GS2025 Physics entrance question paper(PhD)

Section A

A1 Consider the triangle subtended on the surface of a sphere of radius 1 by joining the points $(\frac{1}{2}, \frac{\sqrt{3}}{2}, 0)$, $\left(-\frac{1}{2}, \frac{\sqrt{3}}{2}, 0\right)$, and $(0, 0, 1)$ with arcs of great circles. The area subtended by this triangle on the surface of the sphere is given by:

(Hint: Drawing a figure might help.)

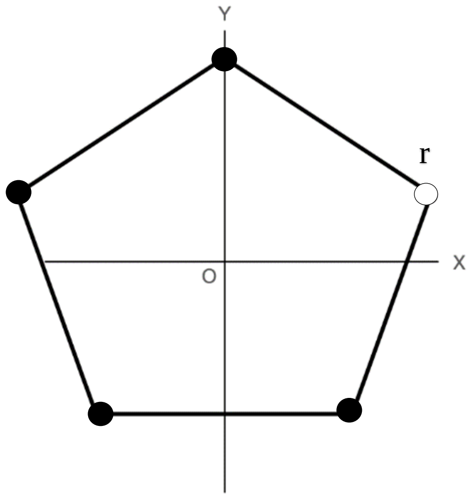
(a) $\pi/3$

(b) $\sqrt{3}\pi/2$

(c) $\sqrt{3}\pi$

(d) $2\pi/3$

A2 The Figure on the right shows a regular pentagon. The black solid circles on its vertices represent point charges with charge $-q$. There is no charge at the position of the white circle at **r** (measured from the origin, O, placed at the centre of the pentagon). The electric field at O is given by:



(a) $$\mathbf{E} = \frac{-q\,\mathbf{r}}{4\pi\epsilon_0 r^3}$$

(b) $$\mathbf{E} = \frac{-4q\,\mathbf{r}}{4\pi\epsilon_0 r^3}$$

(c) $$\mathbf{E} = \frac{q\,\mathbf{r}}{4\pi\epsilon_0 r^3}$$

(d) $$\mathbf{E} = \frac{-4q(\sin\frac{\pi}{10}\,\hat{\mathbf{x}} + \cos\frac{\pi}{10}\hat{\mathbf{y}})}{4\pi\epsilon_0 r^2}$$

A3 Consider a two dimensional insulating solid crystal. At low temperature, how does the specific heat at constant area $c_a = \frac{d\mathcal{E}}{dT}$, where $\mathcal{E}$ is the energy per unit area, depend on T?

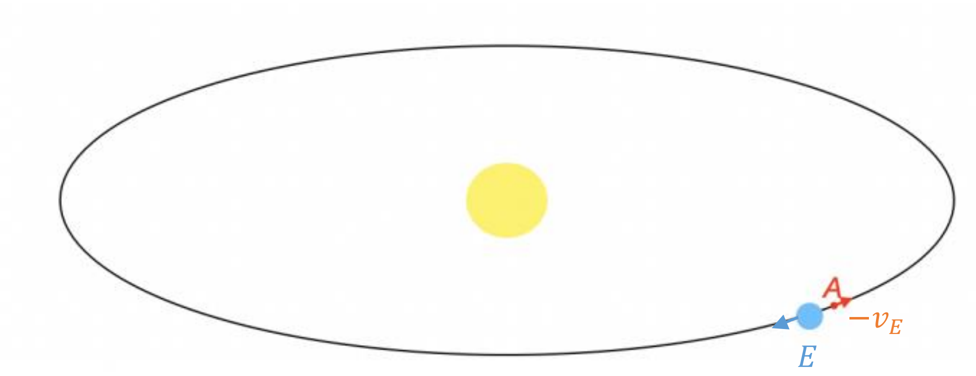
(a) $c_a \sim T^2$

(b) $c_a \sim T^3$

(c) $c_a \sim T$

(d) c_a is independent of T

A4 The Figure below shows a rocket (red arrow) launched from the earth which is now at a point A where the Earth's gravitational field is negligible. The rocket thrusters have stopped. In the rest frame of the Sun, the velocity of the rocket at A is same in magnitude but opposite in direction to that of the earth was, when it was at the same point. Which of the following statements is correct?



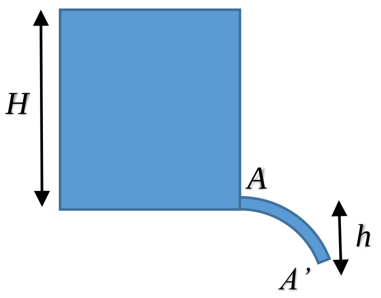
(a) The rocket will move exactly on the earth's elliptical orbit shown in the figure and eventually collide with the earth

(b) The rocket will eventually escape the Sun's gravitational field

(c) The rocket will eventually reverse its direction and follow the earth

(d) The rocket will turn towards the sun and eventually collide with it

A5 Water is flowing out of a small horizontal opening of area, A, at the bottom of a tank of height H. The flow is a laminar flow under the influence of gravity. What is the area, A', of the stream transverse to the fluid velocity, at a height h below the opening? (Neglect atmospheric pressure and dissipation effects. The thickness of the stream is negligible compared to H and h.)



