

**Combined Geo-Scientist (P) Examination 2021**  
**Paper-II (Geophysics)**

1.

A particle with kinetic energy equal to  $\frac{GMm}{R}$  on the surface of rotating earth will:

- (a) Start rotating around the earth
- (b) Escape from the earth
- (c) Remain on the earth with maximum potential energy
- (d) Reach the equator

2.

A satellite is revolving round the earth at a height of 600 km. Considering the radius of the earth as 6400 km, the mass of the earth as  $6 \times 10^{24}$  kg and gravitational constant (G) as  $6.67 \times 10^{-11} \text{Nm}^2/\text{kg}^2$ , the time period of the satellite will be:

- (a)  $4.8 \times 10^3$  s
- (b)  $4.8 \times 10^6$  s
- (c)  $5.8 \times 10^3$  s
- (d)  $4.2 \times 10^2$  s

3.

The most studied and largest fraction of the meteorites recovered on the earth is:

- (a) Achondrites
- (b) Chondrites
- (c) Iron
- (d) Iron-stony

4.

Which one of the following statements is true for planets revolving around the Sun?

- (a) Areal velocity of different planets is different
- (b) Areal velocity of a planet is not constant
- (c) Only Earth has areal velocity
- (d) Jupiter has the largest areal velocity

5.

When the mass of a star becomes more than 1.4 times the solar mass, it would cease to be a:

- (a) White dwarf
- (b) Neutron star
- (c) Black hole
- (d) Pulsar

6.

Consider the following statements:

Statement-1: The earth's gravity increases from equator to pole

Statement-2: The equatorial bulge places an excess mass at equator, which causes the decrease in gravity at the equator

Which one of the following is correct in respect of above statements?

- (a) Both Statement-1 and Statement-2 are true and Statement-2 is the correct explanation of Statement-1
- (b) Both Statement-1 and Statement-2 are true but Statement-2 is not the correct explanation of Statement-1
- (c) Statement-1 is true but Statement-2 is false
- (d) Statement-1 is false but Statement-2 is true

7.

The geostationary orbit of a satellite around the earth is such that the satellite remains stationary with respect to the earth. It requires that the orbit must be:

- a) Geosynchronous, elliptical with height from the surface of earth nearly 36,000 km
- b) Geosynchronous, circular with height from the surface of earth nearly 36,000 km
- c) Geosynchronous, circular and stays over the geographical poles of earth at a height of nearly 36,000 km
- d) Geosynchronous, orthogonal above the south pole at a height of nearly 36,000 km

8.

Major component of earth's magnetic field comes from:

- (a) Core
- (b) Crust
- (c) Mantle
- (d) Ionosphere

9.

Which one of the following properties always exists in presence of magnetic field?

- (a) Ferromagnetism
- (b) Paramagnetism
- (c) Antiferromagnetism
- (d) Diamagnetism

10.

Which one of the following statements regarding earth's magnetism is true?

- (a) A freely suspended magnet will be vertical at the equator
- (b) Magnetic meridian at a place is a line passing through the axis of a freely suspended magnet
- (c) At poles, the angle of dip is  $0^\circ$  and horizontal component of earth's magnetic field is also zero
- (d) Lines joining the points of same declination on the earth surface are called isogonic lines

11.

Consider the following statements regarding Magnetometer:

1. Proton Precession Magnetometer (PPM) is a total field magnetometer
2. PPM uses magnetizing solenoid
3. PPM can measure field components
4. Flux-gate Magnetometer measures components of the magnetic field along its axis

Which of the statements given above are correct?

- (a) 1, 2 and 4
- (b) 1, 2 and 3
- (c) 1, 3 and 4
- (d) 2, 3 and 4

12.

Geostrophic winds:

- (a) Are real winds that blow parallel to the lines of equal temperature
- (b) Exist between the horizontal components of the coriolis force and the vertical pressure gradient force
- (c) Are hypothetical winds that blow parallel to the lines of equal pressure
- (d) Represent to the actual winds at elevations lesser than 800 m

13.

A solution  $u = \cos(at) \sin(bx)$  satisfies the wave equation:  $\frac{1}{c^2} \frac{\partial^2 u}{\partial t^2} = \frac{\partial^2 u}{\partial x^2}$ . The value of constants ( $a$ ,  $b$  and  $c$ ) can be related as:

- (a)  $c^2 = a^2 b^2$
- (b)  $a^2 b^2 c^2 = 1$
- (c)  $b^2 = a^2 c^2$
- (d)  $a^2 = b^2 c^2$

14.

Which one of the following statements regarding longitudinal waves is NOT CORRECT?

- (a) These can travel through fluids
- (b) These are compressional waves
- (c) These are also known as primary waves
- (d) Motion of the particles is perpendicular to the direction of wave propagation

15.

The shear wave will be essentially elliptically polarized when:

- (a) Both SH and SV motions have different frequencies
- (b) Both SH and SV motions have varying phase difference
- (c) Both SH and SV motions have same frequency and fixed phase difference
- (d) Both SH and SV motions have same amplitude

16.

During convergent motion of the oceanic and continental plates, continental plate rides higher because:

- (a) It is denser and thinner than the oceanic crust
- (b) It is less dense and thicker than oceanic crust
- (c) It is denser and thicker than oceanic crust
- (d) It is less dense and thinner than oceanic crust

17.

