

**Paper Specific Instructions**

1. The examination is of 3 hours duration. There are a total of 60 questions carrying 100 marks. The entire paper is divided into three sections, **A**, **B** and **C**. All sections are compulsory. Questions in each section are of different types.
2. **Section – A** contains a total of 30 **Multiple Choice Questions (MCQ)**. Each MCQ type question has four choices out of which only **one** choice is the correct answer. Questions Q.1 – Q.30 belong to this section and carry a total of 50 marks. Q.1 – Q.10 carry 1 mark each and Questions Q.11 – Q.30 carry 2 marks each.
3. **Section – B** contains a total of 10 **Multiple Select Questions (MSQ)**. Each MSQ type question is similar to MCQ but with a difference that there may be **one or more than one** choice(s) that are correct out of the four given choices. The candidate gets full credit if he/she selects all the correct answers only and no wrong answers. Questions Q.31 – Q.40 belong to this section and carry 2 marks each with a total of 20 marks.
4. **Section – C** contains a total of 20 **Numerical Answer Type (NAT)** questions. For these NAT type questions, the answer is a real number which needs to be entered using the virtual keyboard on the monitor. No choices will be shown for these type of questions. Questions Q.41 – Q.60 belong to this section and carry a total of 30 marks. Q.41 – Q.50 carry 1 mark each and Questions Q.51 – Q.60 carry 2 marks each.
5. In all sections, questions not attempted will result in zero mark. In **Section – A** (MCQ), wrong answer will result in **NEGATIVE** marks. For all 1 mark questions, 1/3 marks will be deducted for each wrong answer. For all 2 marks questions, 2/3 marks will be deducted for each wrong answer. In **Section – B** (MSQ), there is **NO NEGATIVE** and **NO PARTIAL** marking provisions. There is **NO NEGATIVE** marking in **Section – C** (NAT) as well.
6. Only Virtual Scientific Calculator is allowed. Charts, graph sheets, tables, cellular phone or other electronic gadgets are **NOT** allowed in the examination hall.
7. The Scribble Pad will be provided for rough work.



**SECTION – A**  
**MULTIPLE CHOICE QUESTIONS (MCQ)**

**Q. 1 – Q.10 carry one mark each.**

Q.1 Among the following rocks, the one with highest metamorphic grade is

- (A) chlorite schist
- (B) glaucophane schist
- (C) phyllite
- (D) gneiss

Q.2 The Earth's radius is maximum at which one of the following latitudes?

- (A) 0°
- (B) 40° N
- (C) 60° S
- (D) 90°

Q.3 The closest value to the percentage of the Earth's surface covered by the oceans is

- (A) 30%
- (B) 50%
- (C) 70%
- (D) 90%

Q.4 Which is the shallowest among the marine environments listed below?

- (A) Neritic
- (B) Littoral
- (C) Abyssal
- (D) Bathyal



Q.5 Among the following, the tungsten-bearing mineral is

- (A) bornite
- (B) cassiterite
- (C) scheelite
- (D) greenockite

Q.6 The host rock of Pb-Zn deposit at Zawar is

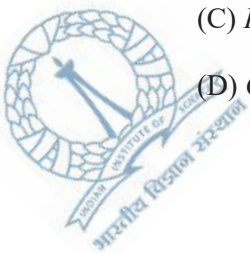
- (A) quartzite
- (B) phyllite
- (C) dolomite
- (D) gneiss

Q.7 Bituminous coal deposits in India occur in which one of the following formations?

- (A) Barren Measures Formation
- (B) Barakar Formation
- (C) Naredi Formation
- (D) Cuddalore Formation

Q.8 Identify the plant fossil from the following list.

- (A) *Glossopteris*
- (B) *Fenestella*
- (C) *Productus*
- (D) *Cidaris*



Q.9 The igneous body with dome or mushroom-like shape is known as a

- (A) lopolith
- (B) ring dike
- (C) sill
- (D) laccolith

Q.10 Which one of the following stratigraphic units belongs to the Cretaceous?

