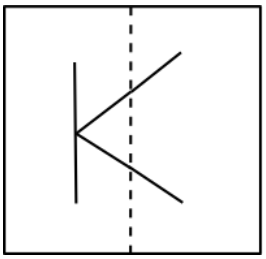
Geology and Geophysics (GG - Geology)

General Aptitude (GA)

Q.1 - Q.5 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: – 1/3).

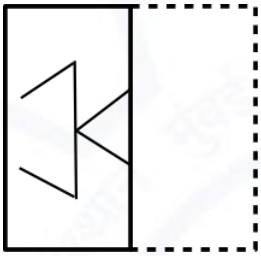
Q.1	**The people _____ were at the demonstration were from all sections of society.**
(A)	whose
(B)	which
(C)	who
(D)	whom

Q.2

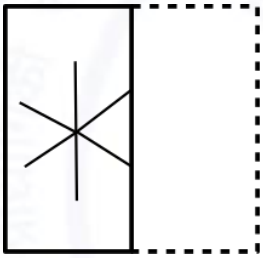


A transparent square sheet shown above is folded along the dotted line. The folded sheet will look like _____.

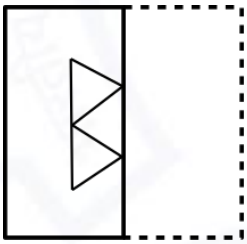
(A)



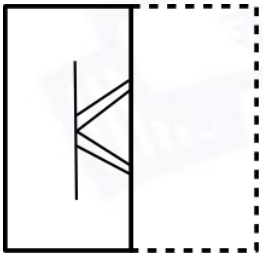
(B)



(C)



(D)



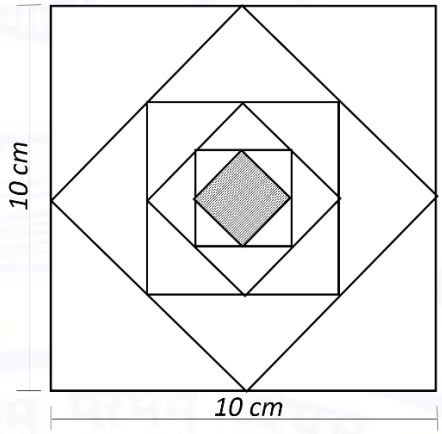
Q.3	**For a regular polygon having 10 sides, the interior angle between the sides of the polygon, in degrees, is:**
(A)	396
(B)	324
(C)	216
(D)	144

Q.4	**Which one of the following numbers is exactly divisible by $\left(11^{13}+1\right)$?**
(A)	$11^{26}+1$
(B)	$11^{33}+1$
(C)	$11^{39}-1$
(D)	$11^{52}-1$

Q.5	***Oasis* is to *sand* as *island* is to _____** **Which one of the following options maintains a similar logical relation in the above sentence?**
(A)	Stone
(B)	Land
(C)	Water
(D)	Mountain

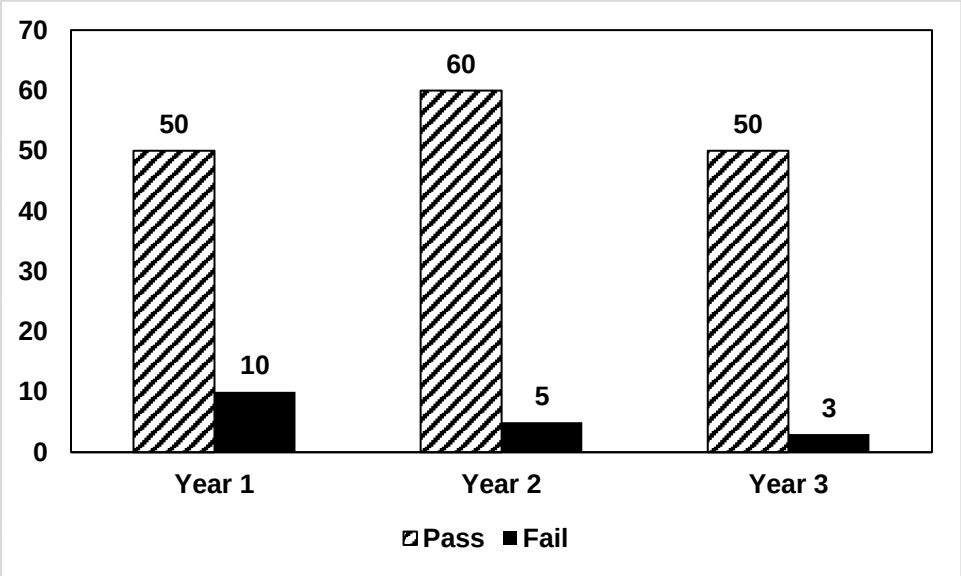
Q. 6 – Q. 10 Multiple Choice Question (MCQ), carry TWO marks each (for each wrong answer: – 2/3).