The P-wave velocities of more than 8 km/s beneath Moho discontinuity indicate the presence of:

- (a) Granite and gabbro
- (b) Granite and basalt
- (c) Basalt, gabbro and granite
- (d) Rocks rich in dense minerals like olivine, pyroxene and garnet

18.

Which one of the following statements regarding velocity variations inside the earth is correct?

- (a) Low velocity zone exists between 100–250 km depth
- (b) Velocities decrease with depth
- (c) Velocities decrease dramatically at 660 km depth
- (d) P-wave velocities decrease at the boundary between liquid outer core and solid inner core

19.

The continuous movement of tectonic plates result in earthquakes. The point inside the earth from which earth shock waves generate is called:

- (a) Seismic focus
- (b) Epicentre
- (c) Richter centre
- (d) Trigger centre

20.

Which one of the following statements regarding tectonic earthquakes is correct?

- (a) These are randomly distributed over the globe
- (b) These are the abrupt release of strain within the earth
- (c) They only occur on or near the plate boundaries and not within the lithospheric plates
- (d) The result from the motion of underground magma

21.

Which one of the following statements is correct with reference to the geosyncline?

- (a) It is a linear part of the crust of earth that sagged widely through time
- (b) It is a linear part of the crust of earth that sagged deeply through time
- (c) It is not linked with the origin of mountains
- (d) Generally, it is few kilometers long and hundreds of kilometers wide

22.

Teleseismic events have an epicentral distance of:

- (a) Greater than  $20^{\circ}$
- (b) Less than  $20^{\circ}$
- (c) Less than  $5^{\circ}$
- (d) Less than  $1^{\circ}$

23.

The energy released by an earthquake of magnitude 7 will be approximately equal to energy released by:

- (a) 1000 earthquakes of magnitude 5
- (b) 100 earthquakes of magnitude 5
- (c) 500 earthquakes of magnitude 5
- (d) 110 earthquakes of magnitude 5

24.

If  $\mathbf{r} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$ , then, what is the divergence of  $(r^n \mathbf{r})$ ?

- (a)  $(3 - n) r^n$
- (b)  $(3 + n) r^{-n}$
- (c)  $(3 + n) r^2$
- (d)  $(3 + n) r^n$

25.

Two constant forces  $\mathbf{F}_1 = (2\mathbf{i} + 3\mathbf{j} + 3\mathbf{k})$  Newton and  $\mathbf{F}_2 = (5\mathbf{i} - 6\mathbf{j} - 2\mathbf{k})$  Newton act together on an object during its displacement from the point  $(20\mathbf{i} + 15\mathbf{j})$  meter to a point  $8\mathbf{k}$  meter. What is the amount of work done on the particle?

- (a) - 28 Joule
- (b) - 87 Joule
- (c) - 46 Joule
- (d) - 62 Joule

26.

The possible eigen values of given matrix M are:

$$M = \begin{pmatrix} 1 & 0 & -i \\ 0 & 2 & 0 \\ i & 0 & -1 \end{pmatrix}$$

- (a) (1, 2, -1)
- (b) (1, 0, -i)
- (c) (1, -i, i)
- (d) (2,  $\sqrt{2}$ ,  $-\sqrt{2}$ )

27.

Which one of the following correctly gives the value of determinant of a  $(4 \times 4)$  diagonal matrix (1, 2, 4, -6)?

- (a) 1
- (b) 48
- (c) - 48
- (d) - 1

28.

Which one of the following statements regarding gravitational forces is NOT true?

- (a) It is always attractive
- (b) It is a conservative force
- (c) It depends on the medium between the particles
- (d) It is a long range force

29.

A satellite of mass  $m$  is in geosynchronous orbit around the earth of mass  $M$  and angular velocity  $\omega$ . What is the radius of the geosynchronous orbit?

- (a)  $\sqrt{(GM/\omega^2)}$
- (b)  $GM/\omega^2$
- (c)  $(GM/\omega^2)^{1/3}$
- (d)  $(GM/\omega^2)^{1/4}$

30.

If strength of strong force is 1, then what is the relative strength of electromagnetic force?

- (a)  $10^{-37}$
- (b)  $10^{-2}$
- (c)  $10^2$
- (d)  $10^{37}$

31.

The fundamental force(s) relevant for geophysical phenomena is/are:

- (a) Gravitational force only
- (b) Gravitational and electromagnetic forces
- (c) Strong and gravitational forces
- (d) Strong force only

32.

A particle is moving under a potential  $V(r) = -(A/r)$ , where the constant  $A > 0$ . Which one of the following statements is NOT true for the particle?

- (a) Its angular momentum is always conserved
- (b) Its kinetic energy is always conserved
- (c) It always follows a closed path
- (d) The force on it is always radial

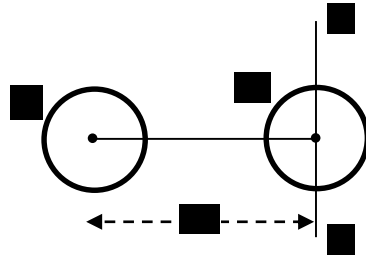
33.

A bomb moving with velocity  $(40\mathbf{i} + 50\mathbf{j} - 25\mathbf{k})$  explodes into two pieces of masses  $m$  and  $4m$ , respectively. After explosion, what would be the velocity of larger piece, if the smaller piece moves away with a velocity  $(200\mathbf{i} + 70\mathbf{j} + 15\mathbf{k})$ ?