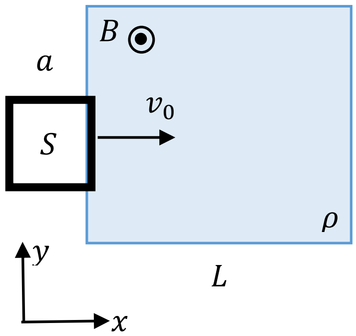
(a) $A\sqrt{\frac{H}{h+H}}$

(b) $A\frac{H}{h+H}$

(c) $A(1+\frac{h}{H})$

(d) $A\sqrt{1+\frac{h}{H}}$

A6 A small metallic wire with mass m and electric resistance R is bent into a closed square shape S with sides a. It passes through a region ρ of length $L > a$ with magnetic field $B\hat{z}$. The initial velocity $v_0\hat{x}$ of the square is large enough that it emerges out of ρ from the right. What is the final velocity of S after it completely emerges from ρ?



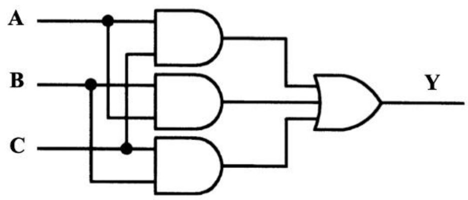
(a) $v_0\left(1-\dfrac{a^3B^2}{mRv_0}\right)^2\hat{x}$

(b) $v_0 e^{-\frac{a^2B^2L}{mRv_0}}\hat{x}$

(c) $v_0(1-\dfrac{a^3B^2}{mRv_0})\hat{x}$

(d) $v_0\hat{x}$

A7 The output pulse train Y of the circuit shown on the right, with three synchronized input trains,



$$A = 00001111$$

$$B = 00110011$$

$$C = 01010101$$

will be:

(a) 00010111

(b) 00100111

(c) 01010101

(d) 00010001

A8 Consider a stationary electron in a uniform, time-independent magnetic field of strength $B_0/4$ oriented in the $\hat{z}$-direction. The Hamiltonian for this system is expressed as

$$H = -\frac{e}{m}\boldsymbol{S}.\boldsymbol{B}$$

where $\boldsymbol{S}$ is the spin-$1/2$ operator for electrons. The initial electron spin is oriented in the $\hat{x}$-direction. The spin precession frequency of the electrons is:

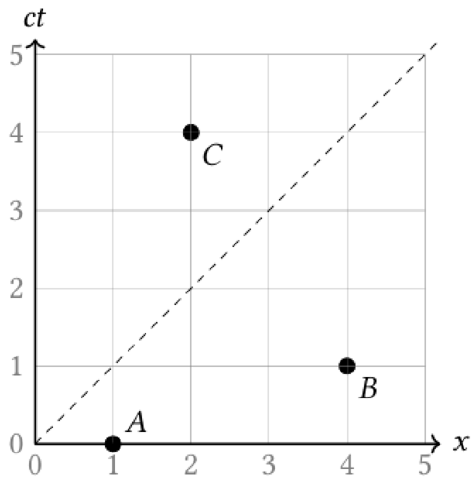
(a) $\frac{|e|\hbar B_0}{4m}$

(b) $\frac{|e|\hbar B_0}{8m}$

(c) $\frac{|e|\hbar B_0}{2m}$

(d) 0

A9 Consider the following space-time diagram which indicates three events A, B and C for an inertial observer. Which of the following statements is true?



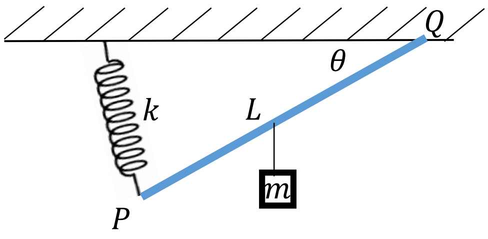
(a) It is always possible to find an inertial observer for whom events A and B are simultaneous. However, no inertial observer can be found for whom events A and C are simultaneous.

(b) It is always possible to find an inertial observer for whom events A and C are simultaneous. However, no inertial observer can be found for whom events A and B are simultaneous.

(c) It is always possible to find an inertial observer for whom events A and B are simultaneous. Similarly, an inertial observer can also be found for whom events A and C are simultaneous.

(d) It is impossible to find an inertial observer for whom events A and B are simultaneous. Similarly, no inertial observer can be found for whom events A and C are simultaneous.

A10 A massless rigid rod of length L is suspended with an ideal spring of spring constant k at one end P, and by a hinge on the other end, Q. The rest length of the spring is zero. A mass m is suspended from the mid-point of the rod. This results in tilting of the rod by angle θ. What is the angle θ?



