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 will be **more than one** choices 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-mark 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. A Scribble Pad will be provided for rough work.

Special Instructions / Useful Data

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

Q.1 The density contrast across which one of the following transitions in the Earth is maximum?

(A) Upper crust – lower crust

(B) Upper mantle – lower mantle

(C) Lower mantle – outer core

(D) Outer core – inner core

Q.2 Which one of the following is NOT an ultramafic rock?

(A) Wehrlite

(B) Olivine websterite

(C) Harzburgite

(D) Anorthosite

Q.3 The longitude of the person's position at a place 3 hours ahead of UTC (Prime Meridian) is

(A) 15° E

(B) 30° W

(C) 45° E

(D) 45° W

Q.4 Which one of the following does NOT have a polymorph?

(A) Fluorite

(B) Pyrite

(C) Calcite

(D) Diamond

Q.5 Which one of the following CORRECTLY describes the footwall block relative to the hanging wall of a planar normal fault?

(A) Lies above the fault plane and relatively moves down

(B) Lies below the fault plane and relatively moves horizontally

(C) Lies above the fault plane and relatively moves up

(D) Lies below the fault plane and relatively moves up

Q.6 Which one of the following minerals has a characteristic pale yellow streak?

(A) Sphalerite

(B) Pyrite

(C) Hematite

(D) Cuprite

Q.7 Which one of the following is a fluorite deposit?

(A) Sonapahar, Meghalaya

(B) Mangampeta, Andhra Pradesh

(C) Belka Pahar, Rajasthan

(D) Dongargaon, Maharashtra

Q.8 According to Dunham's classification, which one of the following limestones is grain-supported and contains mud?

(A) Wackestone

(B) Packstone

(C) Grainstone

(D) Mudstone

Q.9 Which one of the following vertebrate fauna is a Proboscidea?

(A) *Hipparion*

(B) *Mastodon*

(C) *Indratherium*

(D) *Sivapithecus*

Q10. Which one of the following is an undifferentiated meteorite?

(A) Basaltic achondrite

(B) Carbonaceous chondrite

(C) Eucrite

(D) Pallasite

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

Q.11 Which one of the following is the CORRECT sequence of igneous rocks with increasing SiO_2 content?

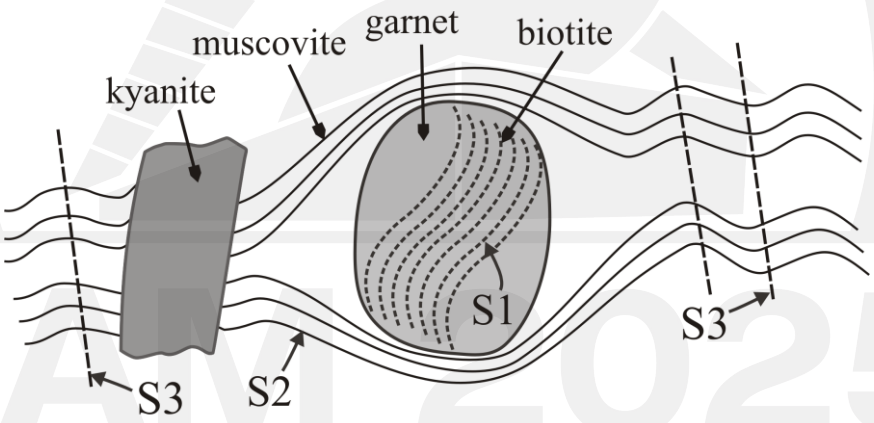
(A) basalt → komatiite → dacite → andesite

(B) dacite → basalt → komatiite → andesite

(C) basalt → dacite → andesite → komatiite

(D) komatiite → basalt → andesite → dacite

Q.12 The schematic diagram given below shows textural relationship among garnet, muscovite, biotite and kyanite in a metapelite. Biotite defines S1 foliation and muscovite defines S2 and S3 foliations. S1, S2 and S3 fabrics were developed during distinct deformation events D1, D2 and D3, respectively. Which one of the following represents the pre-D3 mineral assemblage?