- (a)  $(45\mathbf{j} - 35\mathbf{k})$
- (b)  $(80\mathbf{j} - 35\mathbf{k})$
- (c)  $(80\mathbf{j} - 27.5\mathbf{k})$
- (d)  $(45\mathbf{j} - 27.5\mathbf{k})$

34.

Two spheres each of mass  $M$  and diameter  $R$  are connected with a massless rod of length  $2R$  as shown in the figure. What will be the moment of inertia of the system about an axis passing through the centre of one of the sphere and perpendicular to the rod?



- (a)  $\frac{21}{5}MR^2$
- (b)  $\frac{2}{5}MR^2$
- (c)  $\frac{5}{2}MR^2$
- (d)  $\frac{5}{21}MR^2$

35.

A wheel is moving due to an external force  $\mathbf{F}$ . The time rate of change of angular momentum of the wheel can be maximized by:

- (a) Applying  $\mathbf{F}$  near the axle of the wheel in radially outward direction to the axle
- (b) Applying  $\mathbf{F}$  near the rim of the wheel in radially outward direction to the axle
- (c) Applying  $\mathbf{F}$  near the axle of the wheel and parallel to a tangent at the rim
- (d) Applying  $\mathbf{F}$  near the rim of the wheel and tangent to the rim

36.

How does the angular momentum of a person changes when he spreads his arms horizontally while uniformly rotating on a frictionless turntable?

- (a) It increases
- (b) It remains the same
- (c) It decreases
- (d) It changes depending on the direction of rotational motion

37.

A light beam is propagating through a block of glass with index of refraction ' $n$ '. If the glass is moving at a uniform speed  $v$  in the same direction as the beam, what is the speed of light in the glass block as measured by an observer in the laboratory?

- (a)  $v$
- (b)  $c$
- (c)  $c + nv$
- (d)  $\frac{c+nv}{n+\frac{v}{c}}$

38.

An experiment is designed to measure the length of a rod. Initially the experimentalist and the rod are at rest with respect to the laboratory. Consider the following statements in this regard:

1. If the rod starts moving parallel to its length but the experimentalist stays at rest, the measured length would appear to be reduced to the experimentalist
2. If the rod stays at rest but the experimentalist starts moving parallel to the measured length of the rod, the length of the rod would appear to be reduced to the experimentalist

Which one of the following is correct in respect of above statements?

- (a) Statement 1 is correct but statement 2 is wrong
- (b) Statement 2 is correct but statement 1 is wrong
- (c) Both the statements are correct
- (d) Both the statements are wrong

39.

Consider the following group of equations:

$$y_1 = a_0 + a_1 x_1 + a_2 x_1^2$$

$$y_2 = a_0 + a_1 x_2 + a_2 x_2^2$$

$$y_3 = a_0 + a_1 x_3 + a_2 x_3^2$$

$$y_4 = a_0 + a_1 x_4 + a_2 x_4^2$$

$$y_5 = a_0 + a_1 x_5 + a_2 x_5^2$$

Which one of the following is correct regarding the solutions of the above equations?

- (a) The solutions cannot be determined
- (b) The solutions are overdetermined
- (c) The solutions are exactly determined
- (d) The solutions can be approximately determined

40.

Which one of the following is true for a sequence of random numbers generated by a digital computer?

- (a) It is truly random
- (b) It will repeat itself eventually
- (c) It is useful only for playing games
- (d) It is useful for traffic system

41.

A sample of 2 liters of water is collected from a pond that contains 40 mosquito larvae. From this pond a 100 mL sample was taken to carry out further analysis. The probability that this 100 mL sample has any mosquito larvae present in it is:

(where  $e = 2.718$ )

- (a) 5.0 %
- (b) 13.5 %
- (c) 14.5 %
- (d) 86.5 %



42.

Six cups are numbered 1 to 6. Each cup can hold one marble. There are three red marbles and one blue marble. How many different ways are there to fill the cups with all four marbles?

- (a) 12
- (b) 24
- (c) 30
- (d) 60

43.

At what value(s) the following differential equation possesses regular singularity?

$$(1 - x^2) \frac{d^2y}{dx^2} - x \frac{dy}{dx} + n^2y = 0$$

- (a) (1, -1)
- (b)  $\infty$
- (c) (-1, 1,  $\infty$ )
- (d) (-1,  $\infty$ )

44.

An observer measures the length 100 m of a space-craft moving with a speed 0.8 c, where c is the speed of light in vacuum. What is the length of the space-craft as measured by a pilot in the same space-craft?

- (a) 100 m
- (b) 60 m
- (c) 30 m
- (d) 10 m

45.

What is the value of following integral using the Simpson's  $\frac{1}{3}$  rule?

$$\int_1^5 \frac{dx}{x+2}; (n = 4)$$

- (a) 0.8476
- (b) 1.4876
- (c) 2.8276
- (d) 0.6323

46.

Which one of the following numerical methods for solving the ordinary differential equations gives the solution in the form of a series?

- (a) Taylor's method
- (b) Runge-Kutta method
- (c) Euler's method
- (d) Adams-Bashforth method

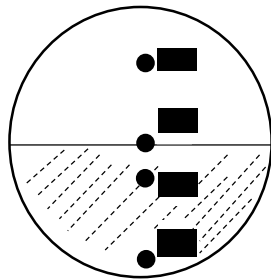
47.

