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

Q.1	Which one of the following is a geochronologic unit?
(A)	System
(B)	Period
(C)	Member
(D)	Formation

Q.2	Which one of the following must have thickness less than 1 cm?
(A)	Lamina
(B)	Bed
(C)	Stratum
(D)	Layer

Q.3	Which one of the following organisms became extinct during the Cretaceous-Tertiary mass extinction event?
(A)	Trilobite
(B)	Ammonite
(C)	Brachiopod
(D)	Echinoderm

Q.4	Match the geomorphic features in **Group I** with the related processes in **Group II**.

	Group I	**Group II**
	P. Cirque	1. Fluvial
	Q. Ventifact	2. Glacial
	R. Point bar	3. Volcanic
	S. Tephra	4. Aeolian

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

Q.5	Which one of the given textural features results from exsolution?
(A)	Ophitic
(B)	Perthitic
(C)	Graphic
(D)	Glomeroporphyritic
Q.6	In the holosymmetric class of the Cubic System, how many more faces does the {110} form have compared to the {111} form?
(A)	2
(B)	4
(C)	6
(D)	8

Q.7	Which one of the following seismic waves involves compression and rarefaction (but not rotation) of the material that it passes through?
(A)	P-waves
(B)	S-waves
(C)	Rayleigh waves
(D)	Love waves
Q.8	Realgar and orpiment are both minerals of arsenic (As) and have the same chemical composition. Which one of the following properties can be used to distinguish between the two minerals in hand specimen?
(A)	Lustre
(B)	Hardness
(C)	Colour
(D)	Fracture

Q.9	Buckle folds result from
(A)	layer parallel shortening
(B)	layer perpendicular slip
(C)	layer parallel shearing
(D)	layer perpendicular shortening
Q.10	Sandstone beds above a magmatic body are domal in shape, while the beds below are horizontal. The magmatic body is a
(A)	Batholith
(B)	Laccolith
(C)	Lopolith
(D)	Sill

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

Q.11	Match the morphological features in **Group I** with the corresponding fossil groups in **Group II**.

	Group I	**Group II**
	P. Pedicle Foramen	1. Trilobita
	Q. Pallial Sinus	2. Cephalopoda
	R. Pygidium	3. Pelecypoda
	S. Siphuncle	4. Brachiopoda

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

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

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

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

Q.12	The Triassic-Jurassic boundary lies within which one of the following stratigraphic units?

(A)	Panchet Formation

(B)	Dharmaram Formation

(C)	Pachmarhi Formation

(D)	Denwa Formation

Q.13	Which one is the correct order of stability of the minerals (arranged from the most stable to the least stable) during chemical weathering?
(A)	Muscovite > Amphibole > Quartz > Olivine
(B)	Quartz > Amphibole > Olivine > Muscovite
(C)	Quartz > Muscovite > Amphibole > Olivine
(D)	Muscovite > Olivine > Quartz > Amphibole
Q.14	Match the following sedimentary rocks in **Group I** with their compositions in **Group II**.

Group I	**Group II**
P. Packstone	1. <15% matrix, > 25% rock fragments
Q. Grainstone	2. >15% matrix, >25% feldspar
R. Lithic arenite	3. Grain supported, contains no mud
S. Arkosic wacke	4. Grain supported, contains mud

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

Q.15	Match the parameters in **Group I** with their corresponding dimensions in **Group II**.

Group I	Group II
P. Shear modulus	1. $M^0L^0T^0$
Q. Hydraulic conductivity	2. $M^1L^{-3}T^0$
R. Volumetric strain	3. $M^0L^1T^{-1}$
S. Dry density	4. $M^1L^{-1}T^{-2}$

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

Q.16	Match the countries in **Group I** with the plate tectonic features in **Group II** that cause seismic activity in them.
	Group I **Group II**
	P. Iceland 1. Subduction Zone
	Q. Indonesia 2. Transform Fault
	R. Nepal 3. Mid-Oceanic Ridge
	S. New Zealand 4. Continental Collision
(A)	P-3, Q-1, R-4, S-2
(B)	P-3, Q-1, R-2, S-4
(C)	P-1, Q-3, R-4, S-2
(D)	P-2, Q-1, R-4, S-3

Q.17	Which one of the magnitude scales given below **DOES NOT** saturate while estimating size of earthquakes?
(A)	Local magnitude scale (M_L)
(B)	Body wave magnitude scale (M_b)
(C)	Surface wave magnitude scale (M_S)
(D)	Moment magnitude scale (M_W)
Q.18	What is the minimum number of forms that an actual crystal must contain in Class 1 (Pedial) of the Triclinic System?
(A)	1
(B)	2
(C)	3
(D)	4

