

HCU-2015

Q1. The unit vector parallel to the resultant of the vectors $\vec{r}_1 = 2\hat{i} + 4\hat{j} - 5\hat{k}$ and $\vec{r}_2 = \hat{i} + 2\hat{j} + 3\hat{k}$ is given by

(a) $\frac{1}{3}\hat{i} + \frac{1}{6}\hat{j} - \frac{1}{2}\hat{k}$

(b) $\frac{3}{7}\hat{i} + \frac{6}{7}\hat{j} - \frac{2}{7}\hat{k}$

(c) $\frac{2}{7}\hat{i} - \frac{3}{7}\hat{j} + \frac{6}{7}\hat{k}$

(d) $3\hat{i} + 6\hat{j} - 2\hat{k}$

Q2. The solution to the differential equation $\frac{d^2x}{dt^2} = t^2$ is given by

(a) $x = \frac{t^3}{3} + A$

(b) $x = \frac{t^3}{3} + At + B$

(c) $x = \frac{t^4}{12} + At + B$

(d) $x = \frac{t^3}{3} + \frac{t^2}{2} + A$

where A and B are constants.

Q3. If $T = \sin x \sin y \sin z$, $\nabla^2 T$ is given by

(a) 0

(b) $-2 \sin x \sin y \sin z$

(c) $3 \sin x \sin y \sin z$

(d) $-3 \sin x \sin y \sin z$

Q4. a force $F = -A(x^2\hat{i} + y\hat{j})$ is irrotational. The potential energy function associated with it is given by

(a) $U = A\left(\frac{x^2}{3} + \frac{y^2}{2}\right)$

(b) $U = A\left(\frac{x}{3} + \frac{y^2}{2}\right)$

(c) $U = A\left(\frac{x^2}{3} + \frac{y}{2}\right)$

(d) $U = A\left(\frac{x}{3} + \frac{y^3}{2}\right)$

Q5. A bead moves outward with constant speed u along the spoke of a wheel. It starts from the centre at $\theta = \omega t$. The angular position of the spoke is given by ωt , where ω is a constant. The acceleration of the bead is given by

(a) $u\omega^2\hat{r} + u\omega\hat{\theta}$

(b) $u\hat{r} + u\omega\hat{\theta}$

(c) $u\omega^2\hat{r} + u\omega\hat{\theta}$

(d) $-u\omega^2\hat{r} + 2u\omega\hat{\theta}$

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

- Q6. A solid cylinder and a hollow cylinder are placed at the same height at the top of a long incline and released at the same time.
- (a) Both the cylinders reach the bottom together.
 (b) Solid cylinder reaches the bottom first.
 (c) Hollow cylinder reaches the bottom first
 (d) Any one of them can reach the bottom first.
- Q7. A large vertical drum spins so fast that a ball inside it, is pinned to the wall. What is the minimum steady angular velocity ω which prevents the ball from falling to the bottom of the drum? (The radius of the drum is R , the mass of the ball is M and μ is the co-efficient of friction.)
- (a) $\omega^2 \geq \frac{Mg}{R}$ (b) $\omega^2 \geq \frac{g}{\mu R}$ (c) $\omega^2 \geq \frac{g}{MR}$ (d) $\omega^2 \geq \frac{\mu g}{R}$
- Q8. The equation of traveling wave is given as: $y = 10\cos\left(\frac{\pi}{5\text{cm}}x - \frac{\pi}{20\text{s}}t\right)$. What is the speed of the wave?
- (a) 1cm/s (b) 0.5cm/s (c) 0.25cm/s (d) 0.1cm/s
- Q9. Two sound sources oscillate in phase with a frequency of 100Hz . At a point 5m from one source and 5.85m from the other the amplitude of the sound from each source separately is A . What is the phase difference of the two waves at that point (Assume that the speed of sound is 343m/s .)
- (a) 99° (b) 45° (c) 60° (d) 89°
- Q10. It is given that surface tension of water is 0.072N/m and its density 10^3kg/m^3 . What is the height to which water will rise in a tube of diameter 0.2mm ?
- (a) 14.7cm (b) 34.2cm (c) 29.4cm (d) 1.27cm
- Q11. An air bubble of diameter 2mm rises steadily through a solution of density 1750kg/m^3 at the rate of 0.35cm/sec . If the density of air is negligible, what is the coefficient of viscosity of the solution?
- (a) 1 poise (b) 11 poise (c) 20 poise (d) 4 poise

