GATE 2024 Geology & Geophysics (GG) Question Paper

Graduate Aptitude Test in Engineering (GATE)

General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1 If '→' denotes increasing order of intensity, then the meaning of the words [simmer → seethe → smolder] is analogous to [break → raze → _____]. Which one of the given options is appropriate to fill the blank?

(A) obfuscate

(B) obliterate

(C) fracture

(D) fissure

Q.2 In a locality, the houses are numbered in the following way:

The house-numbers on one side of a road are consecutive odd integers starting from 301, while the house-numbers on the other side of the road are consecutive even numbers starting from 302. The total number of houses is the same on both sides of the road.

If the difference of the sum of the house-numbers between the two sides of the road is 27, then the number of houses on each side of the road is

(A) 27

(B) 52

(C) 54

(D) 26

Q.3 For positive integers p and q, with $\frac{p}{q} \neq 1$, $\left(\frac{p}{q}\right)^{\frac{p}{q}} = p^{\left(\frac{p}{q}-1\right)}$. Then,

(A) $q^p = p^q$

(B) $q^p = p^{2q}$

(C) $\sqrt{q} = \sqrt{p}$

(D) $\sqrt[p]{q} = \sqrt[q]{p}$

Q.4 Which one of the given options is a possible value of x in the following sequence?

3, 7, 15, x, 63, 127, 255

(A) 35

(B) 40

(C) 45

(D) 31

Q.5 On a given day, how many times will the second-hand and the minute-hand of a clock cross each other during the clock time 12:05:00 hours to 12:55:00 hours?

(A) 51

(B) 49

(C) 50

(D) 55

Q.6 – Q.10 Carry TWO marks Each

Q.6 In the given text, the blanks are numbered (i)–(iv). Select the best match for all the blanks.

From the ancient Athenian arena to the modern Olympic stadiums, athletics (i) _____ the potential for a spectacle. The crowd (ii) _____ with bated breath as the Olympian artist twists his body, stretching the javelin behind him. Twelve strides in, he begins to cross-step. Six cross-steps (iii) _____ in an abrupt stop on his left foot. As his body (iv) _____ like a door turning on a hinge, the javelin is launched skyward at a precise angle.

(A)	(i) hold	(ii) waits	(iii) culminates	(iv) pivot
(B)	(i) holds	(ii) wait	(iii) culminates	(iv) pivot
(C)	(i) hold	(ii) wait	(iii) culminate	(iv) pivots
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Q.7 Three distinct sets of indistinguishable twins are to be seated at a circular table that has 8 identical chairs. Unique seating arrangements are defined by the relative positions of the people.

How many unique seating arrangements are possible such that each person is sitting next to their twin?

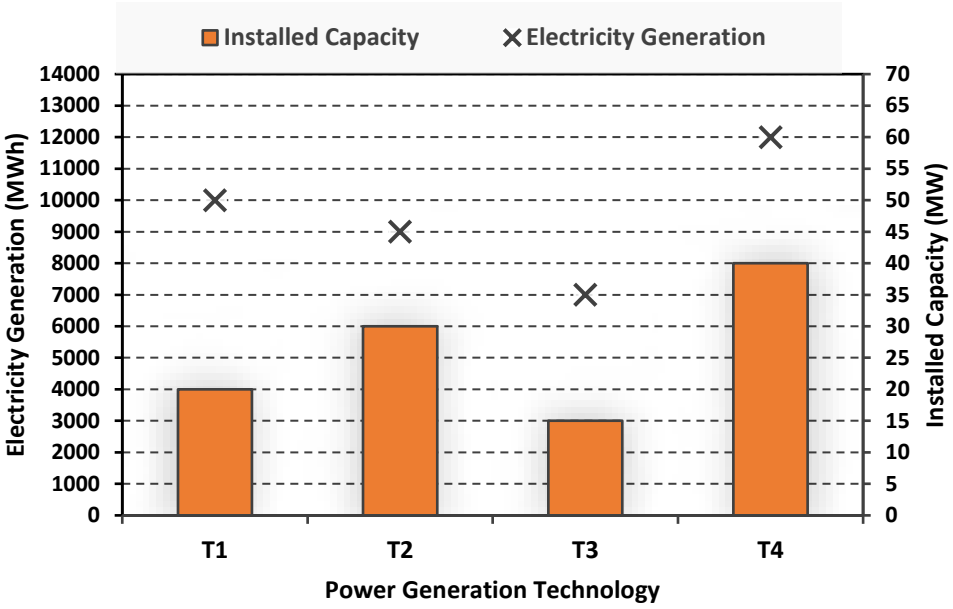
(A) 12

(B) 14

(C) 10

(D) 28

Q.8 The chart given below compares the Installed Capacity (MW) of four power generation technologies, T1, T2, T3, and T4, and their Electricity Generation (MWh) in a time of 1000 hours (h).



The Capacity Factor of a power generation technology is:

$$\text{Capacity Factor} = \frac{\text{Electricity Generation (MWh)}}{\text{Installed Capacity (MW)} \times 1000\ \text{(h)}}$$

Which one of the given technologies has the highest Capacity Factor?

(A) T1

(B) T2

(C) T3

(D) T4

Q.9 In the 4 × 4 array shown below, each cell of the first three columns has either a cross (X) or a number, as per the given rule.

1	1	2	
2	X	3	
2	X	4	
1	2	X	

Rule: The number in a cell represents the count of crosses around its immediate neighboring cells (left, right, top, bottom, diagonals).

As per this rule, the **maximum** number of crosses possible in the empty column is

(A) 0

(B) 1

(C) 2

(D) 3

Q.10 During a half-moon phase, the Earth-Moon-Sun form a right triangle. If the Moon-Earth-Sun angle at this half-moon phase is measured to be 89.85°, the ratio of the Earth-Sun and Earth-Moon distances is closest to

(A) 328

(B) 382

(C) 238

(D) 283

PART A: COMPULSORY SECTION FOR ALL CANDIDATES

Q.11– Q .17 Carry ONE mark Each

Q.11 The Earth's magnetic field originates from convection in which one of the following layers?

(A) Inner core

(B) Outer core

(C) Lithosphere

(D) Asthenosphere

Q.12 Which one of the following logging tools is used to measure the diameter of a borehole?

(A) Sonic

(B) Density

(C) Neutron

(D) Caliper

Q.13 The given figure depicts an array used in DC resistivity surveys, where the current electrodes are denoted by C1 and C2, and potential electrodes by P1 and P2. If all the electrodes are equally spaced, then the given array corresponds to which one of the following configurations?