- (A) Lameta Formation
- (B) Talchir Boulder Bed
- (C) *Fenestella* Shale
- (D) Kasauli Formation

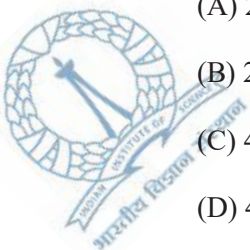
**Q. 11 – Q. 30 carry two marks each.**

Q.11 Select the youngest volcanic event out of the following.

- (A) Rajmahal volcanics
- (B) Dalma volcanics
- (C) Panjal volcanics
- (D) Deccan volcanics

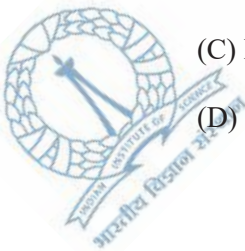
Q.12 Which among the following is the only possible plunge for a lineation located on the foliation plane striking  $20^\circ$  N and dipping  $40^\circ$  southeasterly?

- (A)  $20^\circ$  SE
- (B)  $20^\circ$  NW
- (C)  $45^\circ$  SE
- (D)  $40^\circ$  NW



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- Q.13 Which one of the following tectonic plates has the maximum average velocity?
- (A) Eurasian
  - (B) Pacific
  - (C) African
  - (D) North American
- Q.14 A limestone contains lime mud and around 25% allochems, which are separated from each other. The name of the rock as per Dunham's classification is
- (A) mudstone
  - (B) wackestone
  - (C) packstone
  - (D) grainstone
- Q.15 Find the **CORRECT** statement out of the following.
- (A) Convolute laminae form by desiccation.
  - (B) Load cast is an erosional structure.
  - (C) Prod mark is found at the bottom of a bed.
  - (D) Wave ripple occurs at the top of a turbidite deposit.
- Q.16 Which one of the following crystal forms **DOES NOT** belong to the di-tetragonal pyramidal class?
- (A) c-Pedion
  - (B) Prism of 1<sup>st</sup> order
  - (C) Di-tetragonal prism
  - (D) Tetragonal dipyrmaid



- Q.17 If a coarse-grained igneous rock is composed of >90% of plagioclase and <10% of olivine and pyroxene, then the name of this rock according to the IUGS classification is
- (A) anorthosite  
(B) olivine gabbro  
(C) tonalite  
(D) olivine websterite
- Q.18 Which one of the following represents the compositional change in plagioclase during the crystallization of mafic magma?
- (A) Na/Ca ratio decreases; Al/Si ratio increases  
(B) Both Na/Ca and Al/Si ratios increase  
(C) Na/Ca ratio increases; Al/Si ratio decreases  
(D) Both Na/Ca and Al/Si ratios decrease
- Q.19 Choose the **CORRECT** sequence of older to younger formations in the stratigraphy of the Cuddapah Supergroup
- (A) Pulivendla-Gulcheru-Vempalle-Tadpatri  
(B) Gulcheru-Vempalle-Pulivendla-Tadpatri  
(C) Gulcheru-Pulivendla-Tadpatri-Vempalle  
(D) Vempalle-Gulcheru-Tadpatri-Pulivendla
- Q.20 Match the economic deposits (**Group I**) with their places of occurrence (**Group II**).

**Group I**

P. Iron ore  
Q. Base metal  
R. Chromite  
S. Uranium

**Group II**

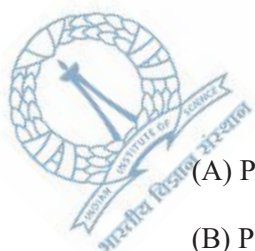
1. Bhatnagar  
2. Sukinda  
3. Rampura-Agucha  
4. Bellary

(A) P-4; Q-1; R-2; S-3

(B) P-2; Q-4; R-3; S-1

(C) P-2; Q-3; R-1; S-4

(D) P-4; Q-3; R-2; S-1



Q.21 Select the answer that is a **CORRECT** match for the three types of unconformities. (Grey bands = sediments, [ + ] = igneous rock).