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
 Near IIT, Hauz Khas, New Delhi-16
 Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
 28-B/6, Jia Sarai, Near IIT
 Hauz Khas, New Delhi-16

- Q12. Internal energy of an idea gas changes when
- (a) temperature changes. (b) volume changes.
(c) entropy changes (d) pressure changes
- Q13. A gas expands adiabatically and reversibly to a temperature T_A . If the same expansion happens adiabatically, but irreversibly, the final temperature is T . Then
- (a) $T > T_A$ (b) $T < T_A$
(c) $T = T_A$ (d) T can take any value independent of T_A
- Q14. A cylinder fitted with a piston contains an ideal gas at 500 Kilo Pascals and occupies a volume of $0.2m^3$. The gas expands isothermally to a pressure of 100 Kilo Pascals. The work done by the gas is
- (a) 160.9 KJ (b) 16090 KJ (c) 16.09 KJ (d) 5×10^4 KJ
- Q15. The sun delivers about $1000W/cm^2$ of electromagnetic flux to the earth's surface. Assume 7% conversion efficiency of the solar panel of dimensions $8m \times 20m$. If the radiation is incident normally the solar power converted for use is
- (a) $11.42 \times 10^4 W$ (b) $11.35 \times 10^4 W$ (c) $1.56 \times 10^4 W$ (d) $1.12 \times 10^4 W$
- Q16. The angle of refraction for a light beam incident on a heavy flint glass ($n = 1.65$) at the polarizing angle is given by
- (a) 31.22° (b) 30.25° (c) 28.20° (d) 33.41°
- Q17. A radio pulse from a doppler radar reflects off an aircraft in mid-flight. If the frequency of the reflected radio pulse is less than the original one, then which of the following statements is true?
- (a) The aircraft is not moving.
(b) The aircraft is moving away from the radar
(c) The aircraft is moving towards the radar.
(d) Something is wrong with the radar

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

Q18. The total charge within a sphere of radius r in a charge cloud is given by:

$$q \frac{r^2}{a^2} \left(e^{\frac{-r}{a}} - e^{\frac{-2r}{a}} \right).$$

The electric field at the surface of the above sphere is given by

(a) $\frac{q}{4\pi \epsilon_0 a^2} \left(e^{\frac{-r}{a}} - e^{\frac{r}{a}} \right)$

(b) $\frac{q}{\epsilon_0 a^2} \left(e^{\frac{-r}{a}} - e^{\frac{-2r}{a}} \right)$

(c) $\frac{q}{\epsilon_0 a^2} \left(e^{\frac{-2r}{a}} - e^{\frac{-r}{2a}} \right)$

(d) $\frac{q}{4\pi \epsilon_0 q^2} \left(e^{\frac{-r}{a}} - e^{\frac{-2r}{a}} \right)$

Q19. The electric field in the $x - y$ plane is given by $\vec{E} = \hat{i}8x - \hat{j}4y$. Then the equation for the lines of force is given by

(a) $xy^2 = \text{constant}$

(b) $x^2y = \text{constant}$

(c) $x^2 + y = \text{constant}$

(d) $xy = \text{constant}$

Q20. Consider Maxwell's equation: $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$. If ϕ is the scalar potential and \vec{A} is the vector potential, then \vec{E} can be written as

(a) $-\vec{\nabla}\phi - \vec{\nabla} \times \vec{A}$

(b) $-\vec{\nabla}\phi - \frac{\nabla \vec{A}}{\partial t}$

(c) $-\frac{\partial \phi}{\partial t} - \vec{\nabla} \times \vec{A}$

(d) $-\vec{\nabla}\phi - \frac{\partial}{\partial t} (\vec{\nabla} \times \vec{A})$

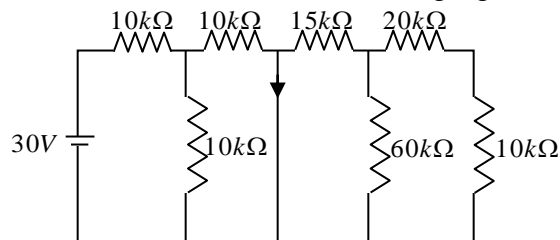
Q21. What is the current I_1 , flowing in the circuit shown in the following figure?

