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

Q.1   Hollandite is an ore mineral of which one of the following elements?

(A) Fe

(B) Mn

(C) Pt

(D) Cr

Q.2   The transition from spinel to perovskite structure occurs between _____.

(A) lower mantle and outer core

(B) outer core and inner core

(C) upper mantle and lower mantle

(D) lower crust and upper mantle

Q.3   Which one of the following textures shows cuneiform-shape intergrowth between alkali feldspar and quartz?

(A) Spherulite texture

(B) Graphic texture

(C) Porphyritic texture

(D) Spinifex texture

Q.4   A pelitic rock consisting of cordierite + garnet + K-feldspar + sillimanite belongs to which one of the following metamorphic facies?

(A) Granulite

(B) Eclogite

(C) Greenschist

(D) Blueschist

Q.5   Which one of the following dams resists external forces by its own weight?

(A) Earthen dam

(B) Gravity dam

(C) Storage dam

(D) Detention dam

Q.6   Which one of the following minerals is NOT a framework silicate?

(A) Feldspar

(B) Zeolite

(C) Chlorite

(D) Quartz

Q.7 Crustal thickness is maximum at the _____.

(A) ocean-ocean convergent plate boundary

(B) ocean-continent convergent plate boundary

(C) continent-continent convergent plate boundary

(D) continent-continent divergent plate boundary

Q.8 Which one of the following causes sediment movement parallel to shoreline in the coastal area?

(A) Longshore current

(B) Rip current

(C) Backwash

(D) Edge wave

Q.9　　Which one of the following dinosaur fossils is a theropod?

(A) *Kotasaurus*

(B) *Titanosaurus*

(C) *Rajasaurus*

(D) *Barapasaurus*

Q.10　　Spiti Shale was deposited during the _____ time.

(A) Palaeozoic

(B) Mesozoic

(C) Cenozoic

(D) Proterozoic

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

Q.11   Which one of the following is a gently sloping (< 10°) volcanic landform resulting from eruption of basaltic lava?

(A)   Shield volcano

(B)   Composite volcano

(C)   Lava dome

(D)   Caldera

Q.12   On the magnetic polarity time scale, the present day epoch/chron is called _____.

(A)   Matuyama

(B)   Gilbert

(C)   Gauss

(D)   Bruhnes

Q.13 Which one of the following options is the CORRECT sequence of seismic waves in order of arrival time recorded on a seismogram after an earthquake?

