IIT-JAM-2014 (PHYSICS) (CODE-A)

PART-I : OBJECTIVE QUESTIONS

Q. 1 - Q. 10 carry one mark each.

1. For vectors $\vec{a}=\hat{j}+\hat{k}$, $\vec{b}=2\hat{i}+3\hat{j}-5\hat{k}$ and $\vec{c}=\hat{j}-\hat{k}$, the vector product $\vec{a}\times(\vec{b}\times\vec{c})$ is

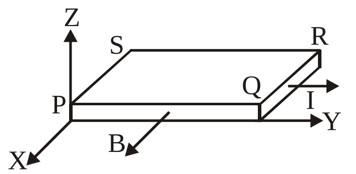
(a) in the same direction as $\vec{c}$ (b) in the direction opposite to $\vec{c}$

(c) in the same direction as $\vec{b}$ (d) in the direction opposite to $\vec{b}$

2. A particle of mass m carrying charge q is moving in a circle in a magnetic field B. According to Bohr's model, the energy of the particle in the n^{th} level is

(a) $\frac{1}{n^2}\left(\frac{hqB}{\pi m}\right)$ (b) $n\left(\frac{hqB}{\pi m}\right)$ (c) $n\left(\frac{hqB}{2\pi m}\right)$ (d) $n\left(\frac{hqB}{4\pi m}\right)$

3. A conducting slab of copper PQRS is kept on the xy plane in a uniform magnetic field along x-axis as indicated in the figure. A steady current I flows through the cross section of the slab along the y-axis. The direction of the electric field inside the slab, arising due to the applied magnetic field is along the



(a) negative Y direction (b) positive Y direction

(c) negative Z direction (d) positive Z direction

4. A collimated beam of light of diameter 1mm is propagating along the x-axis. The beam is to be expanded to a collimated beam of diameter 10 mm using a combination of two convex lenses. A lens of focal length of 50 mm and another lens with focal length F are to be kept at a distance d between them. The values of F and d respectively, are

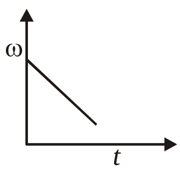
(a) 450 mm and 10 mm (b) 400 mm and 500 mm

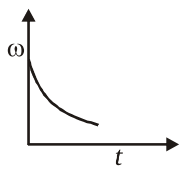
(c) 550 mm and 600 mm (d) 500 mm and 550 mm

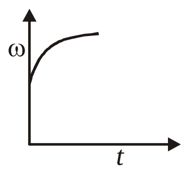
5. Octal equivalent of decimal number 478_{10} is

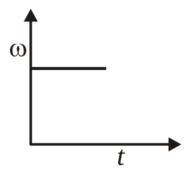
(a) 736_8 (b) 673_8 (c) 637_8 (d) 367_8

6. A spherical ball of ice has radius R_0 and is rotating with an angular speed ω about an axis passing through its centre. At time $t = 0$, it starts acquiring mass because the moisture (at rest) around it starts to freeze on it uniformly. As a result its radius increases as $R(t)=R_0+\alpha t$, where α is a constant. The curve which best describes its angular speed with time is

(a) 

(b) 

(c) 

(d) 

(a) a bright fringe will be obtained for $\cos\theta = -1$

(b) a bright fringe intensity is given by $(E_{10})^2 + (E_{20})^2$

(c) a dark fringe will be obtained for $\cos\theta = 1$

(d) a dark fringe intensity is given by $(E_{10} - E_{20})^2$

14. A solid metallic cube of heat capacity S is at temperature 300K. It is brought in contact with a reservoir at 600K. If the heat transfer takes place only between the reservoir and the cube, the entropy change of the universe after reaching the thermal equilibrium is

(a) 0.69 S (b) 0.54 S (c) 0.27 S (d) 0.19 S

15. If the surface integral of the field $\vec{A}(x,y,z) = 2\alpha x\hat{i} + \beta y\hat{j} - 3\gamma z\hat{k}$ over the closed surface of an arbitrary unit sphere is to be zero, then the relationship between α, β and γ is

