# TEST SERIES CSIR-NET/JRF DEC. 2018

**BOOKLET SERIES A**

**Paper Code 05**

**Test Type: TEST SERIES**

## PHYSICAL SCIENCES

**Duration: 02:30 Hours**

**Date: 19-11-2018**

**Maximum Marks: 120**

**Read the following instructions carefully:**

* Single Paper Test is divided into **TWO** Parts.

**Part - A:** This part shall carry **10** questions. Each question shall be of **2 marks.**

**Part - B:** This part shall contain **50** questions. Each question shall be of **2 marks**.

* Darken the appropriate bubbles with HB pencil/Ball Pen to write your answer.

* There will be negative marking @25% for each wrong answer.

* The candidates shall be allowed to carry the Question Paper Booklet after completion of the exam.

* For rough work, blank sheet is attached at the end of test booklet.

## PART-A : GENERAL APTITUDE

1. Pointing towards a photograph Ram says 'She is the daughter of my brother's son's wife'. How is Ram related to the daughter's father

   (a) Nephew (b) Niece (c) Son (d) Cousin

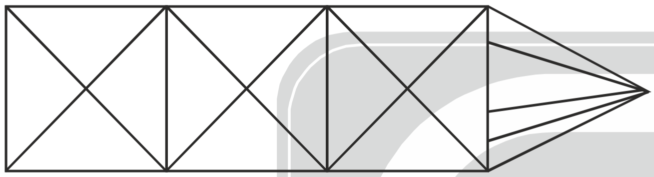
2. Statements:
   Some A are B
   no B are C
   All B are D
   based on these statements find out which conclusions of the below follows.
   (1) Some D are not C
   (2) Some D are C

   (a) Only 1 follows (b) Only 2 follows (c) both follows (d) none follows

3. What is the area enclosed between circumcircle and incircle of a regular hexagon having side of 10 cm

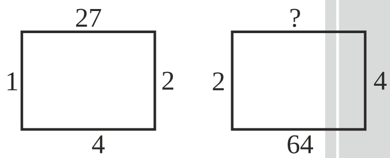
   (a) $20\pi$ (b) $25\pi$ (c) $40\pi$ (d) $50\pi$

4. Count total no of triangles in the figure given below.



   (a) 29 (b) 34 (c) 32 (d) 38

5. In the figures given below it follows a certain patten in (a); similarly what should come at (?)




(a) (b)

   (a) 216 (b) 393 (c) 196 (d) 125

6. What is sum of the series upto $n$ terms ($5 + 55 + 555 + ..........+ n^{th}$ term)

   (a) $\frac{5}{9}\left[\frac{10}{9}(10^n - 1) - n\right]$ (b) $\frac{5}{81}\left[\frac{10}{9}(10^n - 1) - n\right]$

   (c) $\frac{5}{9}\left[10(10^n - 1) - n\right]$ (d) $\frac{5}{9}\left[(10^n - 1) - n\right]$

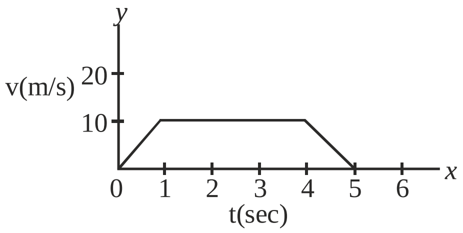
7. In a octagon total how many diagonals can be formed .

   (a) 22 (b) 28 (c) 20 (d) 40

8. Water stored in a reservior of rectangular shape having a dimension, of 80 m, 60 m and 6.5 m. In how much time the reservior can be emptied by a pipe having a square cross section whose side is 20 cm if water flows at a speed 15 km/h through the pipe.

   (a) 52 h (b) 60 h (c) 45 h (d) 40 h

9.




The above graph is a plot of velocity and time (sec) of a particle moving in a straight line. What is the average velocity of the particle.

(a) 20 m/sec (b) 8 m/sec (c) 25 m/sec (d) 12 m/sec

10. If $x=15$, what is the value of

$x^5-16x^4+16x^3-16x^2+16x-1$

(a) 14 (b) 15 (c) 196 (d) 225

## PART-B : EMT, NUCLEAR & PARTICLE PHYSICS AND QUANTUM MECHANICS

11. A photon of wavelength $\lambda$ scatters off an electron of mass $m_0=\frac{4h}{\lambda c}$ which was at rest. The angle of scattering is 45°. The ratio of the momentum of the incident photon to that of the scattered one is,