(a) Infinite

(b) 1 mA

(c) 0.5 mA

(d) zero



Q22. A 50Hz sinusoidal signal is applied to the input of a full-wave rectifier. The frequency of the output signal is

(a) 100Hz

(b) 50Hz

(c) 70.7Hz

(d) 0Hz

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

Q23. In a Bipolar Junction Transistor (BJT), the base-width is kept thinner than Emitter and Collector width. This is to

- (a) reduce the base current (b) increase the base current
 (c) increase the base current (d) decrease the collector current

Q24. If ψ_1 and ψ_2 are two independent solutions of the time-independent Schrödinger equation, which of the following is also a solution of the same Schrodinger equation?

- (a) $\psi_1 \times \psi_2$ (b) $\frac{\psi_1}{\psi_2}$ (c) $\psi_1 \pm \psi_2$ (d) $(\psi_1 \psi_2)^{1/2}$

Q25. If H_1 and H_2 are Hamiltonians of two non-interacting systems with wave functions ψ_1 and ψ_2 and energies E_1 and E_2 respectively, the total wave function Ψ and energy E of the composite system are given by

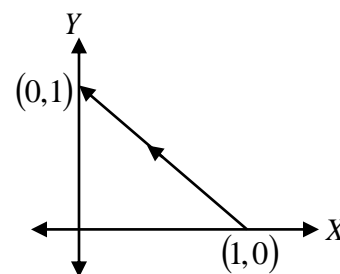
- (a) $\Psi = \psi_1 + \psi_2, E = E_1 + E_2$ (b) $\Psi = \psi_1 \psi_2, E = E_1 E_2$
 (c) $\Psi = \psi_1 + \psi_2, E = E_1 E_2$ (d) $\Psi = \psi_1 \psi_2, E = E_1 + E_2$

Q26. What value of α will make the matrix $\begin{pmatrix} 1 & 0 & 0 \\ 0 & \alpha & -\alpha \\ 0 & \alpha & \alpha \end{pmatrix}$ orthogonal?

- (a) $\sqrt{2}$ (b) 1 (c) $\frac{1}{\sqrt{2}}$ (d) $\frac{1}{2}$

Q27. The value of the integral of the function $f(x, y) = x^2 + y^2$ integrated along a straight line from $(1, 0)$ to $(0, 1)$ as shown in the figure is

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



Head office

fiziks, H.No. 23, G.F, Jia Sarai,
 Near IIT, Hauz Khas, New Delhi-16
 Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
 28-B/6, Jia Sarai, Near IIT
 Hauz Khas, New Delhi-16

Q28. If $abc = P$ and $A = \begin{bmatrix} a & b & c \\ c & a & b \\ b & c & a \end{bmatrix}$, where A is an orthogonal matrix, then the value of

$a + b + c$ is

- (a) 2 (b) P (c) $2P$ (d) ± 1

Q29. The general solution to the differential equation $\frac{d^2 y}{dx^2} - \frac{2dy}{dx} + 2y = 0$, is

- (a) $e^x [A \cos x + iB \sin x]$ (b) $e^{ix} [A \cos x + iB \sin x]$
 (c) $e^{ix} [A \cos x - iB \sin x]$ (d) $e^x [A \cos x - iB \sin x]$

where A and B are arbitrary constants.

Q30. In the complex z -plane, the equation $|z| = 2|z - 1|$ represents

- (a) a circle of radius $\frac{2}{3}$ (b) a circle of radius $\frac{1}{2}$,
 (c) a circle of radius $\frac{3}{2}$ (d) a straight line through $(0,0)$ and $(1,1)$.

Q31. The power series $\sum_{n=1}^{\infty} (-1)^n n^2 x^n$ converges for

- (a) $-1 < x < 1$ (b) $-1 \leq x \leq 1$ (c) $-1 < x \leq 1$ (d) $-1 \leq x <$

Q32. On changing variable from x to t where $t = \log x$, the differential equation

$$x^2 \frac{d^2 y}{dt^2} + \alpha e^t \frac{dy}{dt} + \beta y = 0, \text{ becomes}$$