(A) kyanite + garnet + biotite

(B) garnet + biotite + muscovite

(C) garnet + kyanite + muscovite

(D) biotite + muscovite + kyanite

Q.13 Which one of the following characteristic mineral assemblages represents eclogite facies metamorphism of a pelitic protolith?

(A) garnet + K-feldspar + sillimanite + cordierite

(B) talc + kyanite + phengite + garnet

(C) chlorite + muscovite + biotite + albite

(D) staurolite + chloritoid + biotite + garnet

Q.14 Which one of the following drainage patterns is formed by stream paths that follow circular segments?

(A) Annular

(B) Trellis

(C) Radial

(D) Centripetal

Q.15 A mineral displays magenta interference colour (retardation, Δ_m = 550 nm) under crossed polarized light. If an accessory plate adds retardation of 100 nm, the interference colour observed is

(A) 1st order yellow

(B) 1st order green

(C) 2nd order blue

(D) 2nd order red

Q.16 Match the symmetry elements in Group I with the corresponding crystal system in Group II.

	Group I		Group II
P.	$3A_2$, 3m, $4A_3$+i	1.	Orthorhombic
Q.	i, $1A_4$, m	2.	Hexagonal
R.	i, $3A_2$, 3m	3.	Tetragonal
S.	$1A_3$+m, 3m, $3A_2$	4.	Cubic

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

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

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

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

Q.17 Match the cycles in Group I with the corresponding processes in Group II.

	Group I		Group II
P.	Hydrological cycle	1.	Regolith formation
Q.	Biogeochemical cycle	2.	Ocean closure
R.	Rock cycle	3.	Infiltration
S.	Wilson cycle	4.	Denitrification

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

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

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

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

Q.18 Which one of the following is the oldest volcanics?

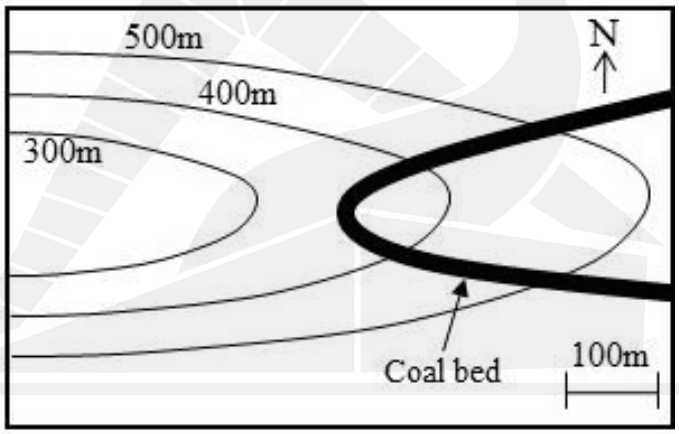
(A) Deccan

(B) Panjal

(C) Sylhet

(D) Rajmahal

Q.19 The following map shows an outcrop of a coal bed that intersects the elevation contours. Which one of the following statements is CORRECT?



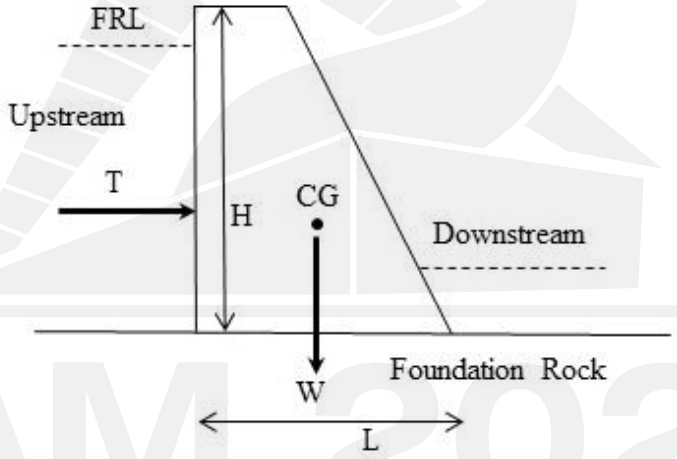
(A) Bed intersects a spur and dip of bed is less than gradient of spur axis