(a) $\frac{4\sqrt{2}}{5\sqrt{2}-1}$ (b) $\frac{5\sqrt{2}+1}{4\sqrt{2}}$ (c) $\frac{3\sqrt{2}-1}{2}$ (d) $\frac{5\sqrt{2}-1}{4\sqrt{2}}$

12. The phase velocity of a wave is given by

$$v_p=a\lambda^2-b\lambda \qquad [a,b>0]$$

The wavelength for which the group velocity of the wave will be equal to its phase velocity is,

(a) $\frac{2a}{b}$ (b) $\frac{b}{2a}$ (c) $\frac{a}{b}$ (d) $\frac{b}{a}$

13. $|0\rangle$ and $|1\rangle$ are two orthonormal vectors that constitute the basis of a 2-D hilbert space. A generic state $|\psi\rangle$ in this space is,

$$|\psi\rangle=a|0\rangle+b|1\rangle \qquad \left[a^2+b^2=1,\ a \text{ and } b \text{ are real}\right]$$

And an operator, $\hat{A}=|1\rangle\langle 1|+i\left(|0\rangle\langle 1|-|1\rangle\langle 0|\right)$. The value of $b$ for which $\langle\hat{A}\rangle$ for the state $|\psi\rangle$ is minimum, will be

(a) $\frac{1}{\sqrt{2}}$ (b) 0 (c) $\sqrt{\frac{2}{3}}$ (d) $\sqrt{\frac{3}{4}}$

14. Consider an operator $\hat{A}$ defined by, $\hat{A}=\left[x,\hat{p}_x^2\right]$. The eigenvalues of the operator will be,

(a) real (b) purely imaginary (c) of unit modulus (d) unity

15. The uncertainty in position for the ground state of a 1-D infinite symmetric potential well of width 'a' is

(a) $\frac{a}{\pi}\sqrt{\frac{\pi^2-3}{6}}$ (b) $\frac{a}{\pi}\sqrt{\frac{\pi^2+3}{6}}$ (c) $\frac{2a}{\pi}\sqrt{\frac{\pi^2-3}{6}}$ (d) $\frac{a}{\pi}\sqrt{\frac{\pi^2-6}{12}}$

16. A particle of mass $m$ moving under a potential $V(x,y)=\frac{k}{2}\left(x^2+y^2\right)+\alpha xy \quad |\alpha|<k$. The energy spectrum of the particle is given by

(a) $E_{n_1,n_2}=\hbar\sqrt{\frac{k+\alpha}{m}}\left(n_1+\frac{1}{2}\right)+\hbar\sqrt{\frac{k-\alpha}{m}}\left(n_2+\frac{1}{2}\right)$

(b) $E_{n_1,n_2}=\hbar\sqrt{\frac{k}{m}}\left(n_1+\frac{1}{2}\right)+\hbar\sqrt{\frac{\alpha}{m}}\left(n_2+\frac{1}{2}\right)$

(c) $E_{n_1,n_2}=\hbar\sqrt{\frac{2k}{m}}\left(n_1+\frac{1}{2}\right)+\hbar\sqrt{\frac{\alpha}{m}}\left(n_2+\frac{1}{2}\right)$

(d) $E_{n_1,n_2}=\hbar\sqrt{\frac{k}{m}}\left(n_1+\frac{1}{2}\right)+\hbar\sqrt{\frac{\alpha}{2m}}\left(n_2+\frac{1}{2}\right)$

17. The normalized wave function of a particle is given by,

$$\psi(r,\theta,\phi)=\frac{1}{4\sqrt{\pi a_0^3}}\left(\frac{r}{a_0}\right)e^{-\frac{r}{2a_0}}\cos\theta$$

The mean distance of the particle from origin is

(a) $4a_0$ (b) $9a_0$ (c) $10a_0$ (d) $8a_0$

18. The wave function of a spherical (three dimensional) rotator is $\psi=c\cos^2\theta$ (where $c$ is a constant). The expectation value of the square of the total angular momentum is given by

$Y_{0,0}(\theta,\phi)=\frac{1}{\sqrt{4\pi}}, Y_{2,0}(\theta,\phi)=\sqrt{\frac{5}{16\pi}}\left(3\cos^2\theta-1\right)$]

(a) 0 (b) $\frac{2\hbar^2}{5}$ (c) $\frac{24\hbar^2}{5}$ (d) $\frac{\hbar^2}{\sqrt{5}}$

19. The energy spectrum for a 1-D harmonic oscillator of frequency $\omega$ by using WKB method will be

(a) $E_n=\left(n+\frac{3}{4}\right)\hbar\omega$ (b) $E_n=\left(n+\frac{3}{5}\right)\hbar\omega$ (c) $E_n=\left(n+\frac{4}{5}\right)\hbar\omega$ (d) $E_n=\left(n+\frac{1}{2}\right)\hbar\omega$

where, $n$ = 0, 1, 2, ........