(A) P-waves, S-waves, Rayleigh waves, Love waves

(B) P-waves, Rayleigh waves, S-waves, Love waves

(C) S-waves, P-waves, Love waves, Rayleigh waves

(D) P-waves, S-waves, Love waves, Rayleigh waves
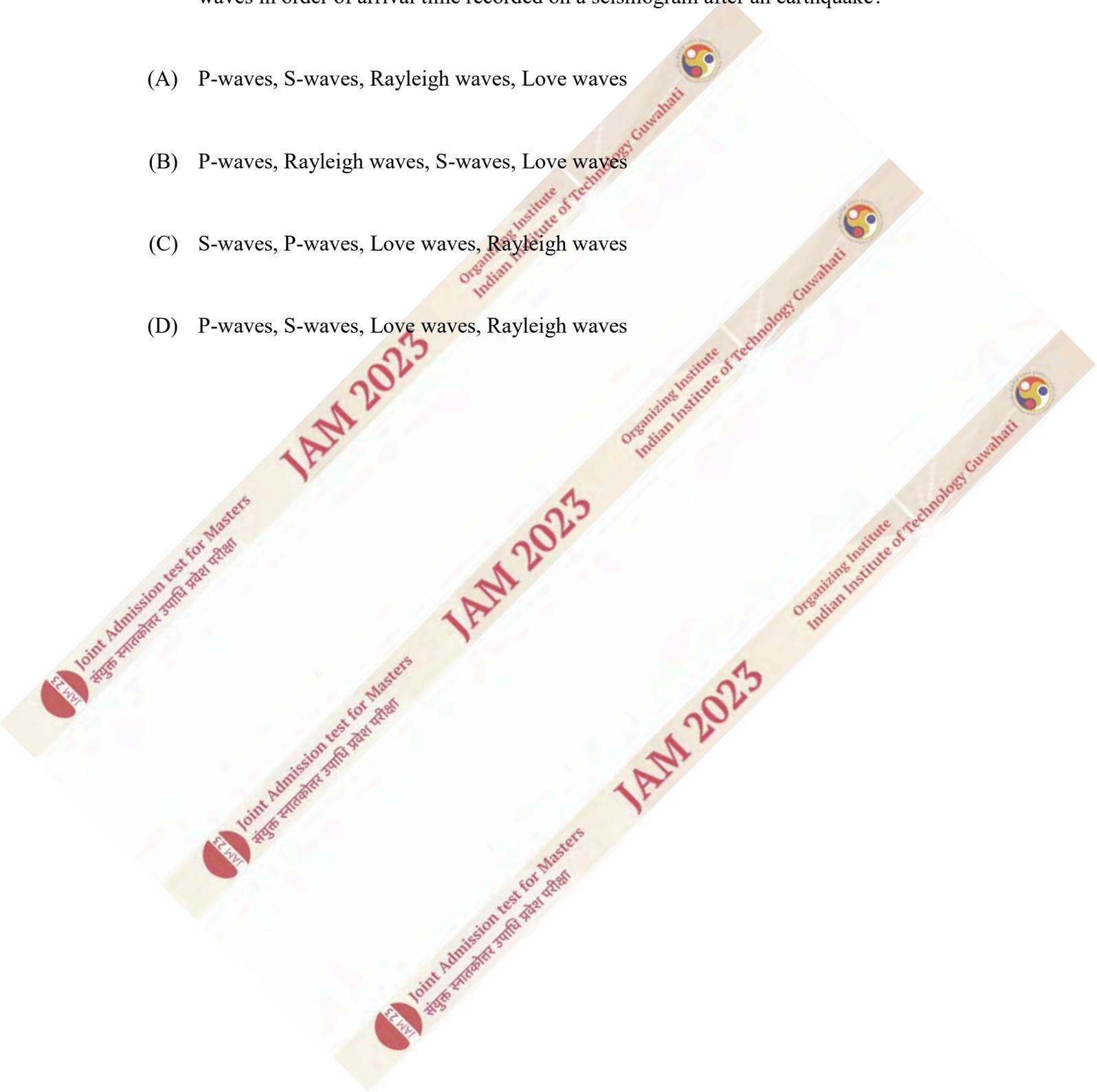
Q.14   Match the geomorphic agents in **Column-I** with their corresponding landforms in **Column-II**.

Column-I	Column-II
P. Wind	1. Backswamp
Q. Groundwater	2. Yardang
R. Glacier	3. Doline
S. River	4. Drumlin

(A)   P – 2, Q – 3, R – 4, S – 1

(B)   P – 3, Q – 1, R – 2, S – 4

(C)   P – 2, Q – 1, R – 4, S – 3

(D)   P – 4, Q – 3, R – 2, S – 1

Q.15   Which one of the following processes is NOT a mechanism for bedload sediment transport in a river channel?

(A) Cavitation

(B) Sliding

(C) Rolling

(D) Saltation

Q.16   Which one of the following relationships between the topographic contour value (t) and the stratum contour value (x) of a bed must be TRUE for an outcrop of the bed to occur on the topographic surface?

(A) $t = x$

(B) $t = 2x$

(C) $t = 3x$

(D) $t = 4x$

Q.17   As per Ramsay's classification of folds, the maximum thickening of fold hinge and the maximum thinning of the fold limbs are observed in _____.

(A)   Class 1A

(B)   Class 1B

(C)   Class 2

(D)   Class 3

Q.18   The number of hinge(s) in a monocline is _____.

(A)   0

(B)   1

(C)   2

(D)   3

Q.19   Which one of the following Gondwana flora is a seed?

(A) *Dadoxylon*

(B) *Cordaicarpus*

(C) *Taeniopteris*

(D) *Palaeovittaria*

Q.20   Which one of the following gastropod genera displays sinistral coiling?

(A) *Physa*

(B) *Cypraea*

(C) *Murex*

(D) *Conus*

Q.21 Which one of the following was emplaced in the Neoproterozoic time?

