

**Section A: Q.1 – Q.10 Carry ONE mark each.**

Q.1 The plate tectonic setting of Benioff-Wadati zone is

- (A) continental rift
- (B) subduction zone
- (C) passive margin
- (D) mid-oceanic ridge

Q.2 Neutron-rich unstable nuclides undergo

- (A)  $\beta^-$  (negatron) decay
- (B)  $\beta^+$  (positron) decay
- (C)  $\alpha$ -decay
- (D) electron capture

Q.3 Which one of the following textures is found in alkali olivine basalt?

- (A) Rapakivi
- (B) Graphic
- (C) Blastoporphyritic
- (D) Intergranular

Q.4 The mineral assemblage found in a granulite facies metabasalt is

- (A) glaucophane + lawsonite + chlorite
- (B) orthopyroxene + garnet + plagioclase + clinopyroxene + quartz
- (C) actinolite + albite + chlorite + epidote
- (D) omphacite + garnet + quartz

Q.5 *Glossopteris* is found in which of the following formations?

- (A) Raniganj
- (B) Bagra
- (C) Lameta
- (D) Nimar Sandstone

Q.6 In a sequence of undeformed sedimentary rocks, younger rocks overlie older rocks. This conforms to the principle of

- (A) superposition
- (B) uniformitarianism
- (C) faunal succession
- (D) original horizontality

Q.7 Dropstones are found in

- (A) Barakar Formation
- (B) Talchir Formation
- (C) Raniganj Formation
- (D) Bijori Formation

Q.8 The sedimentary structure formed by unidirectional current is

- (A) trough cross-bedding
- (B) oscillation ripple
- (C) concretion
- (D) hummocky cross-stratification

Q.9 Which of the following is the precursor of petroleum?

- (A) Sporinite
- (B) Clarain
- (C) Kerogen
- (D) Vitrain

Q.10 Which of the following is an amorphous variety of  $\text{SiO}_2$ ?

- (A) Quartz
- (B) Citrine
- (C) Agate
- (D) Opal

**Section A: Q.11 – Q.30 Carry TWO marks each.**

Q.11 The name of an igneous rock having a modal composition of 55% olivine, 40% orthopyroxene and 5% plagioclase, as per the IUGS classification scheme, is

- (A) gabbro
- (B) troctolite
- (C) lherzolite
- (D) harzburgite

Q.12 Which of the following is the correct decreasing order of abundance of elements in our solar system?

- (A)  $O > H > Fe > He$
- (B)  $O > Fe > H > He$
- (C)  $H > O > Fe > He$
- (D)  $H > He > O > Fe$

Q.13 The suture of a cephalopod having smooth saddles and crenulated lobes is called

- (A) orthoceratitic
- (B) goniatitic
- (C) ceratitic
- (D) ammonitic

Q.14 Which of the following is a body fossil?

- (A) Coprolite
- (B) Footprint
- (C) Cast
- (D) Stromatolite

Q.15 Match the morphological features in Group I with the corresponding taxa in Group II.

Group I	Group II
P. Dissepiment	1. Echinodermata
Q. Delthyrium	2. Trilobita
R. Pygidium	3. Brachiopoda
S. Ambulacrum	4. Anthozoa

(A) P – 4, Q – 3, R – 2, S – 1

(B) P – 4, Q – 3, R – 1, S – 2

(C) P – 2, Q – 3, R – 4, S – 1

(D) P – 3, Q – 4, R – 2, S – 1



Q.16 Match the sedimentary features/structures in Group I with the corresponding processes in Group II.

**Group I**

P. Stylolite

Q. Pseudonodule

R. Current crescent

S. Stromatolite

**Group II**

1. Liquefaction

2. Diagenesis

3. Organo-sedimentary binding

4. Scouring

(A) P – 2, Q – 1, R – 4, S – 3

(B) P – 2, Q – 3, R – 4, S – 1

(C) P – 3, Q – 1, R – 4, S – 2

(D) P – 4, Q – 1, R – 2, S – 3

Q.17 Match the geomorphic features in Group I with the corresponding environments in Group II.