20. The value of the commutator,

$$\left[\hat{x}+\hat{p}_x^2,\ \hat{p}_x+\hat{x}^2\right]$$

is equal to

(a) $i\hbar\left(1-4\hat{p}_x\hat{x}\right)$ (b) $i\hbar\left(1-4\hat{x}\hat{p}_x\right)$ (c) $i\hbar\left(1-2\hat{p}_x\hat{x}-2\hat{x}\hat{p}_x\right)$ (d) $i\hbar\left(1+2\hat{p}_x\hat{x}+2\hat{x}\hat{p}_x\right)$

21. A perturbation of the form $H'=V_0x^2$ is applied on a 1-D harmonic oscillator of frequency $\omega$. The first order correction to the energy of particle of mass 'm' which is in the ground state, is

(a) $\frac{\hbar V_0}{\sqrt{2}m\omega}$ (b) $\frac{\hbar V_0}{m\omega}$ (c) $\frac{2\hbar V_0}{m\omega}$ (d) $\frac{\hbar V_0}{2m\omega}$

22. Two spin-1/2 particles, each of mass 'm' are placed in a 1-D harmonic oscillator potential with angular frequency $\omega$. The system is in spin '1' state and its energy is $4\hbar\omega$. The space part of wavefunction (un-normalized form) will be

(a) $\exp\left(-\frac{m\omega\left(x_1^2+x_2^2\right)}{2\hbar}\right)\left[H_1\left(\sqrt{\frac{m\omega}{\hbar}}x_1\right)H_2\left(\sqrt{\frac{m\omega}{\hbar}}x_2\right)\right]$

(b) $\exp\left(-\frac{m\omega\left(x_1^2+x_2^2\right)}{2\hbar}\right)\left[H_1\left(\sqrt{\frac{m\omega}{\hbar}}x_1\right)H_2\left(\sqrt{\frac{m\omega}{\hbar}}x_2\right)-H_2\left(\sqrt{\frac{m\omega}{\hbar}}x_1\right)H_1\left(\sqrt{\frac{m\omega}{\hbar}}x_2\right)\right]$

(c) $\exp\left(-\frac{m\omega\left(x_1^2+x_2^2\right)}{2\hbar}\right)\left[H_1\left(\sqrt{\frac{m\omega}{\hbar}}x_1\right)H_2\left(\sqrt{\frac{m\omega}{\hbar}}x_2\right)+H_2\left(\sqrt{\frac{m\omega}{\hbar}}x_1\right)H_1\left(\sqrt{\frac{m\omega}{\hbar}}x_2\right)\right]$

(d) $\exp\left(-\frac{m\omega\left(x_1^2+x_2^2\right)}{2\hbar}\right)\left[H_1\left(\sqrt{\frac{m\omega}{\hbar}}x_1\right)H_0\left(\sqrt{\frac{m\omega}{\hbar}}x_2\right)-H_0\left(\sqrt{\frac{m\omega}{\hbar}}x_1\right)H_1\left(\sqrt{\frac{m\omega}{\hbar}}x_2\right)\right]$

23. A particle is in an one dimension potential $V(x)=A\delta\left(x^2-3x+2\right)$. Its wavefunction $\psi(x)$ is continuous everywhere. The discontinuity in $\frac{d\psi}{dx}$ at $x=2$ is,

(a) $\frac{\hbar^2}{2mA}\psi(2)$ (b) $\frac{mA\psi(2)}{\hbar^2}$ (c) $\frac{2mA\psi(2)}{\hbar^2}$ (d) 0

24. The spin-state of an electron in $\hat{S}_z$ basis is given by,

$$|\chi\rangle=\frac{1}{\sqrt{5}}\begin{pmatrix}1+i\\ \sqrt{3}\end{pmatrix}$$

The probability that a measurement of $\hat{S}_y$ will yield the values $+\frac{\hbar}{2}$ and $-\frac{\hbar}{2}$ are, respectively



(a) $\frac{1}{2}+\frac{\sqrt{3}}{5},\frac{1}{2}-\frac{\sqrt{3}}{5}$ (b) $\frac{1}{2},\frac{1}{2}$

(c) $\frac{1}{2}-\frac{\sqrt{3}}{5},\frac{1}{2}+\frac{\sqrt{3}}{5}$ (d) $\frac{1}{4},\frac{3}{4}$