(A) Singhbhum Granite

(B) Dongargarh Granite

(C) Closepet Granite

(D) Erinpura Granite
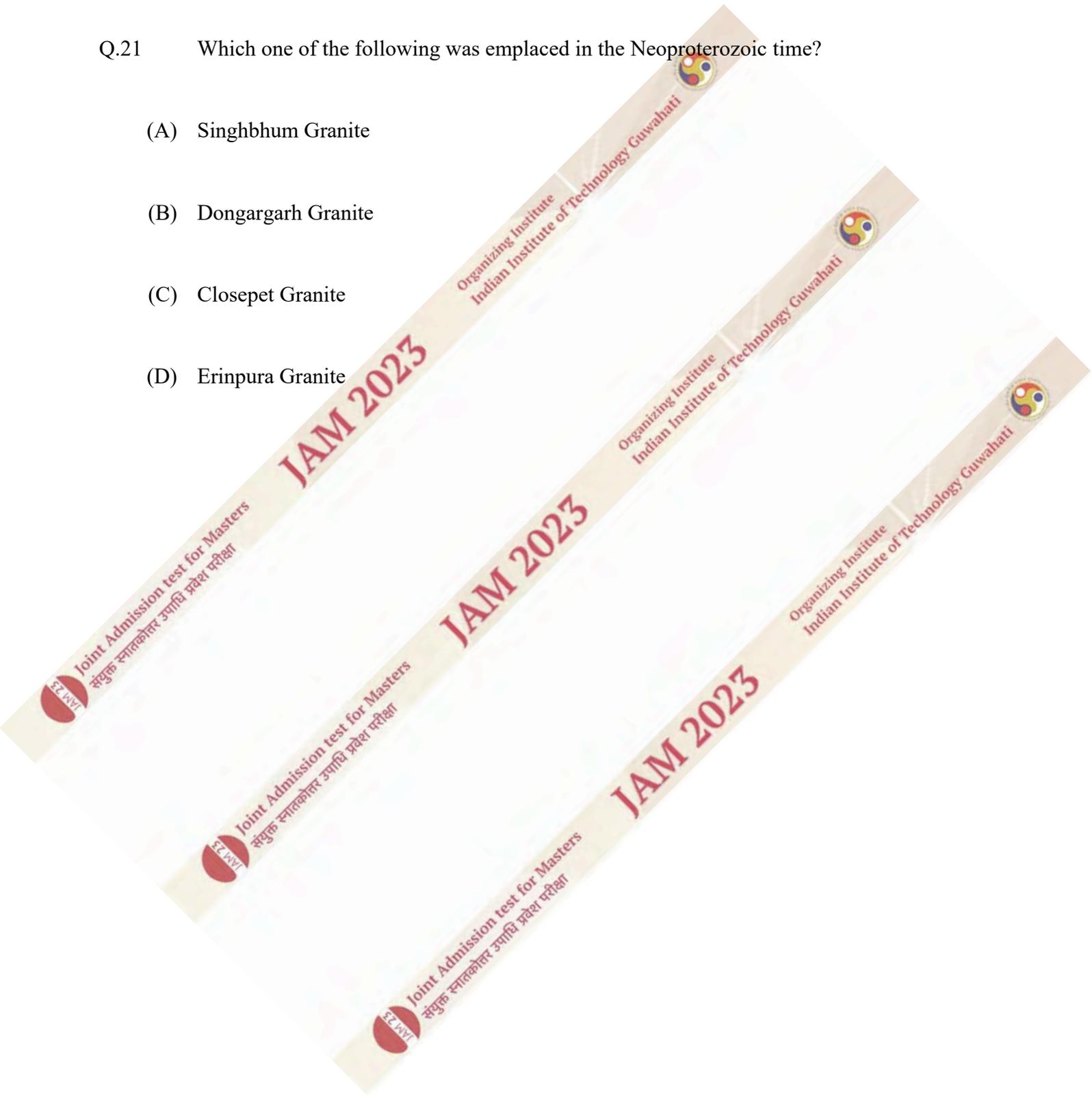
Q.22   Match the lithostratigraphic groups in **Column-I** with their corresponding formations in **Column-II**.