Q.19	The apparent dip of a plane is measured to be 45° towards NE. The true dip of the plane is
(A)	55° towards SSW
(B)	40° towards NNE
(C)	48° towards ENE
(D)	40° towards E
Q.20	A horizontal upright fold will have a
(A)	vertical fold axis and horizontal axial plane
(B)	horizontal fold axis and vertical axial plane
(C)	horizontal fold axis and axial plane with any dip
(D)	plunging fold axis on a vertical axial plane

Q.21	The displacement of the bed shown in the figure below is caused by a single movement along fault XYZ. Of the options given below, which fault-type can explain the observed displacement?
(A)	Strike-slip
(B)	Reverse
(C)	Normal
(D)	Trace-slip
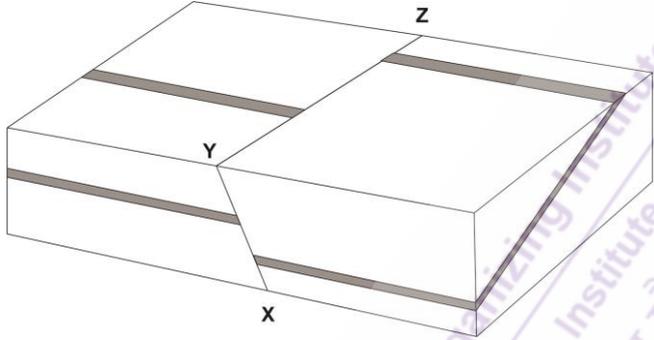
Q.22	In the AFM diagram below, W, X, Y and Z represent four pelitic assemblages. Which combinations of assemblages contain the same mineral phases in equilibrium in the staurolite zone?
(A)	(X-Y) & (W-Z)
(B)	(X-W) & (Y-Z)
(C)	(X-Z) & (Y-W)
(D)	(W-X-Y) & (Z)
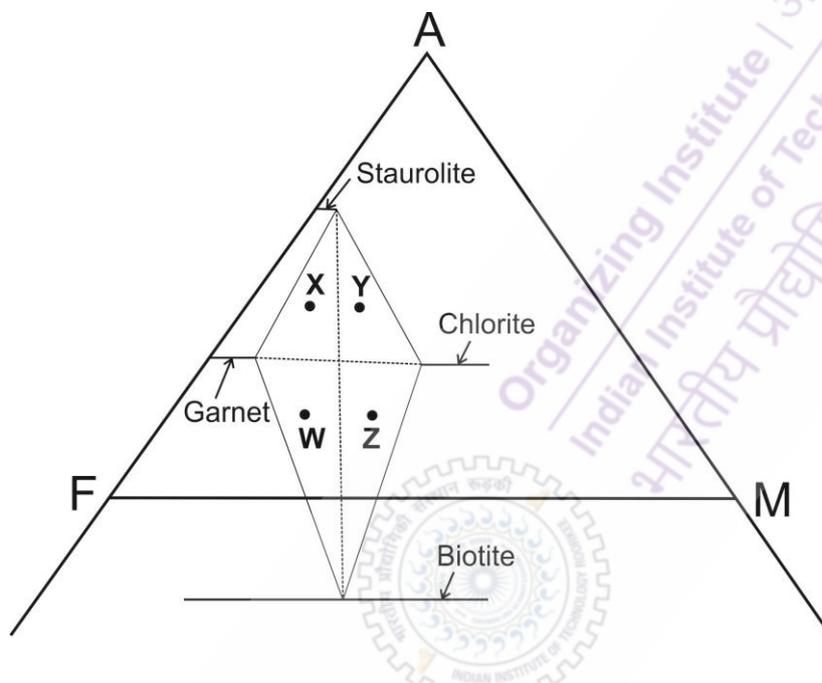
Q.23	Match the rock types in **Group I** with their characteristic mineral assemblages in **Group II**.
	Group I **Group II**
	P. Diorite 1. plagioclase – orthopyroxene ± clinopyroxene
	Q. Tonalite 2. olivine – orthopyroxene – clinopyroxene
	R. Norite 3. plagioclase – hornblende ± quartz
	S. Lherzolite 4. quartz – plagioclase ± K-feldspar
(A)	P-4, Q-3, R-2, S-1
(B)	P-2, Q-1, R-3, S-4
(C)	P-3, Q-4, R-1, S-2
(D)	P-1, Q-3, R-4, S-2