Q.6	**The importance of sleep is often overlooked by students when they are preparing for exams. Research has consistently shown that sleep deprivation greatly reduces the ability to recall the material learnt. Hence, cutting down on sleep to study longer hours can be counterproductive.** **Which one of the following statements is the CORRECT inference from the above passage?**
(A)	Sleeping well alone is enough to prepare for an exam. Studying has lesser benefit.
(B)	Students are efficient and are not wrong in thinking that sleep is a waste of time.
(C)	If a student is extremely well prepared for an exam, he needs little or no sleep.
(D)	To do well in an exam, adequate sleep must be part of the preparation.

Q.7	 **In the figure shown above, each inside square is formed by joining the midpoints of the sides of the next larger square. The area of the smallest square (shaded) as shown, in cm^2 is:**
(A)	12.50
(B)	6.25
(C)	3.125
(D)	1.5625

Q.8	**Let X be a continuous random variable denoting the temperature measured. The range of temperature is [0, 100] degree Celsius and let the probability density function of X be $f(x) = 0.01$ for $0 \leq X \leq 100$.** **The mean of X is _____**
(A)	2.5
(B)	5.0
(C)	25.0
(D)	50.0

Q.9



The number of students passing or failing in an exam for a particular subject are presented in the bar chart above. Students who pass the exam cannot appear for the exam again. Students who fail the exam in the first attempt must appear for the exam in the following year. Students always pass the exam in their second attempt.

The number of students who took the exam for the first time in the year 2 and the year 3 respectively, are _____.

A)	65 and 53
(B)	60 and 50
(C)	55 and 53
(D)	55 and 48

Q.10	**Seven cars P, Q, R, S, T, U and V are parked in a row not necessarily in that order. The cars T and U should be parked next to each other. The cars S and V also should be parked next to each other, whereas P and Q cannot be parked next to each other. Q and S must be parked next to each other. R is parked to the immediate right of V. T is parked to the left of U.** **Based on the above statements, the only INCORRECT option given below is:**
(A)	There are two cars parked in between Q and V.
(B)	Q and R are not parked together.
(C)	V is the only car parked in between S and R.
(D)	Car P is parked at the extreme end.

Geology (GG)

Q.1 - Q.15 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: – 1/3).

Q.1	**Which of the given planets has the highest average density?**
(A)	Mercury
(B)	Venus
(C)	Earth
(D)	Mars

Q.2	**In a multi-electrode resistivity tomography (ERT) survey, using equally spaced electrodes, which of the given configurations will provide the maximum number of data points?**
(A)	Wenner array
(B)	Axial Dipole-dipole array
(C)	Axial Pole-dipole array
(D)	Schlumberger array

Q.3	**In Electromagnetic methods of prospecting, which one of the given options is CORRECT about frequency and type of current source for the Primary field used?**
(A)	High frequency A.C.
(B)	Low frequency A.C.
(C)	Both high frequency A.C. and D.C.
(D)	Low frequency D.C.

Q.4	**'Group' is a unit of:**
(A)	Lithostratigraphy
(B)	Sequence stratigraphy
(C)	Biostratigraphy
(D)	Chronostratigraphy

Q.5	**Furongian is an Epoch of:**
(A)	Cambrian
(B)	Ordovician
(C)	Triassic
(D)	Cretaceous

Q.6	**The stage of textural maturity of a clay-rich sandstone containing poorly-sorted and angular framework grains is:**
(A)	Mature
(B)	Supermature
(C)	Immature
(D)	Submature

Q.7	**Which one of the following structures indicates Synsedimentary deformation?**
(A)	Festoon bedding
(B)	Flaser bedding
(C)	Tabular bedding
(D)	Convolute bedding