25. $\vec{S}$ is the spin operator of an electron and $\vec{n}$ is unit vector along $\left(\theta=60^\circ,\phi=30^\circ\right)$. The eigenstate of the operator $\vec{S}\cdot\vec{n}$ corresponding to the eigen value $-\frac{\hbar}{2}$ is

(a) $\frac{1}{2}\begin{pmatrix}-1\\ \frac{3}{2}+\frac{i\sqrt{3}}{2}\end{pmatrix}$ (b) $\frac{1}{2}\begin{pmatrix}\sqrt{3}\\ \frac{\sqrt{3}}{2}+\frac{i}{2}\end{pmatrix}$ (c) $\frac{1}{2}\begin{pmatrix}1\\ \frac{\sqrt{3}}{2}-\frac{i}{2}\end{pmatrix}$ (d) $\frac{1}{2}\begin{pmatrix}\sqrt{3}\\ \frac{\sqrt{3}}{2}-\frac{i}{2}\end{pmatrix}$

26. Consider a system where energy eigenstates are given by,

$$\psi_n(x) = \frac{1}{\sqrt{L}}\ e^{\frac{i2\pi nx}{L}}, \left(-\frac{L}{2} < x < \frac{L}{2}\right)$$

where $n = 0, \pm 1, \pm 2, \ldots\ldots\ldots\ldots$ and the allowed energies are,

$$E_n = \frac{2}{m}\left(\frac{n\pi\hbar}{L}\right)^2 \qquad [\text{m is the mass of the particle}]$$

If we introduce a perturbation of the form

$$H^P = -V_0\ e^{-\frac{x^2}{a^2}},\ [a << L]$$

The first order correction to the first excited state energy is given by

(a) $E_{\pm} = -\frac{V_0 a}{L}\left(1 \mp e^{-\frac{4\pi^2 a^2}{L^2}}\right)$

(b) $E_{\pm} = -\frac{V_0 a\sqrt{\pi}}{L}\left(1 \mp e^{-\frac{4\pi^2 a^2}{L^2}}\right)$

(c) $E_{\pm} = -\frac{V_0 a}{L}\left(1 \mp e^{-\frac{2\pi a}{L}}\right)$

(d) $E_{\pm} = -\frac{V_0 a\sqrt{\pi}}{L}\left(1 \mp e^{-\frac{2\pi a}{L}}\right)$

27. The Hamiltonian for a three level system is represented by the matrix

$$\hat{H} = \hbar\omega\begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{pmatrix}$$

Also, a hermitian operator $\hat{A}$ is given by

$$\hat{A} = \lambda\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 2 \end{pmatrix}$$

If the system starts out in a state

$$|\psi(t=0)\rangle = \begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix} \qquad \left[|c_1|^2 + |c_2|^2 + |c_3|^2 = 1\right]$$

The probability that a value of $\lambda$ will be obtained while measuring $\hat{A}$ on the state at time 't' is

(a) $1 - |c_1|^2$

(b) $1 - |c_2|^2$

(c) $\frac{1}{2}\left(|c_1|^2 + |c_2|^2 + c_1 c_2^*\ e^{i\omega t} + c_2 c_1^*\ e^{-i\omega t}\right)$

(d) zero

28. The $S$-wave phase shift for the elastic scattering of a high energy particle from the potential

$$V(r)=\begin{cases}-V_0\, e^{-r/a} & \text{for } r<a\\ 0 & \text{for } r>a\end{cases}$$

with $V_0>0$, is (where $E=\frac{\hbar^2k^2}{2m}$)

(a) $\frac{mV_0a}{\hbar^2k}\left(1+\frac{1}{e}\right)$ (b) $\left(\frac{mV_0a}{\hbar^2k}\right)$ (c) $\frac{mV_0a}{\hbar^2k}\left(1-\frac{1}{e}\right)$ (d) $\left(\frac{mV_0a}{e\hbar^2k}\right)$

29. A micro particle of mass $m$ moving on a ring of radius a lies in the $xy$ plane. The wave function of the particle is given by

$$\psi = A\cos^3\phi$$

$\phi$ being the azimuthal angle and $A$ is a constant. If a measurement of the z-component of orbital angular momentum of the particle is carried out, the probability of getting the result $+\hbar$ is

(a) $\frac{1}{20}$ (b) $\frac{9}{20}$ (c) $\frac{3}{10}$ (d) $\frac{1}{10}$

30. A Hermitian operator $\hat{A}$ has only two eigenstates $|\phi_1\rangle$ and $|\phi_2\rangle$ with eigenvalues $a_1$ and $a_2$ respectively. If $\langle\hat{A}\rangle$ for a state $|\psi\rangle$ is $\frac{a_1+2a_2}{3}$, the uncertainty in $\hat{A}$ for the state $|\psi\rangle$ will be

