Assignment 11

DESABOINA SRI SATHWIK-AI24BTECH11007

GATE-2018:PH

1) An interstellar object has speed v at the point of its shortest distance R from a star of much larger mass M. Given $v^2 = \frac{2GM}{R}$, the trajectory of the object is:

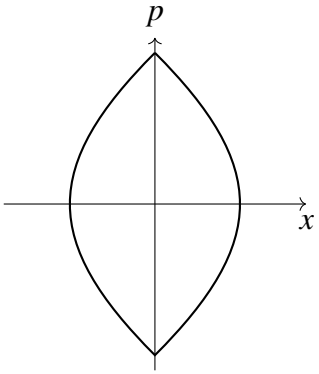
(PH:2018)

a) circle b) ellipse c) parabola d) hyperbola

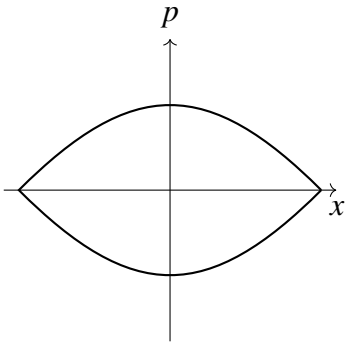
2) A particle moves in one dimension under a potential $V(x) = \alpha|x|$ with some non-zero total energy. Which one of the following best describes the particle trajectory in the phase space?

(PH:2018)

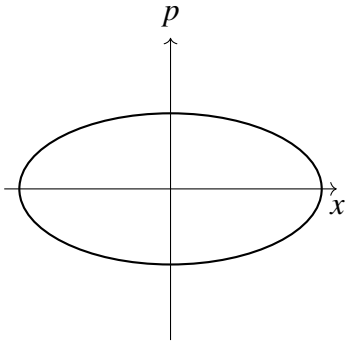
a)



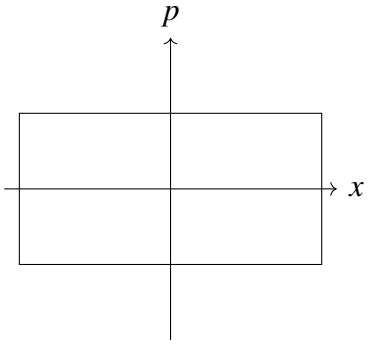
b)



c)



d)



3) Consider an infinitely long solenoid with N turns per unit length, radius R and carrying a current $I(t) = \alpha \cos \omega t$, where α is a constant and ω is the angular frequency. The magnitude of the electric field at the surface of the solenoid is:

(PH:2018)

a) $\frac{1}{2}\mu_0 NR\omega\alpha \sin \omega t$
b) $\frac{1}{2}\mu_0 \omega NR \cos \omega t$
c) $\mu_0 NR\omega\alpha \sin \omega t$
d) $\mu_0 \omega NR \cos \omega t$

4) A constant and uniform magnetic field $\mathbf{B} = B_0\hat{z}$ pervades all space. Which one of the following is the correct choice for the vector potential in Coulomb gauge?

(PH:2018)

a) $-B_0(x+y)\hat{i}$ b) $B_0(x+y)\hat{j}$ c) $B_0 x\hat{j}$ d) $-\frac{1}{2}B_0(x\hat{i}-y\hat{j})$

5) If H is the Hamiltonian for a free particle with mass m, the commutator $[x,[x,H]]$ is:
(PH:2018)

a) $\frac{\hbar^2}{m}$ b) $-\frac{\hbar^2}{m}$ c) $-\frac{\hbar^2}{2m}$ d) $\frac{\hbar^2}{2m}$

6) A long straight wire, having radius a and resistance per unit length r, carries a current I. The magnitude and direction of the Poynting vector on the surface of the wire is:
(PH:2018)

a) $\frac{I^2 r}{2\pi a}$, perpendicular to the axis of the wire and pointing inwards
b) $\frac{I^2 r}{2\pi a}$, perpendicular to the axis of the wire and pointing outwards
c) $\frac{I^2 r}{\pi a}$, perpendicular to the axis of the wire and pointing inwards
d) $\frac{I^2 r}{\pi a}$, perpendicular to the axis of the wire and pointing outwards