Q.8	**Low value in SP log as observed in dispersed shales is mainly due to the impeded movement of:**
(A)	Na^+ ion
(B)	Cl ion
(C)	K^+ ion
(D)	OH^- ion

Q.9	**In Radiometric survey, the g-ray spectrometer count rate depends on:**
(A)	Cracks present in the target rock volume
(B)	Solid angle of the target rock about the spectrometer
(C)	Temperature in the target rock
(D)	Pressure in the target rock

Q.10	**The dimension of radiant emittance of a blackbody as per Stefan-Boltzmann law is:**
(A)	$M^0L^1T^{-1}$
(B)	$M^1L^{-1}T^{-2}$
(C)	$M^1L^2T^{-2}$
(D)	$M^1L^0T^{-3}$

Q.11	**A surface geological process that can create a landform called Cirque is:**
(A)	aeolian deposition
(B)	fluvial deposition
(C)	glacial erosion
(D)	deposition of volcanic ash

Q.12	**If α and β are P- and S-wave velocities, respectively, then $\alpha^2 - (4/3)\beta^2$ is equal to:** **(κ is the bulk modulus, μ is shear modulus and ρ is density)**
(A)	κ/ρ
(B)	μ/ρ
(C)	$\kappa + \mu/\rho$
(D)	$\kappa - \mu/\rho$

Q.13	Which one of the following phases is P-wave that converts to S-wave during passage through the solid inner core?
(A)	PKIKP
(B)	PKJKP
(C)	PKiKP
(D)	PKPPcP

Q.14	In reduction of gravity data, the latitude correction is maximum at:
(A)	35° latitude
(B)	45° latitude
(C)	55° latitude
(D)	65° latitude

Q.15	The most coaliferous unit of the Gondwana Supergroup is:
(A)	Talchir Formation
(B)	Barakar Formation
(C)	Karharbari Formation
(D)	Panchet Formation

Q.16 - Q.25 Numerical Answer Type (NAT), carry ONE mark each (no negative marks).

Q.16	**A vertical borehole encounters a shale bed of uniform thickness occurring at a depth of 5 m and dipping 60º. The borehole pierces through this shale bed for a length of 10 m to reach a sandstone layer below. The true thickness of the shale bed is _____ m. [*in integer*]**

Q.17	**The mass and volume of a fully dried soil sample are 2200 gm and 1100 cm^3, respectively. If the specific gravity of the soil particles is 2.5 and water density is 1 gm/cm^3, the void ratio of the soil is _____. [*round off to 2 decimal places*]**

Q.18	**A constant-head permeability test was performed on a vertical sand column of height 40 cm and cross-sectional area of 25 cm^2. During the test, when the loss of head was 50 cm, the volume of water collected in 2 minutes was 300 cm^3. Applying Darcy's law, the calculated coefficient of permeability of the sand column is _____ cm/sec. [*round off to 2 decimal places*]**

Q.19	**The radius (r) of the oblate spheroid at 45° latitude with ellipticity of polar flattening of 1/298.25 and equatorial radius of 6378140 m is _____ km. [*round off to 2 decimal places*]**

Q.20	**Light passes through two media with refractive indices of 1.75 and 1.55, respectively. The thickness of both the media is 30 mm. The resultant path difference of the yellow light component (λ = 589 nm) is _____ mm. (Take π = 3.141) [*round off to one decimal places*]**

Q.21	**The water table in an unconfined aquifer at a place near the coast is 1 m above the Mean Sea Level. Given the densities of fresh and saline water as 1.001 and 1.025 g/cc, respectively, the fresh-saline water interface at the same location should be at a depth of _____ m from the water table. [*round off to one decimal place*]**

Q.22	**The volume percentage of galena and quartz in an ore body of Pb are 90 and 10, respectively. The densities of galena and quartz are 7.6 and 2.65 g/cc, respectively. The grade of the ore body in terms of weight percent of Pb is _____. (Atomic weights of Pb = 206 and S = 32) [*round off to 2 decimal places*]**

Q.23	**Normal moveout (NMO) for reflected phase of seismic data is 2 milliseconds. Consider the diffraction source at the edge of the same reflector, where the shot point is directly above diffraction source. In this case, the NMO due to diffraction is _____ milliseconds [*in integer*].**