Which one of the following expressions correctly describe the fourth forward differences in a set of values of  $y = \{y_0, y_1, y_2, y_3 \dots \dots y_n\}$ ?

- (a)  $y_n - 4 y_{n-3} + 6 y_{n-2} - 4 y_{n-1} + y_{n-4}$
- (b)  $y_n - 4 y_{n-1} + 6 y_{n-2} - 4 y_{n-3} + y_0$
- (c)  $y_n - 4 y_{n-1} + 6 y_{n-2} - 4 y_{n-3} + y_{n-4}$
- (d)  $y_n + 4 y_{n-1} - 6 y_{n-2} - 4 y_{n-3} + y_0$

48.

Consider a hollow metallic sphere partially filled with sand as shown in the figure:



Which one of the following points is likely to be the center of mass of the sphere?

- (a) Point A
- (b) Point B
- (c) Point C
- (d) Point D

49.

What is the possible partial differential equation responsible for the solution of the form

$\psi(x, y, z, t) = a \sin(z - vt) + b \cos(x + iy)$ , with  $(a, b, v) > 0$ ?

- (a)  $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} - \frac{\partial^2 \psi}{\partial z^2} - \frac{1}{v^2} \frac{\partial^2 \psi}{\partial t^2} = 0$
- (b)  $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} - \frac{1}{v^2} \frac{\partial^2 \psi}{\partial t^2} = 0$
- (c)  $\frac{\partial^2 \psi}{\partial x^2} - \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} - \frac{1}{v^2} \frac{\partial^2 \psi}{\partial t^2} = 0$
- (d)  $\frac{\partial^2 \psi}{\partial x^2} - \frac{\partial^2 \psi}{\partial y^2} - \frac{\partial^2 \psi}{\partial z^2} + \frac{1}{v^2} \frac{\partial^2 \psi}{\partial t^2} = 0$

50.

Which one of the following could be a primary reason for magnetism?

- (a) Pauli exclusion principle and intrinsic spin of electrons
- (b) Atomic currents and intrinsic spin of electrons
- (c) Polar nature of molecules and atomic currents
- (d) Polar nature of molecules and Pauli exclusion principle

51.

The electrostatic energy stored in the space outside of a metal sphere of radius  $R$ , carrying a total charge  $Q$  is given by:

(a)  $\frac{1}{8\pi\epsilon_0} \frac{Q^2}{R}$

(b)  $\frac{1}{4\pi\epsilon_0} \frac{Q^2}{R}$

(c)  $\frac{1}{2\pi\epsilon_0} \frac{Q^2}{R}$

(d)  $\frac{1}{\pi\epsilon_0} \frac{Q^2}{R}$

52.

A right angled triangle  $DAB$ , with angle  $A = 90^\circ$ ,  $AB = 3$  m and  $AD = 4$  m, possesses two equal charges  $+2$  C each at the vertices  $A$  and  $B$ . A third charge  $+4$  C is placed at the vertex  $D$ . What is the approximate electrostatic energy of the configuration?

(a)  $\frac{1}{\pi\epsilon_0}$  units

(b)  $\frac{1}{2\pi\epsilon_0}$  units

(c)  $\frac{3}{4\pi\epsilon_0}$  units

(d)  $\frac{5}{4\pi\epsilon_0}$  units

53.

What is the total force experienced by a charge  $q$ , in presence of both electric field  $\mathbf{E}$  and magnetic field  $\mathbf{B}$ , and moving parallel to the magnetic field with velocity  $\mathbf{v}$ ?

(a)  $\mathbf{F} = q (\mathbf{E} + \mathbf{v} \times \mathbf{B})$

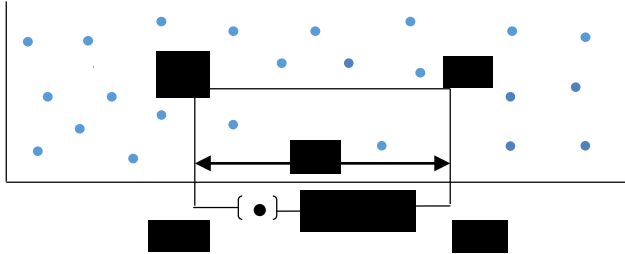
(b)  $\mathbf{F} = q \mathbf{E}$

(c)  $\mathbf{F} = q (\mathbf{v} \times \mathbf{B})$

(d)  $\mathbf{F} = q (\mathbf{E} \times \mathbf{B})$

54.

A current carrying wire in rectangular shaped WXYZ supports a non-metallic bob of mass  $m$ . It is hanged vertically with its one edge  $XY = r$  in an uniform magnetic field  $\mathbf{B}$  into the page as shown in the figure:



What is the current that must be set in circuit WXYZ such that the gravitational force is exactly be balanced by the magnetic force?

- (a)  $\frac{rB}{mg}$  and in the clockwise direction
- (b)  $\frac{mg}{rB}$  and in the anti-clockwise direction
- (c)  $\frac{mg}{rB}$  and in the clockwise direction
- (d)  $\frac{rB}{mg}$  and in the anti-clockwise direction

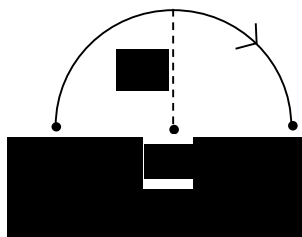
55.