Q.24	Match the mineral deposit types in **Group I** with the water types in **Group II** considered dominantly responsible for their origin.
	Group I **Group II** P. Porphyry copper deposits 1. Meteoric water Q. Mississippi Valley Type deposits 2. Groundwater R. Roll-front uranium deposits 3. Magmatic water S. Epithermal gold deposits 4. Connate water
(A)	P-4, Q-3, R-2, S-1
(B)	P-3, Q-4, R-1, S-2
(C)	P-3, Q-4, R-2, S-1
(D)	P-4, Q-1, R-2, S-3

Q.25	Match the minerals in **Group I** with their optical properties in **Group II**.
	Group I **Group II** P. Sodalite 1. Mottled extinction Q. Tourmaline 2. Isotropic R. Calcite 3. Pleochroic from blue to brown S. Muscovite 4. Twinkling effect
(A)	P-4, Q-3, R-2, S-1
(B)	P-2, Q-3, R-4, S-1
(C)	P-3, Q-1, R-2, S-4
(D)	P-1, Q-3, R-4, S-2
Q.26	The contact between the Talchir Formation and the underlying Precambrian basement is
(A)	an angular unconformity
(B)	a disconformity
(C)	a paraconformity
(D)	a nonconformity

Q.27	Increased diversity of siphonate bivalves occurred in response to
(A)	the Cambrian explosion in the Paleozoic
(B)	increased temperature in the Cenozoic
(C)	increased predation pressure in the Mesozoic
(D)	increased oxygen level in the Proterozoic
Q.28	An index fossil should have
(A)	large geographic range and small temporal range
(B)	small geographic range and large temporal range
(C)	small geographic range and small temporal range
(D)	large geographic range and large temporal range

Q.29	Match the formations in **Group I** with corresponding stratigraphic periods in **Group II**.
	<table><tr><td>**Group I**</td><td>**Group II**</td></tr><tr><td>P. *Syringothyris* Limestone</td><td>1. Permian</td></tr><tr><td>Q. Karai Shale</td><td>2. Jurassic</td></tr><tr><td>R. Chari</td><td>3. Carboniferous</td></tr><tr><td>S. Barren Measures</td><td>4. Cretaceous</td></tr></table>
(A)	P-1, Q-2, R-3, S-4
(B)	P-2, Q-4, R-1, S-3
(C)	P-3, Q-4, R-2, S-1
(D)	P-4, Q-1, R-2, S-3
Q.30	Which one of the given statements is correct?
(A)	van der Waal's bonding is absent in silicate minerals
(B)	Sulfide minerals form by covalent bonding between metal and sulfur
(C)	Silicate minerals have a significant component of metallic bonding
(D)	Metal-sulfide formation does not involve splitting of d-orbitals

Section B: Q.31 – Q.40 Carry TWO marks each.	
Q.31	Which of the following structures form in marine environment?
(A)	Lateral accretionary surfaces
(B)	Hummocky cross stratification
(C)	Herringbone cross stratification
(D)	Barchanoids
Q.32	Identify the correct stratigraphic successions ordered from oldest to youngest.
(A)	Papaghni Group - Kurnool Group - Nallamalai Group - Chitravati Group
(B)	Semri Group - Kaimur Group - Rewa Group - Bhander Group
(C)	Papaghni Group - Chitravati Group - Nallamalai Group - Kurnool Group
(D)	Semri Group - Rewa Group - Bhander Group - Kaimur Group

Q.33	Which of the following stratigraphic units contain coal seams?
(A)	Barakar Formation
(B)	Lakadong Formation
(C)	Pachmarhi Formation
(D)	Panchet Formation
Q.34	Which of the following statements are CORRECT?
(A)	*Mytilus* represents byssally attached bivalves
(B)	*Nautilus* is the only living cephalopod genus with a coiled external shell
(C)	The cidaroids are the only echinoid group still living
(D)	Trilobites did not moult

Q.35	Which of the following genera are stem fossils?
(A)	*Dadoxylon*
(B)	*Dicroidium*
(C)	*Vertebraria*
(D)	*Ptilophyllum*
Q.36	Which of the following statements are correct?
(A)	Abutments are the sides of the valley supporting the dam structure
(B)	Spillways can control the release of water from the reservoir
(C)	The toe of the dam is the upstream edge of the base of the dam structure
(D)	Galleries serve as passages through the dam