- (a) $e^{2t} \frac{d^2 y}{dt^2} + \alpha e^t \frac{dy}{dt} + \beta y = 0$ (b) $\frac{d^2 y}{dt^2} + \alpha \frac{dy}{dt} + \beta y = 0$
 (c) $\frac{d^2 y}{dt^2} + \alpha \frac{dy}{dt} + (\alpha + \beta)y = 0$ (d) $\frac{d^2 y}{dt^2} + (\alpha - 1) \frac{dy}{dt} + \beta y = 0$

Head office

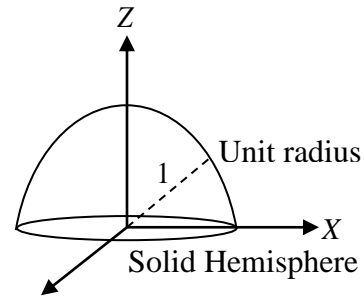
fiziks, H.No. 23, G.F, Jia Sarai,
 Near IIT, Hauz Khas, New Delhi-16
 Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
 28-B/6, Jia Sarai, Near IIT
 Hauz Khas, New Delhi-16

Q37. The centre of mass of a solid hemisphere (as shown in figure) of unit radius is given by

- (a) $\left(0, 0, \frac{3}{8}\right)$ (b) $\left(0, \frac{3}{8}, 0\right)$
 (c) $\left(1, \frac{3}{8}, 1\right)$ (d) $\left(0, 0, \frac{2}{3}\right)$

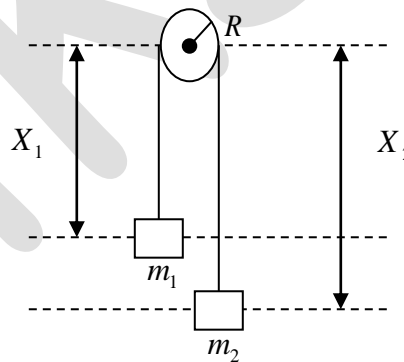


Q38. A particle of mass m starts at rest from the top of a smooth fixed hemisphere of radius a . The angle at which the particle leaves the hemisphere is equal to

- (a) $\cos^{-1}\left(\frac{1}{3}\right)$ (b) $\frac{\pi}{2}$ (c) $\cos^{-1}\left(\frac{2}{3}\right)$ (d) $\sin^{-1}\left(\frac{2}{3}\right)$

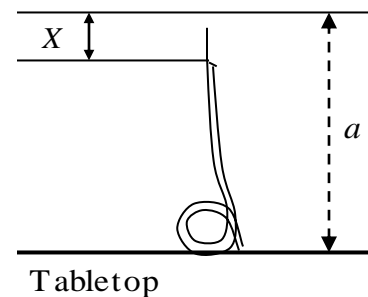
Q39. The Lagrangian of Atwood's machine (shown in the figure, where $m_2 > m_1$) is given by

- (a) $\frac{1}{2}m_1\dot{x}_1^2 + \frac{1}{2}m_2\dot{x}_2^2 + m_1gx_1 + m_2gx_2$
 (b) $\frac{1}{2}m_1\dot{x}_1^2 + \frac{1}{2}m_2\dot{x}_2^2 - m_1gx_1 + m_2gx_2$
 (c) $\frac{1}{2}(m_1 + m_2)\dot{x}_1^2 - (m_1 + m_2)gx_1$
 (d) $\frac{1}{2}(m_1 + m_2)\dot{x}_1^2 - (m_1 - m_2)gx_1$



Q40. Consider a rope of mass per unit length ρ length a , suspended just above a table as shown in figure. If the rope is released from rest at the top, the force on the table when a length x of the rope has dropped to the table is

- (a) ρxg
 (b) $2\rho xg$
 (c) $3\rho xg$
 (d) $4\rho xg$



Head office

fiziks, H.No. 23, G.F, Jia Sarai,
 Near IIT, Hauz Khas, New Delhi-16
 Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
 28-B/6, Jia Sarai, Near IIT
 Hauz Khas, New Delhi-16

Q41. An object of unit mass orbits in a central potential given by $U(r)$. Its orbit is $r = a \exp(-b\phi)$ with $b > 0$. The relationship between the angular momentum and the total energy E is given by

(a) $E = \frac{L^2}{2}(b^2 + 1) + U(r)$

(b) $E = \frac{L^2}{2r^2}(b^2 + 1) + U(r)$

(c) $E = \frac{L}{r}(b + 1) + U(r)$

(d) $E = \frac{a^2 L^2}{r^2}(b + 1) + U(r)$

Q42. A wave is propagating in a string of tension T and mass per unit length μ . The traveling wave can be described as $y(x, t) = A \sin(kx - \omega t)$. What is the kinetic energy in one wavelength (λ) of the traveling wave