(a) $\frac{1}{\sqrt{3}}|a_1-a_2|$ (b) $\frac{\sqrt{2}}{3}|a_1-a_2|$ (c) $\frac{\sqrt{2}}{3}|a_1+a_2|$ (d) $\frac{1}{\sqrt{3}}|a_1+a_2|$

31. Consider a vector field given by

$$\vec{F}=\frac{A}{s}\hat{s}+\frac{B}{s}\hat{z}$$

where $(s,\phi,z)$ represents cylindrical co-ordinates. For what value of $A$ and $B$ will this represent an electrostatic field?

(a) $A$ = 0; $B$ =0 (b) $A$ = $B$ = constant
(c) $A$ = 0 ; $B$ can have any value (d) $A$ can have any value ; $B$ = 0

32. Consider two concentric spherical conducting shells centred at the origin. The outer radius of the inner conductor is $r_a$ and the inner radius of outer conductor is $r_b$. The region $r_a<r<r_b$ is free spaces and there have no free charges in this region. If $V=V_0$ at $r=r_a$ and $V=0$ at $r=r_b$. The surface charge density on the inner surface of the outer conductor is given by

(a) $\frac{-\varepsilon_0V_0}{r_a^2\left(\frac{1}{r_a}-\frac{1}{r_b}\right)}$ (b) $\frac{\varepsilon_0V_0}{r_a^2\left(\frac{1}{r_a}-\frac{1}{r_b}\right)}$ (c) $\frac{\varepsilon_0V_0}{r_b^2\left(\frac{1}{r_b}-\frac{1}{r_a}\right)}$ (d) $\frac{-\varepsilon_0V_0}{r_b^2\left(\frac{1}{r_b}-\frac{1}{r_a}\right)}$

33. The magnitude of electric field inside a sphere of radius $R$ is given by

$$E=\frac{\rho_0}{\varepsilon_0}\left(\frac{r}{3}+\frac{r^2}{4R}\right)$$

The electrostatics potential at a distance $2R$ from the centre of the sphere is given by

(a) $\frac{2\rho_0R^2}{3\,\varepsilon_0}$ (b) $\frac{7\rho_0R^2}{24\,\varepsilon_0}$ (c) $\frac{15\rho_0R^2}{7\,\varepsilon_0}$ (d) $\frac{14\rho_0R^2}{3\,\varepsilon_0}$

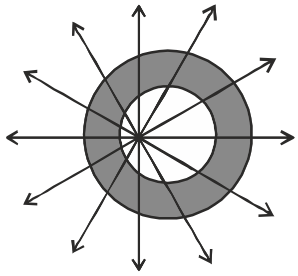
34. If electric field in some region is given by

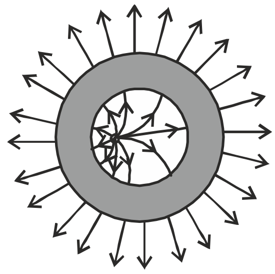
$$\vec{E}(r) = \frac{A\hat{r} + B\sin\theta\cos\phi\hat{\phi}}{r}$$

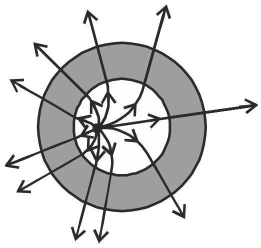
where $(r,\theta,\phi)$ are spherical coordinates and $A$ and $B$ are constant. The electric flux passing through the sphere of radius $R$ whose centre at the origin is

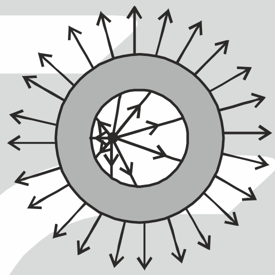
(a) zero (b) $4\pi BR$ (c) $4\pi AR$ (d) $4\pi R\left(A - \frac{B}{2}\right)$

35. A point charge is placed inside the hollow region of hollow conducting spherical shell of inner and outer radius $a$ and $b$ respectively. Which of the following figure is the best illustration of the electric field line

(a) 

(b) 

(c) 

(d) 

36. A thin conducting ring of radius $R$ having a charge $Q$ is placed with its plane parallel to an infinite conducting plane at a distance $d$ from it. The potential at the centre of the ring is

(a) $V = \frac{q}{4\pi\varepsilon_0 R}$

(b) $V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{R} - \frac{1}{\sqrt{R^2 + 4d^2}}\right)$