Which one of the following statements about the magnetic forces is NOT CORRECT?

- (a) The forces between two parallel current-carrying wires are not electrostatic in nature
- (b) The magnetic forces do not work
- (c) The magnetic force between two infinitely long current-carrying wires is always attractive
- (d) The magnetic force can change the directions of both a moving proton or a moving electron

56.

A current carrying wire is bent to a half circle detour of radius  $r$  around its center. It carries current  $I$  in clockwise direction. What will be the magnetic field at the center of detour?



- (a)  $\frac{\mu_0 I}{2r}$  and in a direction out of the paper
- (b)  $\frac{\mu_0 I}{2r}$  and in a direction into the paper
- (c)  $\frac{\mu_0 I}{4r}$  and in a direction out of the paper
- (d)  $\frac{\mu_0 I}{4r}$  and in a direction into the paper

57.

What is the nature of the force between two parallel current-carrying wires of fixed lengths, if the currents in both the wires are alternating having equal frequency, equal amplitude but opposite in phase?

- (a) Attractive
- (b) Repulsive
- (c) Zero
- (d) Cannot be determined

58.

A steady current  $I$  flows around a hollow cylindrical tube of base radius  $a$ . If  $r$  be the distance of a given point from the cylindrical axis of symmetry, what will be the magnitude of the magnetic field  $\mathbf{B}$  at a point inside the cylinder?

- (a) Zero
- (b)  $\frac{\mu_0 I}{2\pi r}$
- (c)  $\frac{\mu_0 I}{\pi r^2}$
- (d)  $\frac{2\mu_0 I}{r^2}$

59.

A magnetic field  $\mathbf{B}$  is produced by a very long solenoid of radius  $R$  and having  $n$  turns per unit length with a steady current  $I$ . Consider the following statements in this regard:

Statement 1:  $\mathbf{B} = \mu_0 n I$  inside the solenoid

Statement 2:  $\mathbf{B} = 0$  outside the solenoid

Which of the statements given above is/are correct?

- (a) 1 and 2
- (b) 1 only
- (c) 2 only
- (d) Neither 1 nor 2

60.

Which one among the following statements is true for the Laplacian or the Laplace operator?

- (a) It represents the gradient of the divergence of a vector
- (b) It represents the divergence of the gradient of a function
- (c) It represents the divergence of a vector
- (d) It represents the gradient of a scalar

61.

Which one of the following can be explained using Lenz's law?

- (a) Only paramagnetism
- (b) Only diamagnetism
- (c) Only ferromagnetism
- (d) All types of magnetism

62.

What will be the nature of induced electromotive force (emf) if a rectangular-shaped current-carrying wire is moved back-and-forth parallel to the direction of a uniform magnetic field?

- (a) It will continuously increase with time
- (b) It will have the non-zero constant value throughout
- (c) It will be zero
- (d) It will decrease with time

63.

What is the cause of the displacement current in an electric circuit?

- (a) It is due to the variation of magnetic field
- (b) It is due to the flow of steady current
- (c) It is due to the variation of electric field
- (d) It is due to the magnetic flux linked with the circuit

64.

A uniform magnetic field  $\mathbf{B}$  along a vertically upward direction passes through a circular area of radius  $r$ . If the magnetic field varies with time  $t$ , then what will be the induced electric field  $\mathbf{E}$ ?

- (a)  $\mathbf{E} = -\pi r^3 \frac{d\mathbf{B}}{dt}$
- (b)  $\mathbf{E} = -\pi r^2 \frac{d\mathbf{B}}{dt}$
- (c)  $\mathbf{E} = -\pi r^4 \frac{d\mathbf{B}}{dt}$
- (d)  $\mathbf{E} = -\pi r^{1/2} \frac{d\mathbf{B}}{dt}$

65.

Which one of the following statements is true for Maxwell's equations?

- (a) They delve with the conduction current
- (b) They delve with the conduction current density
- (c) They delve with the convection current
- (d) They delve with the displacement current

66.

If magnetic monopole exists, then which of the following equations will get modified?

1.  $\nabla \cdot \mathbf{B} = 0$
2.  $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$
3.  $\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0}$

Select the correct answer using the code given below:

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

67.

What is the number of coupled Maxwell's equations between electric field and magnetic field?

- (a) One
- (b) Two
- (c) Three
- (d) Four

68.

A wave of 1 MHz is propagating in sea water having attenuation coefficient  $0.1258 \text{ m}^{-1}$ . How far does the wave will propagate before it is attenuated to 50 % of its original intensity?

( $\ln 2 = 0.693$ )

- (a) 1 mm
- (b) 1 m
- (c) 5.5 m
- (d) 100 m

69.

What is the nature of Magnetotelluric (MT) field?

- (a) Plane wave
- (b) Elliptically polarized wave
- (c) Circularly polarized wave
- (d) Spherically polarized wave

70.

The relation between electric displacement  $\mathbf{D}$ , electric field  $\mathbf{E}$  and electric polarization  $\mathbf{P}$  in electrostatic units is given by:

- (a)  $\mathbf{D} = \mathbf{E} + 4\pi\mathbf{P}$
- (b)  $\mathbf{E} = \mathbf{D} + 4\mathbf{P}$
- (c)  $\mathbf{P} = \mathbf{D} + 4\pi\mathbf{E}$
- (d)  $\mathbf{E} = 2\pi\mathbf{D} + 4\mathbf{P}$

71.

