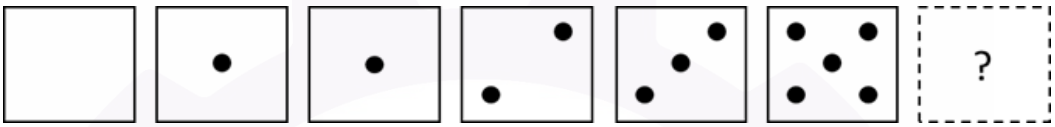
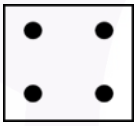
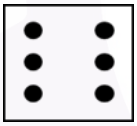
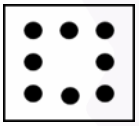
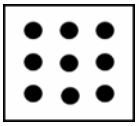
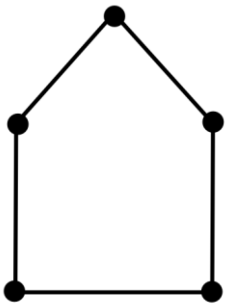
General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1	Suresh said, “I did it yesterday.” Which one of the following options is the correct form of this sentence in indirect speech?
(A)	Suresh said that I did it yesterday.
(B)	Suresh says I did it yesterday.
(C)	Suresh says that he did it the day before.
(D)	Suresh said that he had done it the day before.

Q.2	To continue the sequence of tiles shown, the tile indicated by the question mark should be 
(A)	
(B)	
(C)	
(D)	

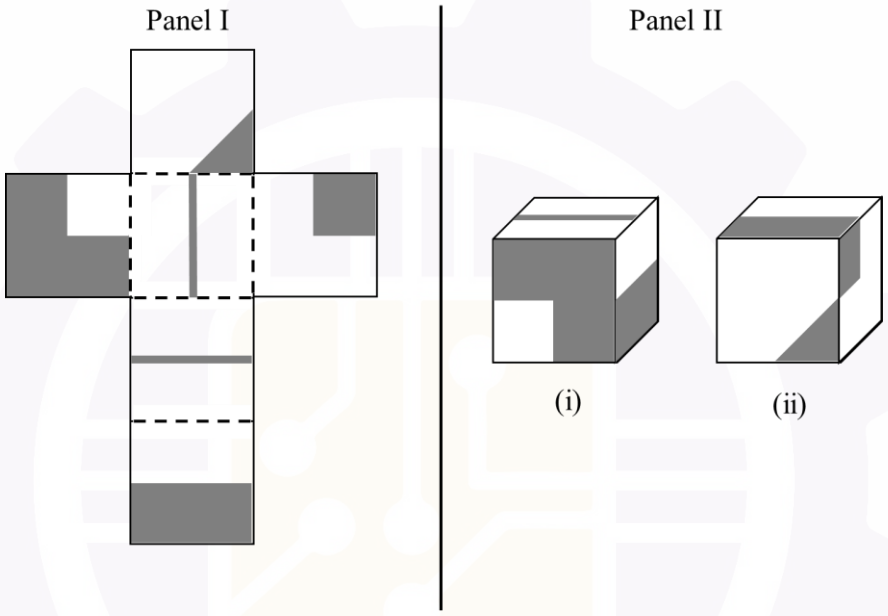
Q.3	Consider an art gallery whose walkways are shown as lines in the diagram. A black dot represents a junction of two walkways. A guard may be placed at a junction to watch over the walkways that join at that junction. The minimum number of guards needed to watch all the walkways is _____. 
(A)	2
(B)	3
(C)	4
(D)	5

Q.4	The 2nd of June is a Thursday in a certain year. Which day of the week is the 3rd of July in that year?
(A)	Thursday
(B)	Friday
(C)	Saturday
(D)	Sunday

Q.5	A coin with heads facing up is shown as (H) and a coin with tails facing up is shown as (T) . Six coins are placed in the Starting Arrangement, as shown in the figure below. A "step" is defined as interchanging a pair of adjacent coins without flipping them. The minimum number of steps needed to go from the Starting Arrangement to the Final Arrangement, as shown in the figure, is _____. Starting Arrangement Final Arrangement
(A)	3
(B)	6
(C)	9
(D)	12