(B) Bed intersects a valley and dip of bed is greater than valley gradient

(C) Bed intersects a spur and dip of bed is equal to gradient of spur axis

(D) Bed intersects a valley and dip of bed is less than valley gradient

Q.20 Refer the dam section shown below. Which one of the following conditions represents the most stable state of the dam against rotation about its center of gravity?



FRL – Full Reservoir Level; T – horizontal thrust on dam at FRL;
W – weight of dam; CG – center of gravity; L – base length; H – height of dam

(A) $T > 3W$ and $L < H$

(B) Resultant force of T and W passes through the base of the dam

(C) $H > 3L$ and $T = W$

(D) Resultant force of T and W passes outside the base of the dam

Q.21 Which one of the following is related to porphyry Cu-Mo deposit?

(A) Host rock is pegmatite

(B) Forms due to first boiling process

(C) Occurs in rift settings

(D) Forms due to sulfur saturation

Q.22 Which one of the following statements is CORRECT for coal?

(A) Sapropelic coals are composed of a mixture of macroscopic plant debris

(B) Fusain is a microlithotype in coal

(C) Clarain is grey in color and has dull lustre

(D) High value of vitrinite reflectance indicates a low rank coal

Q.23 Which one of the following sedimentary structures is formed by rapid release of water?

(A) Ripple lamination

(B) Gutter cast

(C) Convolute lamination

(D) Prod mark

Q.24 Which one of the following represents the CORRECT combination of stratigraphic unit with its corresponding age?

(A) Barail Formation – Miocene

(B) Mahadek Formation – Oligocene

(C) Naredi Formation – Eocene

(D) Dalmiapuram Formation – Paleocene

Q.25 Match the stratigraphic units in Group I with their corresponding basins in Group II.

	Group I		Group II
P.	Kajrahat Limestone	1.	Cuddapah
Q.	Shahabad Limestone	2.	Pranhita-Godavari
R.	Chanda Limestone	3.	Vindhyan
S.	Narji Limestone	4.	Bhima

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

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

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

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

Q.26 Match the morphological features in Group I with their corresponding descriptions given in Group II.

	Group I		Group II
P.	Hyponome	1.	A large plate
Q.	Myophore	2.	Irregular prismatic crystals
R.	Hypostome	3.	Long tubular structure
S.	Myostracum	4.	Shaft with a head

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

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

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

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

Q.27 Which one of the following is a Paleozoic flora?

(A) *Williamsonia*

(B) *Dicroidium*

(C) *Gangamopteris*

(D) *Nilssonia*

Q.28 Which one of the following lithospheric plates has the least length of convergent boundary?

(A) Pacific

(B) Indian

(C) Antarctic

(D) South American

Q.29 Which one of the following elements in the Earth is a chalcophile and shows siderophilic behavior?

(A) Mg

(B) Fe

(C) Li

(D) Pb

Q.30 Which one of the following set of landforms results dominantly due to erosion?