**Group I**

P. Dreikanter

Q. Cirque

R. Natural levee

S. Berm

**Group II**

1. Glacial

2. Beach

3. Eolian

4. Fluvial

(A) P – 3, Q – 1, R – 4, S – 2

(B) P – 2, Q – 1, R – 4, S – 3

(C) P – 3, Q – 4, R – 1, S – 2

(D) P – 4, Q – 2, R – 3, S – 1

Q.18 The correct hierarchy of the given stratigraphic units is

- (A) Group > Member > Formation > Bed
- (B) Eon > Era > Epoch > Period
- (C) Group > Formation > Member > Bed
- (D) Eon > Era > Series > Systems

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Q.19 Match the minerals in Group I with their highest order of interference color in Group II (for 0.03 mm mineral thickness).

**Group I**

P. Sillimanite

Q. Quartz

R. Muscovite

S. Calcite

**Group II**

1. First order

2. Second order

3. Greater than third order

4. Third order variegated

(A) P – 2, Q – 4, R – 1, S – 3

(B) P – 3, Q – 1, R – 2, S – 4

(C) P – 2, Q – 1, R – 4, S – 3

(D) P – 4, Q – 2, R – 3, S – 1

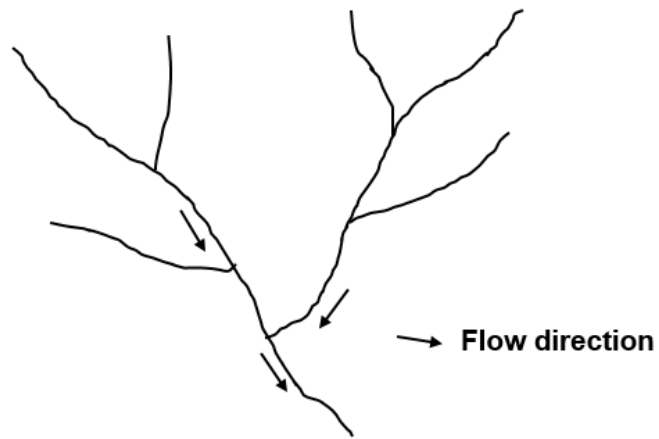
Q.20 The saturated thickness of an unconfined aquifer is defined by the distance between

- (A) the ground surface and the water table
- (B) the water table and the underlying confining layer
- (C) the water table and the mean sea level
- (D) the ground surface and the underlying confining layer

Q.21 Darcy's law quantifies the volume of groundwater flow

- (A) per unit surface area of the aquifer
- (B) per unit time
- (C) per unit cross-sectional area of the aquifer
- (D) per unit cross-sectional area of the aquifer per unit time

- Q.22 According to Strahler's stream ordering system, what is the highest order of stream in the given diagram?



- (A) 4  
(B) 3  
(C) 2  
(D) 1

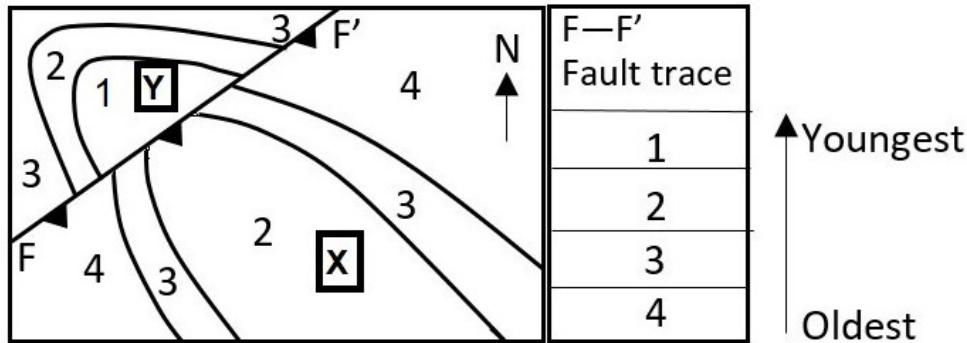
Q.23 A tunnel with vertical walls and arched crown is constructed through a set of sedimentary beds. The thickness of individual beds is significantly less than the wall-height of the tunnel. For which of the following conditions, one of the tunnel walls becomes unstable?