Column-I	Column-II
P. Papaghni Group	1. Kajrahat Formation
Q. Uttatur Group	2. Nagri Formation
R. Siwalik Group	3. Vempalle Formation
S. Semri Group	4. Karai Formation

(A) P – 4, Q – 3, R – 1, S – 2

(B) P – 3, Q – 4, R – 2, S – 1

(C) P – 3, Q – 1, R – 2, S – 4

(D) P – 2, Q – 4, R – 3, S – 1

Q.23   Which one of the following symmetry elements is an INCORRECT representation of rotoinversion operation?

(A) $1A_3$ + inversion centre = $\bar{3}$

(B) $1A_2 = \bar{4}$

(C)   Mirror plane = $\bar{2}$

(D) $1A_3/m = \bar{6}$

Q.24   A plutonic igneous rock is composed of 50% orthopyroxene, 45% olivine and 5% clinopyroxene. What is the appropriate name of the rock according to the IUGS classification?

(A)   Norite

(B)   Wehrlite

(C)   Troctolite

(D)   Harzburgite

Q.25   Which one of the following is NOT a sediment-gravity flow?

(A) Hypopycnal flow

(B) Cohesive debris flow

(C) Turbidity flow

(D) Mud flow

Q.26   Which one among the following mineral pairs crystallise early during the cooling of a basaltic melt?

(A) Forsterite and albite

(B) Biotite and anorthite

(C) Enstatite and bytownite

(D) Forsterite and quartz

Q.27   Match the ore deposits in **Column-I** with their corresponding ores in **Column-II**.

Column-I	Column-II
P. Malanjkhand	1. Uranium ore
Q. Tummalapalle	2. Gold ore
R. Bhukia	3. Tin ore
S. Tosham	4. Copper ore

(A)   P – 4, Q – 3, R – 2, S – 1

(B)   P – 3, Q – 1, R – 4, S – 2

(C)   P – 4, Q – 1, R – 2, S – 3

(D)   P – 2, Q – 4, R – 1, S – 3

Q.28   Which one of the following statements is CORRECT?

(A)   Banded Iron Formations are of chemogenic origin

(B)   Porphyry-type deposits are formed purely by sedimentary processes

(C)   Quartz-Pebble Conglomerate hosted gold deposits are formed by supergene enrichment

(D)   Fullerene is formed by residual concentration process

Q.29   Which one of the following statements about the hydrological cycle is CORRECT?

(A)   Groundwater represents the largest share of fresh water on Earth

(B)   'Precipitation rate greater than infiltration rate' is a necessary condition to generate surface runoff

(C)   All precipitation falling on the land finally ends up as groundwater

(D)   Groundwater flows in curved and concave-upward path

Q.30   Which one of the following mineral deposits is NOT related to the mining for energy production?

(A)   Narwapahar

(B)   Rampura-Agucha

(C)   Jaduguda

(D)   Turamdih

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

Q.31   At which of the following locations do lignite deposits occur in India?

(A)   Raniganj

(B)   Singrauli

(C)   Barmer

(D)   Neyveli

Q.32   Which of the following types of dunes form(s) primarily by uni-directional wind?

(A)   Linear dunes

(B)   Parabolic dunes

(C)   Barchan dunes

(D)   Star dunes

Q.33   The attitude of a fault plane was measured to be 350°, 75°E. The rake of the slickenline on the fault plane was found to be 90°. Which of the faults listed below satisfy(ies) these observations?

(A)   Dip-slip fault

(B)   Normal fault

(C)   Reverse fault

(D)   Strike-slip fault

Q.34   What type(s) of fossil remains is/are studied in ichnology?

(A)   Fishes and amphibians

(B)   Spores and pollens

(C)   Tracks and trails

(D)   Burrows and bioturbation

Q.35   Which of the following combinations of Basin and Formation is/are CORRECT?

(A)   Cauvery Basin – Niniyur Formation

(B)   Assam Basin – Tipam Formation

(C)   Bengal Basin – Jalangi Formation

(D)   Kutch Basin – Dhok Pathan Formation

Q.36   Which of the following optical properties CORRECTLY indentify(ies) the apatite {0001} section?