Q.24	**In a 2D seismic survey, first receiver location is at (1000 m, 4000 m), second receiver location is at (2000 m, 4000 m) and the source location is at (2000 m, 1000 m). Consider P-wave velocity as 5000 m/sec. The difference in first arrival time of P-wave phase for the two receivers is _____ seconds. [*round off to 2 decimal places*].**

Q.25	**The potential difference measured between potential electrodes using Wenner array is 500 mV when a current of 2 A is passed through the subsurface between current electrodes. If the computed apparent resistivity is 100 Ωm then the distance between the current electrodes will be _____ m. [*round off to 2 decimal places*] (Use π = 3.141)**

Q.26 - Q.42 Multiple Choice Question (MCQ), carry TWO marks each (for each wrong answer: – 2/3).

Q.26	**Which one of the following statements is CORRECT?**
(A)	Taphonomy refers to the study of fossilization pathways from death of an organism to its recovery as a fossil.
(B)	Biostratinomy refers to the study of fossilization pathways from burial of an organism under sediments to its recovery as a fossil.
(C)	Biostratinomy is an integral component of biostratigraphy and refers to the characterization of strata based on fossil content.
(D)	Taphonomy refers to the study of fossilization pathways from death of an organism to its burial under the sediments.

Q.27	**Based on the three statements given below, choose the CORRECT option:** **<u>Statement I:</u> Gunderdehi Formation is a stratigraphic unit of the Chattisgarh Supergroup.** **<u>Statement II:</u> Raniganj Formation is a coal-bearing Triassic unit of the Gondwana Supergroup.** **<u>Statement III:</u> Pitepani Volcanics is a stratigraphic unit of the Dongargarh Supergroup.**
(A)	All the statements are correct
(B)	Statement I is correct, but statements II and III are incorrect
(C)	Statements I and III are correct, but statement II is incorrect
(D)	Statements II and III are correct but statement I is incorrect

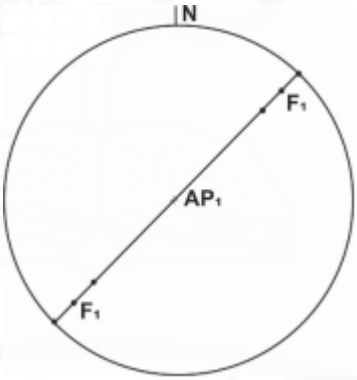
Q.28	**Which one of the following equid genera was a one-toed grazer?**
(A)	*Merychippus*
(B)	*Parahippus*
(C)	*Pliohippus*
(D)	*Mesohippus*

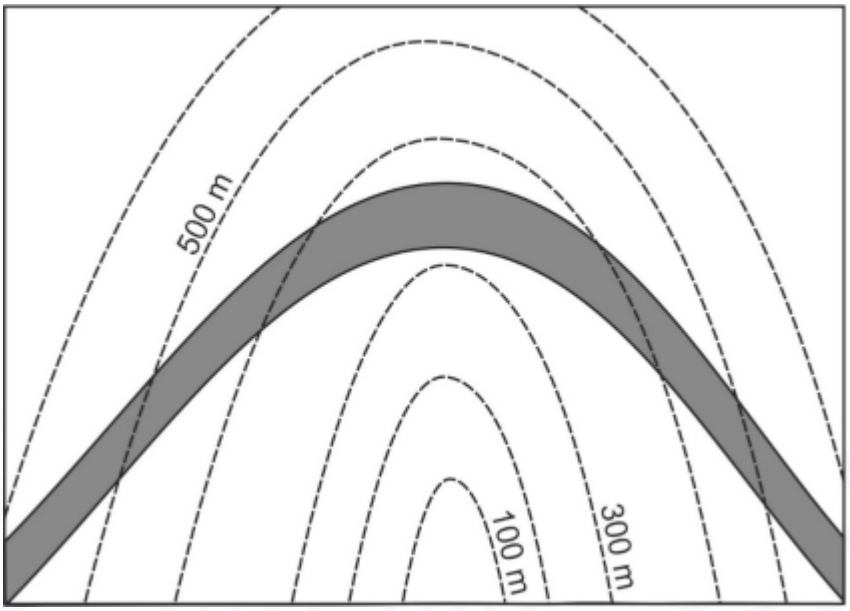
Q.29	**Match the following invertebrate genera in Group I with their corresponding Class/Phylum in Group II:** **Group I** **P. *Mytilus*** **Q. *Planorbis*** **R. *Productus*** **S. *Acanthoceras*** **Group II** **1. Brachiopoda** **2. Cephalopoda** **3. Gastropoda** **4. Pelecypoda**
(A)	P-4, Q-3, R-1, S-2
(B)	P-4, Q-1, R-2, S-3
(C)	P-4, Q-3, R-2, S-1
(D)	P-3, Q-1, R-4, S-2