- (A) The tunnel axis is horizontal and the beds are horizontal
- (B) The tunnel axis is parallel to the strike of beds and the beds dip  $45^\circ - 60^\circ$
- (C) The tunnel axis is parallel to the strike of beds and the beds are vertical
- (D) The tunnel axis is perpendicular to the strike of beds and the beds are vertical

Q.24 A plunging fold will NOT show a V-shaped outcrop pattern on a planar ground surface if the plunge of the fold axis is

- (A) equal to the dip of the ground surface in the same direction
- (B) steeper than the dip of the ground surface in the same direction
- (C) equal to the dip of the ground surface in the opposite direction
- (D) steeper than the dip of the ground surface in the opposite direction

- Q.25 The given map shows the outcrop patterns of beds (1 – 4) across a fault plane, F – F', on a flat ground. X and Y refer to the two blocks across F – F'. Which one of the following options is the correct interpretation of the structure depicted on the map?



- (A) A south-easterly plunging synform that was subsequently faulted with block X upthrown
- (B) A north-westerly plunging antiform that was subsequently faulted with block Y upthrown
- (C) A south-easterly plunging antiform that was subsequently faulted with block X downthrown
- (D) A north-westerly plunging synform that was subsequently faulted with block Y downthrown



Q.26 The crystal form 'dome' contains

- (A) two parallel faces related by a 2-fold axis of symmetry
- (B) two non-parallel faces related by a 2-fold axis of symmetry
- (C) two parallel faces related by a mirror plane
- (D) two non-parallel faces related by a mirror plane

Q.27 The symbols  $[100]$ ,  $\{100\}$  and  $(100)$  in a crystal represent the sequence

- (A) form, line and face
- (B) form, face and line
- (C) line, face and form
- (D) line, form and face

Q.28 Match the stratigraphic units in Group I with the corresponding Archean cratons in Group II.

**Group I**

P. Bababudan Group

Q. Banded Gneissic Complex-I

R. Bonai Granite

S. Kolar Group

**Group II**

1. Eastern Dharwar

2. Western Dharwar

3. Aravalli

4. Singhbhum

(A) P – 2, Q – 3, R – 4, S – 1

(B) P – 3, Q – 2, R – 1, S – 4

(C) P – 2, Q – 1, R – 4, S – 3

(D) P – 4, Q – 3, R – 2, S – 1

Q.29 Which one of the metamorphic facies sequence in order of increasing metamorphic grade defines thermal metamorphism ?

- (A) Sanidinite → pyroxene hornfels → hornblende hornfels → albite-epidote hornfels
- (B) Albite-epidote hornfels → hornblende hornfels → sanidinite → pyroxene hornfels
- (C) Hornblende hornfels → albite-epidote hornfels → pyroxene hornfels → sanidinite
- (D) Albite-epidote hornfels → hornblende hornfels → pyroxene hornfels → sanidinite

Q.30 Nickel ores are NOT associated with

- (A) ultramafic igneous rocks
- (B) laterites
- (C) sea-floor polymetallic nodules
- (D) skarns

**Section B: Q.31 – Q.40 Carry TWO marks each.**

Q.31 Which of the following statements on mantle partial melting are correct?

- (A) Shallow melting produces tholeiitic basalts.
- (B) Low-degree melting produces alkaline basalts.
- (C) Presence of CO<sub>2</sub>-rich volatiles favors the formation of tholeiitic basalts.
- (D) Presence of H<sub>2</sub>O-rich volatiles favors the formation of alkaline basalts.

Q.32 Which of the following fossil groups are from the Siwalik Group?

- (A) Proboscidea
- (B) Giraffidae
- (C) Dinosauria
- (D) Equidae

Q.33 The correct stratigraphic successions arranged from the oldest to the youngest are

- (A) Uttatur → Trichinopoly → Ariyalur → Niniyur
- (B) Chari → Patcham → Umia → Katrol
- (C) Chinji → Nagri → Dhok Pathan → Tatrot
- (D) Semri → Rewa → Kaimur → Bhandar

Q.34 Which of the following combinations are correctly matched?