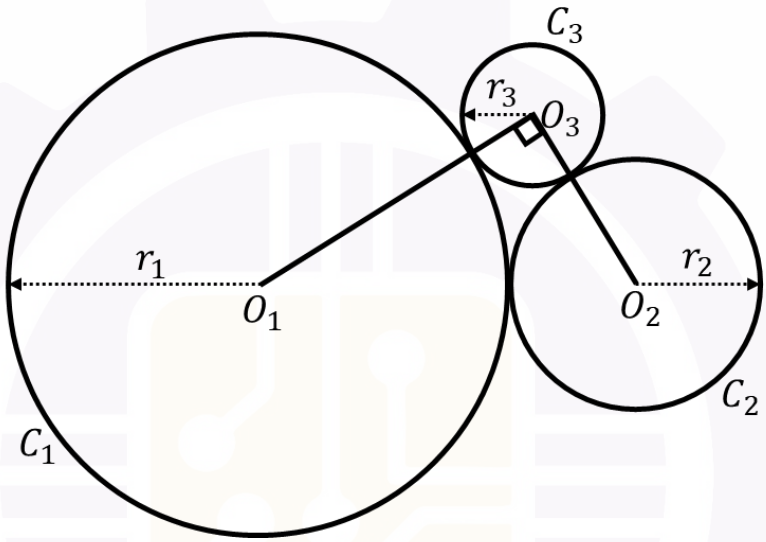
Q.6 – Q.10 Carry TWO marks Each

Q.6	Exacerbate : Mitigate :: _____ Choose the option with the correct pair of words to fill the blank.
(A)	Aggravate : Alleviate
(B)	Alleviate : Precipitate
(C)	Aggravate : Precipitate
(D)	Emancipate : Exonerate

Q.7	A paper shown in Panel I is folded along the dashed lines (- - -) to construct a cube. The shaded regions shown in Panel I appear on the outer surface of the cube. Referring to cubes shown in Panel II, which one of the options is correct? 
(A)	Only (i) can correspond to the unfolded cube in Panel I.
(B)	Only (ii) can correspond to the unfolded cube in Panel I.
(C)	Both (i) and (ii) can correspond to the unfolded cube in Panel I.
(D)	Neither (i) nor (ii) can correspond to the unfolded cube in Panel I.

Q.8	In a population, patients who have high cholesterol also have high blood-pressure (BP). Some patients with high BP also have diabetes. There are no patients who have both high cholesterol and diabetes. Furthermore, 1. the total number of patients with at least one of these conditions is 75, 2. the number of patients with high cholesterol is 10, 3. the number of patients with high BP is 45, and 4. the number of patients with only high BP and no other conditions is 20. Then the number of patients who have both diabetes and high BP is _____
(A)	0
(B)	15
(C)	20
(D)	10

Q.9	Four people P, Q, R, and S, of different ages, make the following observations. P – I am younger than S. Q – I am neither the youngest nor the oldest. R – P is older than me. Based on these observations, the youngest person is _____.
(A)	P
(B)	Q
(C)	R
(D)	S

Q.10	Circles C_1, C_2, and C_3, with centers O_1, O_2, and O_3 , and radii r_1 , r_2, and r_3, respectively, touch each other as shown in the following figure. Given $r_1 = 2$ cm, $r_2 = 1$ cm and the angle $\angle O_1O_3O_2$ is 90°, r_3 = _____ cm. 
(A)	$\frac{1}{2}(-3+\sqrt{17})$
(B)	$\frac{1}{2}(3+\sqrt{17})$
(C)	$\frac{1}{2}(-2+\sqrt{17})$
(D)	$\frac{1}{2}(-3+2\sqrt{17})$