Q.30	**Tillite with faceted boulders and green shale with dropstones characterize the lithology of:**
(A)	Lameta Formation
(B)	Bagra Formation
(C)	Talchir Formation
(D)	Panchet Formation

Q.31	**Match the following structures in Group I with the corresponding environment of deposition in Group II:** **Group I** **P. Lateral accretionary surfaces** **Q. Herringbone cross stratification** **R. Lateral moraine** **S. Star dune** **Group II** **1. Tidal** **2. Glacial** **3. Aeolian** **4. Fluvial**
(A)	P-4, Q-1, R-2, S-3
(B)	P-4, Q-1, R-3, S-2
(C)	P-3, Q-1, R-2, S-4
(D)	P-2, Q-4, R-1, S-3

Q.32	**Match the items in Group-I with appropriate items in Group-II** **Group-I** / **Group-II** **P. Boula-Nuasahi Deposits** — **1. REE Mineralization** **Q. Amba Dongar Igneous Complex** — **2. Residual Concentration** **R. East Coast Bauxite** — **3. Gangpur Group** **S. Sargipalli Pb - Zn** — **4. PGM resource**
(A)	P-4, Q-3, R-1, S-2
(B)	P-2, Q-3, R-4, S-1
(C)	P-4, Q-1, R-2, S-3
(D)	P-3, Q-2, R-1, S-4

Q.33	**With regard to superposed folding, the stereographic projection represents a geometry of:** 
(A)	plane cylindrical fold.
(B)	plane non-cylindrical fold.
(C)	non-plane cylindrical fold.
(D)	non-plane non-cylindrical fold.

Q.34	**The given outcrop pattern of a bed (shaded in grey) with respect to contours (dashed lines) indicates that the bed** 
(A)	dips upstream.
(B)	is horizontal.
(C)	dips steeply downstream.
(D)	dips downstream at an angle equal to the valley gradient.

Q.35	**With regard to occurrence of groundwater in an area, which of the given statements is CORRECT?**
(A)	Vadose water occurs in the zone of saturation.
(B)	The zone of aeration lies below the zone of saturation.
(C)	The water table marks the uppermost surface of the vadose zone.
(D)	The depth of the perched water table is less than that of the water table.

Q.36	**There are indications of presence of a massive tabular multimetal sulfide ore body at a shallow depth from the surface. Which of the following would be the most efficient geophysical method to confirm the presence of the ore body?**
(A)	resistivity sounding
(B)	ground geomagnetic survey
(C)	self-potential method of geophysical prospecting
(D)	ground gravity survey

Q.37	**The following reaction takes place in the amphibolite grade of metamorphism of pelitic rocks:** **kyanite + chlorite ⇔ staurolite + quartz +H_2O** **Which of the following is a CORRECT statement on this reaction?**
(A)	The reaction can be represented as a sharp univariant boundary.
(B)	Initially chlorite and staurolite are Fe-rich and will gradually become Mg-rich with increasing temperature.
(C)	With increasing temperature chlorite becomes Mg-rich and staurolite becomes Fe –rich.
(D)	The reaction is independent of fugacity of H_2O.

Q.38	**Match the items in Group-I with corresponding appropriate items in Group-II.** **Group-I** — **Group-II** **P. Cs** — **1. Siderophile** **Q. Au** — **2. Chalcophile** **R. Cd** — **3. Atmophile** **S. Rn** — **4. Lithophile**
(A)	P-4, Q-1, R-2, S-3
(B)	P-4, Q-3, R-1, S-2
(C)	P-3, Q-1, R-2, S-4
(D)	P-2, Q-1, R-4, S-3

Q.39	**The symmetry elements of a point group are: 3 crystallographic axes of 2-fold symmetry and 3 mirror planes perpendicular to the crystallographic axes. The Hermann – Mauguin notation of the point group is:**
(A)	2m2m2m
(B)	2mm
(C)	2/m2/m2/m
(D)	2/m