Q.37	The acceleration due to gravity on the Earth's surface depends on
(A)	latitude
(B)	longitude
(C)	elevation
(D)	topography of the surrounding terrain
Q.38	A metamorphosed basaltic assemblage can include the minerals
(A)	garnet-omphacite
(B)	hornblende-plagioclase
(C)	garnet-staurolite
(D)	glaucophane-lawsonite

Q.39	Which of the following pairs represent correct plutonic – volcanic equivalents?
(A)	Granodiorite – dacite
(B)	Norite – basalt
(C)	Dunite – komatiite
(D)	Nepheline syenite – phonolite
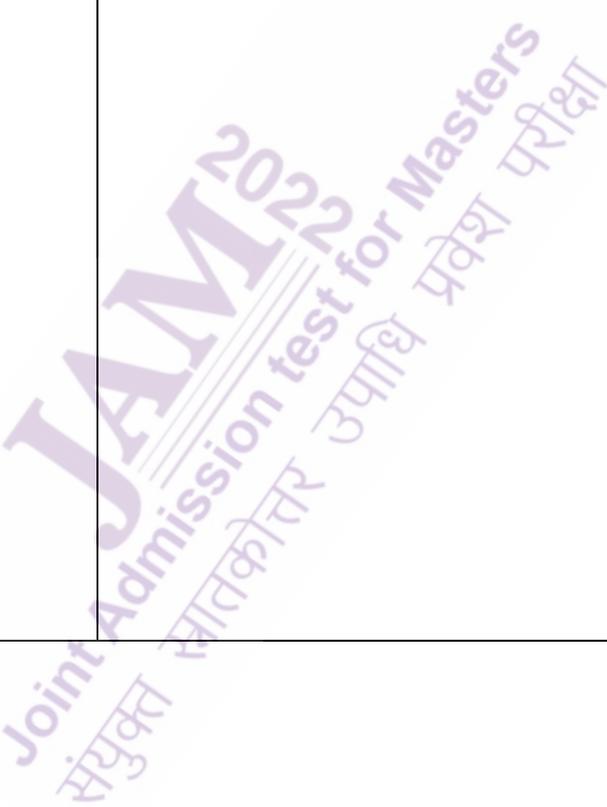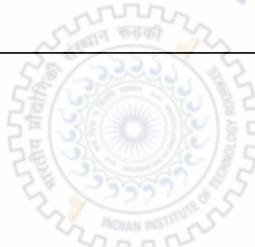
Q.40	Based on the given stereographic projection, the fold can be classified as
(A)	reclined fold
(B)	vertical fold
(C)	overturned fold
(D)	non-plunging fold
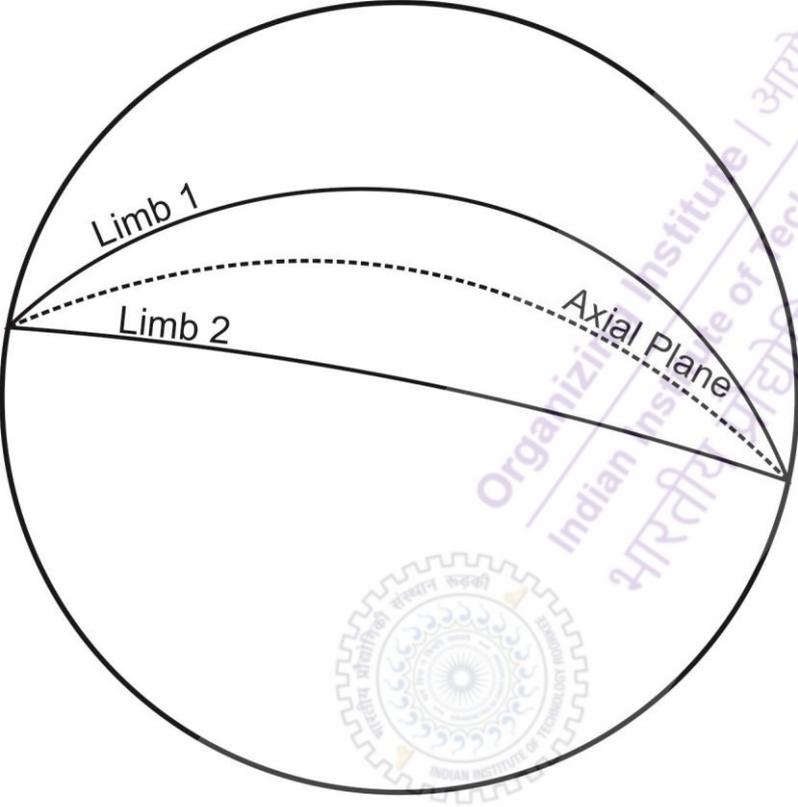
Section C: Q.41 – Q.50 Carry ONE mark each.