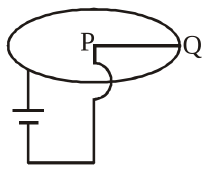
(a) $\alpha + \beta/6 - \gamma = 0$ (b) $\alpha/3 + \beta/6 - \gamma/2 = 0$

(c) $\alpha/2 + \beta - \gamma/3 = 0$ (d) $2/\alpha + 1/\beta - 3/\gamma = 0$

16. The moment of inertia of a disc about one of its diameters is I_M. The mass per unit area of the disc is proportional to the distance from its centre. If the radius of the disc is R and its mass is M, the value of I_M is

(a) $\frac{1}{2}MR^2$ (b) $\frac{2}{5}MR^2$ (c) $\frac{3}{10}MR^2$ (d) $\frac{3}{5}MR^2$

17. A rigid uniform horizontal wire PQ of mass M, pivoted at P, carries a constant current I. It rotates with a constant angular speed in a uniform vertical magnetic field B. If the current were switched off, the angular acceleration of the wire, in terms of B, M and I would be



(a) 0 (b) $\frac{2BI}{3M}$ (c) $\frac{3BI}{2M}$ (d) $\frac{BI}{M}$

18. Two points N and S are located in the northern and southern hemisphere, respectively, on the same longitude. Projectiles P and Q are fired from N and S, respectively, towards each other. Which of the following options is correct for the projectiles as they approach the equator?

(a) Both P and Q will move towards the east

(b) Both P and Q will move towards the west

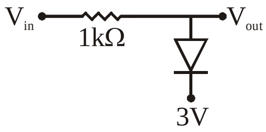
(c) P will move towards the east and Q towards the west

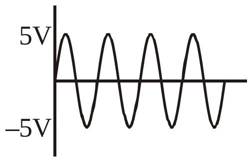
(d) P will move towards the west and Q towards the east

19. Two particles A and B of mass m and one particle C of mass M are kept on the x axis in the order ABC. Particle A is given a velocity $v\hat{i}$. Consequently there are two collisions, both of which are completely inelastic. If the net energy loss because of these collisions is $\frac{7}{8}$ of the initial energy, the value of M is (ignore frictional losses)

(a) 8 m (b) 6 m (c) 4 m (d) 2 m

27. A sine wave of 5V amplitude is applied at the input of the circuit shown in the figure. Which of the following waveforms represents the output most closely?



(a)


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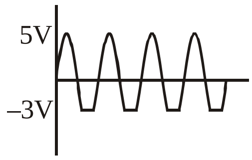
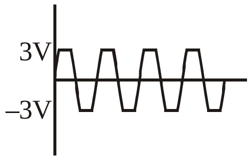
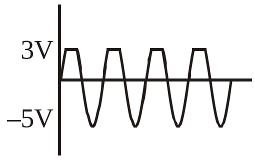
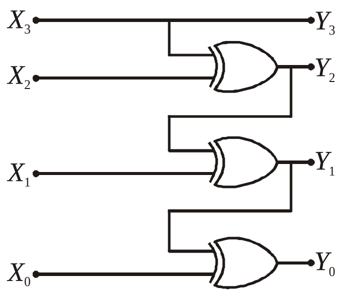


(c)


(d)


28. 1011 binary input have been applied at $X_3X_2X_1X_0$ input in the shown logic circuit made of *XOR* gates. The binary output $Y_3Y_2Y_1Y_0$ of the circuit will be

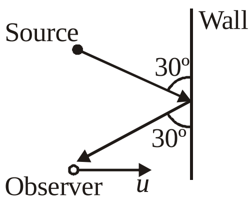


(a) 1101 (b) 1010 (c) 1111 (d) 0101

29. A ring of radius R carries a linear charge density λ. It is rotating with angular speed ω. The magnetic field at its centre is