PART A: COMPULSORY SECTION FOR ALL CANDIDATES

Q.11 – Q.17 Carry ONE mark Each

Q.11	Which one of the following increases over time when the soil is fully saturated?
(A)	Infiltration
(B)	Runoff
(C)	Porosity
(D)	Permeability
Q.12	In which one of the following layers inside the Earth, the velocity of the P-wave exceeds 13 km/s?
(A)	Upper mantle
(B)	Outer core
(C)	Lower mantle
(D)	Inner core

Q.13	Which one of the following is NOT a volcanic igneous rock?
(A)	Dacite
(B)	Syenite
(C)	Trachyte
(D)	Komatiite
Q.14	If r_1 and r_2, respectively, denote the equatorial and polar radii of a reference ellipsoid, then the radius, R, of its equivalent sphere is given by
(A)	$(r_1 r_2^2)^{2/3}$
(B)	$r_1 r_2^2$
(C)	$(r_1^2 r_2)^{1/3}$
(D)	$r_1^2 r_2$

Q.15	Which of the following sources is/are used in land seismic surveys?
(A)	Vibrosis
(B)	Dynamite
(C)	Airgun
(D)	Thumper
Q.16	A pebble has an average diameter of 8 mm. Its ϕ-value on the Udden-Wentworth scale is _____ (*answer in integer*).
Q.17	A quartz vein in a granitic outcrop has an initial length of 20 cm. If it undergoes uniform stretching resulting in a longitudinal strain of 0.45, the length of the vein post deformation is _____cm (*answer in integer*).

Q.18 – Q.26 Carry TWO marks Each

Q.18	Which one of the following is the CORRECT pair of radioactive parent isotope and the corresponding radiogenic daughter isotope?
(A)	$^{87}Rb \rightarrow {}^{86}Sr$
(B)	$^{147}Sm \rightarrow {}^{143}Nd$
(C)	$^{235}U \rightarrow {}^{206}Pb$
(D)	$^{238}U \rightarrow {}^{207}Pb$
Q.19	Which one of the following pairs of geophysical signatures most commonly indicates volcanogenic massive sulphide deposits?
(A)	High gravity and low resistivity
(B)	Low gravity and high resistivity
(C)	Low gravity and low resistivity
(D)	High gravity and high resistivity

Q.20	Which one of the following is a physical weathering process?
(A)	Oxidation
(B)	Hydrolysis
(C)	Exfoliation
(D)	Carbonation
Q.21	Which of the following statements is/are CORRECT according to the laws of electromagnetic induction in the Earth?
(A)	Current density in a region of finite conductivity is solenoidal
(B)	Magnetic vector potential is irrotational
(C)	Magnetic field is solenoidal
(D)	Curl of electric field is negative time rate of change of curl of magnetic vector potential

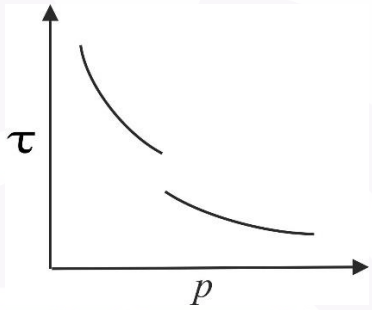
Q.22	Which of the following is/are REE-bearing mineral(s)?
(A)	Monazite
(B)	Natrolite
(C)	Spodumene
(D)	Gibbsite
Q.23	Which of the following pair(s) of well logs does/do NOT exhibit crossover for gas-bearing zones in hydrocarbon reservoirs?
(A)	Neutron and density
(B)	Caliper and resistivity
(C)	Neutron and self-potential
(D)	Caliper and gamma-ray

Q.24	If the diameter of a scaled-down model of the Earth is 45 cm, then the equivalent length on the surface of the Earth for 1 cm on the model is _____ km (*rounded off to two decimal places*). [Use: Radius of the Earth = 6371 km]
Q.25	The wavelength of a certain portion of the electromagnetic spectrum ranges from 2000 nm to 3000 nm. The highest frequency associated with the above portion of the spectrum is_____$\times 10^8$ MHz (*rounded off to one decimal place*).
Q.26	Consider that the upper continental crust is 10 km thick and made up of granitic rock having density of 2800 kg/m^3. The surface heat flow due to radiogenic heat from the granitic rock having heat production value of 10^{-9} W/kg is_____ mW/m^2 (*answer in integer*).