(A) Cirque and ventifact

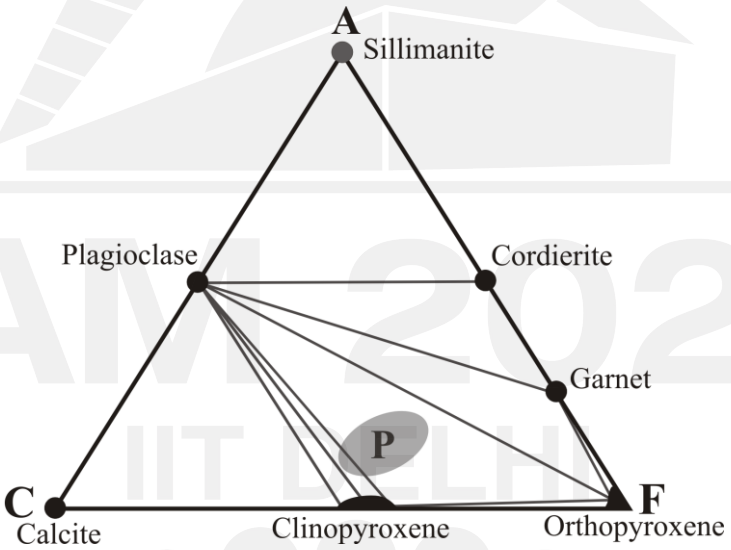
(B) Loess and yardangs

(C) Barchans and till

(D) Moraine and eskers

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

Q.31 The shaded region (P) in the given ACF diagram represents the compositional range of mafic rocks that have undergone granulite facies metamorphism. Which of the following equilibrium mineral assemblage(s) is/are identified in these mafic rocks?



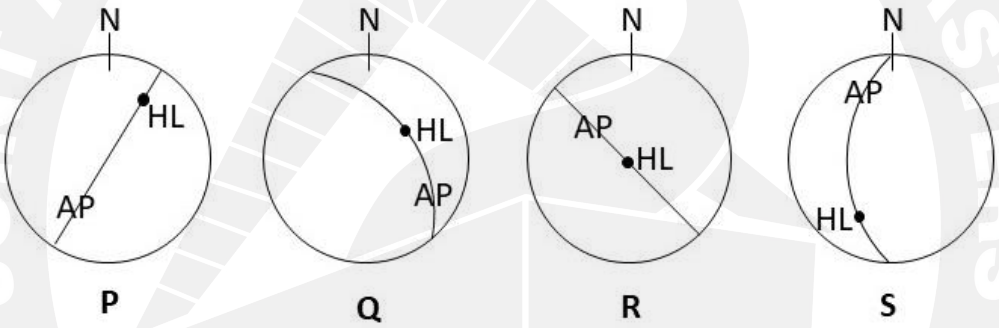
(A) plagioclase + clinopyroxene

(B) plagioclase + clinopyroxene + orthopyroxene

(C) plagioclase + orthopyroxene + garnet

(D) plagioclase + garnet + cordierite

Q.32 Which of the following stereographic projections represent(s) an upright plunging fold?



AP: axial plane; HL: hinge line

(A) P

(B) Q

(C) R

(D) S

Q.33 Which of the following property/properties of a mineral indicate(s) uniaxial negative optic sign?

(A) Ordinary ray is slow

(B) Extraordinary ray is slow

(C) $n_\varepsilon < n_\omega$

(D) $n_\varepsilon > n_\omega$

Q.34 Which of the following statements related to stratigraphy is/are CORRECT?

(A) Grain-size of sediments progressively coarsens upward in a deltaic succession

(B) Paraconformity shows a distinct erosional surface

(C) Paleogene Period includes Paleocene, Eocene and Oligocene Epochs

(D) Sea-level fall causes shifting of river mouth towards deep ocean

Q.35 Which of following combinations of sedimentary environments and their features is/are CORRECTLY matched?

(A) Fluvial – tabular cross-stratification

(B) Submarine fan – rain print

(C) Beach – planar lamination

(D) Supratidal – mud-cracks

Q.36 Which of the following is/are characteristic feature(s) of Brachiopods?

(A) Valves equilateral

(B) Inequivalved

(C) Plane of symmetry between valves

(D) Presence of ligament

Q.37 Which of the following characteristics of fossils is/are necessary for biostratigraphic applications?

(A) Wide geographic distribution

(B) Long vertical range

(C) Good preservation of hard shells

(D) Facies dependence

Q.38 Moon is considered to have been formed due to high temperature condensation of post-collisional ejected material. Which of the following statement(s) related to its mantle composition as compared to CI carbonaceous chondrite is/are CORRECT?