(c) $V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{R} + \frac{1}{\sqrt{R^2 + 4d^2}}\right)$

(d) $V = \frac{q}{4\pi\varepsilon_0}\frac{1}{\sqrt{R^2 + 4d^2}}$

37. If a long wire of radius $R$ carries a current $I$ with the volume current density $J = \alpha s^2 \hat{z}$ (where $\alpha$ is a constant). The variation of magnetic vector potential with $s$ is given by

(a) $A \propto s^3$ for $s < R$ ; $A \propto \ln s$ for $s > R$

(b) $A \propto s^4$ for $s < R$ ; $A \propto \ln s$ for $s > R$

(c) $A \propto s^2$ for $s < R$ ; $A \propto s^{-1}$ for $s > R$

(d) $A \propto s^3$ for $s < R$ ; $A \propto s^{-1}$ for $s > R$

38. A long straight solenoid having $N$ turn per unit length carries a current $I = I_0 \sin(\omega t)$. The displacement current density as a function of $s$ within the solenoid is given by

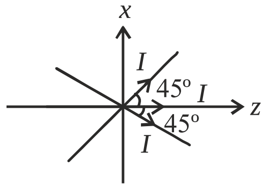
(a) $\vec{J}_d = \frac{s\omega^2}{2c^2} NI_0 \cos(\omega t)\hat{\phi}$

(b) $\vec{J}_d = \frac{s\omega^2}{2c^2} NI_0 \sin(\omega t)\hat{\phi}$

(c) $\vec{J}_d = \frac{s^2\omega^2}{2c^2} NI_0 \tan(\omega t)\hat{\phi}$

(d) $\vec{J}_d = \frac{s\omega^2}{2c^2} NI_0 \cot(\omega t)\hat{\phi}$

39. Three long, straight wires in the $x$-$z$ plane each carrying current $I$, cross at the origin of coordinates, as shown in figure. The magnitude of the magnetic field B is a function of x with $y = z = 0$, is




(a) $\frac{3\mu_0 I}{2\pi x}$ (b) $\frac{3\mu_0 I}{2\pi x}$ (c) $\frac{\mu_0 I}{2\pi x}\left(1+2\sqrt{2}\right)$ (d) $\frac{\mu_0 I}{2\pi x}$

40. Suppose a square of side a lying in the xy plane with its centre at the origin carries current $I$ in anti-clockwise direction. The magnetic field on the $x$-axis at a distance $d$ from the origin is given by (Assume $d$ >> a)

(a) $-\frac{\mu_0 I}{4\pi d^2}\hat{x}$ (b) $-\frac{\mu_0 I a^2}{4\pi d^3}\hat{z}$ (c) $\frac{\mu_0 I}{4\pi d^3}\hat{y}$ (d) zero

41. The scalar and vector potential $\phi(r,t)$ and $\vec{A}(r,t)$ are transformed to $\phi'(r,t)=\phi(r,t)-\phi_0 e^{-\lambda t}$ and $\vec{A}'(r,t)=\vec{A}(r,t)-\phi_0\vec{r}$ respectively. If the electric field and magnetic field remain unchange due to this transformation then the value of $\lambda e^{-\lambda t}$ is

(a) $+3c^2$ (b) $+2c^2$ (c) zero (d) none of these

42. The $\vec{E}$-field associated with an electromagnetic wave in free space is described by

$$\vec{E} = 3\cos(kz+\omega t)\hat{x} + 4\sin(kz+\omega t)\hat{y}\ Vm^{-1}$$

The wave is incident normally on the surface (z = 0) of a perfect conductor and gets reflected. The magnetic field of the reflected wave for $z \ge 0$ is

(a) $\frac{3}{c}\cos(kz+\omega t)\hat{x} - \frac{4}{c}\sin(kz+\omega t)\hat{y}\ A/m$ (b) $-\frac{3}{c}\cos(kz-\omega t)\hat{y} + \frac{4}{c}\sin(kz-\omega t)\hat{x}\ A/m$

(c) $\frac{3}{c}\cos(kz-\omega t)\hat{y} - \frac{4}{c}\sin(kz-\omega t)\hat{x}\ A/m$ (d) $-\frac{3}{c}\cos(kz+\omega t)\hat{y} + \frac{4}{c}\sin(kz+\omega t)\hat{y}\ A/m$

43. The electric field of an electromagnetic wave is given by

$$\vec{E} = \hat{x}\frac{\sqrt{3}}{2}\cos(\omega t) + \hat{y}\frac{1}{2}\cos\left(\omega t + \frac{\pi}{3}\right) \quad \left[\text{Given: } \tan^{-1}\frac{\sqrt{3}}{2} \approx 45^\circ\right]$$

(a) The wave is left handed elliptical polarized light with major axis making angle 45° with $x$-axis.
(b) The wave is right handed elliptical polarized light with major axis making angle 22.5° with $x$-axis.
(c) The wave is right handed elliptical polarized light with major axis making angle 45° with $x$-axis.
(d) The wave is right handed circular polarized light.