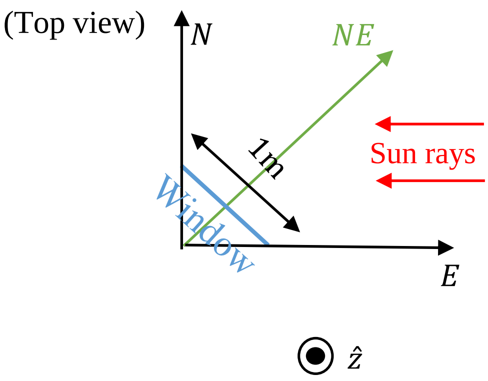
(a) $\tan^{-1}\left(\frac{mg}{2kL}\right)$

(b) $\sin^{-1}\left(\frac{mg}{2kL}\right)$

(c) $\cos^{-1}\left(\frac{mg}{kL}\right)$

(d) $\sec^{-1}\left(\frac{mg}{kL}\right)$

A11 There is an open window of dimension $1\text{m} \times 1\text{m}$ on the north east (NE) facing wall of a house. At 9 AM, the sun shines through the window and illuminates a certain part of the floor of the house. What is the area A illuminated by the sun? (Assume that the sun rises in the east (E) at 6 AM and is directly overhead ($\hat{z}$) at 12 noon.)



(a) $\frac{1}{\sqrt{2}}\ \text{m}^2$

(b) $1\ \text{m}^2$

(c) $\frac{1}{2}\ \text{m}^2$

(d) $\sqrt{2}\ \text{m}^2$

A12 For a one dimensional quantum harmonic oscillator, at time $t = 0$, the particle is in the ground state. What is the expectation value of the position and momentum operator at time t?

(a) $\langle x(t) \rangle = \langle p(t) \rangle = 0$

(b) $\langle x(t) \rangle = \sqrt{\frac{\hbar}{m\omega}} \sin \omega t \,, \langle p(t) \rangle = 0$

(c) $\langle x(t) \rangle = \sqrt{\frac{\hbar}{m\omega}} \sin \omega t \,, \langle p(t) \rangle = \sqrt{\hbar m\omega} \cos \omega t$

(d) $\langle x(t) \rangle = 0, \langle p(t) \rangle = \sqrt{\hbar m\omega} \cos \omega t$

A13 Consider two ideal gases A and B with atomic masses m_A and m_B respectively such that $m_A > m_B$. The two gases with same number of moles are kept at the same temperature and confined in containers with the same volume. Which of the gases will exert more pressure and molecules of which gas will have a higher RMS momentum?

(a) Both will exert the same pressure but molecules of Gas A will have more RMS momentum

(b) Gas A will exert more pressure and molecules of Gas B will have more RMS momentum

(c) Gas B will exert more pressure but molecules of Gas A will have more RMS momentum

(d) Both will exert the same pressure and molecules of both gases have the same RMS momentum

A14 For a given measurement of particles in a counter, a 10-minute data collection resulted in a statistical uncertainty of 2.5%. How much additional time must be allocated to reduce the statistical uncertainty to 0.5%?

(a) 240 minutes

(b) 40 minutes

(c) 250 minutes

(d) 50 minutes

A15 Laser light is incident normally on a thin film of material with a refractive index (n_s) larger than that of air ($n_a \approx 1$). As the wavelength of the laser light is varied, the intensity of the transmitted light through the film shows a peak at 633 nm. If the thickness of the film is 118 nm, the minimum n_s is closest to:

(a) 2.68

(b) 5.36

(c) 1.34

(d) 3.68

A16 The asymptotic expansion of the following function for $x \to \infty$

$$x \tanh^{-1} \frac{1}{x}$$

is given by:

(a) $1 + \frac{1}{3x^2} + \frac{1}{5x^4} + \frac{1}{7x^6} + \cdots$

(b) $1 - \frac{1}{3x^2} + \frac{1}{5x^4} - \frac{1}{7x^6} + \cdots$

(c) $x + \frac{1}{2x} + \frac{1}{4x^3} + \frac{1}{6x^5} + \cdots$

(d) $1 + \frac{1}{2x^2} + \frac{1}{4x^4} + \frac{1}{6x^6} + \cdots$

A17 The $n \times n$ $(n > 4)$ matrix M, with all entries equal to 1 has:

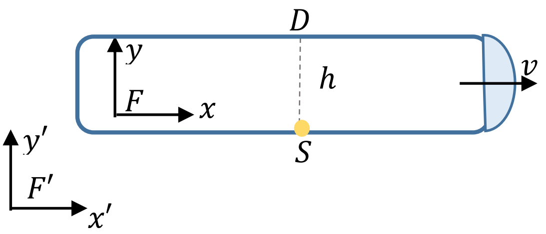
(a) Precisely $n - 1$ degenerate eigenvalues and one other non-degenerate eigenvalue

(b) Precisely $n - 2$ degenerate eigenvalues and two other non-degenerate eigenvalues

(c) Precisely 2 degenerate eigenvalues and $n - 2$ other non-degenerate eigenvalues

(d) No degenerate eigenvalues

A18 A spaceship is moving with a constant relativistic velocity $v\hat{x}'$ with respect to an inertial frame F'. In the frame F moving with spaceship, light is emitted from the source S and is detected at the detector D with displacement $h\hat{y}$ from S. In the frame F', what is the time t' taken for the light to reach from S to D?