(A) Wenner

(B) Schlumberger

(C) Dipole–Dipole

(D) Pole–Pole

Q.14 Which one of the following is an ultramafic rock?

(A) Granite

(B) Gabbro

(C) Dunite

(D) Basalt

Q.15 Gold is being produced from which one of the following mines in India?

(A) Baula

(B) Hutti

(C) Dariba

(D) Jaduguda

Q.16 Which of the following hydrocarbon fields is/are located in the western offshore of India?

(A) Tapti

(B) Lakwa

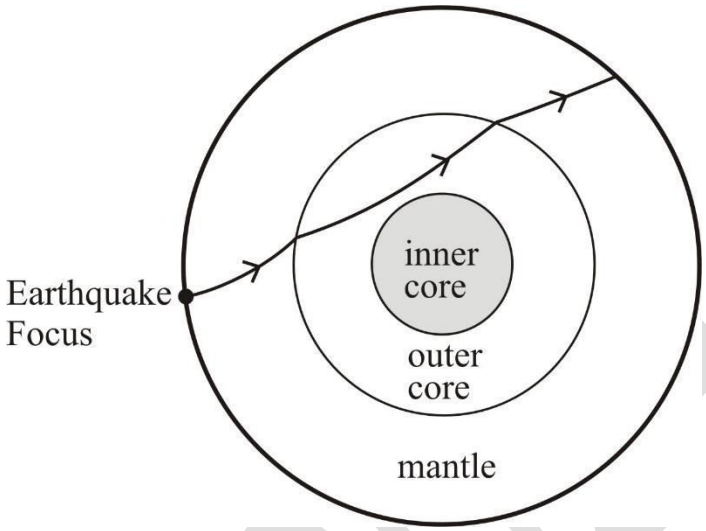
(C) Ravva

(D) Panna

Q.17 A cylindrical sample of granite (diameter = 54.7 mm; length = 137 mm) shows a linear relationship between axial stress and axial strain under uniaxial compression up to the peak stress level at which the specimen fails. If the uniaxial compressive strength of this sample is 200 MPa and the axial strain corresponding to this peak stress is 0.005, the Young's modulus of the sample in GPa is _____ (*in integer*).

Q.18 – Q.26 Carry TWO marks Each

Q.18 The given figure shows the ray path of a P–wave propagating through the Earth. Choose the CORRECT P–phase corresponding to the ray path.



(A) PcP

(B) PKP

(C) PPP

(D) PmP

Q.19 Match the geophysical methods in Group–I with their associated physical properties in Group–II.

Group–I		Group–II	
P.	Magnetic	1.	Chargeability
Q.	Gravity	2.	Electrical conductivity
R.	Magnetotelluric	3.	Susceptibility
S.	Induced Polarization	4.	Density

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

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

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

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

Q.20 The number of planes of symmetry in a tetrahedron is

(A) 9

(B) 6

(C) 4

(D) 3

Q.21 Which of the following Epochs belong(s) to the Quaternary Period?

(A) Holocene

(B) Pleistocene

(C) Pliocene

(D) Miocene

Q.22 Which one or more of the following minerals shows O:Si ratio of 4:1 in its silicate structure?

(A) Olivine

(B) Quartz

(C) Diopside

(D) Albite

Q.23 Which of the following rock structures is/are fold(s)?

(A) Antiform

(B) Horst

(C) Syncline

(D) Synform

Q.24 Assume heat producing elements are uniformly distributed within a 16 km thick layer in the crust in a heat flow province. Given that the surface heat flow and reduced heat flow are 54 mW/m^2 and 22 mW/m^2, respectively, the radiogenic heat production in the given crustal layer in $\mu W/m^3$ is _____ (*in integer*).

Q.25 A confined aquifer with a uniform saturated thickness of 10 m has hydraulic conductivity of 10^{-2} cm/s. Considering a steady flow, the transmissivity of the aquifer in m^2/day is _____ (*rounded off to one decimal place*).

Q.26 A current of 2 A passes through a cylindrical rod with uniform cross-sectional area of 4 m^2 and resistivity of 100 Ω-m. The magnitude of the electric field (**E**) measured along the length of the rod in V/m is _____ (*in integer*).

PART B1: FOR Geology CANDIDATES ONLY

Q.27 – Q.44 Carry ONE mark Each

Q.27 Which one of the following lineations can be observed on a foliation with an attitude 210°, 40° NW?

(A) $40° \rightarrow 300°$

(B) $40° \rightarrow 040°$

(C) $40° \rightarrow 220°$

(D) $40° \rightarrow 350°$

Q.28 Match the minerals in Group–I with the corresponding cleavage types in Group–II.

Group–I		Group–II	
P.	Diopside	1.	Cubic
Q.	Galena	2.	Octahedral
R.	Calcite	3.	Prismatic
S.	Fluorite	4.	Rhombohedral

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

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

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

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

Q.29 The composition of which one of the following reservoirs closely matches with that of iron meteorites?

(A) Primitive Mantle

(B) Earth's Core

(C) Depleted Mantle

(D) Bulk Silicate Earth

Q.30 Match the microstructures in Group–I with their characteristics in Group–II.

Group–I		Group–II	
P.	Core–mantle	1.	Radiating fibrous aggregate of K-feldspar with or without quartz
Q.	Decussate	2.	Large strained mineral grains surrounded by fine-grained, recrystallized grains
R.	Spherulite	3.	Inclusion trails in a porphyroblast curves into the matrix foliation by developing concave outward pattern
S.	Millipede	4.	Randomly oriented mineral grains dominated by crystal faces, such as in sheet silicates

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

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

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

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

Q.31 Which one among the following is the least abundant sedimentary rock in the stratigraphic record?

(A) Sandstone

(B) Limestone

(C) Conglomerate

(D) Shale

Q.32 Which one of the following sequences of index minerals correctly represents the order of increasing metamorphic grade during regional metamorphism of siliceous dolomitic limestones?

(A) Tremolite → Diopside → Talc

(B) Diopside → Tremolite → Forsterite

(C) Talc → Tremolite → Diopside

(D) Talc → Forsterite → Tremolite

Q.33 Which one among the following is the oldest horse genus?

(A) *Orohippus*

(B) *Mesohippus*

(C) *Merychippus*

(D) *Pliohippus*

Q.34 The measured plate velocity is maximum (in International Terrestrial Reference Frame) at which one of the following locations on the Indian Plate?