Q.40	**An aqueous polyphase (L + V + solid) inclusion contains a halite daughter crystal at room temperature and pressure. Which of the given statements is CORRECT in relation to this inclusion?**
(A)	The salinity of the bulk aqueous fluid can be determined from the temperature of melting of ice.
(B)	The salinity of the bulk aqueous fluid can be determined from the temperature of dissolution of halite.
(C)	The density in all cases can be determined from the temperature of liquid-vapor homogenization.
(D)	The density in all cases can be determined from the temperature of dissolution of the halite daughter crystal.

Q.41	**Match the rock types in Group-I with their most likely corresponding lithospheric / tectonic settings of formation in Group-II** **Group-I** / **Group-II** **P. Boninite** — **1. Continental anorogenic** **Q. Lamproite** — **2. Island-arc** **R. Phonolite** — **3. Continental collision** **S. Leucogranite** — **4. Intraplate oceanic**
(A)	P-1, Q-3, R-4, S-2
(B)	P-2, Q-4, R-1, S-3
(C)	P-2, Q-1, R-4, S-3
(D)	P-3, Q-2, R-4, S-1

Q.42	**A mantle source rock melts at a time t_0 giving rise to melt (M) and residue (R). Which of the following statements is CORRECT about evolution of the ($^{143}Nd/^{144}Nd$) and ($^{87}Sr/^{86}Sr$) isotope ratio in M (that crystallized to form a rock) and R?**
(A)	The growth of Nd isotope ratio versus time is faster in R than M and the Sr isotope ratio grows slower in R than M.
(B)	The growth of Nd isotope ratio versus time is slower in R than M and the Sr isotope ratio grows faster in R than M.
(C)	Both the Nd and Sr isotope ratios grow at identical rates in R and M.
(D)	The growth of Nd and Sr isotope ratio in M and R would depend on the initial concentrations of Sm and Rb in the mantle source rock.

Geology and Geophysics (GG - Geology)

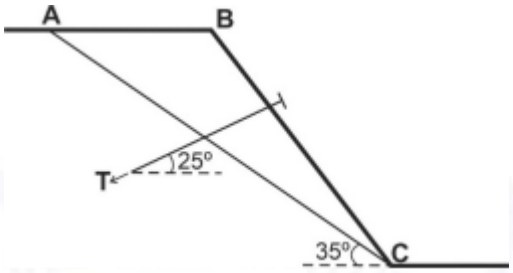
Q.43 - Q.55 Numerical Answer Type (NAT), carry TWO mark each (no negative marks).

Q.43	**The mole percentages of SiO_2, Al_2O_3 and K_2O in a granitic rock are 84.21, 7.89 and 7.89, respectively. The molar proportion (in %) of K-feldspar in the rock is _____. [*round off to one decimal place*]**

Q.44	**In a zone of active normal faulting, the maximum and minimum *in situ* principal stresses (compressive in nature) are 30 MPa (s_1) and 10 MPa (s_3), respectively. The fault plane striking N-S has a dip amount of 60° towards E. Considering Anderson theory of faulting and using the given information, the calculated normal stress on the fault plane is _____ MPa. [*in integer*]**

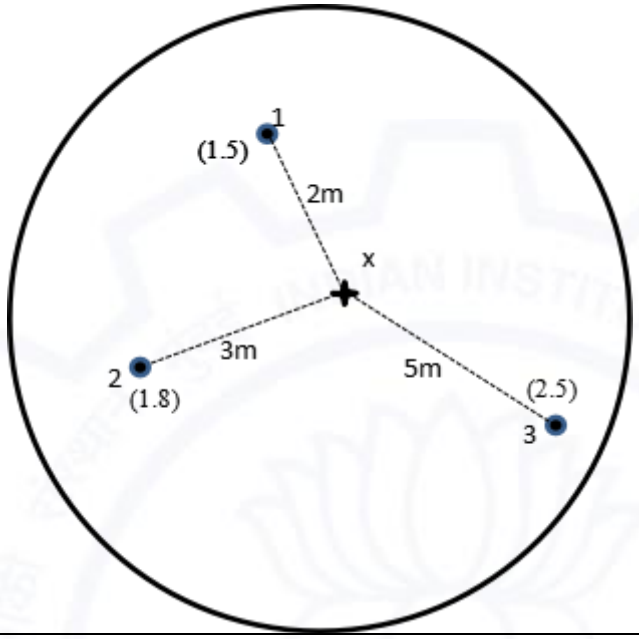
Q.45	**A circular tunnel is being excavated in a blocky rock mass by drilling and blasting. An excavation disturbed zone (EDZ) around the tunnel extends 0.70 m into the rock from the excavation surface. Considering the unit weight of the rock as 25 kN/m^3, the support pressure required at the crown of the tunnel to stabilize the loose blocks of the EDZ is _____ kPa. [*round off to one decimal place*]**