(a) $$\frac{\left(\frac{h}{c}\right)}{\sqrt{1 - v^2/c^2}}$$

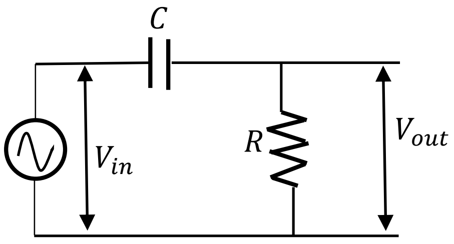
(b) $\left(\frac{h}{c}\right)\sqrt{1 - v^2/c^2}$

(c) $\left(\frac{h}{c}\right)\sqrt{\frac{1 - v/c}{1 + v/c}}$

(d) $\left(\frac{h}{c}\right)$

A19 The sinusoidal signal

$$V_{in} = V_i \sin(2\pi f t)$$



is given to a high-pass filter (see Figure). The output signal is given by

$$V_{out} = V_i\,|A| \sin(2\pi f t + \phi).$$

What is the value of $|A|$?

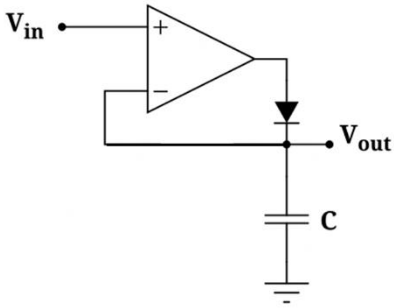
(a) $$\frac{1}{\left|1+\left(\frac{1}{2\pi RCf}\right)^2\right|^{1/2}}$$

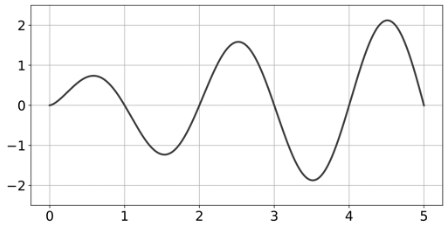
(b) $$\frac{1}{\left|1+\left(\frac{1}{2\pi RCf}\right)\right|}$$

(c) $$\frac{1}{\left|1+\left(\frac{1}{2\pi RCf}\right)^2\right|}$$

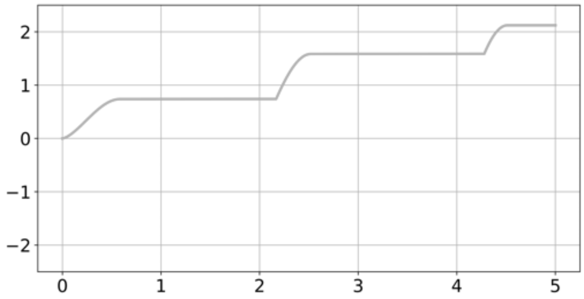
(d) $$\frac{1}{\left|1+\left(\frac{1}{2\pi RCf}\right)\right|^{1/2}}$$

A20 For the circuit on the right, which graph represents V_{out} correctly for the V_{in} shown below?

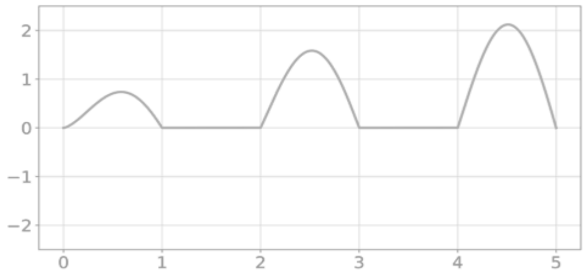




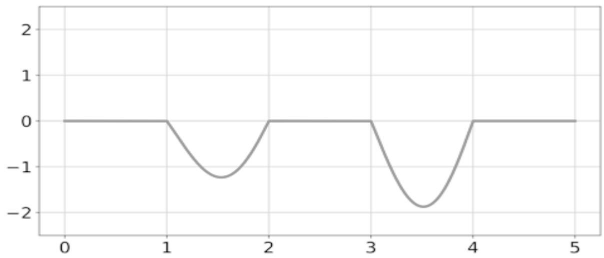
(a)



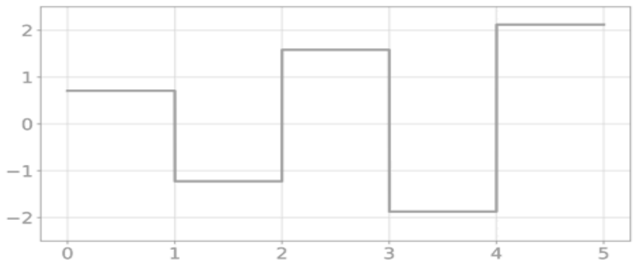
(b)



