

Assignment 11

DESABOINA SRI SATHWIK-AI24BTECH11007

GATE-2018:PH

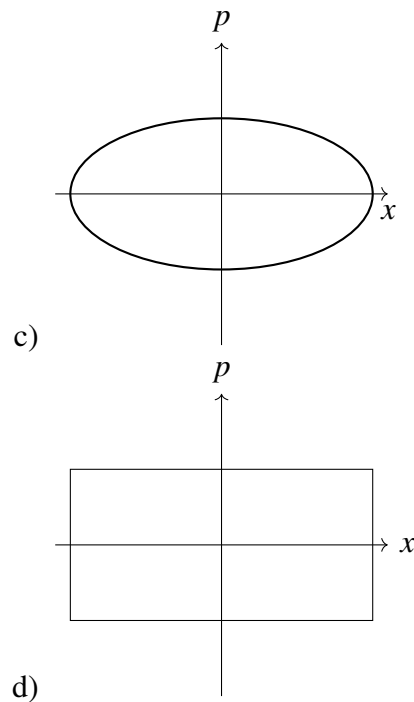
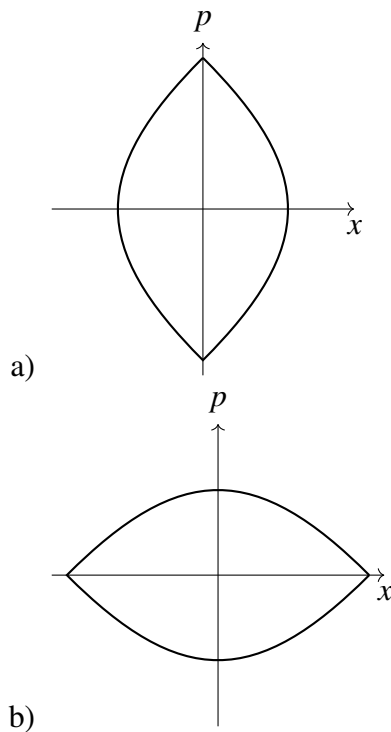
- 1) An interstellar object has speed v at the point of its shortest distance R from a star of much larger mass M . Given $v^2 = \frac{2GM}{R}$, the trajectory of the object is:

(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)



- 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) $\frac{1}{2}\mu_0 NR\omega\alpha \sin \omega t$ c) $\mu_0 NR\omega\alpha \sin \omega t$
 b) $\frac{1}{2}\mu_0 \omega NR \cos \omega t$ 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) $B_0x\hat{j}$ 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)

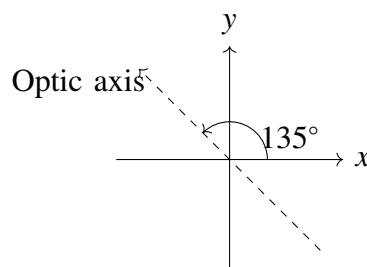
- a) $\frac{2\hbar^2}{Wa^2}$ b) $\frac{\hbar^2}{Wa^2}$ c) $\frac{\hbar^2}{2Wa^2}$ d) $\frac{\hbar^2}{4Wa^2}$

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 $\vec{E} = (\hat{x} + \hat{y})E_0 e^{i(kz - \omega t)}$ is incident normally on a quarter wave plate which has its optic axis making an angle 135° with the x -axis as shown.



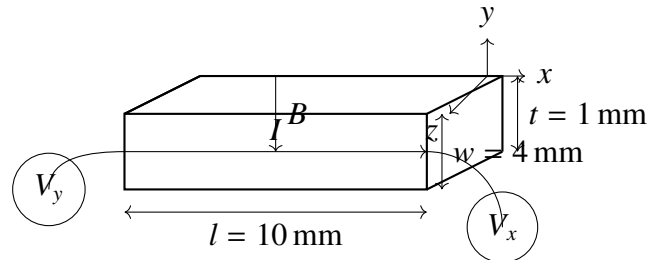
The emergent electromagnetic wave would be

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

(PH:2018)



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

(PH:2018)