PART B (SECTION 2): FOR GEOPHYSICS CANDIDATES ONLY

Q.27 – Q.44 Carry ONE mark Each

Q.27	What is the value of magnetotelluric impedance phase over a homogeneous half-space?
(A)	0°
(B)	90°
(C)	45°
(D)	180°
Q.28	If A_b and A_s denote the amplitudes of the body and surface waves, respectively, at a distance, r, from the source, then the relation between them is given by
(A)	$\frac{A_b}{A_s} \propto \sqrt{r}$
(B)	$\frac{A_b}{A_s} \propto r$
(C)	$\frac{A_b}{A_s} \propto \frac{1}{r}$
(D)	$\frac{A_b}{A_s} \propto \frac{1}{\sqrt{r}}$

Q.29	If τ and p denote intercept time and slowness, respectively, in the $\tau - p$ diagram, then which one of the following is CORRECT for a P-wave propagating inside the Earth? 
(A)	Velocity continuously increases with depth
(B)	Velocity continuously decreases with depth
(C)	Velocity initially increases then decreases and again increases with depth
(D)	Velocity initially decreases then increases and again decreases with depth

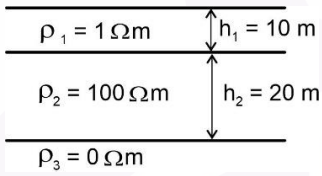
Q.30	If $\hat{f}(t)$ denotes the Hilbert transform of $f(t)$, then the Hilbert transform of $\hat{f}(t)$ is equal to
(A)	$-\hat{f}(t)$
(B)	$f(t)$
(C)	$-f(t)$
(D)	$-\frac{d}{dt}f(t)$
Q.31	What happens to the magnetic susceptibility (k) and remanent magnetization (I_r), when the molten rock undergoes rapid cooling?
(A)	k increases and I_r decreases
(B)	k decreases and I_r increases
(C)	Both k and I_r decrease
(D)	Both k and I_r increase

Q.32	Between L_1 and L_2 norms, which one of the following is CORRECT in the treatment of outliers in the data?
(A)	L_1 norm gives higher weightage to outliers than L_2 norm
(B)	L_2 norm gives higher weightage to outliers than L_1 norm
(C)	Both L_1 and L_2 norms give equal weightage to outliers
(D)	L_1 norm occasionally gives higher weightage to outliers than L_2 norm
Q.33	Which pairs of the following combinations of the H-, Q-, K- and A- type of resistivity sounding curves is/are NOT possible to generate four-layer models?
(A)	HQ and AQ
(B)	KQ and QH
(C)	KH and AA
(D)	HH and KA

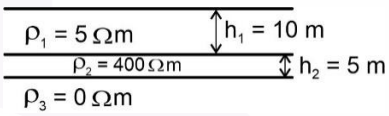
Q.34	Which of the following is/are the correct explanation(s) for an increase in the adiabatic temperature gradient from the lower mantle (LM) to the outer core (OC)?
(A)	OC has lower specific heat capacity and higher temperature than LM
(B)	OC has higher specific heat capacity and lower temperature than LM
(C)	OC has lower specific heat capacity and lower temperature than LM
(D)	OC has higher specific heat capacity and higher temperature than LM
Q.35	Given the Rayleigh wave velocity (V_r), shear wave velocity (V_s) and the P-wave velocity (V_p), which of the following relationships is/are CORRECT?
(A)	$V_r < V_s < V_p$
(B)	$V_s < V_r < V_p$
(C)	$V_s < V_p < V_r$
(D)	$V_s = V_r < V_p$

Q.36	Among the given layered models, labelled as P, Q, R and S, which of the following pairs is/are NOT possible to distinguish according to the principle of equivalence?