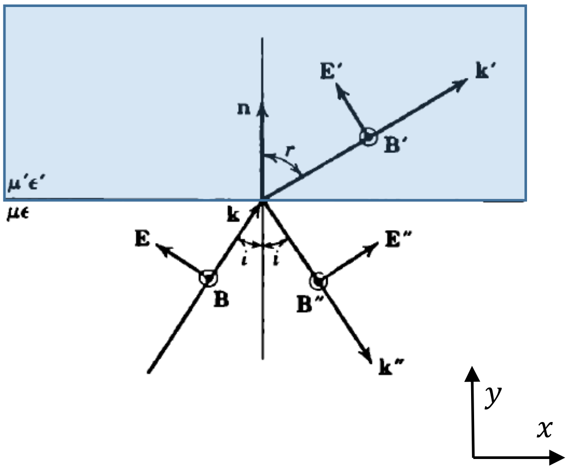
(c)



(d)



A21 Light in medium with electric permittivity ϵ and magnetic permeability μ is incident on a medium with electric permittivity ϵ' and magnetic permeability μ'. The angle of incidence is i. The E field is linearly polarized in the plane as shown, and the B field is in the $\hat{z}$ direction. Which of the following is a correct boundary condition on the fields?



(a) $\epsilon\,(E \sin i + E'' \sin i) = \epsilon' E' \sin r$

(b) $\epsilon\,(E \cos i - E'' \cos i) = \epsilon'\, E' \cos r$

(c) $E \sin i + E'' \sin i = E' \sin r$

(d) $\mu\,(B + B'') = \mu' B'$

A22 An experimental set-up needs to be kept in an environment with zero magnetic field by minimizing the Earth's magnetic field. This can be achieved by:

(a) Keeping the setup in a place completely covered with a sheet of metal of very high magnetic permeability

(b) Keeping the setup in a place completely covered with a sheet of metal of very high permittivity

(c) Keeping the setup at the centre of the interior of a long solenoid

(d) Keeping the setup in a place completely covered with a sheet of an insulating material

A23 Two types of particles A and B have the same mass, but are distinguished by an internal degree of freedom. A classical ideal gas in a volume V at temperature T contains (X) $2N$ particles of A-type and (Y) N particles of A-type and N particles of B-type. Which of the following is true?

(a) Pressure of (X) and (Y) are same; (Y) has more entropy than (X)

(b) Pressure of (X) and (Y) are same; (X) has more entropy than (Y)

(c) Pressure of (X) is greater than pressure of (Y); (X) has more entropy than (Y)

(d) Pressure of (X) is greater than pressure of (Y); (Y) has more entropy than (X)

A24 A negative electric charge $-q$ moves in a (classical) circular orbit at a non-relativistic speed v around a positive charge. The magnetic field at the centre of the circular orbit due to the negative charge is found to be B_1. Now, consider another situation where a negative charge $-2q$ moves in a circular orbit at the same speed v around the same positive charge. The magnetic field at the centre of the circular orbit in this case is B_2. What is the ratio B_2/B_1?

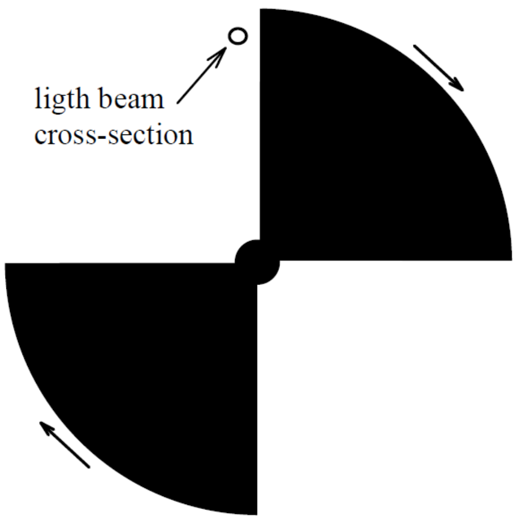
(a) $1/2$

(b) 1

(c) 2

(d) 4

A25 Consider a fan with blades rotating with frequency f, as shown in the Figure. It is used to periodically block a light beam of intensity I_0. The beam has a very small cross-sectional area and hits the blade near its outer edge, as shown. The transmitted beam is detected by a photo-detection unit which gives out a voltage signal V proportional to the transmitted intensity I. If this voltage signal pattern is displayed on an oscilloscope, what would best describe the signal pattern?