(A) Leh

(B) Delhi

(C) Bengaluru

(D) Maldives

Q.35 Which one of the following textures is called the chalcopyrite disease?

(A) Chalcopyrite blebs in sphalerite

(B) Sphalerite stars in chalcopyrite

(C) Chalcopyrite lamellae in bornite

(D) Bornite lamellae in chalcopyrite

Q.36 Which one of the following is the correct arrangement of volcanics from the oldest to the youngest?

(A) Bijli → Rajmahal → Malani → Deccan

(B) Malani → Bijli → Deccan → Rajmahal

(C) Bijli → Malani → Rajmahal → Deccan

(D) Malani → Rajmahal → Bijli → Deccan

Q.37 Which of the following types of deposits is/are formed by fractional crystallization of magma?

(A) Komatiite hosted Ni–Cu

(B) Peridotite hosted Cr

(C) Leucogranite hosted U

(D) Anorthosite hosted Ti–Fe

Q.38 Which of the following sedimentary basins is/are producing hydrocarbon commercially?

(A) Ganga

(B) Krishna–Godavari

(C) Kerala–Konkan

(D) Cauvery

Q.39 Which of the following bivalves is/are swimmers?

(A) *Aspergillum*

(B) *Lima*

(C) *Tellina*

(D) *Pecten*

Q.40 Which of the following structures is/are associated with duplexes in fold–thrust belts?

(A) Roof thrust

(B) Floor thrust

(C) Imbricate fan

(D) Horses

Q.41 Which of the following statements is/are CORRECT ?

(A) Karst topography is formed in limestone terrains

(B) Fjords are formed by aeolian activities

(C) Oxbow lakes are formed in fluvial environments

(D) Ventifacts are formed by glaciers

Q.42 Consider the solubility product of barite ($BaSO_4$) at 25 °C and 1 bar to be 10^{-10}. If the activities of Ba^{2+} and SO_4^{2-} ions are 0.5×10^{-5} and 10^{-X}, respectively, then the absolute value of 'X' is _____ (*rounded off to one decimal place*).

Q.43 The support pressure of 20 kPa is required to stabilize the loose blocks of the Excavation Disturbed Zone (EDZ) at the crown of a circular tunnel with horizontal axis. The EDZ is to be stabilized by inserting rock bolts vertically into the roof. If the working capacity of a bolt is 160 kN, the area of the roof supported by a single bolt in m^2 is _____ (*in integer*).

Q.44 The areas of drainage basins A and B are 25 km^2 and 50 km^2, respectively. The total length of drainages of all orders in basin A is 20 km. If both the basins have the same drainage density, the total length of drainages of all orders in basin B in km is _____ (*in integer*).

Q.45 – Q .65 Carry TWO marks Each

Q.45 Match the stratigraphic units in Group–I with the sedimentary basins in Group–II.

Group–I		Group–II	
P.	Ramgundam Sandstone	1.	Chhattisgarh
Q.	Raipur Formation	2.	Kaladgi
R.	Bagalkot Group	3.	Marwar
S.	Sonia Sandstone	4.	Godavari

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

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

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

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

Q.46 Which one of the following openings is a type of decline in underground mines?

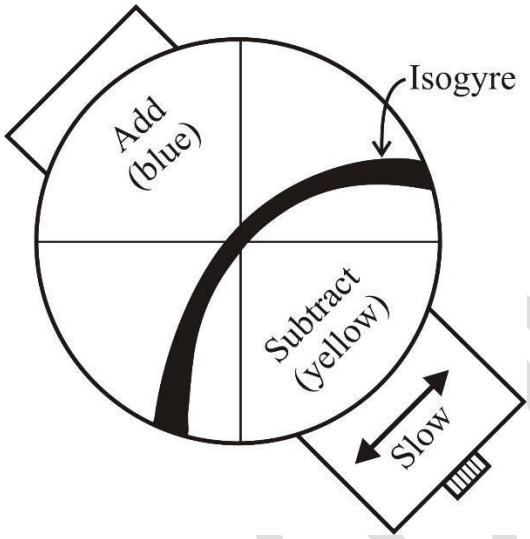
(A) Crosscut

(B) Winze

(C) Spiral tunnel

(D) Drift

Q.47 Which one of the following optic signs is CORRECT for a mineral with the given centered optic axis figure?



(A) Uniaxial positive

(B) Biaxial positive

(C) Uniaxial negative

(D) Biaxial negative

Q.48 Match the following invertebrates in Group–I with their morphological features in Group–II.

Group–I		Group–II	
P.	Trilobite	1.	Periproct
Q.	Brachiopod	2.	Hypostome
R.	Bivalve	3.	Deltidial plate
S.	Echinoid	4.	Lunule

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

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

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

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

Q.49 During high-temperature metamorphism of pelites, which one of the following mineral reactions represents the second sillimanite isograd?

(A) $\text{Muscovite} + \text{Quartz} = \text{Sillimanite} + \text{K-feldspar} + H_2O$

(B) $\text{Staurolite} + \text{Quartz} = \text{Garnet} + \text{Sillimanite} + H_2O$

(C) $\text{Staurolite} + \text{Muscovite} + \text{Quartz} = \text{Garnet} + \text{Biotite} + \text{Sillimanite} + H_2O$

(D) $\text{Kyanite} = \text{Sillimanite}$

Q.50 Which one of the following represents deviatoric stress in a 2D stress Mohr Circle?

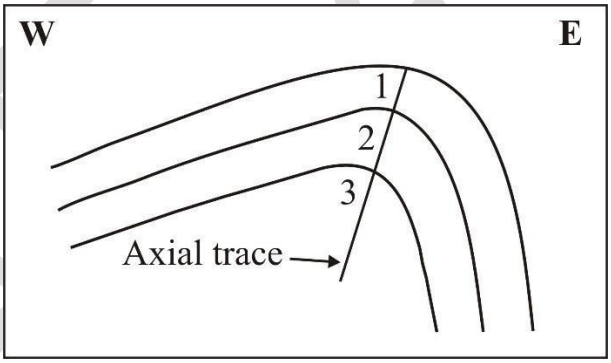
(A) Radius

(B) Center

(C) Pole

(D) Diameter

Q.51 In the fold profile section shown in the figure, 1 and 3 are the oldest and the youngest stratigraphic units, respectively. Which one of the following fold descriptions CORRECTLY matches the asymmetric fold shown in the given figure?