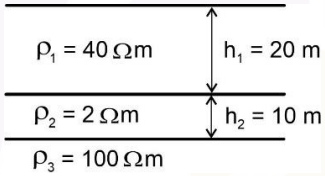
(P)



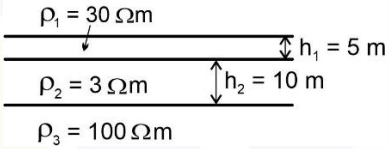
(Q)



(R)



(S)

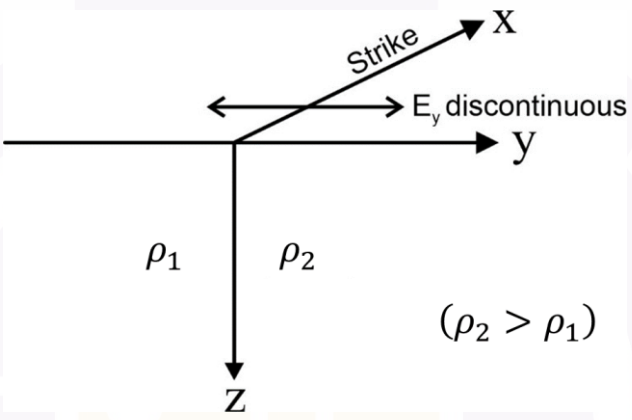


(A)	P, R
(B)	P, S
(C)	P, Q
(D)	R, S

Q.37	Given data $d = \begin{bmatrix} d_{11} \\ d_{21} \end{bmatrix}$ and the kernel $G = \begin{bmatrix} G_{11} & G_{12} & G_{13} \\ G_{21} & G_{22} & G_{23} \end{bmatrix}$, which one of the following expressions correctly represents the generalized linear inverse formula for the model, m, satisfying $d = Gm$?
(A)	$(G^T G)^{-1} G^T$
(B)	$G^T (GG^T)^{-1}$
(C)	$(GG^T)^{-1} G$
(D)	$GG^T G^{-1}$
Q.38	If a seismic wave is travelling along the radial direction, then which of the following statements is/are CORRECT for Rayleigh (R) and Love (L) waves?
(A)	Radial component shows the largest amplitude for both R and L waves
(B)	Transverse component shows the largest and smallest amplitudes for L and R waves, respectively
(C)	Vertical component shows the largest and smallest amplitudes for L and R waves, respectively
(D)	Vertical component shows largest amplitude for R wave only

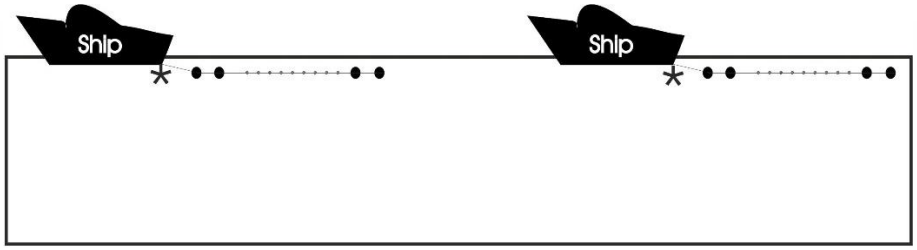
Q.39	If a signal is sampled at a sampling rate of 0.2 ms, then its sampling frequency is _____kHz.
Q.40	A P-wave of frequency 20 Hz is travelling through a non-dispersive medium with a velocity of 5 km/s. The amplitude retained at a distance of 10 km from source is _____ % (*rounded off to one decimal place*). (Use quality factor, $Q = 80$)
Q.41	A land magnetic survey was carried out along a profile length of 500 m with an inter-station spacing of 5 m over a buried ore body. The optimum width of the body that can be best resolved is _____m (*answer in integer*).
Q.42	If the depth of penetration of an inducing electromagnetic wave of 1 kHz frequency is 400 m, then the resistivity of the subsurface is _____Ωm (*answer in integer*).
Q.43	If ***F*** represents the Earth's total magnetic field corresponding to its dipole source only, then the increase in ***F*** from 0° to 60° N magnetic latitude is _____ % (*rounded off to one decimal place*).
Q.44	Considering a surface point source, the horizontal resolution recoverable from the seismic data acquired using a 10 Hz seismic pulse reflected from a depth of 30 km within the crust, with a velocity of 6.5 km/s is_____km (*rounded off to two decimal places*).