The Magnetotelluric (MT) sounding utilizing long period electromagnetic signals in the range of 10–1000 seconds is very useful for structure investigations of:

- (a) Lower mantle and outer core
- (b) Crust and upper mantle
- (c) Upper mantle and lower mantle
- (d) Outer core and inner core

72.

Consider the following statements regarding Vertical Electric Sounding (VES) method:

1. It can reveal the resistivity profile with depth in the horizontal layered earth
2. It can detect the saline water 'pools' beneath few meters of dry sand
3. It can locate low resistivity layers at very small potential difference
4. It can reveal the lateral variation of resistivity profile inside the earth

Which of the statements given above are correct?

- (a) 1, 2, 3 and 4
- (b) 1 and 3 only
- (c) 1 and 2 only
- (d) 3 and 4 only

73.

Match the list-I with list-II and select the correct answer using the code given below the lists:

List-I	List-II
<i>(Electromagnetic method)</i>	<i>(Source of primary field)</i>
A. AFMAG	1. Transmitter coil
B. VLF	2. Straight wire or loop
C. Slingram	3. Thunderstorm
D. Turam	4. Radio station

**Code:**

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
(a)	3	4	1	2
(b)	3	1	4	2
(c)	2	4	1	3
(d)	2	1	4	3

74.

Free fluid index (FFI) of a rock formation is estimated using:

- (a) Neutron log
- (b) Resistivity log
- (c) SP log
- (d) NMR log

75.

The Satellite Laser-Ranging (SLR) and Very Long Baseline Interferometry (VLBI) allow exceptionally accurate measurements of the distance between:

- (a) Earth and Moon
- (b) Two stations on the earth
- (c) Two planets
- (d) Two stars



76.

An electromagnetic wave of frequency ' $\omega$ ' and wave factor ' $k$ ' impinges on the interface separating two media with different permittivity and permeability. If this wave gets partially reflected and partly refracted, then which one of the following statements regarding the magnitude of wave vector is correct?

- (a) It changes for reflection but not for refraction
- (b) It changes for refraction but not for reflection
- (c) It changes for reflection and refraction both
- (d) It doesn't change for reflection and refraction both

77.

The input of a digital system  $x(t)$  is related to output  $y(t)$  as  $y(t) = tx(t)$ . The system is:

- (a) Linear
- (b) Non-linear
- (c) Stable
- (d) Time invariant

78.

Let  $x_1(t)$  and  $x_2(t)$  be two periodic signals with fundamental periods  $T_1$  and  $T_2$ , respectively. For  $x_1(t) + x_2(t)$  to be periodic, which one of the following should be a rational number?

- (a)  $T_1 + T_2$
- (b)  $T_1 - T_2$
- (c)  $\frac{T_1}{T_2}$
- (d)  $T_1 \times T_2$

79.

Which one of the following applications does NOT signify the use of Hilbert Transform in digital signal processing?

- (a) Automatic gain control
- (b) Time difference of arrival measurements
- (c) Audio and color image compression
- (d) Linear and stationary system analysis

80.

Which of the following conditions make digital signal processing beneficial over analog signal processing?

1. Flexibility
2. Accuracy
3. Storage

Select the correct answer using the code given below:

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

81.

The required condition(s) for a signal to be represented as Fourier series is/are:

- (a) Dirichlet's conditions
- (b) Periodicity condition
- (c) Stability and Zero phase condition
- (d) Discontinuity condition

82.

In the Fourier transform of a Gaussian function  $e^{-at^2}$ , with  $a > 0$ , an increase in 'a' will make the original Gaussian:

- (a) Wider
- (b) Narrower
- (c) Flat
- (d) Oval

83.

If  $f(x) = \begin{cases} 1 & -\pi < x < 0 \\ 0 & 0 < x < \pi \end{cases}$  and has a period of  $2\pi$

The value of the series  $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots$  would be:

- (a)  $\frac{\pi^2}{12}$
- (b)  $\frac{\pi^2}{4}$
- (c)  $\frac{\pi}{2}$
- (d)  $\frac{\pi}{4}$

84.

Fourier cosine transform of the function  $f(x) = \begin{cases} k & 0 < x < a \\ 0 & x > a \end{cases}$  is:

- (a)  $\frac{k \sin \omega a}{a}$
- (b)  $ka \sin \omega a$
- (c)  $\frac{-k \sin \omega a}{\omega}$
- (d)  $\frac{k \sin \omega a}{\omega}$

85.

The auto-correlation function of a complex valued signal exhibits:

- (a) Commutative property
- (b) Distributive property
- (c) Associative property
- (d) Conjugate property

86.

In Laplace transform, two very different signals may have identical algebraic expressions for  $X(s)$ .

Which one of the following can distinguish them?

- (a) Region of convergence
- (b) Length of the convergence
- (c) Property of the first signal
- (d) Property of the second signal

87.

The Laplace transform of given unit step function  $u(t-a)$  is:

- (a)  $e^{-as}$
- (b)  $e^{as}$
- (c)  $\frac{e^{-as}}{s}$
- (d)  $\frac{e^{as}}{s}$

88.

