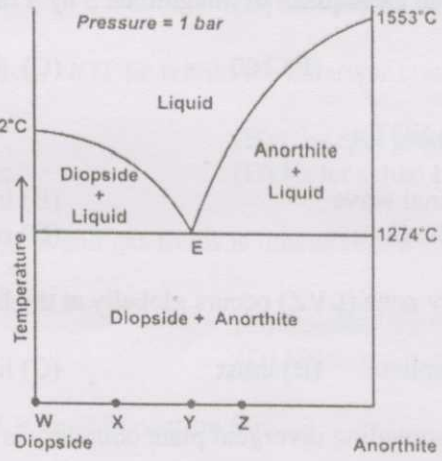
Q.23 When a hydrous fluid infiltrates a rock containing the assemblage wollastonite + calcite + quartz at a fixed pressure and temperature, the modal proportion of

(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

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) potel
(G - universal gravitational constant, ρ - density, I - intensity of magnetization and
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 radioac 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

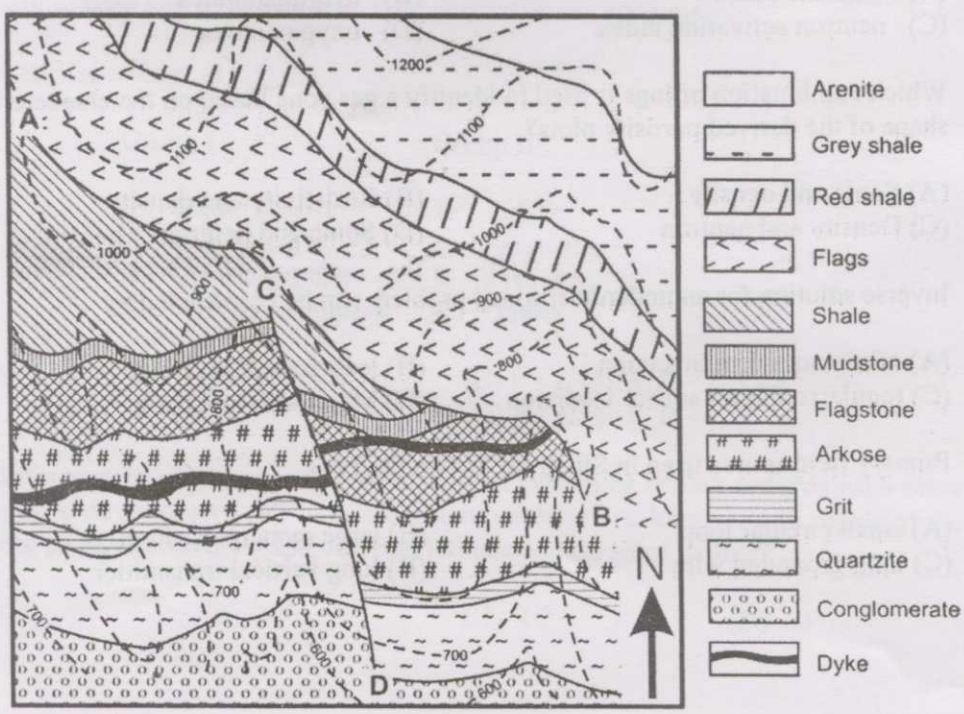
(A) 160 (B) 165 (C) 170 (D) 175

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