(A) Depleted in volatile and refractory elements

(B) Depleted in volatile and enriched in refractory elements

(C) Higher Rb/Sr element ratio

(D) Lower K/U element ratio

Q.39 Which of the following statement(s) related to ore-forming processes is/are CORRECT?

(A) Lateritization involves eluviation and illuviation processes

(B) Stratiform sediment-hosted copper (SSC)-type deposits are formed at mid-oceanic ridges

(C) Fluid phase separation is the major process of formation of Mississippi Valley (MV)-type deposits

(D) Formation of Superior-type banded iron formation (BIF) is related to the Great Oxidation Event

Q.40 Which of the following landforms is/are weathering dominated?

(A) Duricrusts

(B) Berms

(C) Inselbergs

(D) Tors

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

Q.41 A metapelite is composed of muscovite + quartz + K-feldspar + kyanite mineral assemblage. If the muscovite and K-feldspar show solid solution between 'Na' and 'K' end-members, the minimum number of components that defines this metapelitic assemblage is _____. (*In integer*)

Q.42 The mineral formula of orthopyroxene calculated on 6 Oxygen atom basis is $(Mg_{1.2}Fe_{0.8})Si_2O_6$**.** The weight percentage of MgO in the chemical composition of orthopyroxene is _____. (*Round off to one decimal place*)

Use the following data:

Oxide	Molecular weight (g mol^{-1})
SiO_2	60.08
MgO	40.30
FeO	71.84

Q.43 A grain has a size of 36 mm when observed under a magnification of 125 times. The actual size of the grain in µm is _____. (*In integer*)

Q.44 Radiogenic atoms of ^{40}K have a half-life of 1.25×10^9 years. The percentage of ^{40}K atoms left after six half-lives will be _____. (*Round off to two decimal places*)

Q.45 For a $\frac{2}{m}$ pyroxene, the extinction angle between the vibration direction and crystallographic axis, X ∧ c, is 36°. Then the angle Y ∧ b in degrees will be _____. (*In integer)*

Q.46 A kimberlite pipe has a bulk density of 2.5 g/cc and contains diamond of grade 100 carat/metric ton. If the pipe contains only 1-carat diamond crystals, then the number of diamond crystals per cubic meter in the pipe is _____. (*In integer*)

Q.47 Consider the present volume of the Earth's continental crust as 7.5×10^{18} m^3. If continental crust formation started 3.0 Ga ago, then the average rate of continental crustal growth is _____ $km^3\ yr^{-1}$. (*Round off to one decimal place*)

Q.48 The Throw of a fault is 4 m and the Heave is 3 m. The Dip separation of the fault, in meters, is _____. (*In integer*)

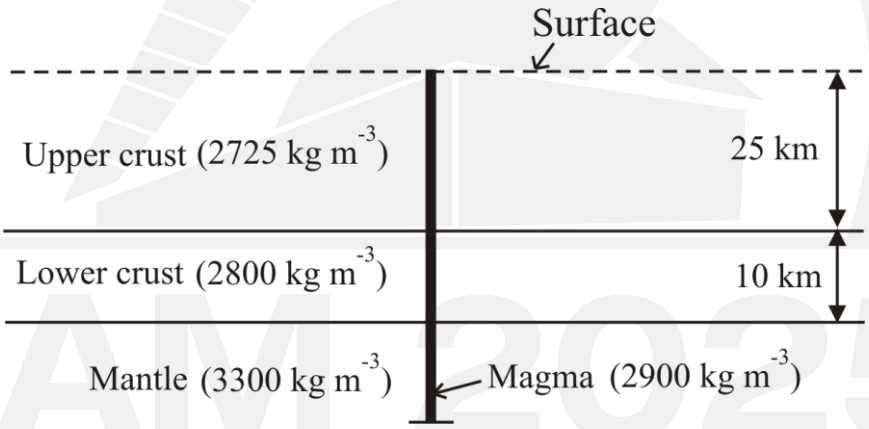
Q.49 A Rb–Sr isochron plot of cogenetic volcanic rocks yielded a slope of 0.003. The eruption age of these rocks is _____ Ma. (*Round off to one decimal place*)