If  $f(s)$  be the Laplace transform of a function  $f(t)$ , then  $\lim_{s \rightarrow \infty} f(s)$  will be equal to:

- (a) Zero
- (b) 1
- (c) -1
- (d)  $\infty$

89.

According to Parseval's theorem, the energy spectral density curve is equal to the area under:

- (a) Magnitude of the signal
- (b) Square root of the magnitude of the signal
- (c) Square of the magnitude of the signal
- (d) Independent of the magnitude of the signal

90.

Which one of the following processes does NOT use the power spectrum in digital signal processing?

- (a) Pattern recognition
- (b) Signal coding
- (c) Signal reconstruction
- (d) Data forecasting

91.

The continuous time unit step function is defined as  $(x) = \begin{cases} 1 & x > 0 \\ 0 & x < 0 \end{cases}$ , then  $\frac{du(x)}{dx}$  will be:

- (a) 1
- (b) Zero
- (c)  $\delta(x)$
- (d) -1

92.

The ozone layer termed as protector of blanket of earth's atmosphere. It protects earth from harmful radiations and converts ultraviolet radiation into:

- (a) Visible radiation
- (b) Microwave radiation
- (c) Infra red radiation
- (d) X-rays radiation

93.

A goniometer is used for measurement of bidirectional reflectance distribution function (BDRF) of the surface for the purpose of:

- (a) Measuring reflectance for all combinations of illumination and viewing angles at a particular wavelength
- (b) Illuminations parallel to the surface only
- (c) Illuminations in the perpendicular direction only
- (d) Illuminations at  $45^\circ$  from the surface only

94.

The absorption band at  $9.2\text{--}10.2\ \mu\text{m}$  in the thermal-infrared region is due to:

- (a) Presence of carbon dioxide in the atmosphere
- (b) Presence of ozone in the upper atmosphere
- (c) Presence of water vapors in the lower atmosphere
- (d) Presence of suspended particulate matter

95.

The part of the signal emanating from the atmosphere is called:

- (a) Path length
- (b) Path radiance
- (c) Ground radiance
- (d) Back scattering

96.

Light enters a denser medium B from a rarer medium A. Which one among the following relation is true (where  $\lambda$  is the wavelength and  $\nu$  is the frequency in respective media)?

- (a)  $\lambda_A = \lambda_B$  and  $\nu_A = \nu_B$
- (b)  $\lambda_A > \lambda_B$  and  $\nu_A = \nu_B$
- (c)  $\lambda_A < \lambda_B$  and  $\nu_A = \nu_B$
- (d)  $\lambda_A > \lambda_B$  and  $\nu_A < \nu_B$

97.

Which one of the following pairs of electric field vector  $\mathbf{E}$  and magnetic field vector  $\mathbf{B}$  may represent a plane electromagnetic wave propagating along  $z$  direction?

- (a)  $(E_x \text{ and } B_y)$  and  $(E_x \text{ and } B_z)$
- (b)  $(E_y \text{ and } B_x)$  and  $(E_x \text{ and } B_y)$
- (c)  $(E_x \text{ and } B_z)$  and  $(E_z \text{ and } B_x)$
- (d)  $(E_y \text{ and } B_x)$  and  $(E_y \text{ and } B_y)$

98.

What is the wavelength range of the visible spectrum of electromagnetic wave?

- (a) 0.5 nm to 0.7 nm
- (b) 0.9 nm to 0.11 nm
- (c) 0.2 mm to 0.4 mm
- (d)  $0.4\ \mu\text{m}$  to  $0.7\ \mu\text{m}$

99.

What will happen to the maximum value of spectral energy density of a blackbody when its temperature is doubled?

- (a) It becomes 32 times of its initial value
- (b) It becomes 8 times of its initial value
- (c) It becomes 2 times of its initial value
- (d) It becomes 16 times of its initial value

100.

A hot body at 2000 K emits maximum energy at a wavelength of 15,000 angstrom. If Sun emits a maximum energy at 5000 angstrom, what would be the approximate temperature of the Sun?

- (a) 6000 K
- (b) 600 K
- (c) 8000 K
- (d) 5000 K

101.

The radiant power emitted by a body depends on the emissivity of the body. Which one of the following relations correctly describe the value of emissivity?

- (a) It is always more than 1 for a black body while it is less than 1 for a gray body
- (b) It is always equal to 1 for a black body while it is zero for a gray body
- (c) It is always equal to 1 for a black body while it is less than 1 for a gray body
- (d) It is always positive for a black body while for a gray body it is negative

102.

With the increase in temperature of a blackbody, what is the wavelength shift in the emitted radiation of highest intensity?

- (a) Blue shift
- (b) Red shift
- (c) No shift and no change in intensity
- (d) No shift but change in intensity

103.

Which one of the following laws gives the distribution of radiation energy over wavelength for a blackbody at a given temperature?

- (a) Kirchhoff's law
- (b) Planck's law
- (c) Snell's law
- (d) Lambert's law

104.

When 26,400 J of energy is supplied to a 2.0 kg block of aluminum, its temperature rises from 20 °C to 35 °C. The block is well insulated so that there is no energy loss to the surroundings. What is the specific heat capacity of aluminum?