44. Unpolarized light with an intensity of $I_0$ is incident on two polarizing lenses. The transmission angle of the first lens is 90° to the $x$-axis and the transmission angle of the second lens is 30° to the $x$-axis. Now, if we put a half wave plate between two polarizing lenses, whose fast axis making an angle 45° to the $x$-axis. Then, the intensity of the output light will be

(a) $\frac{I_0}{2}$ (b) $\frac{3I_0}{4}$ (c) $\frac{3I_0}{8}$ (d) $\frac{3I_0}{16}$

45. A charge particle of mass $m_0$ and charge $q$ is at rest in lab frame in presence of a uniform electric field and magnetic field $\vec{E}=E_0\hat{z}$ and $\vec{B}=B_0\hat{x}$ respectively and another frame $(S')$ moving with speed $v$ parallel to the $y$-axis. If an observer in the $S'$ frame observe that electric field is zero in $S'$ frame then the mass of the particle in the $S'$ frame will be (Assume that $\frac{E_0}{B_0}<c$)

(a) $m_0$ (b) $\frac{2m_0}{\sqrt{E_0^2+B_0^2}}$ (c) $\frac{m_0B_0c}{\sqrt{c^2B_0^2-E_0^2}}$ (d) $\frac{m_0B_0c}{\sqrt{c^2B_0^2+E_0^2}}$

46. A circular loop of radius $R$ carries a current $I_0=I_0\sin(\omega t)$, if the electromagnetic radiation power at distance $d$ from the centre of the loop is $P$ then (Assume $d>>R$)

(a) $P\propto\omega^2$ (b) $P\propto\omega^4$ (c) $P\propto\omega^3$ (d) $P\propto\omega$

47. Suppose $z$ = 0 plane is the interface between air ($z$ < 0) and perfect conductor ($z$ > 0). If an electromagnetic wave incendent on the interface from air whose electric field is given by $\vec{E}=\hat{y}E_0\sin\left(\omega t-kx-\sqrt{3}kz\right)$. The pressure exerted by the wave on the interface is

(a) $\varepsilon_0E_0^2$ (b) $\frac{\sqrt{3}}{2}\varepsilon_0E_0^2$ (c) $\frac{1}{2}\varepsilon_0E_0^2$ (d) $\frac{\sqrt{3}}{4}\varepsilon_0E_0^2$

48. A charge particle rotating in a circular path of radius $R$ with speed $v$. Keeping speed constant if we increase the radius to 2R. The power of the electromagnetic radiation will

(a) decrease by a factor 0.5 (b) increase by factor 0.5
(c) decrease by a factor 0.25 (d) increase by a factor 0.25.

49. In a certain region of space through which an electromagnetic wave is propagrating the Poynting's vector is given by $\vec{S}=A\hat{x}\sin^2(kx-\omega t)$. The time average power carried by the wave through square of side a on the plane $y+2x=3$ is

(a) $\left(\frac{2A}{\sqrt{5}}\right)$ (b) $\left(\frac{2Aa^2}{\sqrt{5}}\right)$ (c) $\left(\frac{Aa^2}{\sqrt{5}}\right)$ (d) zero

50. A proton moves in $z$-direction after being accelerated from rest through a potential difference $V$. The proton then passes through a region with a uniform electric field $E_0$ in the +$x$-direction and a uniform magnetic field in $B_0$ in the +$y$-direction, but the proton's trajectory is not affected. If the experiment were repected using a potential difference of $V/2$, then the proton's trajectory would be

(a) circular in $x$-$z$ plane (b) helical in $x$-$y$ plane
(c) cycloid in $x$-$z$ plane (d) straight line

51. Which of the following $\beta$- decay reaction is allowed by pure Gamow-Teller (GT) selection rule :

(a) $\text{Co}^{60}\,(I^\pi=5^+)\to\text{Ni}^{60}\,(I^\pi=4^+)+\overline{e}+\overline{\nu}_e$