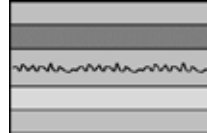
P. Disconformity

1.



Q. Non-conformity

2.



R. Angular Unconformity

3.



(A) P-2; Q-3; R-1

(B) P-2; Q-1; R-3

(C) P-1; Q-3; R-2

(D) P-3; Q-2; R-1

Q.22 Which one of the following statements is **FALSE**?

(A) Ammonites have fluted septa.

(B) Brachiopods have a pedicle.

(C) Echinoids have genal spines.

(D) Trilobites have a pygidium.

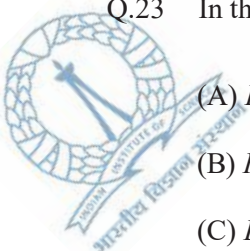
Q.23 In the context of phylogeny of horses, the **CORRECT** chronological order from old to young is

(A) *Hyracotherium*, *Mesohippus*, *Merychippus*, *Equus*

(B) *Hyracotherium*, *Merychippus*, *Mesohippus*, *Equus*

(C) *Equus*, *Merychippus*, *Mesohippus*, *Hyracotherium*

(D) *Merychippus*, *Equus*, *Mesohippus*, *Hyracotherium*



Q.24 Choose the **CORRECT** match between items in **Group I** with the items in **Group II**.

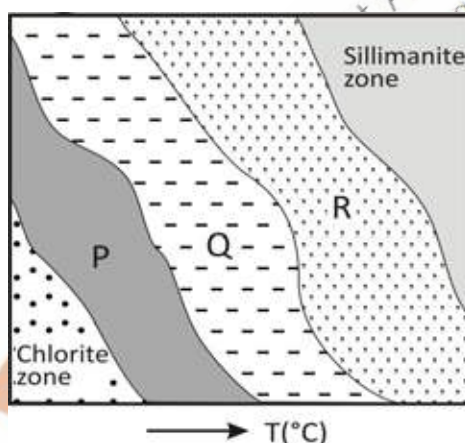
**Group I**

- P. Polarity zone  
Q. Formation  
R. Biozone  
S. Epoch

**Group II**

1. Biostratigraphy  
2. Chronostratigraphy  
3. Magnetostratigraphy  
4. Lithostratigraphy

- (A) P-1; Q-2; R-3; S-4  
(B) P-2; Q-3; R-1; S-4  
(C) P-3; Q-4; R-1; S-2  
(D) P-3; Q-4; R-2; S-1
- Q.25 The following diagram represents the prograde sequence of metamorphic zones that develop during Buchan-type of metamorphism (<4 kbar) of typical pelites. Identify the zones labelled P, Q and R.



- (A) P - Biotite zone; Q - Garnet zone; R - Kyanite zone  
(B) P - Garnet zone; Q - Kyanite zone; R - Staurolite zone  
(C) P - Biotite zone; Q - Cordierite zone; R - Andalusite zone  
(D) P - Andalusite zone; Q - Biotite zone; R - Cordierite zone



Q.26 Match the minerals in **Group I** with the corresponding composition in **Group II**.