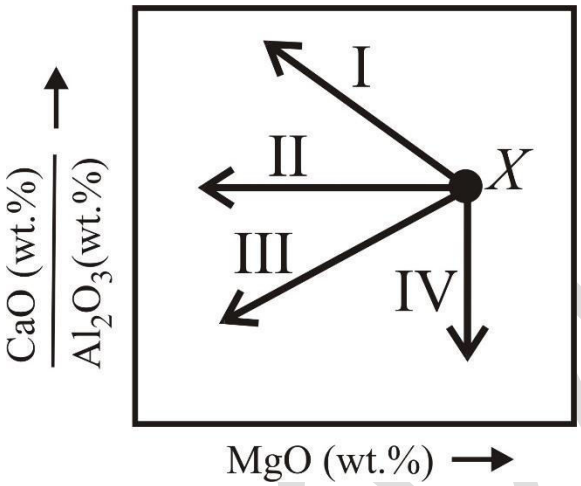
(A) Antiform facing east

(B) Synform facing east

(C) Antiform facing west

(D) Synform facing west

Q52. If '*X*' represents the initial composition of a melt, which one of the trends indicated by arrows in the schematic diagram corresponds to the evolution of the residual melt composition during crystallization of diopside?



(A) I

(B) II

(C) III

(D) IV

Q.53 Match the following copper deposits in Group–I with their host rocks in Group–II.

Group–I		Group–II	
P.	Khetri	1.	Chlorite–biotite schist and soda–granite
Q.	Mosabani	2.	Garnetiferous chlorite schist
R.	Malanjkhand	3.	Metachert
S.	Kalyadi	4.	Tonalite–granodiorite–granite

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

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

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

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

Q.54 Which one of the following events represents the termination of the Wilson Cycle in Plate Tectonics?

(A) Ocean–continent subduction

(B) Continent–continent collision

(C) Continental rifting

(D) Seafloor spreading

Q.55 The fraction of the incident electromagnetic energy reflected from a material is known as

(A) acuity

(B) albedo

(C) spectral hue

(D) artifact

Q.56 Which of the following statements regarding ore deposits is/are CORRECT ?

(A) Both replacement and exhalative ores are possible in SEDEX type deposits

(B) Rampura–Agucha Pb–Zn deposit is a Mississippi Valley Type deposit

(C) Orogenic gold deposit is an epigenetic type deposit

(D) Fluid boiling in the early stage of magmatic crystallization is responsible for Cu–(Mo) deposits

Q.57 Which of the following sedimentary structures is/are found in intertidal deposits?

(A) Ladder-back ripple

(B) Rain print

(C) Double mud drape

(D) Mud-crack

Q.58 Which of the following materials is/are used for estimation of hydrocarbon source rock maturation based on color?

(A) Conodont

(B) Illite

(C) Spore

(D) Zircon

Q.59 Which of the following schist belts occur(s) to the east of the Closepet Granite in southern India?

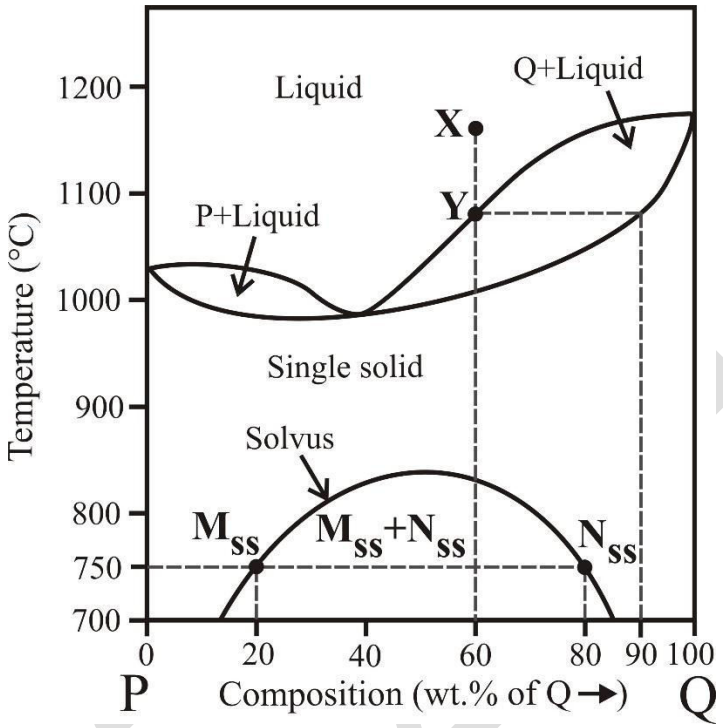
(A) Shimoga

(B) Kolar

(C) Bababudan

(D) Hutti

Q.60 The diagram given below shows phase relations between components **P** and **Q** at 1 bar pressure. If '**X**' represents the initial liquid composition, which of the following statements is/are CORRECT during equilibrium crystallization?



(A) Initial liquid composition is 60 wt.% of **P** and 40 wt.% of **Q**

(B) The composition of the solid in equilibrium with the liquid at '**Y**' is 10 wt.% of **P** and 90 wt.% of **Q**

(C) The bulk composition of the final solid product is 40 wt.% of **P** and 60 wt.% of **Q**

(D) The proportion (on the basis of wt.%) of two phases, M_{ss} : N_{ss} is 1 : 2 at 750 °C

Q.61 Which of the following statements is/are CORRECT for the M-plane of any fault?

(A) M-plane pole of a fault is located on the fault plane

(B) M-plane pole of a fault is perpendicular to the slickenline on the fault plane

(C) M-plane pole of a fault is parallel to the slickenline on the fault plane

(D) M-plane pole of a fault is perpendicular to the pole to the fault plane

Q.62 Which of the following microfossils is/are foraminifera?

(A) *Miliammina*

(B) *Triceratium*

(C) *Cibicides*

(D) *Guembelitria*

Q.63 The *in situ* stress at a point in a dry sandstone terrain is as follows: $\sigma_1 = 12$ MPa and $\sigma_3 = 4$ MPa. The pore water pressure (p_w) increases by the construction of a reservoir. The failure criterion of the sandstone is given by $\sigma_1' = 3.48\ \text{MPa} + 3\sigma_3'$, where σ_1' and σ_3' are the effective maximum and minimum principal stresses, respectively. Assuming that the failure occurs at peak stress, the minimum value of p_w (in MPa) that will cause the sandstone to fail *in situ* is _____ (*rounded off to two decimal places*).

Q.64 If the Rb-Sr isochron formed by a suite of gabbro samples has a slope of 0.0265, then the calculated age of the gabbro in million years is _____ (*in integer*).