- (A) Photic zone – biogenic carbonate rocks
- (B) Delta – progradational coarsening-up succession
- (C) Sabkha – shelf storm deposit
- (D) Shelf break – submarine fans

Q.35 High drainage density is representative of a terrain with

- (A) high relief
- (B) arid climate
- (C) impermeable surface layer
- (D) permeable surface layer

Q.36 Mass-wasting processes are

- (A) landslides
- (B) lahars
- (C) avalanches
- (D) sand storms

Q.37 Which ones of the following correspond to the Pyroxene group?

- (A)  $\text{CaMgSi}_2\text{O}_6$
- (B)  $\text{CaAl}_2\text{SiO}_6$
- (C)  $\text{Ca}_2\text{Si}_2\text{O}_6$
- (D)  $\text{NaFeSi}_2\text{O}_6$

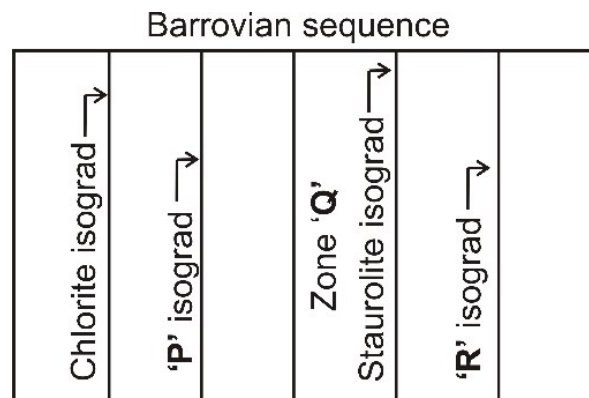
Q.38 Which of the following processes are correctly matched with corresponding deformation structures?

- (A) Pressure solution – rock cleavage
- (B) Jointing – plumose markings
- (C) Layer parallel compression – buckle folds
- (D) Cohesion loss – slickensides

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- Q.39 For the given Barrovian metamorphic sequence, which of the following statements are correct?



- A) Grade of metamorphism increases from left to right.
- (B) 'P' isograd is the Garnet isograd.
- (C) Zone 'Q' is the Garnet zone.
- (D) 'R' isograd is the Kyanite isograd.

Q.40 Which ones of the following are formed by brittle deformation?

- (A) Cataclasite
- (B) Breccia
- (C) Mylonite
- (D) Gouge

**Section C: Q.41 – Q.50 Carry ONE mark each.**

Q.41 The value of  $\phi$  (*phi*) of a sediment grain having a diameter of 0.125 mm is \_\_\_\_\_. (*In integer*)

Q.42 The vertical separation of a displaced horizontal stratum along a dip-slip reverse fault is 10 m when measured on a section perpendicular to the fault-strike. If the dip of the fault is  $30^\circ$ , the net slip of the fault will be \_\_\_\_\_ m. (*In integer*)

- Q.43 The dips of the normal and overturned limbs of a horizontal-overturned antiform are  $30^\circ$  and  $70^\circ$ , respectively. The interlimb angle of this fold is \_\_\_\_\_ degrees. (*In integer*)
- Q.44 In a mineral with formula  $\text{KAl}_3\text{Si}_3\text{O}_{10}(\text{F}_{0.5}\text{OH}_x)$ , the value of 'x' is \_\_\_\_\_. (*Round off to one decimal place*)
- Q.45 The atom percent of Fe in pyrrhotite of composition  $\text{Fe}_{0.77}\text{S}$  is \_\_\_\_\_. (*Round off to two decimal places*)
- Q.46 Consider the univariant metamorphic reaction  $\text{Albite} = \text{Jadeite} + \text{Quartz}$ . The minimum number of chemical components required to describe the composition of all the phases is \_\_\_\_\_. (*In integer*)