Q.41   The Ripple Symmetry Index (RSI) for the given hypothetical asymmetric ripple

is _____. (*Round off to one decimal place*)

Flow direction
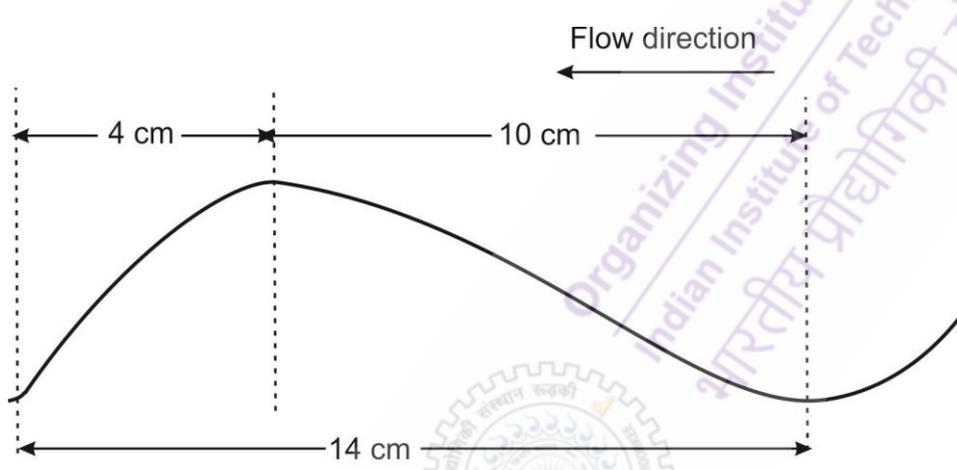
Q.42   Within a fourth order drainage basin, the total lengths of the 1st, 2nd, 3rd and 4th

order streams are 10.5 km, 7.5 km, 5.5 km and 1.5 km, respectively. If the

drainage density of the basin is 0.5 km^{-1}, the basin area is _____ km^2.

(*In integer*)

Q.43   A soil has a void ratio of 0.5. The total porosity of the soil is _____.
(*Round off to two decimal places*)

Q.44	The average unit weight of the uppermost part of the crust is 25000 N/m³. The vertical stress at a depth of 1 km would be _____ MPa. (*In integer*)
Q.45	The radius of the Earth's circular orbit round the Sun is 149×10^6 km. The Earth takes 365 days to orbit the Sun. The tangential velocity of the Earth is _____ km/hour. ($\pi = 3.14$) (*Round off to one decimal place*)
Q.46	A borehole inclined at 60° to the horizontal pierces a vertical basaltic dyke of uniform thickness. If the length of the basaltic drill core along the core axis is 12 m, the thickness of the dyke is _____ m. (*In integer*)
Q.47	A P-ray arrives at the mantle-core boundary at an angle 25° with respect to the normal. At what angle to the normal does it enter the core? (P-wave velocity in the lower mantle is 13.7 km/s and outer core is 8.1 km/s) (*Round off to two decimal places*)

Q.48	The mass of the Earth is 80 times that of the Moon while the radius of the Earth is four times that of the Moon. The surface gravity of the Earth is _____ times that of the Moon? (*In integer*)
Q.49	A hypothetical rock contains the assemblage kyanite, sillimanite and quartz. The variance (degree of freedom) of the assemblage is _____. (*In integer*)
Q.50	The cut-off grade of copper is 0.45 wt%. A mine has 1 million tonne of waste with a grade of 0.25 wt%. The mine also has stock of high grade ore with a grade of 1.8 wt%. How much of this high grade ore (in million tonne) must be blended with the waste to sell the blended ore at a grade of 0.5 wt%? (*Round off to three decimal places*)