(A) Isotropic under crossed nicols

(B) Second-order interference colour

(C) Centered uniaxial interference figure

(D) High birefringence
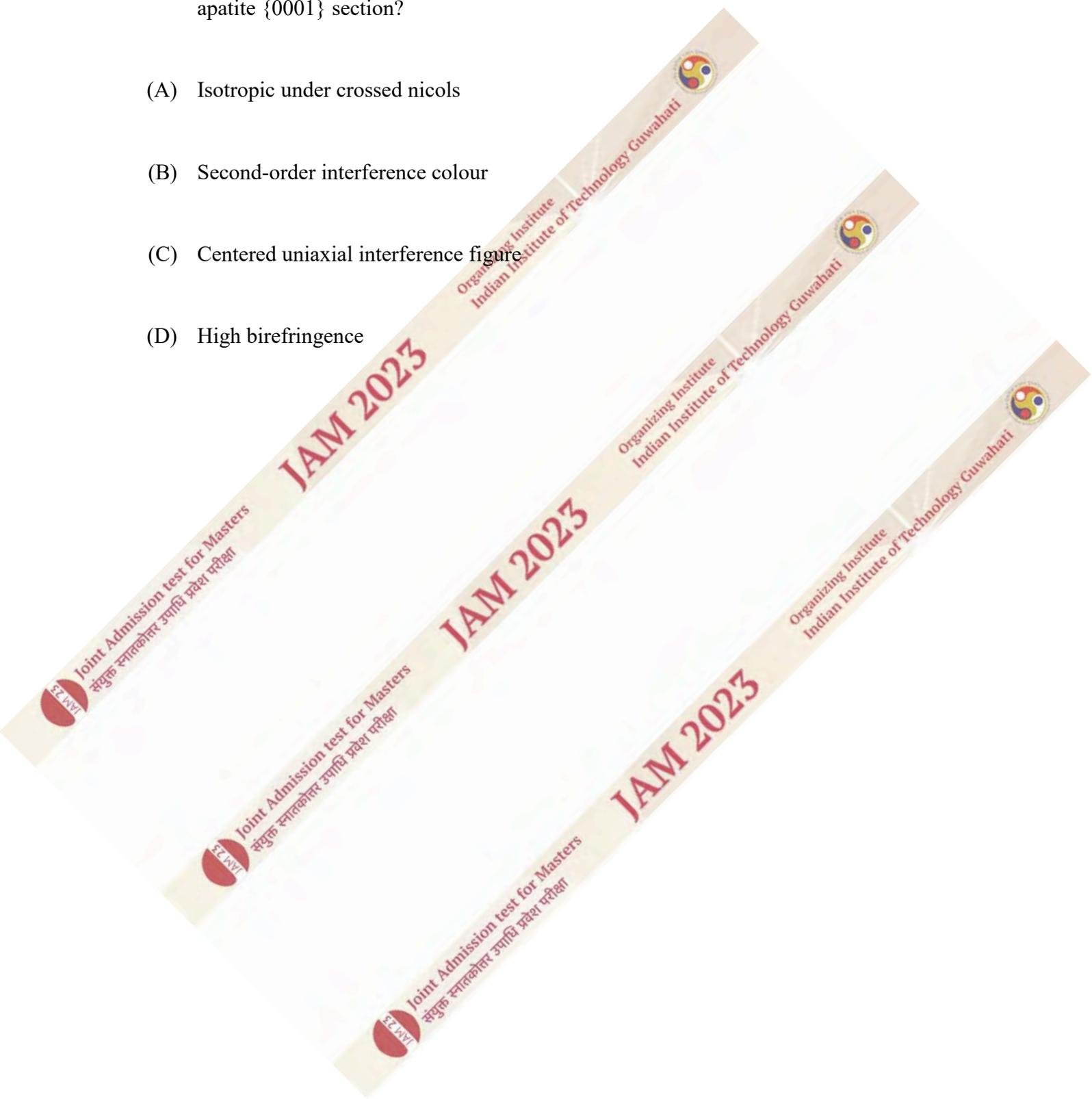
Q.37   The AFM diagram given below shows stability of minerals in the garnet zone. If P, Q, R and S represent the compositions of different pelitic rocks, which of the following is/are characterised by the equilibrium assemblage of muscovite + garnet + biotite + quartz?
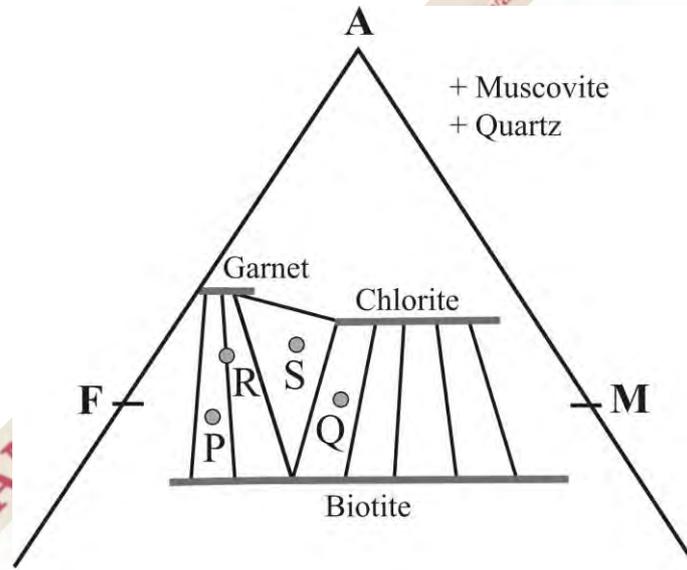
(A)   P