**Group I**

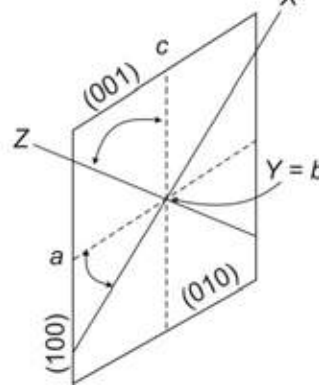
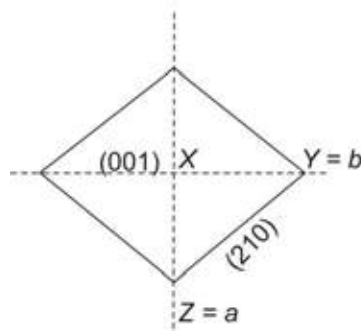
P. Leucite  
Q. Andradite  
R. Sanidine  
S. Jadeite

**Group II**

1.  $(K,Na)AlSi_3O_8$   
2.  $NaAlSi_2O_6$   
3.  $KAlSi_2O_6$   
4.  $Ca_3Fe_2Si_3O_{12}$

- (A) P-3; Q-1; R-4; S-2  
(B) P-2; Q-3; R-1; S-4  
(C) P-1; Q-4; R-2; S-3  
(D) P-3; Q-4; R-1; S-2

Q.27 Choose the **CORRECT** pair of crystal systems that represents the optic orientation shown in the figure. ( $X, Y, Z$  are the principal optical vibration directions and  $a, b, c$  are the crystallographic axes).



- (A) Orthorhombic - Triclinic  
(B) Orthorhombic - Monoclinic  
(C) Cubic - Hexagonal  
(D) Tetragonal - Monoclinic



- Q.28 Match the environment representing physical geological processes in **Group I** with the corresponding geomorphic landform/feature in **Group II**.

**Group I**

P. Aeolian  
Q. Glacial  
R. Fluvial  
S. Coastal

**Group II**

1. Drumlin  
2. Tombolo  
3. Yardang  
4. Natural levee

- (A) P-2; Q-1; R-4; S-3  
(B) P-2; Q-4; R-1; S-3  
(C) P-3; Q-1; R-4; S-2  
(D) P-3; Q-4; R-1; S-2

- Q.29 Match the items in **Group I** with the corresponding items in **Group II**.

**Group I**

P. Chalcocite  
Q. Bauxite  
R. Monazite placers  
S. Chromite

**Group II**

1. Supergene enrichment  
2. Mechanical accumulation  
3. Magmatic crystallization  
4. Residual processes

- (A) P-1; Q-4; R-2; S-3  
(B) P-2; Q-3; R-4; S-1  
(C) P-2; Q-4; R-1; S-3  
(D) P-1; Q-3; R-2; S-4
- Q.30 Which one of the following statements is **FALSE**?

- (A) Perched water table exists within the zone of aeration.  
(B) Juvenile water is derived from sediment diagenesis.  
(C) Zone of aeration lies above the zone of saturation.  
(D) Both aquiclude and aquifuge are impermeable.



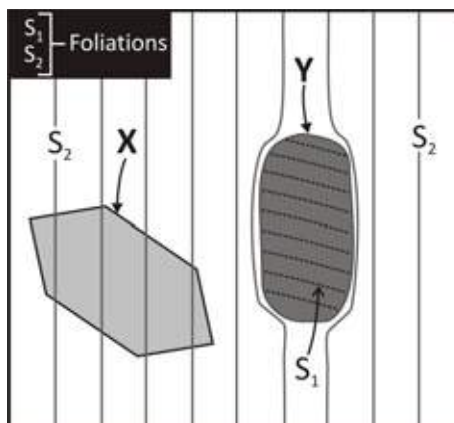
**SECTION - B**  
**MULTIPLE SELECT QUESTIONS (MSQ)**

**Q. 31 – Q. 40 carry two marks each.**

- Q.31 Fossils from which of the following invertebrate classes show pentameral symmetry?
- (A) Echinoidea
  - (B) Anthozoa
  - (C) Cephalopoda
  - (D) Trilobita
- Q.32 The attitude of the two limbs of a fold was measured as striking  $4^\circ$  N, dipping  $85^\circ$  easterly and striking  $30^\circ$  N, dipping  $60^\circ$  easterly. Which of the following is/are **TRUE** for describing the geometry of the fold?
- (A) Synform
  - (B) Antiform
  - (C) Overturned
  - (D) Plunging
- Q.33 Which of the following statement(s) is/are **CORRECT** regarding ophitic texture?
- (A) Plagioclase laths are completely enclosed by large pyroxene crystals.
  - (B) Intergrowth occurs between quartz and alkali-feldspar.
  - (C) It is a variety of poikilitic texture.
  - (D) It is a texture observed in peridotite.