[Use $\lambda(^{87}\text{Rb}) = 1.42 \times 10^{-11}\ \text{year}^{-1}$]

Q.65 A soil mass comprises two horizontal layers (of equal thickness and equal width) stacked one above the other. The hydraulic conductivities of the two layers are 5×10^{-2} cm/s and 3×10^{-2} cm/s. Considering Darcian flow of water and same hydraulic gradient for both the layers, the effective hydraulic conductivity of the soil mass in cm/s is _____ (*rounded off to two decimal places*).

General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1 If '→' denotes increasing order of intensity, then the meaning of the words [simmer → seethe → smolder] is analogous to [break → raze → _____]. Which one of the given options is appropriate to fill the blank?

(A) obfuscate

(B) obliterate

(C) fracture

(D) fissure

Q.2 In a locality, the houses are numbered in the following way:

The house-numbers on one side of a road are consecutive odd integers starting from 301, while the house-numbers on the other side of the road are consecutive even numbers starting from 302. The total number of houses is the same on both sides of the road.

If the difference of the sum of the house-numbers between the two sides of the road is 27, then the number of houses on each side of the road is

(A) 27

(B) 52

(C) 54

(D) 26

Q.3 For positive integers p and q, with $\frac{p}{q} \neq 1$, $\left(\frac{p}{q}\right)^{\frac{p}{q}} = p^{\left(\frac{p}{q}-1\right)}$. Then,

(A) $q^p = p^q$

(B) $q^p = p^{2q}$

(C) $\sqrt{q} = \sqrt{p}$

(D) $\sqrt[p]{q} = \sqrt[q]{p}$

Q.4 Which one of the given options is a possible value of x in the following sequence?

3, 7, 15, x, 63, 127, 255

(A) 35

(B) 40

(C) 45

(D) 31

Q.5 On a given day, how many times will the second-hand and the minute-hand of a clock cross each other during the clock time 12:05:00 hours to 12:55:00 hours?

(A) 51

(B) 49

(C) 50

(D) 55

Q.6 – Q.10 Carry TWO marks Each

Q.6 In the given text, the blanks are numbered (i)–(iv). Select the best match for all the blanks.

From the ancient Athenian arena to the modern Olympic stadiums, athletics _____(i)_____ the potential for a spectacle. The crowd _____(ii)_____ with bated breath as the Olympian artist twists his body, stretching the javelin behind him. Twelve strides in, he begins to cross-step. Six cross-steps _____(iii)_____ in an abrupt stop on his left foot. As his body _____(iv)_____ like a door turning on a hinge, the javelin is launched skyward at a precise angle.

(A)	(i) hold	(ii) waits	(iii) culminates	(iv) pivot
(B)	(i) holds	(ii) wait	(iii) culminates	(iv) pivot
(C)	(i) hold	(ii) wait	(iii) culminate	(iv) pivots
(D)	(i) holds	(ii) waits	(iii) culminate	(iv) pivots

Q.7 Three distinct sets of indistinguishable twins are to be seated at a circular table that has 8 identical chairs. Unique seating arrangements are defined by the relative positions of the people.

How many unique seating arrangements are possible such that each person is sitting next to their twin?

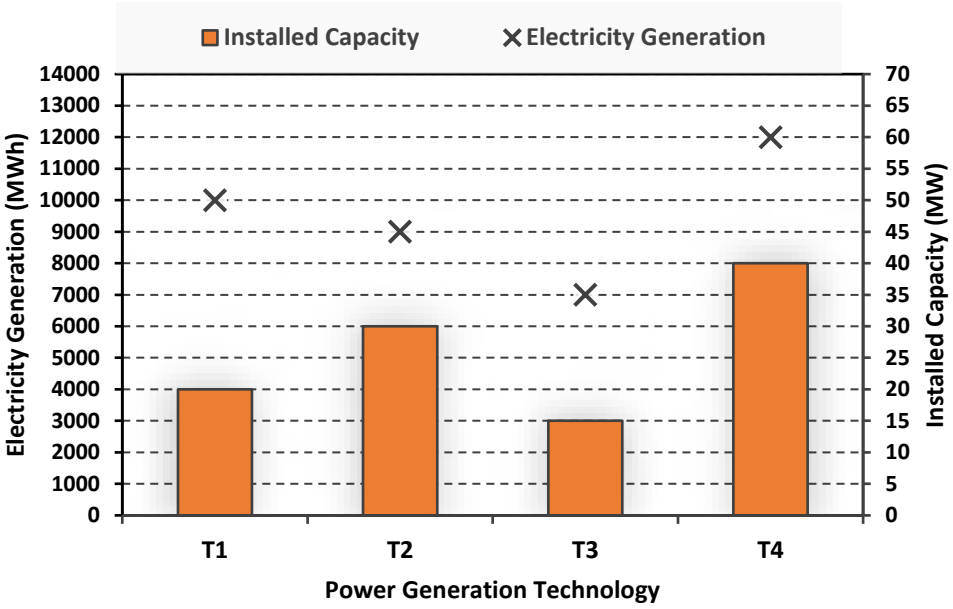
(A) 12

(B) 14

(C) 10

(D) 28

Q.8 The chart given below compares the Installed Capacity (MW) of four power generation technologies, T1, T2, T3, and T4, and their Electricity Generation (MWh) in a time of 1000 hours (h).



The Capacity Factor of a power generation technology is:

$$\text{Capacity Factor} = \frac{\text{Electricity Generation (MWh)}}{\text{Installed Capacity (MW)} \times 1000\ \text{(h)}}$$

Which one of the given technologies has the highest Capacity Factor?

(A) T1

(B) T2

(C) T3

(D) T4

Q.9 In the 4 × 4 array shown below, each cell of the first three columns has either a cross (X) or a number, as per the given rule.

1	1	2	
2	X	3	
2	X	4	
1	2	X	

Rule: The number in a cell represents the count of crosses around its immediate neighboring cells (left, right, top, bottom, diagonals).

As per this rule, the **maximum** number of crosses possible in the empty column is

(A) 0

(B) 1

(C) 2

(D) 3

Q.10 During a half-moon phase, the Earth-Moon-Sun form a right triangle. If the Moon-Earth-Sun angle at this half-moon phase is measured to be 89.85°, the ratio of the Earth-Sun and Earth-Moon distances is closest to

(A) 328

(B) 382

(C) 238

(D) 283

PART A: COMPULSORY SECTION FOR ALL CANDIDATES

Q.11– Q .17 Carry ONE mark Each

Q.11 The Earth's magnetic field originates from convection in which one of the following layers?