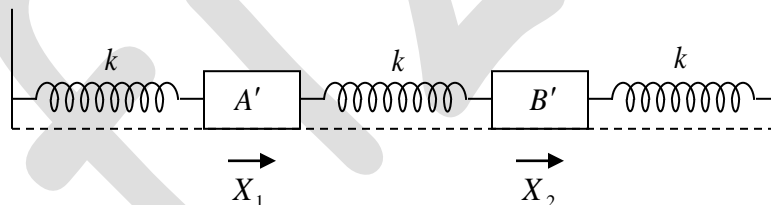
(a) $\frac{2TA^2\pi^2}{\lambda}$

(b) $\frac{TA^2\pi^2}{\lambda}$

(c) $\frac{TA^2\pi^2}{2\lambda}$

(d) $\frac{TA^2\pi^2}{4\lambda}$

Q43. Consider the figure as shown. A and B have equal masses m and all the springs have the same spring constant k . What are the normal frequencies for the system, if the oscillations are assumed to be small?



(a) $\sqrt{\frac{k}{m}}, \sqrt{\frac{2k}{m}}$

(b) $\sqrt{\frac{k}{2m}}, \sqrt{\frac{k}{m}}$

(c) $\sqrt{\frac{k}{m}}, \sqrt{\frac{3k}{m}}$

(d) $\sqrt{\frac{k}{m}}, \sqrt{\frac{k}{m} + 1}$

Q44. A violin string is held under tension T . What will be fractional change in the frequency of its fundamental mode of vibration if the tension is increased by the amount δT ?

(a) $\frac{\delta T}{T^2}$

(b) $\frac{\delta T}{\sqrt{T}}$

(c) $\frac{\delta T}{T}$

(d) $\frac{\delta T}{2T}$

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

- Q45. One can estimate the resonant frequencies of the human ear canal of length 2.2 cm , that are in the range of human hearing. How many resonant frequencies lie in this range? Speed of sound is given as 343 m/s .
- (a) 3 (b) 4 (c) 5 (d) 6
- Q46. One end of a 100 cm long wire (without load) is fixed and a mass of 2 kg is attached to the other end. The mass is kept moving with uniform speed in a horizontal circle of radius 60 cm . What is the strain of the wire if the radius of the wire is 0.032 cm and Young's modulus is $2 \times 10^{11} / \text{dynes/cm}^2$?
- (a) 0.032×10^{-2} (b) 32×10^{-2} (c) 0.32×10^{-2} (d) 3.2×10^{-2}
- Q47. What will be density of lead under a pressure of $20,000\text{ N/cm}^2$? (Density of lead = 11.5 gm/cm^3 and bulk modulus of lead = $0.80 \times 10^{10} \text{ N/m}^2$)
- (a) 11.69 gm/cc (b) 14.19 gm/cc
(c) 13.89 gm/cc (d) 15.98 gm/cc
- Q48. The excess of pressure inside a spherical soap bubble of radius 1 cm is balanced by that due to a column of oil of specific gravity 0.9 gm/cm^3 and height 1.36 mm . What is the surface tension T ?
- (a) $T \approx 3.06 \times 10^{-3} \text{ N/m}$ (b) $T \approx 323.0 \times 10^{-2} \text{ N/m}$
(c) $T \approx 3.06 \times 10^{-2} \text{ N/m}$ (d) $T \approx 3.06 \times 10^{-4} \text{ N/m}$
- Q49. A big drop is formed by coalescing 1000 small droplets of water. By how many times will the surface energy decrease?
- (a) 100 (b) 10 (c) 5 (d) 30
- Q50. A plate of area 100 cm^2 and thickness 2 mm is placed on the upper surface of some castor oil. If the coefficient of viscosity is 15.5 poise, what is the horizontal force necessary to move the plate with a velocity 3 cm/sec ?
- (a) 10.2 N (b) 0.13 N (c) 2.3 N (d) 0.23 N

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

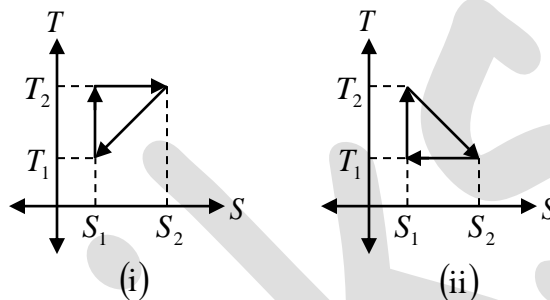
Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

Q51. The velocity of water in a river is 10 km/hr near the surface. If the river is 5 m what is the shearing stress between the horizontal layers of water? (The coefficient of viscosity of water 10^{-2} poise.)