Q.34 On the basis of the following schematic diagram, choose the **CORRECT** statement(s).



- (A) Minerals **X** and **Y** predate matrix foliation (S<sub>2</sub>).
- (B) Mineral **X** grew after the development of matrix foliation (S<sub>2</sub>).
- (C) Mineral **Y** grew during or after the development of internal foliation (S<sub>1</sub>).
- (D) Minerals **X** and **Y** postdate matrix foliation (S<sub>2</sub>).
- Q.35 A marine organic-rich, black shale with tiny pyrite crystals shows complete absence of body or trace fossils. Which of the following statement(s) is/are **TRUE**?
- (A) The sediments were deposited in low-energy conditions.
- (B) The deposition took place in dysoxic to anoxic conditions.
- (C) The rate of sedimentation was high.
- (D) The environment was stressful for survival of living organisms.
- Q.36 Which mineral(s) among the following represent(s) AB<sub>2</sub>O<sub>4</sub> composition?

- (A) Spinel
- (B) Magnetite
- (C) Chromite
- (D) Ilmenite



- Q.37 Which among the following statement(s) is/are **TRUE**?
- (A) Attrition is more dominant in aeolian than in glacial environment.
  - (B) Centrifugal force drives the sediment-laden water outward when the river channel meanders.
  - (C) U-shaped valley is a common fluvial geomorphic feature.
  - (D) The downstream water velocity in a river channel increases upward from the channel bed towards the water surface.
- Q.38 Which of the following statement(s) regarding hydrocarbon occurrence is/are **CORRECT**?
- (A) Gandhar field is in Cambay basin.
  - (B) Oil and gas occur in Mesozoic reservoir rocks in Bombay High field.
  - (C) Digboi field is in Assam basin.
  - (D) Hydrocarbon occurs in limestone reservoir in Ankleshwar field.
- Q.39 Following are the statements regarding types of sandstone as per Pettijohn's classification. Which is/are the **CORRECT** statement(s) out of the following?
- (A) Arkose contains more than 25% feldspar.
  - (B) Greywacke contains more than 90% matrix.
  - (C) Litharenite contains more than 25% lithic fragment.
  - (D) Quartz arenite contains more than 95% quartz.
- Q.40 Choose the **CORRECT** statement(s) out of the following.
- (A) Shoreline shifts landward during transgression.
  - (B) Shoreline shifts seaward during transgression.
  - (C) Delta deposits preserve the record of transgression.
  - (D) Incised river valley forms because of transgression.

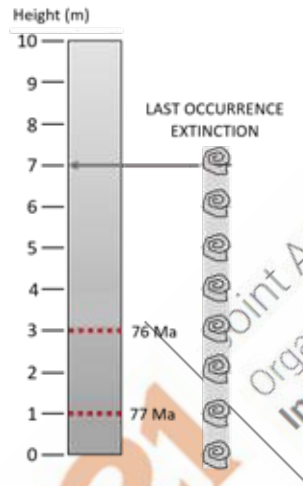


## SECTION – C

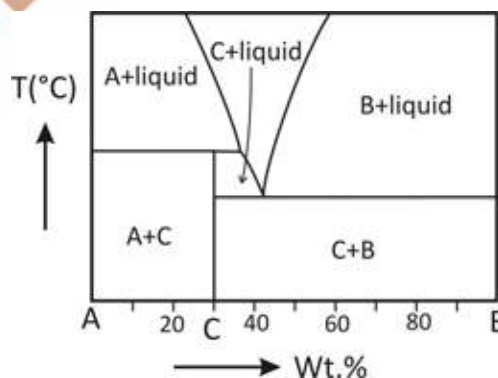
### NUMERICAL ANSWER TYPE (NAT)