(A) Inner core

(B) Outer core

(C) Lithosphere

(D) Asthenosphere

Q.12 Which one of the following logging tools is used to measure the diameter of a borehole?

(A) Sonic

(B) Density

(C) Neutron

(D) Caliper

Q.13 The given figure depicts an array used in DC resistivity surveys, where the current electrodes are denoted by C1 and C2, and potential electrodes by P1 and P2. If all the electrodes are equally spaced, then the given array corresponds to which one of the following configurations?

(A) Wenner

(B) Schlumberger

(C) Dipole–Dipole

(D) Pole–Pole

Q.14 Which one of the following is an ultramafic rock?

(A) Granite

(B) Gabbro

(C) Dunite

(D) Basalt

Q.15 Gold is being produced from which one of the following mines in India?

(A) Baula

(B) Hutti

(C) Dariba

(D) Jaduguda

Q.16 Which of the following hydrocarbon fields is/are located in the western offshore of India?

(A) Tapti

(B) Lakwa

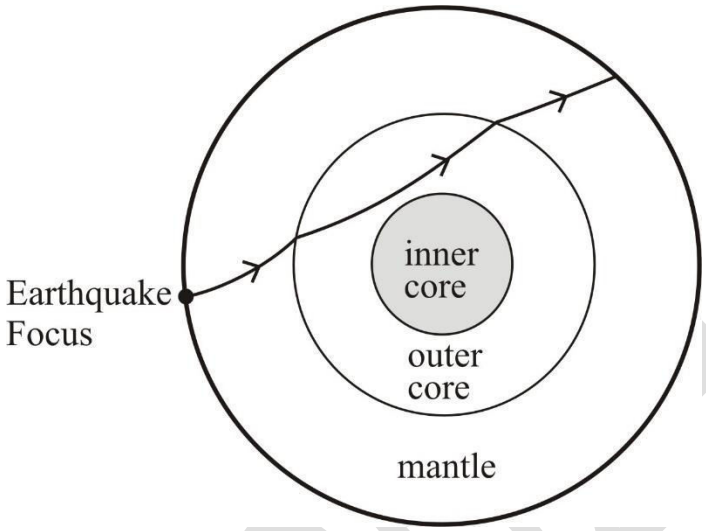
(C) Ravva

(D) Panna

Q.17 A cylindrical sample of granite (diameter = 54.7 mm; length = 137 mm) shows a linear relationship between axial stress and axial strain under uniaxial compression up to the peak stress level at which the specimen fails. If the uniaxial compressive strength of this sample is 200 MPa and the axial strain corresponding to this peak stress is 0.005, the Young's modulus of the sample in GPa is _____ (*in integer*).

Q.18 – Q.26 Carry TWO marks Each

Q.18 The given figure shows the ray path of a P–wave propagating through the Earth. Choose the CORRECT P–phase corresponding to the ray path.



(A) PcP

(B) PKP

(C) PPP

(D) PmP

Q.19 Match the geophysical methods in Group–I with their associated physical properties in Group–II.

Group–I		Group–II	
P.	Magnetic	1.	Chargeability
Q.	Gravity	2.	Electrical conductivity
R.	Magnetotelluric	3.	Susceptibility
S.	Induced Polarization	4.	Density

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

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

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

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

Q.20 The number of planes of symmetry in a tetrahedron is

(A) 9

(B) 6

(C) 4

(D) 3

Q.21 Which of the following Epochs belong(s) to the Quaternary Period?

(A) Holocene

(B) Pleistocene

(C) Pliocene

(D) Miocene

Q.22 Which one or more of the following minerals shows O:Si ratio of 4:1 in its silicate structure?

(A) Olivine

(B) Quartz

(C) Diopside

(D) Albite

Q.23 Which of the following rock structures is/are fold(s)?

(A) Antiform

(B) Horst

(C) Syncline

(D) Synform

Q.24 Assume heat producing elements are uniformly distributed within a 16 km thick layer in the crust in a heat flow province. Given that the surface heat flow and reduced heat flow are 54 mW/m^2 and 22 mW/m^2, respectively, the radiogenic heat production in the given crustal layer in $\mu W/m^3$ is _____ (*in integer*).

Q.25 A confined aquifer with a uniform saturated thickness of 10 m has hydraulic conductivity of 10^{-2} cm/s. Considering a steady flow, the transmissivity of the aquifer in m^2/day is _____ (*rounded off to one decimal place*).

Q.26 A current of 2 A passes through a cylindrical rod with uniform cross-sectional area of 4 m^2 and resistivity of 100 Ω-m. The magnitude of the electric field (**E**) measured along the length of the rod in V/m is _____ (*in integer*).

PART B2: FOR Geophysics CANDIDATES ONLY

Q.27 – Q.44 Carry ONE mark Each

Q.27 With increasing depth in the Earth, the P-wave velocity shows a significant **decrease** across which one of the following boundaries?

(A) crust – mantle

(B) mantle – outer core

(C) outer core – inner core

(D) upper mantle – lower mantle

Q.28 The fold of a 2D seismic survey is defined as the maximum number of traces in which one of the following gathers?

(A) Common midpoint gather

(B) Common offset gather

(C) Common shot gather

(D) Common receiver gather

Q.29 The Z-transform of the sequence $\{1, 0, 1, 0, 1\}$ is

(A) $1 + Z^2 + Z^4$

(B) $1 + Z + Z^2$

(C) $Z + Z^3 + Z^5$

(D) $Z + Z^2 + Z^3$

Q.30 Which one among the following events recorded in a land seismic reflection survey using vertical component geophones has the highest apparent slowness?