- (a) 10^{-3} N/m^2 (b) 10^{-5} N/m^2 (c) 10 N/m^2 (d) 10^{-1} N/m^2

Q52. The figures shown represent two engines in $T-S$ phase plane. Let η_a and η_b the efficiencies of the engines (i) and (ii), respectively. Then



- (a) $\eta_b > \eta_a$ (b) $\eta_a > \eta_b$ (c) $\eta_a = \eta_b$ (d) $\eta_a \geq \eta_b$

Q53. The relation between pressure and volume of an ideal gas in a reversible process is given by $P = aV + b$, where $a = \frac{31}{56} \text{ Pascal/meter}^3$, $b = \frac{255}{7} \text{ Pascals}$. The volume at which the temperature attains maximum is

- (a) 32.9 m^3 (b) 329.7 m^3 (c) 0.329 m^3 (d) 20.7 m^3

Q54. Clausius-Clapeyron equation for liquid-gas transition is given by: $\frac{d\rho}{d\tau} = \frac{1}{T(v_g - v_l)}$. If

$v_g \gg v_l$ and $\rho v_g = RT$, the expression for saturated vapour pressure is given by

- (a) $\rho = \text{constant} \times e^{\frac{1}{RT}}$ (b) $\rho = \text{constant} \times e^{\frac{-1}{RT}}$
 (c) $\rho = 0$ (d) $\rho = \text{constant}$

Q55. For a nonmagnetic insulator, the specific heat is proportional to

- (a) T (b) T^2 (c) T^3 (d) $e^{\frac{-\alpha}{k_B T}}$

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

- Q56. Consider the superposition of two sinusoidal waves given by: $y_1 = 4\sin(3x - 2t)cm$ and $y_2 = 4\sin(3x + 2t)cm$. The maximum displacement of the resultant motion at $x = 2.3cm$ is
- (a) $8.65cm$ (b) $1.61cm$ (c) $4.63cm$ (d) $7.60cm$
- Q57. A total of 25 fringes move across the field of view when one of the mirrors of the Michelson interferometer is moved by a distance d . If the interferometer is illuminated by a laser of wavelength $6328nm$, the distance by which the mirror is moved is
- (a) $79.1\mu m$ (b) $38.6\mu m$ (c) 57.3μ (d) $1582\mu m$
- Q58. A parallel light beam of diameter d is incident on a convex lens of focal length f . The emerging beam from this lens passes again through another lens of focal length $2f$, kept at a distance $3f$ from first lens. The diameter of the output beam is
- (a) d (b) $2d$
(c) not related with d (d) $\frac{1}{2}d$
- Q59. Consider a uniformly charged disc of radius a and surface charge density σ . Consider a point P on the axis of the disc at a distance z from the disc. The potential at P is given by
- (a) $\frac{\sigma}{\epsilon_0} \frac{1}{z^2}$ (b) $\frac{\sigma}{2\epsilon_0} [\sqrt{a^2 + z^2} - z]$
(c) $\frac{\sigma}{\epsilon_0} [\sqrt{a^2 + z^2} - \sqrt{a^2 - z^2}]$ (d) $\frac{\sigma}{\epsilon_0} [\sqrt{a^2 + z^2} - a]$
- Q60. A charge q is distributed uniformly over the surface of a thin circular insulating of radius a . The potential at the rim of the disc is given by
- (a) $\frac{q}{\pi^2 a \epsilon_0}$ (b) $\frac{q}{4\pi^2 \epsilon_0 a}$
(c) $\frac{q}{\pi a^2 \epsilon_0}$ (d) $\frac{q}{4\pi^2 a^2 \epsilon_0}$

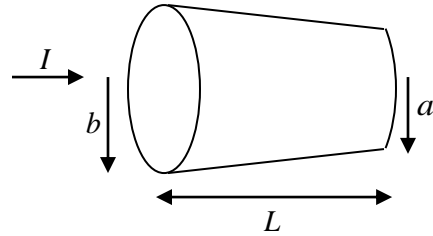
Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

- Q61. Current I is passing through a conical shaped copper wire of resistivity ρ as shown in the figure. If L is the length of the wire, b is the front radius and a is the back radius of the wire, what is the resistance of the wire?