**Q. 41 – Q. 50 carry one mark each.**

- Q.41 The given section with uniform lithology and sedimentation rate records two ash layers dated at 77 Ma and 76 Ma, respectively. An index fossil species present in the lower part of the section becomes extinct at a horizon 7m above the base. The estimated age of the extinction event is \_\_\_\_\_ Ma. (Answer in integer).



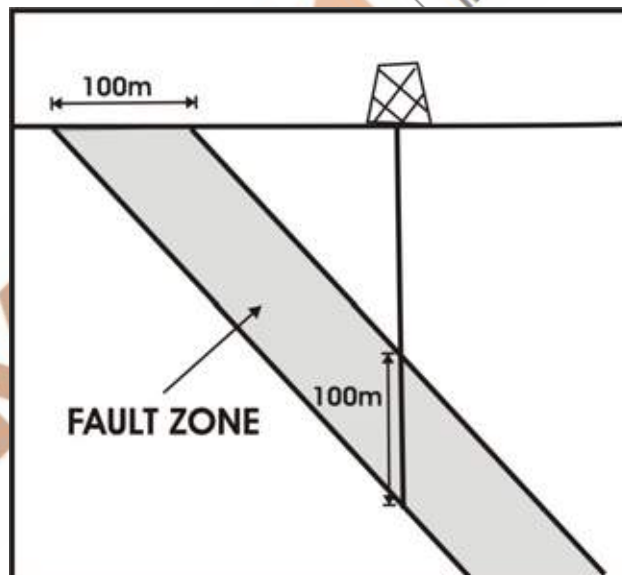
- Q.42 A hollow discoid (cylindrical) microfossil has an outer diameter of 20  $\mu\text{m}$ , height 10  $\mu\text{m}$  and wall thickness 1  $\mu\text{m}$ . The internal volume that can be occupied by the organism is \_\_\_\_\_  $\mu\text{m}^3$ . (use  $\pi = 3.14$ ) (Round off to one decimal place).
- Q.43 In the following isobaric temperature-composition diagram, the number of common phases in all the invariant points is \_\_\_\_\_. (Answer in integer).



- Q.44 A muscovite has the following composition in which iron is ferrous. The amount of 'Al' in the tetrahedral site is \_\_\_\_\_ (per formula unit). (Round off to two decimal places).

Muscovite composition:  $\text{KAl}_{2.50}\text{Fe}_{0.25}\text{Si}_{3.25}\text{O}_{10}(\text{OH})_2$