(A) Primary P-wave reflection

(B) Direct wave

(C) Head wave

(D) Ground roll

Q.31 A GPR pulse is propagated into a non-magnetic medium comprising of a single layer underlain by a half space. If the dielectric constants for the top layer and the half-space are ε_1 and ε_2, respectively, the reflection coefficient at normal incidence is

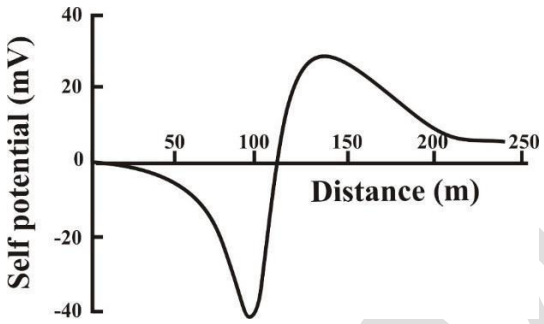
(A) $\dfrac{\sqrt{\varepsilon_1}-\sqrt{\varepsilon_2}}{\sqrt{\varepsilon_1}+\sqrt{\varepsilon_2}}$

(B) $\dfrac{\sqrt{\varepsilon_1}+\sqrt{\varepsilon_2}}{\sqrt{\varepsilon_1}-\sqrt{\varepsilon_2}}$

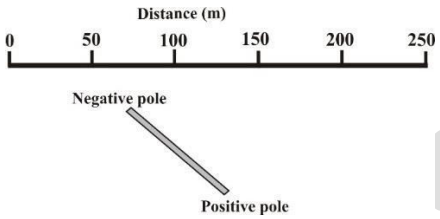
(C) $\dfrac{\sqrt{\varepsilon_1}}{\sqrt{\varepsilon_1}+\sqrt{\varepsilon_2}}$

(D) $\dfrac{\sqrt{\varepsilon_2}}{\sqrt{\varepsilon_1}+\sqrt{\varepsilon_2}}$

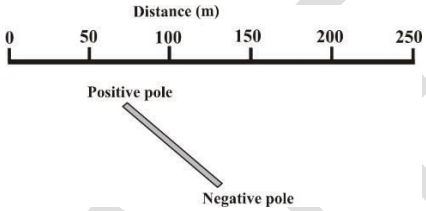
Q.32 The given figure shows the self-potential anomaly observed over a two dimensional thin sheet-type ore body whose strike is perpendicular to the plane of the paper. Which one of the following directions of polarization of the ore body leads to the given anomaly?



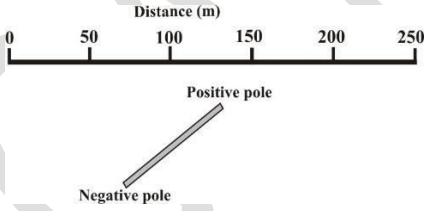
(A)



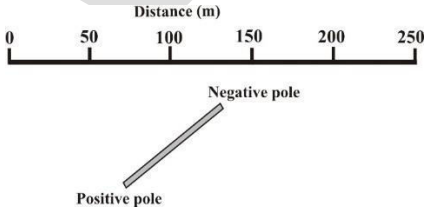
(B)



(C)



(D)



Q.33 Which one of the following geophysical methods is suitable for the identification of seepage of water from dams?

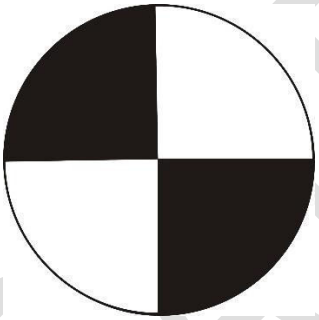
(A) Self-Potential

(B) Gravity

(C) Magnetic

(D) Radiometric

Q.34 The given beach-ball figure denotes the focal mechanism corresponding to which one of the following faults?



(A) oblique slip normal

(B) thrust

(C) strike-slip

(D) normal

Q.35 At present, which one of the following planets does NOT have a magnetic field of internal origin produced by an active dynamo?

(A) Mercury

(B) Venus

(C) Earth

(D) Uranus

Q.36 The dimension of permeability is

(A) L

(B) L^2

(C) L^3

(D) L^2T^{-2}

Q.37 In radiometric surveys, potassium in subsurface rocks will show a γ-ray peak in which one of the following MeV energy channels?

(A) 0.92

(B) 1.46

(C) 1.76

(D) 2.62

Q.38 Assume the acceleration due to gravity is 10 m/s^2. The geoid height anomaly in metres due to the gravitational potential anomaly of -59 m^2/s^2 measured over the spheroid is

(A) -5.9

(B) 5.9

(C) 59

(D) -59

Q.39 Which one among the following factors contributes the least amount of heat to the Earth's annual heat budget?

(A) Geothermal flux from Earth's interior

(B) Reflection and re-radiation of Solar energy

(C) Energy released from Earthquakes

(D) Rotational deceleration by Tidal friction

Q.40 Identify the CORRECT assumption(s) supporting the convolutional model of zero-offset seismic data from the following statements.

(A) Seismic data consist of a single temporal frequency

(B) There are no sharp changes in the material properties in the subsurface

(C) Density is constant in the subsurface

(D) The source waveform is stationary, that is, the source waveform does not change as it travels in the subsurface

Q.41 A spherical ore body produces a maximum gravity anomaly of 18 mGal when its centre is at a depth of 2 km from the surface. Assuming that the density contrast and the radius of the body remain unchanged, the ore body will produce a maximum gravity anomaly of 2 mGal if the depth to its centre in km is _____(*in integer*).

Q.42 The ratio of the largest to the smallest amplitude of waveforms that can be accurately recorded by a digital seismometer is reported as 10^7. Then, the dynamic range of the seismometer in dB is _____(*in integer*).

Q.43 A petroleum company estimates that a reservoir holds oil with a prior probability of 60 %. It then acquires petrophysical data that suggests the presence of oil. If the petrophysical analysis is accurate with a probability of 70 %, the posterior probability of the presence of oil in % is _____(*rounded off to two decimal places*).

Q.44 The magnitude of horizontal and vertical components of the total magnetic field at a particular location are 40500 nT and 36450 nT, respectively. The magnetic inclination at the same location in degrees is _____(*rounded off to one decimal place*).

Q.45 – Q .65 Carry TWO marks Each

Q.45 A stress tensor $\boldsymbol{\sigma}$, with elements in MPa, is as given. The maximum value of the principal stress in MPa is

$$\boldsymbol{\sigma} = \begin{bmatrix} 1 & 0 & \sqrt{2} \\ 0 & 1 & 0 \\ \sqrt{2} & 0 & 0 \end{bmatrix}$$

(A) 2.0

(B) $\sqrt{2}$

(C) 1.0

(D) 0.0

Q.46 An overdetermined linear inverse problem is expressed as $\mathbf{G}\boldsymbol{m} = \boldsymbol{d}$, where $\mathbf{G}$ is the data kernel, $\boldsymbol{m}$ is the vector of model parameters and $\boldsymbol{d}$ is the vector of observed data. If damping is applied to the inverse problem and the resultant generalized inverse is represented by $\mathbf{G}^{-g}$, the **model resolution** matrix can be expressed as

(A) $\mathbf{G}^T\mathbf{G}^{-g}$

(B) $\mathbf{G}^{-g}\,\mathbf{G}^T$

(C) $\mathbf{G}^{-g}\mathbf{G}$

(D) $\mathbf{G}\,\mathbf{G}^{-g}$

Q.47 A Wenner resistivity survey was performed with a spacing of 15 m between the current electrodes. Potential difference values of -25 mV and 225 mV were measured before and after injecting 100 mA current into the ground. The apparent resistivity in Ω-m after correcting for the self-potential effect is

(A) 78.5

(B) 62.8

(C) 188.5

(D) 235.6

Q.48 Nine equally spaced electrodes are placed along a profile to perform Dipole-Dipole multi-electrode resistivity imaging. The maximum number of data points that can be obtained at measurement level $n = 2$ is

(A) 5

(B) 6

(C) 4

(D) 2

Q.49 Match the electromagnetic methods in Group–I with their corresponding frequency range in Group–II.

