

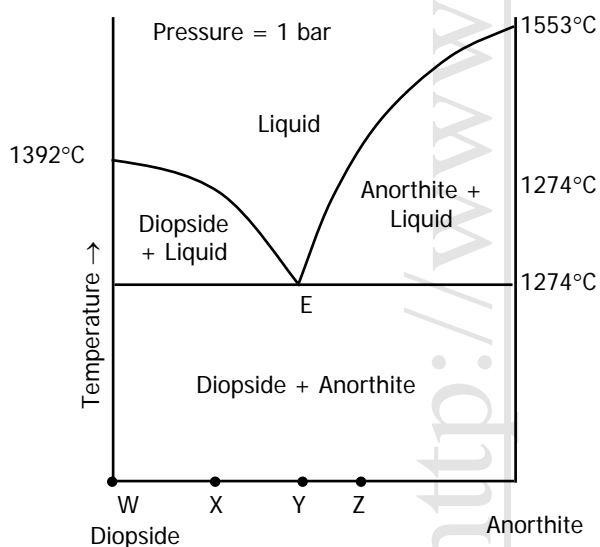
**Q. 1 - Q. 20 carry one mark each.**

1. The maximum curvature of a cylindrically folded surface occurs at the  
(A) axial plane (B) fold axis (C) hinge (D) limb
2. The plutonic equivalent of rhyolite is  
(A) diorite (B) granite (C) hinge (D) limb
3. At a pressure of 14kb and temperature of 600°C, basalt would metamorphose to  
(A) amphibolite (B) eclogite (C) greenschist (D) mafic granulite
4. Which is the most abundant sediment in the deep sea?  
(A) Clay (B) Pebble (C) Sand (D) Silt
5. Which of the following is an ore mineral of iron?  
(A) Manganite (B) Magnesite (C) Malachite (D) Magnetite
6. "Bajada" is  
(A) an arid region landform (B) a fluvial landform  
(C) a glacial landform (D) an oceanic landform
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
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
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
10. Which is the most abundant element in the solar system?  
(A) Hydrogen (B) Iron (C) Oxygen (D) Silicon
11. Latitude correction applied gravity data reduction is maximum at the latitude of  
(A) 0° (B) 30° (C) 45° (D) 60°
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)  $\frac{3}{4}$
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
14. Self-potential method is used in geophysical prospecting of ore deposits predominantly containing  
(A) chalcopryite (B) Chromite (C) Ilmenite (D) magnetite
15. Deep earthquakes are associated with  
(A) mid-oceanic ridges (B) rift zones  
(C) subduction zones (D) transform faults
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
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

18. A P-wave is NOT a  
 (A) dilatational wave (B) irrotational wave  
 (C) longitudinal wave (D) rotational wave
19. Low velocity zone (LVZ) occurs globally at the base of the  
 (A) asthenosphere (B) crust (C) lithosphere (D) outer core
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.**

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  $45^\circ$  to the fold axis  
 (C) perpendicular to the fold axis (D) parallel to the axial plane
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
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
24. Which of the following represents a correct magmatic fractionation sequence?  
 (A) Basalt → Andesite → Dacite → Phonolite  
 (B) Basalt → Andesite → cc → Rhyolite  
 (C) Basalt → Mugearite → Dacite → Rhyolite  
 (D) Basalt → Mugearite → Trachyte → Phonolite
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

26. Which is the most common type of porosity in sandstone?  
 (A) Mouldic (B) Intraparticle (C) Interparticle (D) Shelter
27. Which of the following features is NOT a tool 'mark'?  
 (A) Chevron mark (B) Groove cast (C) Load cast (D) Prod mark
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
29. State the nature of the following reaction:  
 $\text{Si}^{4+} + 4\text{H}_2\text{O} \leftrightarrow \text{H}_4\text{SiO}_4 + 4\text{H}^+$   
 (A) hydration (B) hydrolysis (C) oxidation (D) reduction
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. $\text{Na}^+$    | 1. 2.4  |          |  |
| Q. $\text{Mg}^{2+}$ | 2. 23.0 |          |  |
| R. $\text{Ca}^{2+}$ | 3. 1.0  |          |  |
| S. $\text{K}^+$     | 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
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
32. Which of the following macerals has the lowest H/C ratio?  
 (A) Alginite (B) Fusinite (C) Resinite (D) Sporinite
33. The paleoenvironmental condition indicated by the foraminiferal assemblage, Ammonia - Cibicides - Quinqueloculina is  
 (A) abyssal (B) bathyal (C) non-marine (D) shelf
34. Match the bivalves in Group I with the dentitions in Group II.
- | Group I      |               | Group II |  |
|--------------|---------------|----------|--|
| P. Nucula    | 1. Desmodont  |          |  |
| Q. Spondylus | 2. Pachyodont |          |  |
| 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