- (a) $\frac{\rho L}{\pi ab}$ (b) $\frac{\rho L}{\pi(a+b)}$ (c) $\frac{\rho L}{\pi\left(\frac{a+b}{2}\right)}$ (d) $\frac{\rho L}{\pi\left(\frac{a+b}{ab}\right)}$

- Q62. A very long wire carrying charge q per unit length is held parallel to an infinite conducting plane at a distance h from it. What is the force of attraction per unit length?

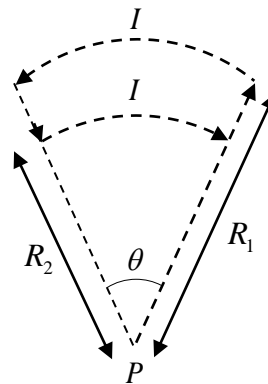
- (a) $\frac{q}{4\pi\epsilon_0 h}$ (b) $\frac{-q^2}{4\pi\epsilon_0 h}$ (c) $\frac{q^2}{2\pi\epsilon_0 h}$ (d) $\frac{-q^2}{2\pi\epsilon_0 h}$

- Q63. The potential in a medium is given by $\phi(r) = \frac{q}{4\pi\epsilon_0} \frac{e^{-\frac{r}{\lambda}}}{r}$. The charge density for $r \neq 0$ is given by

- (a) $-\frac{q}{\epsilon_0} e^{-\frac{r}{\lambda}}$ (b) $-\frac{q}{4\pi r \lambda^2} e^{-\frac{r}{\lambda}}$ (c) $-\frac{q}{4\pi\epsilon_0 r \lambda^2} e^{-\frac{r}{\lambda}}$ (d) $-\frac{q}{4\pi\epsilon_0} e^{-\frac{2r}{\lambda}}$

- Q64. What is the magnetic field (\vec{B}) produced at point P (center of the arcs) due to the current I in the close loop as shown in figure?

- (a) $\vec{B} = \frac{-\mu_0 I \theta}{4\pi} \left[\frac{1}{R_1} - \frac{1}{R_2} \right] \hat{k}$
 (b) $\vec{B} = \frac{-\mu_0 I \theta}{4\pi} \left[\frac{1}{R_1} + \frac{1}{R_2} \right] \hat{k}$
 (c) $\vec{B} = \frac{-\mu_0 I \theta}{4\pi} \left[\frac{1}{R_2} + \frac{1}{R_1} \right] \hat{k}$
 (d) $\vec{B} = \frac{-\mu_0 I \theta}{4\pi} \left[\frac{1}{R_2} - \frac{1}{R_1} \right] \hat{k}$



Head office

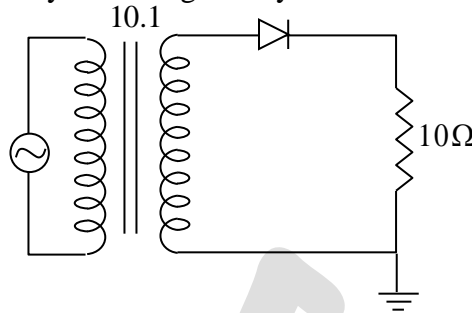
fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

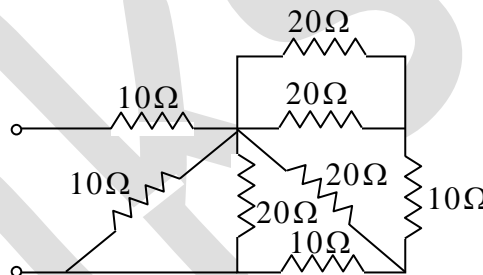
Q65. In the circuit given below, the diode can be considered as ideal. The peak secondary voltage and the D.C. load voltage respectively are then given by

- (a) 31.1V and 9.9V
- (b) 22V and 9.9V
- (c) 22V and 7.0V
- (d) 31.1V and 7.0V



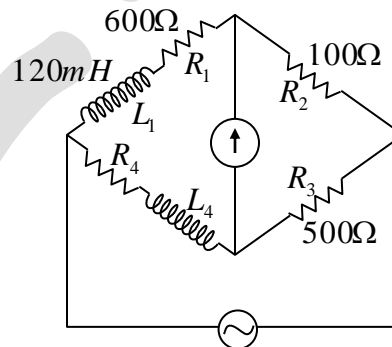
Q66. What is the effective resistance between points A and B ?