Group–I		Group–II	
P.	Very Low Frequency	1.	10 MHz –1 GHz
Q.	Radio Magnetotelluric	2.	1 Hz – 20 kHz
R.	Ground Penetrating Radar	3.	100 kHz – 1 MHz
S.	Control Source Magnetotelluric	4.	15 kHz – 30 kHz

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

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

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

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

Q.50 A geophysical forward problem is expressed as $d = 7m_1^2 m_2 + 6m_2$, where m_1 and m_2 represent the model parameters and d represents the data. Then, the relationship between data and model parameters is

(A) explicit and linear

(B) implicit and linear

(C) explicit and non-linear

(D) implicit and non-linear

Q.51 Assuming that the polar flattening of the Earth $f = 3.353 \times 10^{-3}$, the difference between the geodetic and geocentric latitudes is maximum at

(A) the poles

(B) 60º geocentric latitude

(C) 45º geocentric latitude

(D) 30º geocentric latitude

Q.52 Which of the following statements related to an equipotential surface is/are CORRECT ?

(A) Work is done on moving a test particle on an equipotential surface

(B) Only one equipotential surface can exist at any point in space

(C) The potential is constant on an equipotential surface

(D) Field lines at any point are always parallel to their equipotential surface

Q.53 If **B** is the magnetic field in a region free of currents, then which of the following statements is/are correct?

(A) $\mathbf{B} = -\nabla\phi$, where ϕ is the scalar potential

(B) **B** is rotational

(C) $\nabla \times \mathbf{B} = \mathbf{0}$

(D) $\nabla \cdot \mathbf{B} = \mathbf{0}$

Q.54 Which of the following operations performed in the time-domain with any two causal seismic signals result(s) in the **subtraction of their corresponding phase spectra** in the frequency domain?

(A) Convolution

(B) Crosscorrelation

(C) Deconvolution

(D) Subtraction

Q.55 Choose the CORRECT statement(s) on the phenomenon of spatial aliasing of seismic data.

(A) Spatial aliasing can be reduced by increasing the geophone (group) spacing

(B) Spatial aliasing is more likely to occur for higher temporal frequencies in the data

(C) Subsurface formations with higher interval velocities increase the likelihood of spatial aliasing

(D) Reflections from steep dips are more likely to be spatially aliased

Q.56 The speed of a ship is given as V_1 and V_2 in km/h and knots, respectively. The latitude of observation and the direction of the ship with respect to the North are represented as θ_1 and θ_2, respectively. The CORRECT expression(s) for the Eötvös correction in mGal is/are

(A) $4.040\, V_1 \cos\, \theta_1 \sin\, \theta_2 + 0.001211\, V_1^2$

(B) $7.503\, V_2 \cos\, \theta_1 \sin\, \theta_2 + 0.004154\, V_2^2$

(C) $4.040\, V_2 \cos\, \theta_2 \sin\, \theta_1 + 0.001211\, V_2^2$

(D) $7.503\, V_1 \cos\, \theta_1 \sin\, \theta_2 + 0.004154\, V_1^2$

Q.57 Which of the following statements pertaining to the interpretation of Neutron log is/are CORRECT ?

(A) Overpressured shale shows very low neutron porosity

(B) Neutron log primarily measures liquid (water/oil) filled porosity

(C) Neutron porosity for a gas-bearing clean sandstone formation is lower than the actual porosity of the same formation

(D) A low neutron porosity indicates high Hydrogen Index of the formation

Q.58 A magnetic field (**B**) of strength 50000 nT induces a magnetization (**M**) of magnitude 5 A/m in a rock. Given the magnetic permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ H/m, the susceptibility of the rock is _____(*rounded off to three decimal places*).

Q.59 The amplitude of a monochromatic 1000 Hz EM wave reduces by a factor of $1/e$ after penetrating to a depth of 100 m in a homogeneous medium. Given the magnetic permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ H/m, the electrical conductivity of the medium in S/m is _____(*rounded off to three decimal places*).

Q.60 A plane P-wave is incident at an angle of 60º with respect to the normal to a horizontal reflector. If the incident medium is a homogeneous Poisson solid (Poisson's ratio of 0.25), the angle of the reflected, mode-converted S-wave in degrees with respect to the normal is _____*(rounded off to one decimal place).*

Q.61 A marine seismic survey was performed in a region with a flat, horizontal sea bed at a depth of 100 m from the sea surface. The datum of the stacked seismic section was fixed at the sea surface. If the P-wave velocity in water is 1600 m/s, the radius of the first Fresnel zone at the sea bed at a frequency of 50 Hz corresponding to the stacked seismic section is _____(*rounded off to one decimal place*).

Q.62 A stacked seismic section shows a single dipping event with a slope of 0.5 s/km. Stolt migration with a constant velocity of 2 km/s is applied to the data. The dip of the event in the migrated section in degrees is _____*(rounded off to one decimal place).*

Q.63 The number of half-lives ($t_{1/2}$) required for a radioactive isotope to decrease to 2 % of its original abundance is _____*(rounded off to two decimal places).*

Q.64 A monochromatic cosine wave with frequency of 0.24 Hz and wavelength 16 km interferes with another monochromatic cosine wave with frequency 0.3 Hz and wavelength 10 km. The group velocity of the resulting wave in km/s is _____*(rounded off to one decimal place).*

Q.65 The given figure shows a homogeneous rock layer of thickness 100 m. A vertical borehole is drilled through the rock layer and gravity measurements are acquired at points **A** and **B**. If the difference in measurements at **A** and **B** is 5 mGal, the density of the rock layer (ρ) in g/cc, ignoring terrain corrections is _____(*rounded off to two decimal places*).