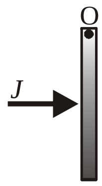
(a) $\frac{3\mu_0\lambda\omega}{2}$ (b) $\frac{\mu_0\lambda\omega}{2}$ (c) $\frac{\mu_0\lambda\omega}{\pi}$ (d) $\mu_0\lambda\omega$

30. A stationary source (see figure below) emits sound waves of frequency *f* towards a wall. If an observer moving with speed *u* in a direction perpendicular to the wall, measures a frequency $f' = \frac{9}{8}f$ at the instant shown, then *u* is related to the speed of sound V_s as



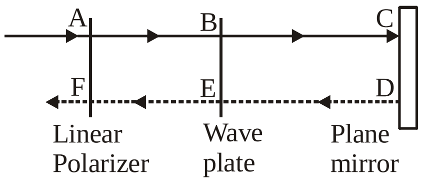
(a) V_s (b) $V_s/2$ (c) $V_s/4$ (d) $V_s/8$

38. A uniform rod of mass m and length l is hinged at one of its ends O and is hanging vertically. It is hit at its midpoint with a very short duration impulse J so that it starts rotating about O. Find the magnitude and direction of the horizontal impulse that O applies on the rod when it is hit.



39. **An easy derivation of PV^γ = constant for an ideal gas undergoing an adiabatic process:** Consider P and V as the basic variables of an ideal gas and write the heat exchanged dQ in terms of dV and dP. Next, using the definition of C_P and C_V in the expression for dQ, obtain a differential equation relating P and V for an adiabatic process and solve it to get the desired relationship. Derivation SHOULD NOT use the first law of thermodynamics. [For a function $f(x, y)$ the differential $df = \left(\frac{\partial f}{\partial x}\right)_y dx + \left(\frac{\partial f}{\partial y}\right)_x dy$]

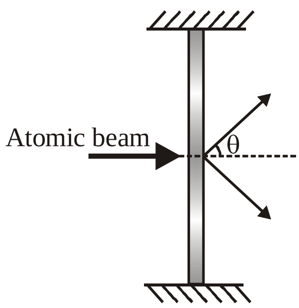
40. As shown in the figure below, an unpolarised beam of light of wavelength 500nm is incident on a linear polariser at AF with vertical polarisation. The light beam then passes through a wave plate BE (half wave or quarter wave plate) of thickness 1.00125 mm and gets reflected from a mirror CD. The reflected light is indicated by the dashed line (DEF) in the diagram. The ordinary and extraordinary refractive indices for the material of the wave plate are 1.658 and 1.558, respectively. Light is incident normally on all surfaces.



(a) What is the polarisation of the beam at C?

(b) What is the polarisation of the beam at E and F?

41. A standing wave of light is formed between two mirrors and a beam of atoms is incident on it normally (see figure below) from the left. On the right side, atoms are detected in the direction of the beam and also at an angle θ as shown in the figure. This is due to material waves of atoms diffracted by the standing wave that acts like a grating; the slit width of this grating is given by the distance between two maxima of the light intensity. If the atomic beam is made of atoms of mass m moving with speed v and the light wave has wavelength λ_L, find the smallest angle θ by using the diffraction condition.



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ANSWER KEY

1. (a)	**2.** (d)	**3.** (c)	**4.** (d)	**5.** (a)
6. (b)	**7.** (d)	**8.** (a)	**9.** (b)	**10.** (a)
11. (a)	**12.** (a)	**13.** (d)	**14.** (d)	**15.** (b)
16. (c)	**17.** (c)	**18.** (b)	**19.** (b)	**20.** (c)
21. (c)	**22.** (X)	**23.** (d)	**24.** (a)	**25.** (b)
26. (d)	**27.** (d)	**28.** (a)	**29.** (b)	**30.** (c)
31. (c)	**32.** (c)	**33.** (c)	**34.** (b)	**35.** (b)