Q.45 – Q.65 Carry TWO marks Each

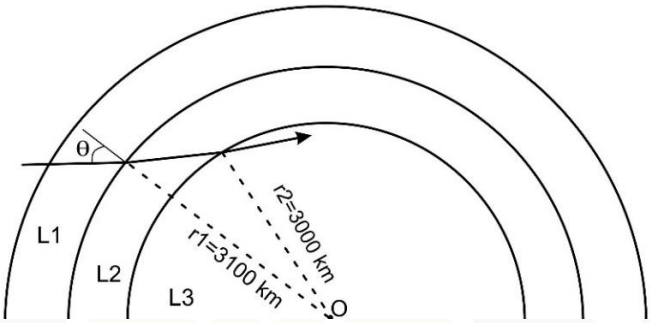
Q.45	A vertical contact separating two resistive domains is shown in the figure below. The magnitude of the discontinuity in the apparent resistivity, when the electric field, **E**, is perpendicular to the strike is 
(A)	$(\rho_1/\rho_2)^2$
(B)	$(\rho_2/\rho_1)^2$
(C)	$(\rho_1/\rho_2)^{1/2}$
(D)	$(\rho_2/\rho_1)^{1/2}$

Q.46	If g_{FA} and g_{BA} respectively denote the free-air and Bouguer gravity anomalies over a fully compensated mountain, then which one of the following is CORRECT in case of Airy-isostacy?
(A)	$g_{FA} = 0, g_{BA} > 0$
(B)	$g_{FA} > 0, g_{BA} = 0$
(C)	$g_{FA} > 0, g_{BA} < 0$
(D)	$g_{FA} = 0, g_{BA} = 0$
Q.47	Analytic signal, $A(\theta)$, for $f(\theta) = \cos\theta$ is equal to
(A)	$A(\theta) = -\cos\theta$
(B)	$A(\theta) = -\sin\theta$
(C)	$A(\theta) = e^{i\theta}$
(D)	$A(\theta) = -e^{i\theta}$

Q.48	In regions of lateral conductivity contrasts, the time-independent separation between the subsurface apparent resistivity curves of transverse electric (TE) and transverse magnetic (TM) modes relative to each other arises mainly due to
(A)	impedance phase change
(B)	amplitude magnification
(C)	local distortion of electric field
(D)	variation in the frequency of the inducing magnetic field

Q.49	How many traces will be present in a zero-offset section that is generated from the following marine seismic survey?  Near offset = 100 m Shot interval = 20 m Receiver interval = 10 m Number of shots = 100 Number of receivers = 1000 (Figure not to scale) ✱ Shot • Receiver
(A)	2400
(B)	2414
(C)	2450
(D)	2420

Q.50	$\Delta T = [\Delta T_1, \Delta T_2, \ldots . \Delta T_{19}, \Delta T_{20}]$, and $\Delta T_u = [\Delta T_{u1}, \Delta T_{u2}, \ldots . \Delta T_{u19}, \Delta T_{u20}]$ denote the magnetic data observed at heights 0 km and 5 km, respectively, along a profile of length 100 km. What is the maximum attenuation at a height of 5 km? [use wave number in radian/km].
(A)	$e^{-\frac{\pi}{2}}$
(B)	$e^{-\pi}$
(C)	$e^{-2\pi}$
(D)	$e^{-3\pi}$