(a) $V_0\,[\frac{1}{2} + \sum_n \frac{4}{\pi n} \sin(2n\pi f t)], \qquad n = 2,6,10,14 \ldots$

(b) $V_0 \sum_n [\cos^2(2n\pi f t) - \sin^2(2n\pi f t)], \qquad n = 2,6,10,14 \ldots$

(c) $V_0\,[\frac{1}{2} + \frac{1}{2}\sin(4\pi f t)]$

(d) $V_0[\cos^2(4\pi f t)]$

Section C

C1 Consider two random variables x and y described by the joint distribution

$$P(x,y) = \frac{1}{2\pi\sqrt{1-a^2}} e^{\frac{2axy - x^2 - y^2}{2(1-a^2)}}$$

with $0 < a < 1$. If the above distribution is written in terms of orthogonal coordinates $z = x - y$ and $u = x + y$, the probability distribution in z is given by:

(a) A Gaussian with mean 0 and standard deviation $\sqrt{2(1-a)}$

(b) A Gaussian with mean $\sqrt{a}$ and standard deviation $\sqrt{2(1-a)}$

(c) A Gaussian with mean 0 and standard deviation $\sqrt{2(1-a^2)}$

(d) Not a Gaussian distribution

C2 Consider a particle with mass m in a quantum harmonic oscillator potential with a frequency ω, such that its Hamiltonian is

$$\hat{H} = \frac{\hat{p}^2}{2m} + \frac{m\omega^2\hat{x}^2}{2}$$

The Hamiltonian is perturbed by adding a term to the potential

$$\Delta\hat{H} = \lambda \sin\hat{x}$$

where λ is small compared to $\hbar\omega$. The relative change in the ground state energy, to the leading order in $\lambda/(\hbar\omega)$ is given by:

(a) $O(\frac{\lambda^2}{(\hbar\omega)^2})$

(b) $O(\frac{\lambda}{(\hbar\omega)})$

(c) $O(1)$

(d) The ground state energy does not change

C3 A relativistic particle moving under the central force of gravity experiences the following effective potential:

$$V_{\text{eff}}(r) = -\frac{GMm}{r} + \frac{l^2}{2mr^2} - \frac{GMl^2}{m\,c^2\,r^3}$$

where the last term is the relativistic correction to the Newtonian formula. The smallest radius at which a stable circular orbit can exist for some value of the angular momentum l is given by:

(a) $\frac{6GM}{c^2}$

(b) $\frac{3GM}{c^2}$

(c) $\frac{2GM}{c^2}$

(d) There are no stable circular orbits

C4 The integral

$$\int_{-\infty}^{+\infty} dk \; \frac{e^{-ikx}}{k^2 + 1}$$

is given by:

(a) πe^{-x}

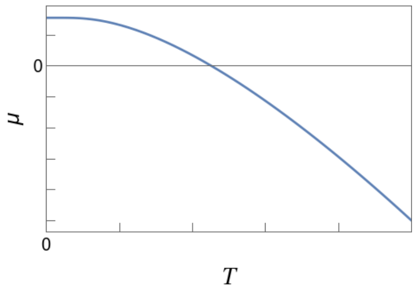
(b) πe^{x}

(c) $-\pi e^{-x}$

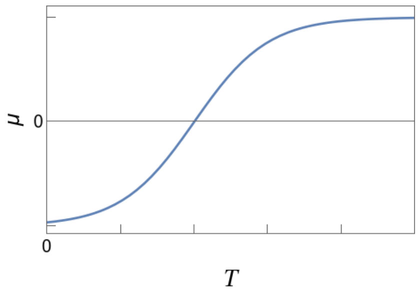
(d) $-\pi e^{x}$

C5 Consider a (non-relativistic) gas of fermions in a container with a fixed density n. Which plot best describes how the chemical potential μ changes with T?

(a)



(b)



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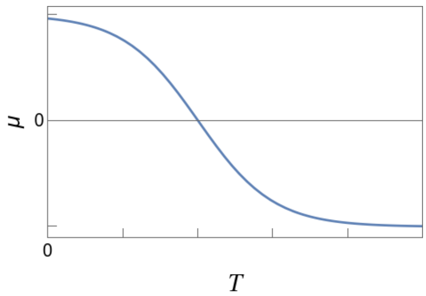
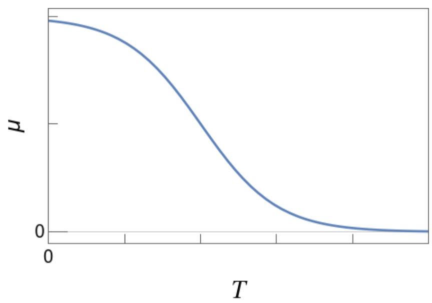
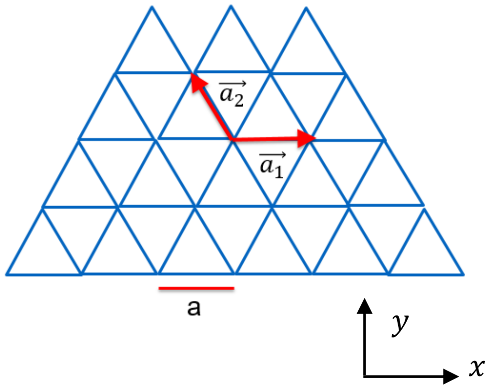


(d)