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

| Q.51 | The maximum and minimum principal stresses in a zone of active normal faulting are 28 MPa and 8 MPa, respectively. The fault plane strikes N30°E and dips 60° towards SE. Considering Anderson's theory of faulting, the normal stress on the fault plane is _____ MPa. (*In integer*) |

| Q.52 | A granite block starts sliding on a slope (inclination of 30° with the horizontal) under the effect of gravity only, along the true direction of inclination of the slope and hits the ground in 4 seconds. Considering zero friction and zero cohesion during sliding, the vertical height of the point (with respect to the ground) from where the block was dislodged is _____ m. (g = 10 m/s^2) (*In integer*) |

| Q.53 | A cylindrical soil sample is encased in an open-ended inclined tube with a diameter of 100 mm. There is a constant supply of water from the upper end of the sample and the outflow from the other end is collected in a beaker. The average amount of water collected is 1000 mm^3 every 10 sec. The average outflow velocity is_____ mm/sec. (π = 3.14) (*Round off to three decimal places*) |

Q.54	Using Airy's hypothesis, calculate the thickness of the root beneath a 4 km high mountain in isostatic equilibrium with a 40 km thick continental crust of density 2800 kg/m^3 and a mantle of density 3300 kg/m^3. Express your answer in km. (*Round off to one decimal place*)
Q.55	Given atomic weights of Cu, Fe and S as 63.55, 55.85 and 32.10, respectively, find out the weight of copper (in gram) metal in an ore (no associated gangue) of 1 kg weight constituting of bornite, chalcopyrite and chalcocite present in weight fractions of 0.4, 0.4 and 0.2, respectively. (*Round off to one decimal place*)

Q.56	An ore body defined by a 300 m × 300 m area is shown in the figure in which the drill hole locations on equally spaced square grid are marked (numbers 1 – 16). The average thickness of the ore body at the 4 interior points is 10.8 m, at the 4 corners is 11.0 m and at the remaining 8 boundary locations is 10.5 m, respectively. The corresponding average grades are 1.5, 1.9 and 1.8 wt%, respectively. Calculate the average grade (in wt%) of the full ore body using the **Included Area Method**. (*Round off to two decimal places*).
Q.57	The $^{87}Sr/^{86}Sr$ ratio of a 1000 Ma granite was measured as 0.8001. If its $^{87}Rb/^{86}Sr$ ratio is 2.499, what was the Sr isotopic ratio of the source at the time of derivation of the granite? (decay constant of $^{87}Rb=1.39 \times 10^{-11}$ yr^{-1}) (*Round off to three places of decimals*)
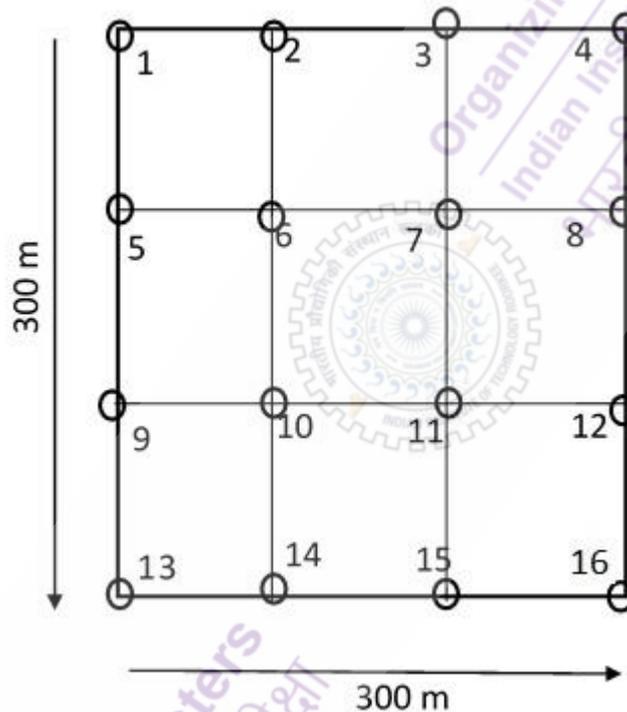
Q.58	The coefficients of permeability of two aquifers – 1 and 2, are 60 m/day and 40 m/day, respectively. Their saturated thicknesses are 30 m and 15 m, respectively. Assuming steady state Darcian flow, the transmissivity of aquifer 1 is _____ times that of aquifer 2. (*In integer*)
Q.59	Assume that ^{218}Po, with a half-life of 138 days, is in secular equilibrium with ^{238}U whose half-life is 4.5×10^9 y. How many grams of ^{218}Po will be present for each gram of ^{238}U in the mineral? Express your answer in **logarithm (to the base 10)**. (*Round off to two decimal places*)

Q.60	The figure below is an isobaric binary temperature-composition (T-X) plot. What amount (in %) of the equilibrium melting of rock R will generate a melt of composition L? *(Round off to one decimal place)*