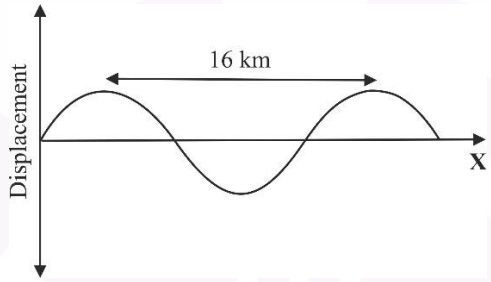
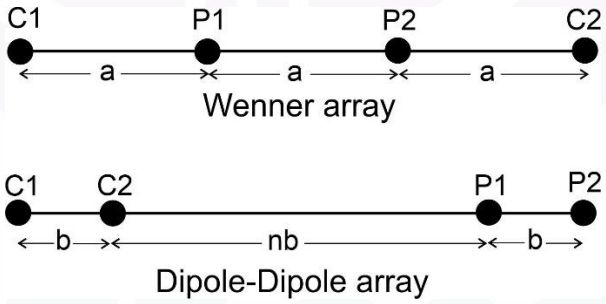
Q.51	The given figure shows the geometry of a seismic ray path inside the Earth, with the P-wave velocities of 10 km/s, 11 km/s and 12 km/s corresponding to the layers L1, L2 and L3, respectively. If the angle of incidence (θ) at L1-L2 boundary is 40°, then what is the angle of refraction at the L2-L3 boundary? (*answer in nearest integer*) 
(A)	49°
(B)	50°
(C)	53°
(D)	55°

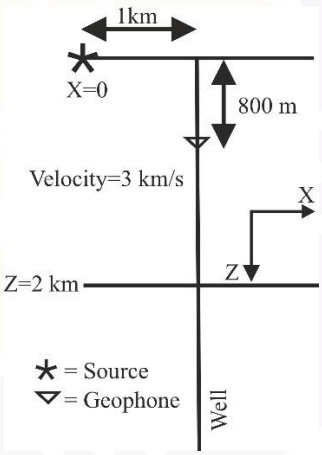
Q.52	Which of the following statements about digital filters is/are CORRECT?
(A)	Non-recursive filters do not have poles
(B)	Recursive filters can have only poles OR both poles and zeros
(C)	The order of the digital filter defines the presence of minimum number of previous inputs only
(D)	The ratio of output to input defines the transfer function of the digital filter

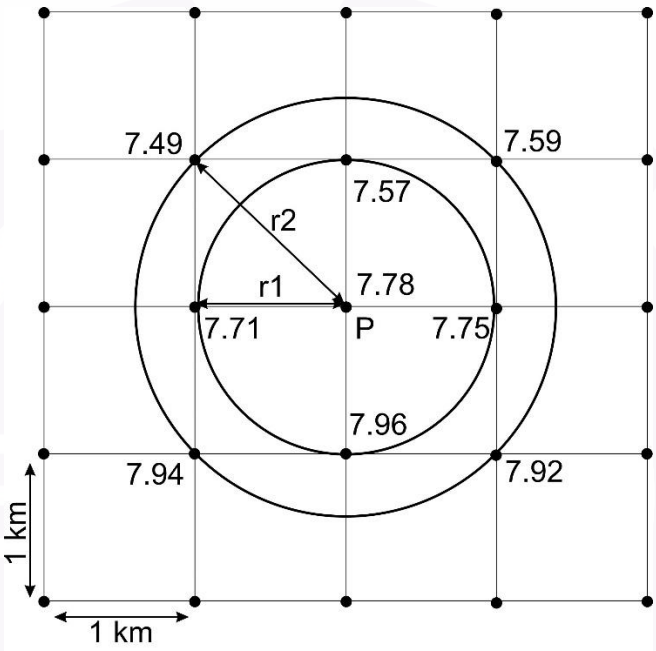
Q.53	ΔB_z represents the maximum vertical magnetic anomaly along a profile due to a horizontal cylinder with susceptibility contrast (Δk), and radius (r) at a depth (z) below the Earth's surface. Which combination(s) of Δk, r, and z labelled as P, Q, R and S given below, produces/produce the same ΔB_z? <table><tr><td>(P) Δk=0.02, $r = 100\ m$, and $z = 200\ m$</td><td>(Q) Δk=0.01, $r = 80\ m$, and $z = 160\ m$</td></tr><tr><td>(R) Δk=0.005, $r = 200\ m$, and $z = 400\ m$</td><td>(S) Δk=0.02, $r = 150\ m$, and $z = 300\ m$</td></tr></table>
(A)	P, S
(B)	P, Q
(C)	R, S
(D)	Q, R