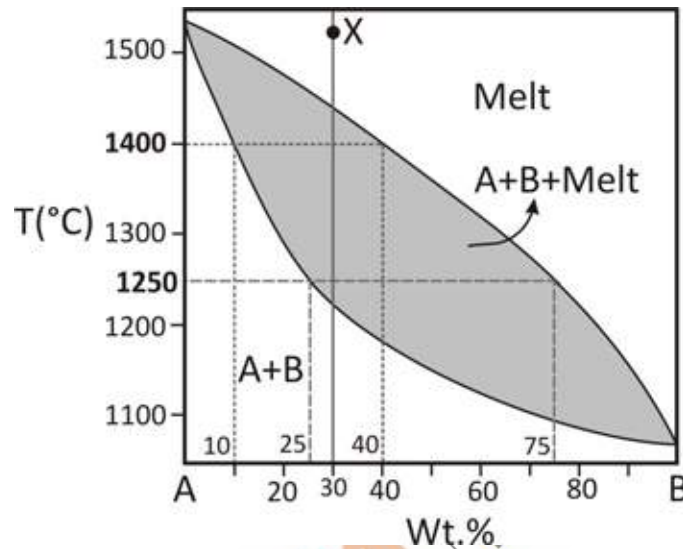
- Q.45 The density of a 200 g gabbro sample, cut in the form of a cube, is  $3125 \text{ kg/m}^3$ . The length of the sample is \_\_\_\_\_ mm. (Answer in integer).
- Q.46 A drill run of 3 m was carried out in a coalfield site, where rock core samples were recovered only for a cumulative length of 255 cm. The core loss in percentage is equal to \_\_\_\_\_. (Answer in integer).
- Q.47 During concretionary growth of a spherical grain of radius  $2 \text{ \AA}$ , the rate of change of surface area with respect to change in radius of the grain is \_\_\_\_\_  $\times 10^{-8} \text{ cm}$  (use  $\pi = 3.14$ ) (Round off to two decimal places).
- Q.48 The weight loss during the conversion of 1 mole of gypsum to anhydrite is \_\_\_\_\_ % (atomic weights of Ca = 40.0, S = 32.0, O = 16.0, H = 1.0). (Round off to two decimal places).
- Q.49 A bed with an attitude  $020^\circ, 30^\circ \text{ NW}$  is rotated  $55^\circ$  counter-clockwise (looking northerly) along its strike line. The dip of the bed after rotation will be \_\_\_\_\_  $^\circ \text{ NW}$ . (Answer in integer).
- Q.50 The width of the outcrop of a fault zone on a flat surface is 100 m as shown in the figure. A vertical borehole through the fault zone measured its vertical thickness to be 100 m. The true thickness of the fault zone is \_\_\_\_\_ m. (Round off to two decimal places).



**Q. 51 – Q. 60 carry two marks each.**

- Q.51 In an oblique slip fault with an attitude  $000, 30^\circ \text{ E}$ , the net slip vector has a length of 20 m and a rake of  $30^\circ \text{ S}$  on the fault plane. The displacement of a horizontal bed along the fault trace in a plane perpendicular to the strike of the fault is \_\_\_\_\_ m. (Answer in integer).
- Q.52 If the activity of a radioactive mineral falls from 800 counts/s to 500 counts/s in 80 minutes, half-life of the mineral is \_\_\_\_\_ minutes. (Round off to two decimal places).

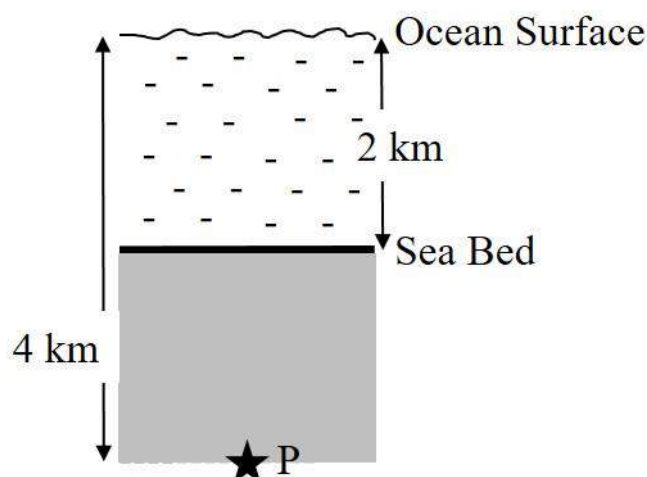
- Q.53 In a laboratory experiment, water discharge through a porous rock sample in 2 hours was  $10 \text{ cm}^3$ . The cylindrical rock sample is 10 cm long and has a diameter of 50 mm. If the discharge occurred at a constant head of 300 cm, the coefficient of permeability of the rock sample is  $\text{_____} \times 10^{-6} \text{ cm/s}$ . (Round off to two decimal places).
- Q.54 The following diagram represents a binary phase diagram for the system A–B at atmospheric pressure. If 'X' is the initial composition of melt, then the amount of melt that converts to solid when the magma cools from  $1400^\circ\text{C}$  to  $1250^\circ\text{C}$  is  $\text{_____}\%$ . (Round off to two decimal places).