(Use $\lambda^{87}\text{Rb} = 1.39 \times 10^{-11}\ \text{yr}^{-1}$)

Q.50 The apparent dip amount of a limestone bed in the direction 010° is 30°. If the bed strikes 320°, the value of true dip amount in degrees is _____. (*Round off to nearest integer*)

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

Q.51 A magma having density of 2900 kg m^{-3} just reaches the surface through a two-layered crust as shown in the figure below. Assuming isostatic equilibrium, its depth of melting is _____ km. (*Round off to one decimal place*)

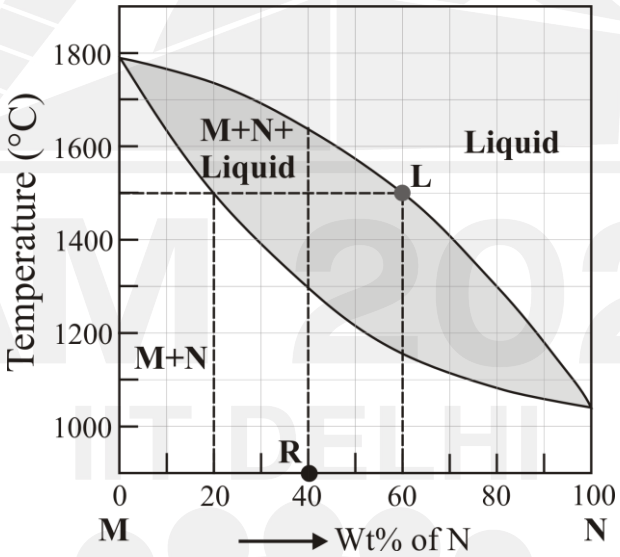


Q.52 The cation exchange equilibrium reaction between end-member components of orthopyroxene and ilmenite is given below:

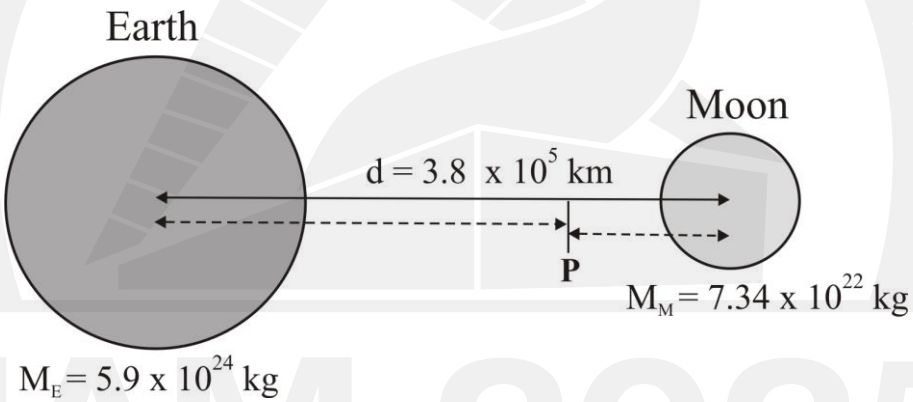
$$\underset{\text{(Enstatite)}}{MgSiO_3} + \underset{\text{(Fe-Ilmenite)}}{FeTiO_3} = \underset{\text{(Ferrosilite)}}{FeSiO_3} + \underset{\text{(Mg-Ilmenite)}}{MgTiO_3}$$

Considering ideal mixing of Fe and Mg in orthopyroxene and ilmenite solid solutions, the mole fractions are $X_{Mg}^{Orthopyroxene} = 0.60$ and $X_{Mg}^{Ilmenite} = 0.40$. The equilibrium constant of the above reaction is _____. (*Round off to two decimal places*)