(B)   Q

(C)   R

(D)   S

Q.38   Which of the following sedimentary structures is/are tool marks?

(A)   Bounce marks

(B)   Wrinkle marks

(C)   Prod marks

(D)   Skip marks

Q.39   Which of the following is/are NOT copper-bearing mineral(s)?

(A)   Bornite

(B)   Chalcocite

(C)   Braunite

(D)   Chrysocolla

Q.40   Which of the following is/are used to estimate the strength of a rock mass?

(A)   API gravity

(B)   Resistivity

(C)   Kriging

(D)   RQD

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

Q.41   The amplitude recorded at a station for a magnitude 5 earthquake is x. If another earthquake recorded at the same station has an amplitude of $15x$, then the magnitude of this earthquake is _____. (*Round off to two decimal places*)

Q.42   If the intercepts of crystallographic axes are 0.5a : 1b : 0.75c on a crystallographic plane $\{h\ k\ l\}$, the value of 'l' is _____. (*In integer*)

Q.43   An ocean wave with a wavelength of 200 m approaches the coast. If water depth at the observation point is 75 m, the wave velocity is _____ m/s. (*Round off to two decimal places*) (Use g = 10 m/s²)

Q.44   A bed with an attitude 045°, 20°SE is rotated 60° clockwise (looking down) about a vertical axis. The strike value (in the azimuthal convention following right hand rule) of the rotated bed is _____ degrees. (*In integer*)

Q.45   A one-meter deep and sheet-like waterflow on a sandy beach developed antidunes. The minimum velocity of the waterflow was _____ m/s. (*Round off to two decimal places*) (Use g = 10 m/s^2)

Q.46   If the angular aperture of a 20X objective is 46°, the numerical aperture of the water immersion objective is _____. (*Round off to two decimal places*) (Use RI of water = 1.33)

Q.47   A metamorphic rock is composed of grossular garnet (Ca$_3$Al$_2$Si$_3$O$_{12}$), kyanite (Al$_2$SiO$_5$), anorthite (CaAl$_2$Si$_2$O$_8$) and quartz (SiO$_2$). If these minerals show an univariant reaction relationship, the number of components in this assemblage is _____. (*In integer*)

Q.48   If the dip separation vector on a normal fault plane has an attitude 60° → 040° and a magnitude of 6 m, the heave on the fault is _____ m. (*In integer*)

Q.49   A hillslope with an angle of 40° consists of soil having an internal friction angle of 30°. The factor of safety of the hillslope is _____.
(*Round off to two decimal places*)

Q.50   The water table over an area of 1 km² was lowered by 4 m. If the porosity of rock is 30% and the specific retention is 10%, the change in the groundwater storage is _____ $\times 10^3$ m³. (*In integer*)

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

Q.51   The $\frac{^{143}\text{Nd}}{^{144}\text{Nd}}$ and $\frac{^{147}\text{Sm}}{^{144}\text{Nd}}$ ratios of a rock are 0.516 and 0.389, respectively. The rock evolved as a closed system. As per the exact parent-daughter relationship equation, the $\frac{^{143}\text{Nd}}{^{144}\text{Nd}}$ ratio of the rock 4.6×10^9 years ago was _____.