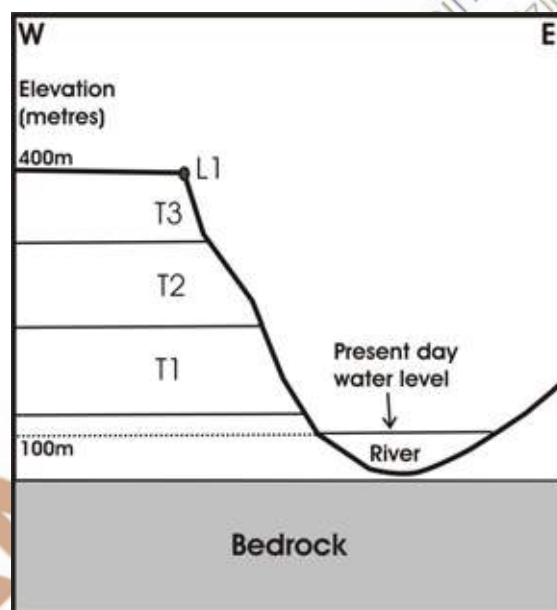
- Q.55 The following table shows modal abundance and mineral composition data of a plutonic igneous rock. The amount of  $\text{SiO}_2$  in bulk composition of the rock is  $\text{_____}\%$ . (Round off to two decimal places).

Mineral	Mode (%)	$\text{SiO}_2$ (wt. %)	CaO (wt. %)	MgO (wt. %)
Olivine	45	34	-	66
Clinopyroxene	35	55	25	20
Orthopyroxene	20	58	-	42

- Q.56 Refer to the schematic sketch given (not to scale). Assume average saturated density of oceanic crustal rocks =  $3200 \text{ kg/m}^3$ , density of ocean water =  $1000 \text{ kg/m}^3$ , and acceleration due to gravity =  $10 \text{ m/s}^2$ . The overburden pressure at a point (P) located 2 km below seabed and 4 km below the ocean surface is  $\text{_____ MPa}$ . (Answer in integer).



- Q.57 If the indices of refraction of a uniaxial section are  $\epsilon = 1.653$  and  $\omega = 1.544$ , and the retardation between the two rays is 550 nm, then the thickness of the section is \_\_\_\_\_  $\mu\text{m}$ . (Round off to two decimal places).
- Q.58 A crystal has lattice parameters of  $a : 4.26 \text{ \AA}$ ,  $b : 10 \text{ \AA}$  and  $c : 3.44 \text{ \AA}$ , respectively. A plane intercepts on the  $a$ ,  $b$  and  $c$  axes at  $2.13 \text{ \AA}$ ,  $10 \text{ \AA}$  and  $1.72 \text{ \AA}$ , respectively. The Miller Indices for the plane, written as an integer, is \_\_\_\_\_ (Answer in integer).
- Q.59 In the uvavovite garnet ( $\text{Ca}_3^{+2}\text{Cr}_2^{+3}\text{Si}_3^{+4}\text{O}_{12}$ ), Ca is in cubic coordination, Cr is in octahedral coordination and Si is in tetrahedral coordination. The electrostatic bond strength of the  $\text{Ca}^{2+}$  central ion is \_\_\_\_\_. (Round off to two decimal places).
- Q.60 In a structurally controlled fluvial setting, an asymmetric flight of river terraces T1, T2, T3 shown in the figure was sampled at location L1. The age of the sample at L1 was 30 ka (kiloyears). Assuming that the terraces were formed entirely due to deformation related uplift, the average uplift rate in the past 30 ka in the region was \_\_\_\_\_ mm/yr. (Answer in integer).



**END OF THE QUESTION PAPER**