Q.53 The isobaric temperature-composition (T–X) phase diagram given below shows the phase relation between components **M** and **N**. The equilibrium melting undergone by the rock **R** to generate the liquid of composition **L** is _____ %. (*In integer*)



Q.54 A satellite launching vehicle is carrying a lander for Moon mapping. As shown in the figure below, **P** is the position where the gravitational forces exerted by Earth and Moon on the vehicle balance out. The distance **P** from the center of the Earth is _____ $\times 10^5$ km. (*Round off to two decimal places*)



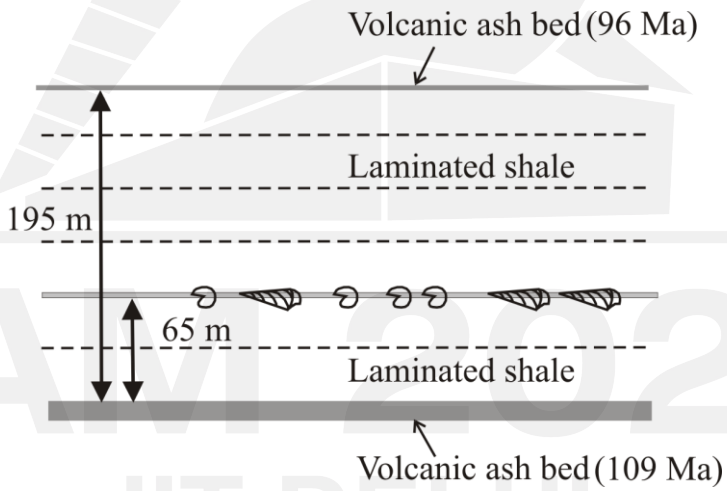
d = distance between the centers of Earth and Moon

M_E = Mass of Earth; M_M = Mass of Moon; G = 6.67 $\times 10^{-11} Nm^2kg^{-2}$

Q.55 The data tabulated below are for flooding events in the last 400 years. The probability of a large flood accompanied by glacial lake outburst flood (GLOF) in 2025 is _____ $\times 10^{-3}$. (*Round off to one decimal place*)

Year	Flood Size	Magnitude rank
1625	Large	2
1658	Large + GLOF	1
1692	Small	4
1704	Large	2
1767	Large	2
1806	Small	4
1872	Large + GLOF	1
1909	Large	2
1932	Large	2
1966	Medium	3
2023	Large + GLOF	1

Q.56 A well-developed succession of laminated shale is bound by two volcanic ash beds that were precisely dated as shown in the schematic diagram given below. Assuming a constant sedimentation rate, the age of the fossiliferous limestone bed 65 m above the basal volcanic ash bed is _____ Ma. (*Round off to nearest integer*)



Q.57 Pumping and extraction of groundwater from an unconfined aquifer resulted in a uniform drop of water table by 40 m over an area of 1 km^2. If the porosity of the aquifer is 35% and specific retention is 15%, the volume of water (in m^3) pumped out from the affected area is _____ $\times 10^6$ m^3. (*In integer*)

Q.58 A Cu deposit of 198 tons with average grade of 1.5% Cu contains 60% chalcopyrite, 30% bornite and 10% gangue. The maximum amount of Cu that can be extracted from chalcopyrite is _____ tons. (*Round off to two decimal places*)

Q.59 The orientations of two planar limbs of an overturned antiform are 045°/72°SE and 225°/37°SE. The interlimb angle of the fold in degrees is _____. (*In integer*)

Q.60 Two boreholes A and B, both inclined towards 270°, penetrate a dipping coal bed at the same point and pass through it entirely in the sub-surface as shown in the figure below. The bed dips towards 270°. The thickness of the coal bed, measured along the borehole A is 10 m and along borehole B is 8 m. The angle between the two boreholes is 20°. The orthogonal thickness (x) of the coal bed is _____m. (*Round off to one decimal place*)