C6 A triangular lattice with lattice constant a has primitive vectors $\overrightarrow{a_1}$ and $\overrightarrow{a_2}$, as shown in the Figure. The primitive wavevectors for the reciprocal lattice are given by:



(a) $\overrightarrow{b_1} = \dfrac{2\pi}{a}\,\hat{x} + \dfrac{2\pi}{a\sqrt{3}}\,\hat{y}, \qquad \overrightarrow{b_2} = \dfrac{4\pi}{a\sqrt{3}}\,\hat{y}$

(b) $\overrightarrow{b_1} = \dfrac{2\pi}{a\sqrt{3}}\,\hat{x} + \dfrac{2\pi}{a}\,\hat{y}\,, \qquad \overrightarrow{b_2} = \dfrac{4\pi}{a\sqrt{3}}\,\hat{y}$

(c) $\overrightarrow{b_1} = \dfrac{2\pi}{a}\,\hat{x} - \dfrac{2\pi}{a\sqrt{3}}\,\hat{y}, \qquad \overrightarrow{b_2} = \dfrac{4\pi}{a\sqrt{3}}\,\hat{x}$

(d) $\overrightarrow{b_1} = \dfrac{2\pi}{a\sqrt{3}}\,\hat{x} - \dfrac{2\pi}{a}\,\hat{y}\,, \qquad \overrightarrow{b_2} = \dfrac{4\pi}{a\sqrt{3}}\,\hat{x}$

C7 Consider a free-particle in 3 spatial dimensions described by the Hamiltonian

$$\hat{H} = \frac{\hat{\boldsymbol{p}}^2}{2m}$$

It is initially in a state described by a normalized wavefunction

$$\psi(\mathbf{r}, t = 0) = \left(\frac{\gamma}{\pi}\right)^{3/4} e^{-\gamma r^2/2}.$$

What is the probability density of finding the particle with energy E at time t?

(Hint: Express the wavefunction in momentum space.)

(The following integral might be useful: $\int_{-\infty}^{+\infty} dx\, \frac{1}{\sqrt{2\pi}} e^{-ikx} e^{-\gamma x^2/2} = \frac{1}{\sqrt{\gamma}} e^{-k^2/(2\gamma)}$.)

(a) $\frac{4\pi m}{\hbar^3}(\gamma\pi)^{-3/2}\sqrt{2mE}\,e^{-2mE/(\gamma\hbar\text{^}2)}$

(b) $\frac{4\pi m}{\hbar^3}(\gamma\pi)^{-3/2}\sqrt{\frac{2m\hbar}{t}}\,e^{-2mE/(\gamma\hbar\text{^}2)}$

(c) $\frac{2m}{\hbar}\frac{1}{\sqrt{2mE}}(\gamma\pi)^{-1/2}e^{-2mE/(\gamma\hbar\text{^}2)}$

(d) $\frac{2\pi m}{\hbar^2}(\gamma\pi)^{-1}e^{-2mE/(\gamma\hbar\text{^}2)}$

C8 Consider two relativistic particles, each with mass m and momentum of magnitude p, colliding head-on. As a result of the collision, two heavier particles are produced, each with mass αm, where $\alpha > 1$. The minimum value of p required for this collision to occur is:

(a) $\sqrt{\alpha^2 - 1}mc$

(b) $(\alpha - 1)mc$

(c) $2\alpha mc$

(d) $(\sqrt{\alpha} - 1)^2 mc$

C9 Consider a particle P moving on a one-dimensional discrete lattice with lattice constant a. P can hop from one site to a neighbouring site. The probabilities of moving to the right and left are p and $q = 1 - p$, respectively. Starting from the origin $x = 0$ at time $t = 0$, what is the mean square displacement $\langle (x - \langle x \rangle)^2 \rangle$ after N steps, where $\langle x \rangle$ is the average position at time t?

(a) $4Na^2 pq$

(b) $4Na^2(p - q)$

(c) $2Na^2 pq$

(d) $2Na^2(p - q)$

C10 In the shell model of a nucleus, states of nucleons (protons or neutrons) in a spherically symmetric potential are labelled as nL_j, where n is the principal quantum number, L is the angular momentum quantum number (s, p, d, f correspond to $L = 0,1,2,3$ respectively), and $\hat{J} = \hat{L} + \hat{S}$. The spin-orbit interaction is given by

$$\hat{H}_{so} = C\,\hat{L}.\hat{S}$$

If the strength of spin-orbit interaction is $C = -2$ MeV, the energy difference between two nucleonic states $1d_{5/2}$ and $1d_{3/2}$ is given by:

(a) 5 MeV

(b) 2 MeV

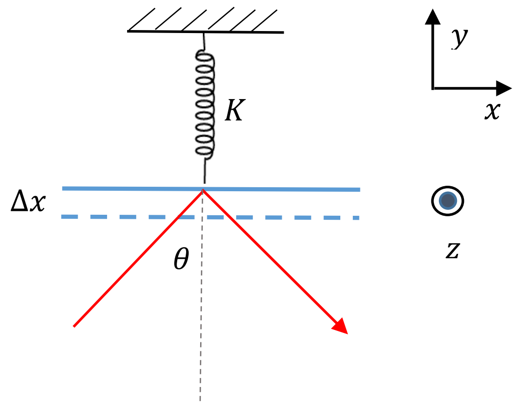
(c) 3 MeV

(d) 4 MeV

C11 A perfect mirror is hanging from the ceiling via a spring of spring constant K. A plane wave laser beam with area A and

$$E(\mathbf{r}, t) = E_0 \hat{z} \cos(\mathbf{k} \cdot \mathbf{r} - \omega t)$$

is incident on the mirror at an angle θ, and lifts the mirror by Δx. What is Δx (averaged over a cycle) in terms of K, E_0, ϵ_0, and μ_0?



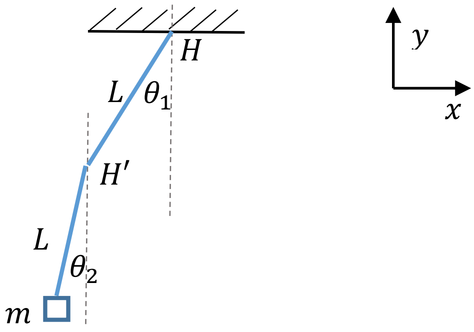
(a) $\frac{E_0^2 A \cos\theta}{K}\sqrt{\frac{\epsilon_0}{\mu_0}}$

(b) $\frac{E_0^2 A \cos^2\theta}{K}\sqrt{\frac{\epsilon_0}{\mu_0}}$

(c) $\frac{E_0^2 A}{K}\sqrt{\frac{\epsilon_0}{\mu_0}}$

(d) $\frac{2E_0^2 A \cos^2\theta}{K}\sqrt{\frac{\epsilon_0}{\mu_0}}$

C12 A composite pendulum consists of two massless rods and a weight m. The two rods are connected by a hinge H'. The other end of the first rod is connected to the ceiling by a hinge H. The rods can move freely about H, H' in the xy plane. What is the Lagrangian of the system?



(a) $\dfrac{L^2 m\left(\dot{\theta}_1^2 + \dot{\theta}_2^2 + 2\dot{\theta}_1\dot{\theta}_2\cos(\theta_1 - \theta_2)\right)}{2} + gLm(\cos\theta_1 + \cos\theta_2)$

(b) $\dfrac{L^2 m\left(\dot{\theta}_1^2 + \dot{\theta}_2^2\right)}{2} + gLm(\cos\theta_1 + \cos\theta_2)$

(c) $\dfrac{L^2 m\left(\dot{\theta}_1^2 + \dot{\theta}_2^2 + 2\dot{\theta}_1\dot{\theta}_2\sin(\theta_1 - \theta_2)\right)}{2} - gLm(\cos\theta_1 + \cos\theta_2)$

(d) $\dfrac{L^2 m\left(\dot{\theta}_1^2 + \dot{\theta}_2^2 - 2\dot{\theta}_1\dot{\theta}_2\cos(\theta_1 - \theta_2)\right)}{2} - gLm(\cos\theta_1 + \cos\theta_2)$

C13 Consider the alpha decay of ^{224}U at rest, to ^{220}Th. The atomic masses are given below:

M_{224U} = 224.0276 amu; M_{220Th} = 220.0158 amu; M_{4He} = 4.0026 amu.

What is the estimate of the kinetic energy of the emitted alpha (^{4}He) particle? (One amu corresponds to 931.5 MeV/c^2.)

(a) 8.4163 MeV

(b) 8.5698 MeV

(c) 8.7261 MeV

(d) 8.1066 MeV

C14 Two students perform a counting experiment independently. Student A measures the counts for 1-minute intervals each and repeats the measurement five times. The obtained counts are given below.

Measurement turn	Counts
1	25
2	35
3	30
4	23
5	27

This student then takes the mean of these counts and reports the count rate (counts/min). The second student (B) makes one measurement for five minutes. She measures 145 counts and reports the count rate (counts/min). If the clock used for all these measurements is accurate up to 0.1 minutes, and there are no other sources of uncertainties, we can conclude that:

(a) The count rate reported by student A will have a larger uncertainty than that reported by student B.

(b) The count rate reported by student B will have a larger uncertainty than that reported by student A.

(c) The reported uncertainty in both results would be identical

(d) Nothing may be concluded about the relative uncertainties between A and B

C15 O_2 is a linear molecule. (The bond length of the oxygen molecule is 1.2Å, and the mass of an oxygen atom is 2.7×10^{-26}kg.) A neutron strikes an O_2 molecule and loses energy by exciting a rotational energy level of O_2.Which of the following is the best estimate of the lowest amount of energy the neutron would have to transfer to the O_2 molecule? (Take the transfer of translational kinetic energy to be negligible.)

(a) 3.6×10^{-4}eV

(b) 7.2×10^{-4}eV

(c) 1.8×10^{-4}eV

(d) 1.4×10^{-3}eV