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

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

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

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

39. Which of the following triple junction 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
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40. Match the following

Group I		Group II	
P.	Nickpoints	1.	Karst topography
Q.	Piedplains	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

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

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)  $\text{pH} = 7$

- (A)  $10^{-17}$  (B)  $10^{-7}$  (C)  $10^{+7}$  (D)  $10^{+17}$

43. A basaltic lava flow is found to have a  $^{87}\text{Sr}/^{86}\text{Sr}$  ratio of 0.720, and a  $^{87}\text{Rb}/^{86}\text{Sr}$  ratio of 0.750. If the initial  $^{87}\text{Sr}/^{86}\text{Sr}$  value is determined to be 0.704, what is the age of the flow? (assume  $\lambda = 1.42 \times 10^{-11} \text{ year}^{-1}$ )

- (A)  $2.5 \times 10^9$  years (B)  $1.5 \times 10^9$  years (C)  $2.5 \times 10^9$  years (D)  $1.5 \times 10^9$  years

44. What are the normal ( $\sigma_n$ ) and shear ( $\tau$ ) stresses acting on a plane that makes an angle of  $30^\circ$  with the maximum principal compressive stress ( $\sigma_1$ ) direction?

- (A)  $\sigma_n = 5.25 \text{ kb}$ ;  $\tau = 1.17 \text{ kb}$  (B)  $\sigma_n = 6.25 \text{ kb}$ ;  $\tau = 2.17 \text{ kb}$   
(C)  $\sigma_n = 7.25 \text{ kb}$ ;  $\tau = 3.17 \text{ kb}$  (D)  $\sigma_n = 8.25 \text{ kb}$ ;  $\tau = 4.17 \text{ kb}$

45. Quartz can be optically distinguished from nepheline based on

- (A) relief (B) birefringence (C) optic sign (D) extinction angle

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

47. A seismic reflection segment after migration

- (A) shallows and steepens  
(B) deepens and steepens  
(C) lengthens and deepens  
(D) shortens and deepens

48. The coverage obtained for a 12 geophone CDP profile with short spacing equal to twice the geophone spacing is

- (A) 3-fold (B) 6-fold (C) 12-fold (D) 24-fold

49. A P-wave incident on a horizontal interface between two layers at an angle of  $30^\circ$  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 respectively).

- (A)  $12^\circ$  (B)  $14^\circ$  (C)  $16^\circ$  (D)  $18^\circ$

50. The decimal number 27 is represented in binary form as

- (A) 11101 (B) 11001 (C) 10111 (D) 11011

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

52. Convoluting 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)  $\{3, 5, 9, 6, 11, 5\}$
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)  $P < R < Q < S$
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
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
56. In magnetotelluric method, phase angle derived from measured data over a homogeneous medium is  
 (A)  $0^\circ$  (B)  $30^\circ$  (C)  $45^\circ$  (D)  $90^\circ$
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)  $P < R < Q < R$  (D)  $P < Q < R < S$
58. The correct expression relating the gravitational (U) and magnetic (W) potentials is (G - universal gravitational constant, P - density, I - intensity of magnetization and  $\alpha$  - the direction of magnetization)  
 (A)  $W = -\frac{I}{Gp} \frac{\partial U}{\partial \alpha}$  (B)  $W = -\frac{p}{GI} \frac{\partial U}{\partial \alpha}$  (C)  $W = -\frac{p}{GI} \frac{\partial W}{\partial \alpha}$  (D)  $W = -\frac{I}{Gp} \frac{\partial W}{\partial \alpha}$
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	45500	45650	45750	45850	45850	45700

Which station shows the maximum anomaly after linear drift correction?

- (A) 2 (B) 3 (C) 4 (D) 5
60. At  $45^\circ\text{N}$  latitude, a spherical body having a radius 500 m, density 3.5 g/cc and magnetic susceptibility  $5.0 \times 10^{11}$  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

61. Match the following

Group I		Group II	
P.	Paramagnetic	1.	Cobalt
Q.	Diamagnetic	2.	Ilmenite
R.	Ferromagnetic	3.	Pyroxence
S.	Antiferromagn etic	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

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°

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

64. Number of atoms and disintegration constants of the parent ( $N_1, \lambda_1$ ) and daughter ( $N_2, \lambda_2$ ) 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)  $\frac{N_1}{\lambda_1} = \frac{N_2}{\lambda_2}$  (D)  $\frac{N_1 \lambda_1}{N_2} = \frac{N_2 \lambda_2}{N_1}$

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

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

67. Determination of formation porosity using neutron logging is based on

- (A) chlorine index (B) hydrogen index  
(C) neutron activation index (D) oxygen index