(*Round off to three decimal places*)

(Use decay constant for $^{147}\text{Sm} = 6.54 \times 10^{-12}$ y^{-1})

Q.52   A longitudinal profile of a river is shown in the figure below. If the average discharge of the river at reach AB is 200 m³/s and increases to 300 m³/s at reach CD, then the stream power from the reach AB to CD will change by a factor of _____. (*Round off to two decimal places*)

(Use $g = 10$ m/s², $\rho_{water} = 1000$ kg/m³)
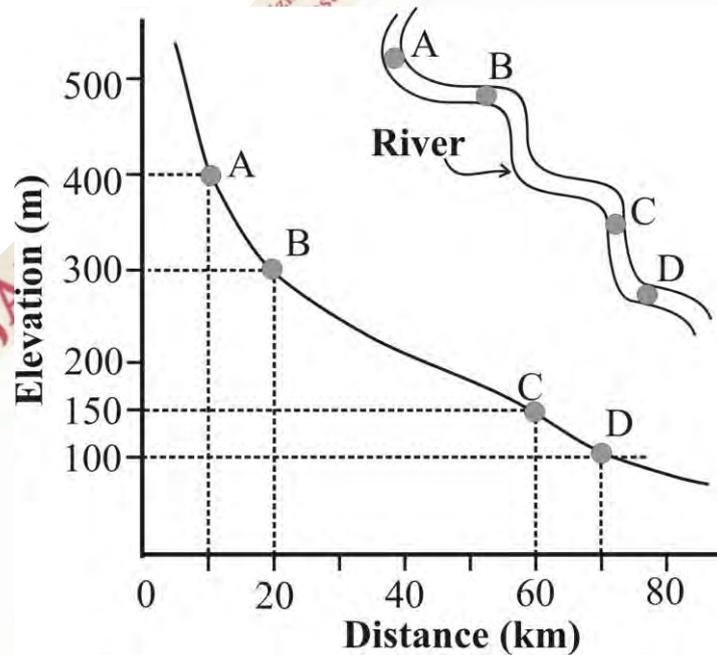
Q.53 An underground vertical dyke is intercepted by an inclined borehole as shown in the figure below. The length of the dyke core intercepted by the borehole is 4 m. If the true thickness of the dyke is 2 m, the inclination of the borehole from the vertical is _____ degrees. (*In integer*)
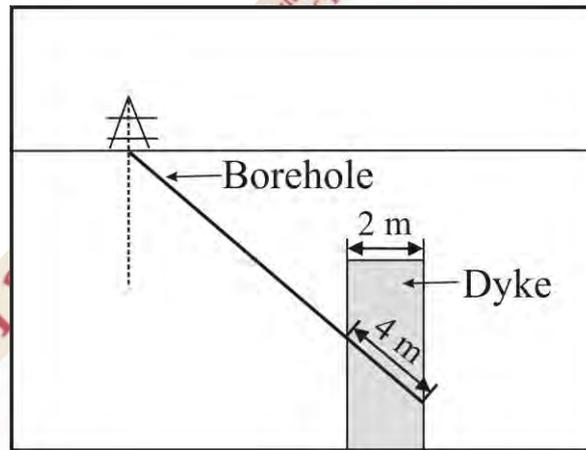
Q.54 A cylindrical copper ore body has a vertical thickness of 45 m and a diameter of 14 m with a density of 2.9 g/cm^3. The reserve of the copper ore body is _____ tons. (*In integer*)

Q.55 The density of a FCC unit cell is 6.5 g/cm^3. If the mass of a single atom is 60 g/mol, the diagonal length of the face {100} is _____ Å. (*Round off to two decimal places*) (Use $N_A = 6.022 \times 10^{23}$)