7) Three particles are to be distributed in four non-degenerate energy levels. The possible number of ways of distribution: (i) for distinguishable particles, and (ii) for identical Bosons, respectively, is:
(PH:2018)

a) (i) 24, (ii) 4 b) (i) 24, (ii) 20 c) (i) 64, (ii) 20 d) (i) 64, (ii) 16

8) The term symbol for the electronic ground state of oxygen atom is:
(PH:2018)

a) $^1S_0$ b) $^1D_2$ c) $^3P_0$ d) $^3P_2$

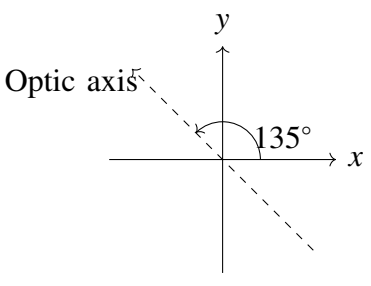
9) The energy dispersion for electrons in one dimensional lattice with lattice parameter a is given by $E(k) = E_0 - \frac{1}{2}W\cos ka$, where W and E_0 are constants. The effective mass of the electron near the bottom of the band is:
(PH:2018)

a) $\frac{2\hbar^2}{Wa^2}$ b) $\frac{\hbar^2}{Wa^2}$ c) $\frac{\hbar^2}{2Wa^2}$ d) $\frac{\hbar^2}{4Wa^2}$

10) Amongst electrical resistivity (ρ), thermal conductivity (κ), specific heat (C), Young's modulus (Y), and magnetic susceptibility (χ), which quantities show a sharp change at the superconducting transition temperature?
(PH:2018)

a) ρ,κ,C,Y b) ρ,C,χ c) ρ,κ,C,χ d) κ,Y,χ

11) A quarter wave plate introduces a path difference of $\frac{\lambda}{4}$ between the two components of polarization parallel and perpendicular to the optic axis. An electromagnetic wave with $\overrightarrow{E} = (\hat{x}+\hat{y})E_0 e^{i(kz-\omega t)}$ is incident normally on a quarter wave plate which has its optic axis making an angle 135 deg with the x-axis as shown.



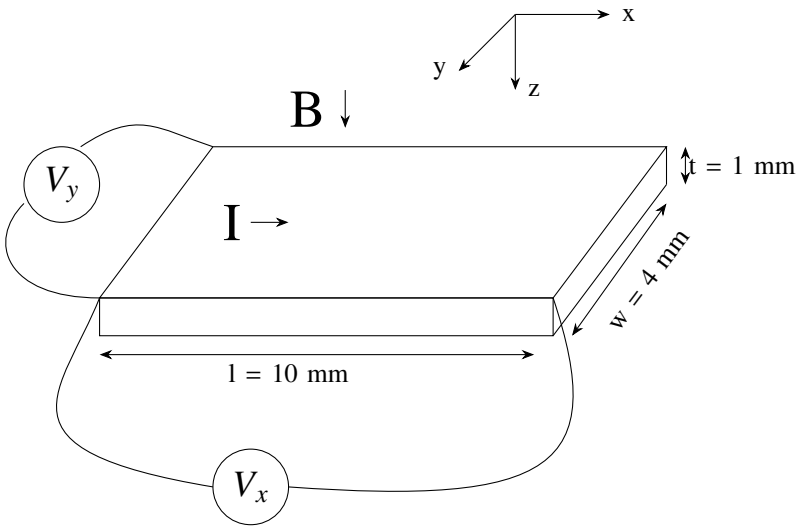
The emergent electromagnetic wave would be

(PH:2018)

a) elliptically polarized
b) circularly polarized
c) linearly polarized with polarization as that of incident wave
d) linearly polarized but with polarization at 90 deg to that of the incident wave

12) A p-doped semiconductor slab carries a current $I = 100mA$ in a magnetic field $B = 0.2T$ as shown. One measures $V_y = 0.25mV$ and $V_x = 2mV$. The mobility of holes in the semiconductor is _____$m^2V^{-1}s^{-1}$(up to two decimal places).

(PH:2018)



13) An n-channel FET having Gate-Source switch-off voltage $V_{GS(OFF)} = -2V$ is used to invert a $0-5V$ square-wave signal as shown. The maximum allowed value of R would be _____$k\Omega$ (up to two decimal places).

(PH:2018)