- (a) 480 J kg<sup>-1</sup> K<sup>-1</sup>
- (b) 880 J kg<sup>-1</sup> K<sup>-1</sup>
- (c) 180 J kg<sup>-1</sup> K<sup>-1</sup>
- (d) 1880 J kg<sup>-1</sup> K<sup>-1</sup>

105.

A heat engine operates between a cold reservoir at temperature  $T_2 = 360$  K and a hot reservoir at temperature  $T_1$ . It takes 100 J of heat from the hot reservoir and delivers 60 J of heat to the cold reservoir in a cycle. What could be the minimum temperature of the hot reservoir?

- (a) 800 K
- (b) 900 K
- (c) 600 K
- (d) 1000 K

106.

What is the approximate mass  $A$  of a nucleus having radius 2.71 fm?

(where  $r_0 = 1.5$  fm)

- (a) 4
- (b) 8
- (c) 7
- (d) 6

107.

$^{17}\text{N}$  undergoes a  $\beta$ -decay to an X isotope. The ground state spin and parity of  $^{17}\text{N}$  is  $\frac{1}{2}^-$ . Which of the following is a possible value for ground state spin and parity of X isotope?

- (a)  $\frac{1}{2}^+$
- (b)  $\frac{5}{2}^-$
- (c)  $\frac{5}{2}^+$
- (d)  $\frac{1}{2}^-$

108.

Why fusion reactions take place at very high temperature?

- (a) The atoms are ionized at high temperature
- (b) The molecules break up at high temperature
- (c) The nuclei break up at high temperature
- (d) The kinetic energy is high enough to overcome the repulsion between nuclei

109.

The energy released per fission of  $^{235}\text{U}_{92}$  is 200 MeV. What is the number of fission processes that should occur per second in a nuclear reactor to operate at a power of 20,000 kW?

- (a)  $6.25 \times 10^7$
- (b)  $6.25 \times 10^{17}$
- (c)  $6.25 \times 10^{13}$
- (d)  $6.25 \times 10^{23}$

110.

The number of alpha and beta particles emitted when uranium nucleus ( ${}_{92}\text{U}^{238}$ ) decays to lead ( ${}_{82}\text{Pb}^{206}$ ) are:

- (a) 6 and 8 respectively
- (b) 8 and 6 respectively
- (c) 6 and 6 respectively
- (d) 8 and 8 respectively

111.

Consider the following statements with respect to the role of neutrino in a nuclear reaction of  $\beta$ -decay:



- 1. It explains the sharp energy line spectra in  $\beta$ -decay
- 2. It explains the continuous energy spectra in  $\beta$ -decay
- 3. It satisfies the linear and angular momenta conservation in  $\beta$ -decay
- 4. It explains the interaction with matter during  $\beta$ -decay

Which of the statements correctly describe the role of neutrino in the above reaction?

- (a) 1 and 3
- (b) 2 and 3
- (c) 1 and 4
- (d) 2 and 3

112.

If pair production were to take place in empty space, then which one of the following sets of physical quantities could NOT be conserved?

- (a) Energy and linear momentum
- (b) Energy and angular momentum
- (c) Mass and linear momentum
- (d) Energy and parity

113.

In Compton effect, for what angle between the directions of the initial and scattered photons, the wavelength change will be twice the Compton wavelength?

- (a)  $0^\circ$
- (b)  $90^\circ$
- (c)  $60^\circ$
- (d)  $180^\circ$

114.

A certain radioisotope has a half-life of 5 hours. Consider the following statements with respect to its decay:

- 1. Every nucleus of this isotope has a 50% change of decaying in every 5 hours period
- 2. There is 100% probability of decaying in 10 hours

Which of the statement(s) given above is/are true?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

115.

The background gamma-ray spectrum inside massive concrete shielding shows a prominent 2.22 MeV line because of:

- (a) Neutron capture in hydrogen atom
- (b) Decay of  $^{40}\text{K}$
- (c) Decay of  $^{22}\text{Na}$
- (d) Annihilation radiation

116.

A GM-counter has a 'dead-time' of 400  $\mu\text{s}$ . What is the true counting rate when the observed counting rate is 100 per minute?

- (a) 1000 per minute
- (b) 100.07 per minute
- (c) 1000.07 per minute
- (d) 100 per minute

117.

In a scintillation counter, a gamma-ray peak of 40 keV energy is observed at a pulse height of 32 V. The full width at half maxima (FWHM) is 4 keV. What is the percentage resolution of the counter?

- (a) 10 %
- (b) 20 %
- (c) 32 %
- (d) 3.2 %

118.

The magnitude of angular momentum due to spin of an electron is:

- (a)  $\frac{\sqrt{3} h}{2\pi}$
- (b)  $\frac{h}{4\pi}$
- (c)  $\frac{1}{2}$
- (d)  $\frac{\sqrt{3} h}{4\pi}$

119.

What is the ratio of the wavelengths for Lyman series spectrum ( $n = 2$  to  $n = 1$  transition) to Balmer series spectrum ( $n = 3$  to  $n = 2$  transition) in the hydrogen spectrum?

- (a)  $\frac{4}{3}$
- (b)  $\frac{36}{5}$
- (c)  $\frac{4}{9}$
- (d)  $\frac{5}{27}$

120.

Which one of the following hydrogen spectrum lines is blue in colour?

- (a)  $\text{H}_\alpha$
- (b)  $\text{H}_\beta$
- (c)  $\text{H}_\gamma$
- (d)  $\text{H}_\delta$