Q.54	If $f(t) = [-1, 2, 1]$ and $g(t) = [0, -1, 2]$ are two wavelets and $f(\tau)$ and $g(\tau)$ represent flipped versions of $f(t)$ and $g(t)$, respectively, then which of the following expressions is/are CORRECT? [* and $\otimes$ denote convolution and cross-correlation operations, respectively]
(A)	$f(t) * g(t) = f(t) \otimes g(t)$
(B)	$f(t) * g(t) = f(t) \otimes g(\tau)$
(C)	$f(t) * g(t) = f(\tau) \otimes g(t)$
(D)	$f(t) * g(t) = f(\tau) \otimes g(\tau)$
Q.55	Which of the following assumptions is/are valid for electromagnetic induction to happen in the Earth?
(A)	Plane-wave approximation of the inducing field
(B)	Displacement currents are not neglected
(C)	Earth behaves as Ohmic conductor due to conservation of charge
(D)	Earth does not generate electromagnetic energy, but only absorbs or dissipates it

Q.56	The model regularization in a damped least square problem is/are used to
(A)	introduce additional constraints to the ill-posed problems
(B)	add stability to the inversion
(C)	convert well-posed problems into ill-posed problems
(D)	control the trade-off between the misfit and the model variance
Q.57	The vector field ($\boldsymbol{F}$) for a region is described by $\boldsymbol{F} = ar^n\hat{r}$ ($r \neq 0$), where a is a non-zero constant and r is the radial distance from the source. For what value(s) of n, $\boldsymbol{F}$ becomes both solenoidal and irrotational?
(A)	2
(B)	-2
(C)	1
(D)	-1

Q.58	The maximum strain for the plane wave at $t = 0$, having a wavelength of 16 km and unit amplitude, travelling along the X-direction, as shown in the figure, is _____(*rounded off to three decimal places*). 
Q.59	A causal recursive filter is given by $y_n = x_n - 2x_{n-1} + 3y_{n-1}$. If the input values, x_0, x_1 and x_2 are 1.2, -0.8 and 2.3, respectively, the output, y_2, of the filter is _____ (*rounded off to one decimal place*).
Q.60	If C1 & C2 and P1 & P2 are the pairs of current and potential electrodes in the Wenner (W) and Dipole-Dipole (DD) array configurations as shown in the figure below, then the fraction of the geometric factor for DD array that will be equal to half of that of W array is _____ (*rounded off to three decimal places*). (Use n = 1 in DD array) 
Q.61	A scintillometer records 300 counts per second (cps) in a radiometric survey. If the background radiation and dead-time of the instrument are 100 cps, and 250μs, respectively, then the true net count rate is _____ cps (*rounded off to two decimals*).
Q.62	Gamma-ray (GR) log values for clean sandstone and shale are 15 API and 115 API, respectively. If GR records 35 API for shaly-sandstone, then the GR index is _____ (*rounded off to one decimal place*).

Q.63	If the inclination of the remanent magnetic field of a 140 million years old crustal block at equator is 50°, then its drift-rate is _____cm/yr (*rounded off to two decimal places*). [use 1° = 111 km]
Q.64	Consider a seismic source located at the Earth's surface. A vertical well is located at a distance of 1 km away from the seismic source and a geophone is suspended inside the well at a depth of 800 m as shown in the figure below. The travel time of the primary reflected wave from a horizontal reflector located at a depth of 2 km is _____s (*rounded off to three decimal places*). 

Q.65	The figure below shows Bouguer gravity anomaly values (in mGal) at a grid interval of 1 km. The second vertical derivative at **P** is _____mGal/km^2 (*rounded off to two decimals*).  r1 and r2 are radial distances from P