- (a) $R_{ab} = 10\Omega$
- (b) $R_{ab} = 11\Omega$
- (c) $R_{ab} = 15\Omega$
- (d) $R_{ab} = 12\Omega$



Q67. What are the values of R_4 and L_4 , if the a.c. bridge shown in figure is balanced?

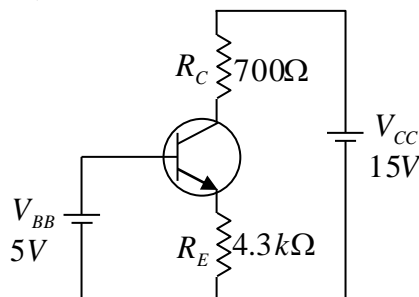
- (a) $R_4 = 720\Omega$ and $L_4 = 12mH$
- (b) $R_4 = 3000\Omega$ and $L_4 = 24mH$
- (c) $R_4 = 120\Omega$ and $L_4 = 600mH$
- (d) $R_4 = 3000\Omega$ and $L_4 = 600mH$



Q68. What is the operating point (V_{CE}, I_C) for the transistor circuit shown in figure? (Assume

$$I_C = I_E \text{ and } V_{BE} = 0.7V)$$

- (a) 5V, 2mA
- (b) 7.5V, 1.5mA
- (c) 7.5V, 1mA
- (d) 10V, 1mA



Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

- Q69. A particle of mass $1.40 \times 10^5 \text{ kg}$ has a relativistic momentum of magnitude $3.15 \times 10^{13} \text{ kg m/s}$. How fast is the particle traveling?
(a) $2.68 \times 10^8 \text{ m/s}$ (b) $1.8 \times 10^8 \text{ m/s}$ (c) $3.3 \times 10^{16} \text{ m/s}$ (d) $3 \times 10^8 \text{ m/s}$
- Q70. A proton of rest mass $1.68 \times 10^{-27} \text{ kg}$ is traveling at $2.5 \times 10^8 \text{ m/s}$. What is kinetic energy of the proton?
(a) $1.18 \times 10^{-10} \text{ J}$ (b) $0.18 \times 10^{-10} \text{ J}$ (c) $2.18 \times 10^{-27} \text{ J}$ (d) $1.32 \times 10^{-27} \text{ J}$
- Q71. A spaceship passes you at a speed of $0.85c$. You measure its length to be 48.2 m . What is its length at rest?
(a) $80m$ (b) $100m$ (c) $91.5m$ (d) $81m$
- Q72. Which of the following functions is the eigen-function of the operator, $-i\hbar \frac{d}{dx}$?
(a) $\exp(ikx)$ (b) $\cos(kx)$ (c) $\sin(kx)$ (d) $(\cos(kx) + \sin(kx))$
- Q73. In a one dimensional problem, the normalized wave function for the ground state is given by $\psi = Ne^{-\alpha x^2}$, where N is the normalization constant. What is the value of N ?
(a) $\sqrt{\frac{\alpha}{\pi}}$ (b) $\sqrt{\frac{\alpha}{2\pi}}$ (c) $\sqrt{\frac{2\alpha}{\pi}}$ (d) $\frac{\alpha}{\pi}$
- Q74. Commutator of two Hermitian operators has to be
(a) Hermitian (b) anti-Hermitian (c) unitary (d) orthogonal
- Q75. A sample of radioactive isotopes contains two different nuclides, labeled A and B . Initially, the sample composition is $1:1$. The half-life of A is 3 hours and that of B is 6 hours. What is the expected ratio $\frac{A}{B}$ after 18 hours?
(a) $\frac{1}{6}$ (b) $\frac{1}{4}$ (c) $\frac{1}{8}$ (d) $\frac{1}{2}$

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16