Q.56 The following figure shows an isobaric temperature-composition (T-X) phase diagram for the binary system A-B. If '**P**' is the initial composition of liquid, the amount of liquid that remains in the system when the liquid cools from 1800 °C (point L_1) to 1500 °C (point L_2) is _____ %. (*In integer*)
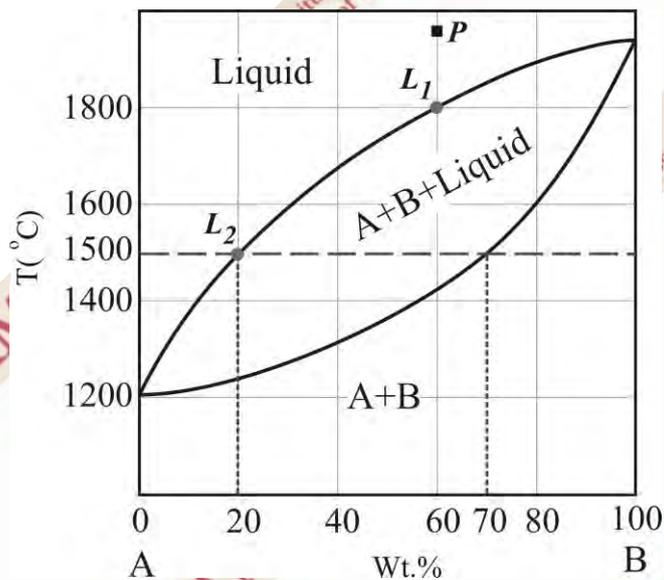
Q.57 A water flow transports spherical particles (diameter = 2 mm; density = 3 g/cm^3) in suspension mode. If additional particles of density 2 g/cm^3 are added into the flow, then the diameter of the particles that can be transported without a change in terminal fall velocity, using Stokes law, is _____ mm. (*Round off to two decimal places*) (Use density of water = 1 g/cm^3)

Q.58   If an iron ore body contains 50% hematite (Fe_2O_3) and 50% magnetite (Fe_3O_4), then the grade of the iron ore body is _____%. (*Round off to two decimal places*) (Use atomic weight of Fe = 55.85 amu and O = 16 amu).

Q.59   The schematic stereographic projection below shows dip amount and dip direction of three sets of joints (J1, J2 and J3) on a hillslope. If the internal friction angle of the hillslope material is 30°, the strike of the potential failure joint plane (in azimuthal convention following right hand rule) is _____ degrees. (*In integer*)

J3 (45°, 300°)   J2 (15°, 095°)

J1 (40°, 085°)

Hillslope (50°, 090°)
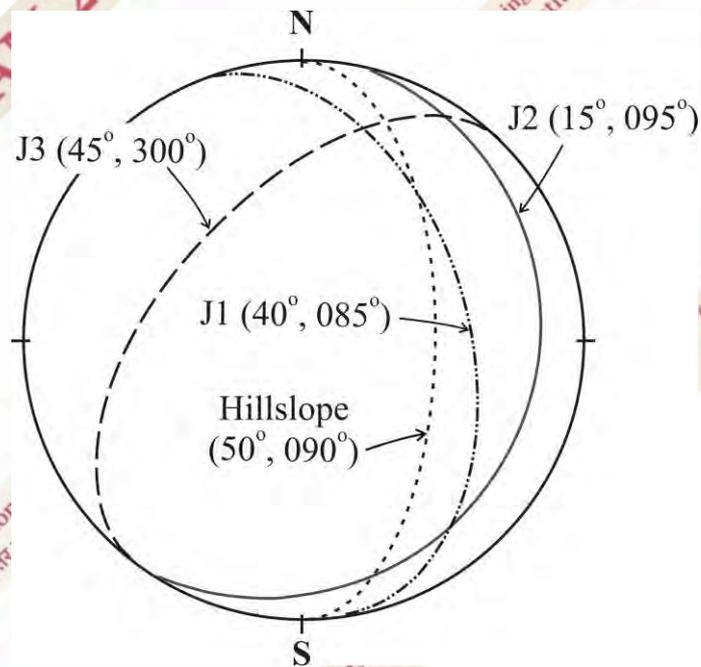
Q.60 The hydraulic conductivity of a 100 cm long cylindrical core is estimated as 1.2 cm/min when hydraulic head difference is 20 cm in an experimental setup. If the effective porosity of the core is 20%, then, assuming steady state Darcy flow, the average interstitial velocity of groundwater through the core is _____ m/day. (*Round off to two decimal places*)