(b) $n\to p^++e^-+\overline{\nu}_e$

(c) $\text{O}^{14}\,(I^\pi=0^+)\to\text{N}^{14}\,(I^\pi=0^+)+e^++\nu_e$

(d) None of the above

52. Proton striking a stationary lithium target activate a reaction $Li^7\,(p,n)\,Be^7$. If $Q$-values (energy of the reaction) is $Q=-1.64$ MeV, the kinetic energy of the proton such that emitted neutron is stationary is

(a) 1.64 MeV (b) 2.0 MeV (c) 1.91 MeV (d) 4.0 MeV

53. Deutron in a cyclotron describe a circle of radius 0.35 m just before emerging from the dees. The AC voltage applied to the dees is $2 \times 10^4$ volt of the time period $T = 10^{-7}$ sec. The velocity of emerging deutron is

(a) $3 \times 10^8$ m/s (b) $1.5 \times 10^7$ m/s (c) $2.20 \times 10^7$ m/s (d) $1.20 \times 10^7$ m/s

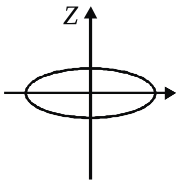
54. The spherical shell model explains the magic numbers stability by including a spin-orbit term $-C\vec{l} \cdot \vec{s}$, where $C = \frac{2\text{ MeV}}{\hbar^2}$ the spin orbit interaction energy difference of *p* state which splits into $p_{1/2}$ and $p_{3/2}$ state is

(a) 1.5 MeV (b) –1.5 MeV (c) 2 MeV (d) 3 MeV

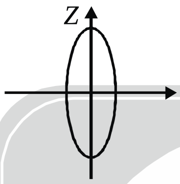
55. Multipoles carried by $\gamma$ transition in $2p_{1/2} \to 1s_{1/2}$ is

(a) $E_1, M_0$ (b) $M_0, E_2$ (c) $E_1$ (d) $M_1$

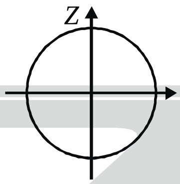
56. If a nucleus has spin $j = \frac{1}{2}$, the shape of the nucleus will be

(a) 

(Oblate)

(b) 

(Prolate)

(c) 

(Spherical)

(d) Shape can not be predicted with the value of $+j$

57. According to the shell model the spin and parity of the nuclie ${}_7\text{N}^{16}$ is

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

58. A $\gamma$-photon of energy 1.25 MeV is emitted from ${}_{12}\text{Mg}^{25}$ nucleus in excited state initially at rest. The recoiled kinetic energy of the nucleus is
[Given : 1 amu = 931.5 MeV/$c^2$]

(a) $3.35 \times 10^{-5}$ MeV (b) 1.25 MeV (c) $5.25 \times 10^{-9}$ MeV (d) $3.35 \times 10^{-8}$ MeV

59. A radioactive substance has initially 3 mole with half life time $T = 5$ hour. How many moles of nuclei get decayed in time 10 hours ? [Use : $e^{-1.386} \simeq 0.25$]

(a) 2.77 mole (b) 1.5 mole (c) 0.75 mole (d) 2.25 mole

60. Which of the following reactions are allowed ?

I. $\pi^+ + n \to K^- + \Sigma^+$

II. $\pi^- + p \to \pi^0 + \Lambda^0$

(a) Only I (b) Only II (c) Both I and II (d) None of these space for rough work

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**Test Series- (A)**
**Date: 19-11-2018**

## ANSWER KEY

PART-A

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. (a) | 2. (a) | 3. (b) | 4. (d) | 5. (a) | 6. (a) | 7. (c) |
| 8. (a) | 9. (b) | 10. (a) | | | | |

**PART-B**

| | | | | | | |
|---|---|---|---|---|---|---|
| 11. (d) | 12. (b) | 13. (b) | 14. (b) | 15. (d) | 16. (a) | 17. (c) |
| 18. (c) | 19. (d) | 20. (c) | 21. (a) | 22. (b) | 23. (c) | 24. (c) |
| 25. (a) | 26. (b) | 27. (c) | 28. (c) | 29. (b) | 30. (b) | 31. (d) |
| 32. (c) | 33. (b) | 34. (c) | 35. (b) | 36. (b) | 37. (b) | 38. (b) |
| 39. (c) | 40. (b) | 41. (a) | 42. (b) | 43. (b) | 44. (c) | 45. (c) |
| 46. (b) | 47. (b) | 48. (c) | 49. (c) | 50. (a) | 51. (a) | 52. (c) |
| 53. (c) | 54. (d) | 55. (c) | 56. (c) | 57. (b) | 58. (a) | 59. (d) |
| 60. (d) | | | | | | |