- Q.47 The mean flow velocity of water in an open channel having an average depth of 0.2 m, and with Froude Number 4, is \_\_\_\_\_ m/s. (*Round off to one decimal place*) (Use  $g = 9.8 \text{ ms}^{-2}$ )
- Q.48 An aquifer has a cross-sectional area of  $10 \text{ m}^2$  and a hydraulic conductivity of 0.25 cm/s. The volume of water that will flow per second through the aquifer for a hydraulic gradient of 0.04 is \_\_\_\_\_  $\text{cm}^3$ . (*Round off to three decimal places*)
- Q.49 The geothermal gradient in the continental crust is  $0.02 \text{ }^\circ\text{C/m}$ . If the surface temperature is  $25 \text{ }^\circ\text{C}$ , the temperature at a depth of 18 km from the surface is \_\_\_\_\_  $^\circ\text{C}$ . (*In integer*)
- Q.50 The area of a triangular block of a massive orebody is  $1500 \text{ m}^2$ . If the thickness of the orebody is 5 m, 6 m and 7 m at the three corners of the triangular block, and the ore density is  $2.5 \text{ tons/m}^3$ , the estimated ore reserve of the block is \_\_\_\_\_ tons. (*In integer*)

**Section C: Q.51 – Q.60 Carry TWO marks each.**

- Q.51 Clinopyroxene crystallizing from a basaltic magma has Sm concentration of 24 ppm. If the clinopyroxene-melt partition coefficient for Sm is 1.2, the concentration of Sm in the basaltic magma will be \_\_\_\_\_ ppm. (*In integer*)
- Q.52 The lithostatic pressure at a depth of 36.5 km in the continental crust having an average density of 2800 kg/m<sup>3</sup>, is \_\_\_\_\_ GPa. (*Round off to the nearest integer*)  
(Use  $g = 9.8 \text{ m/s}^2$ )
- Q.53 The fraction of  ${}^{24}_{11}\text{Na}$  atoms remaining after a decay interval of 5.0 hours will be \_\_\_\_\_. (*Round off to three decimal places*) (Use  $t_{1/2} = 15.0$  hours)
- Q.54 The thickness of a dipping coal bed measured along a vertical drill hole is 15 m. If the dip of the coal bed is 30°, the orthogonal thickness of the coal bed is \_\_\_\_\_ m. (*Round off to the nearest integer*)

- Q.55 The mole fraction of forsterite in olivine with MgO = 29.17 weight %, FeO = 34.65 weight % and SiO<sub>2</sub> = 36.18 weight % is \_\_\_\_\_. (Round off to two decimal places) (Use molecular weight, in g/mol, of MgO = 40.31, FeO = 71.85 and SiO<sub>2</sub> = 60.00)
- Q.56 A partially saturated soil sample has a volume of 1200 cc. The volume of water present in the sample is 300 cc. The mass of solid in the sample is 1908 g and the particle density is 2.65 g/cc. The porosity (n) of the soil sample is \_\_\_\_\_ %. (In integer)
- Q.57 A rock element during deformation, experienced a pressure change of  $5 \times 10^4$  N/m<sup>2</sup>, due to which its volume changed from 4 cm<sup>3</sup> to 3.9 cm<sup>3</sup>. The bulk modulus of the rock is \_\_\_\_\_  $\times 10^6$  N/m<sup>2</sup>. (In integer)
- Q.58 For an anisotropic crystal of thickness 0.04 mm and refractive indices of 1.636 and 1.486 along the slow and fast directions, respectively, the retardation produced is \_\_\_\_\_ nm. (In integer)

Q.59 An orebody contains pyrite and chalcopyrite in the same molar proportions. The percentage concentration of Cu in the ore will be \_\_\_\_\_. (Round off to the nearest integer)

(Use atomic weight, in g/mol, of Cu = 63.55, Fe = 55.85, S = 32.06)

Q.60 In the given isobaric binary temperature-composition (T-X) phase diagram involving solids A and B, the fraction of melt remaining at point Q for a magma having initial composition P will be \_\_\_\_\_. (Round off to one decimal place)