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

69. Inverse solution for an underdetermined problem can be constructed by

- (A) minimum normal inversion (B) Resistivity and density  
(C) Density and neutron (D) Sonic and neutron

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:

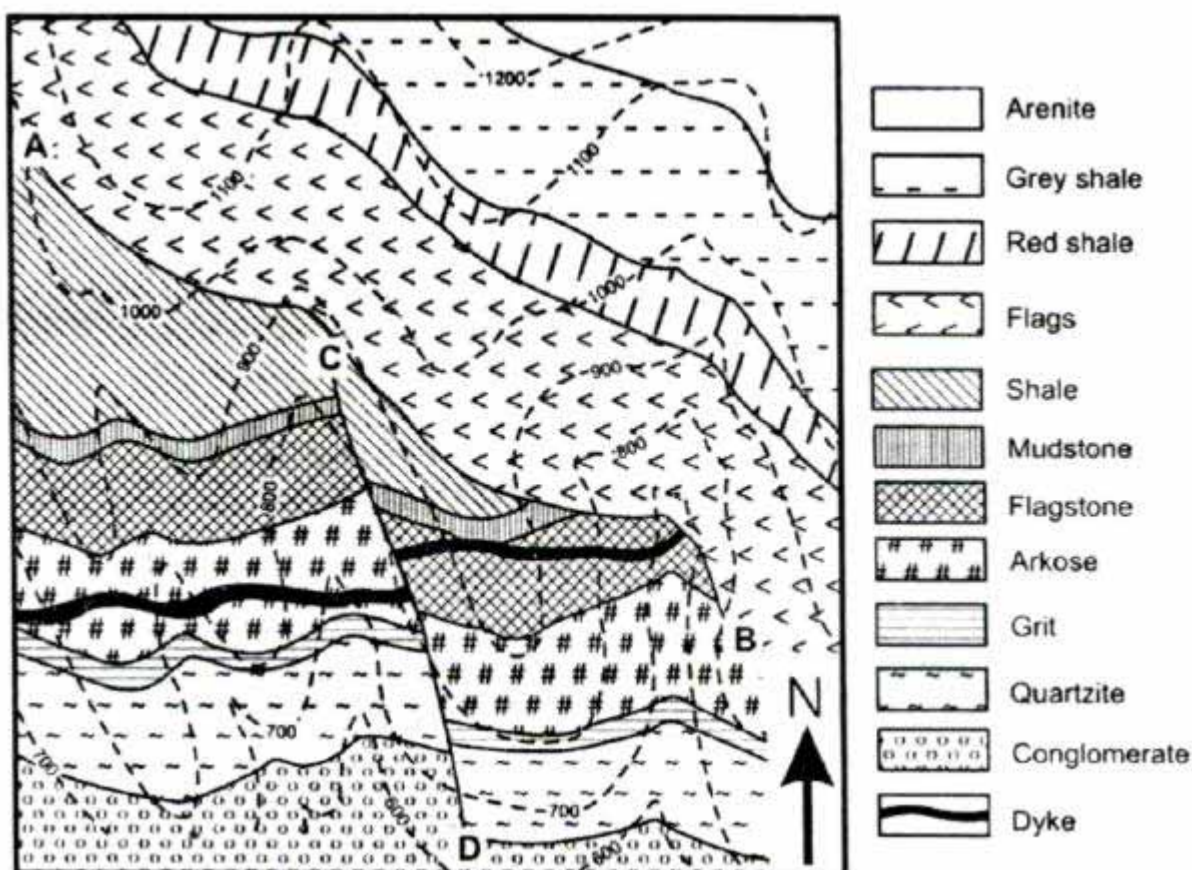
A P-wave generated from a surface source is incident at an angle of 15° on the horizontal interface between two 100 m thick layers with velocities  $V_1 = 2$  km/s and  $V_2 = 4$  km/s for the first and second layers respectively.



71. The crossover distance (metres) for a head wave from the interface between the two layers is  
(A) 326 (B) 165 (C) 170 (D) 356
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
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.



75. The discontinuity CD represents a  
(A) normal fault (B) reverse fault  
(C) strike-slip (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.

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
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.

78. A homogeneous medium is represented by the electrical conductivity ' $\sigma$ ' and magnetic permeability ' $\mu$ '. If the angular frequency of the source field is  $\omega$ , then the expression for the skin depth ' $\delta$ ' 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)  $\delta = \sqrt{\frac{2}{\omega\mu\sigma}}$

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  $\Omega\text{m}$  and magnetic permeability of  $4\pi \times 10^{-7}$  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,

80. The rose diagram generated from the paleocurrent data is  
 (A) bimodal - bipolar (B) polymodal  
 (C) trimodal (D) unimodal
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.

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
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.

84. Calculate the true dip of the limestone bed.  
 (A) 70° (B) 50° (C) 30° (D) 10°
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**