Q.46	**Under uniaxial compression, a cylindrical quartzite specimen (length = 122 mm and diameter = 60 mm) showed linear elastic behaviour. The uniaxial compressive strength and the modulus ratio of the rock are 150 MPa and 500, respectively. The axial strain at 75 MPa during the loading was _____ milli-strain. [*in integer*]**

Q.47	**The sketch shows a triangular rock mass (ABC) resting on a joint plane (AC) inclined at 35º with the horizontal. A rockbolt having an inclination of 25º with the horizontal is used to stabilize the slope. If the bolt tension (T) is 110 kN, the absolute value of shear force along the joint plane induced by the bolt tension is _____ kN. [*in integer*]** 

Q.48	**A stratified confined aquifer consists of three parallel homogeneous and isotropic horizontal layers with thickness of 10 m, 5 m and 5 m. The layers have the same width. The hydraulic conductivities of the strata are 15 m/day, 20 m/day and 30 m/day, respectively. The water flow follows Darcy's law and is parallel to the strata. Considering the same hydraulic gradient for all the layers, the effective hydraulic conductivity of the aquifer is _____ m/day. [*in integer*]**

Q.49	**A drainage basin of fourth order covers an area of 35 km^2. Within the basin, the total lengths of the 1st order, 2nd order and 3rd order drainages are 11.5 km, 8.5 km and 4.2 km, respectively. If the drainage density of the basin is 0.8 km^{-1}, the total length of the 4th order drainage is _____ km. [*round off to one decimal place*]**

Q.50	**The grade of copper (in wt%) of an ore body determined at locations 1, 2 and 3 are indicated (in parentheses) below. The grade of copper at an unknown location x calculated using Inverse-Square Distance Weighting (IDW) is _____ wt %. [*round off to 2 decimal places*]** 

Q.51	**The heat flux at the Earth's surface is 60 mWm^{-2}. If the thermal conductivity at the surface is 2.5 $Wm^{-1}\,°C^{-1}$, the geothermal gradient is _____ °C/km. [*in integer*]**

Q.52	**A rock formed at time $t_0 = 0$ with number of ^{14}C atoms = 10^5. The number of ^{14}C atoms (in $\log_{10}$) after a time of 8×10^3 years is _____. [*round off to 3 decimal places*] (Use a decay constant of $1.25 \times 10^{-4}\ yr^{-1}$)**

Q.53	**In the given reaction,** $$2Fe^{2+} + 3H_2O \rightarrow Fe_2O_3 + 6H^+ + 2e^-$$ **consider ideal condition, take concentration of Fe^{2+} as 10^{-5} molal, $E^0 = 0.98$ V and pH=6. The value of $(2.303 \times R \times T)/F = 0.059$ (where F is the Faraday constant). The value of E_h on the Fe^{2+} / hematite boundary at 25 °C is _____ V. [*round off to 2 decimal places*]**

Q.54	**The first and second dissociation constants of H_2CO_3 are 6.761×10^{-7} and 4.68×10^{-11}, respectively. If the concentration of H_2CO_3 is 1 molal and pH = 6, the $\sum CO_2$ in the solution (assuming ideal condition) is _____ molal. [*round off to 3 decimal places*]**

Q.55	**A satellite orbits the earth at an altitude of 700 km on the equatorial plane of the earth and it revolves in the same direction as the direction of rotation of the earth. Considering the radius of a spherical earth as 6300 km and the acceleration due to gravity as 10 m/s^2, the tangential velocity of the satellite in the orbit is _____ km/s. [*round off to 2 decimal places*]**

END OF THE QUESTION PAPER