ISM MSc. Entrance 2016

Section A

Q1. If $\left|\vec{A}-\vec{B}\right| = \left|\vec{A}+\vec{B}\right|$ with $\vec{A}\neq 0$ and $\vec{B}\neq 0$ then

(a) $\vec{A}$ and $\vec{B}$ are perpendicular

(b) $\left|\vec{A}\right| = \left|\vec{B}\right|$ and the angle between $\vec{A}$ and $\vec{B}$ is 45^0

(c) $\left|\vec{A}\right| = \left|\vec{B}\right|$

(d) $\left|\vec{A}\right| = \left|\vec{B}\right|$ and the angle between $\vec{A}$ and $\vec{B}$ is 60^0

Q2. A vertical drum of radius R is rotating at a very high speed so that a block of mass m is stuck on its wall. The coefficient of friction between the drum wall and the block is μ. The minimum value of the angular speed of the drum wall is (gravitational acceleration is g)

(a) $\sqrt{\frac{\mu mg}{R}}$ (b) $\frac{1}{\mu}\sqrt{\frac{g}{R}}$ (c) $\sqrt{\frac{g}{\mu R}}$ (d) $\sqrt{\frac{mg}{\mu R}}$

Q3. A plane mirror is attached at the ceiling of a train compartment moving with speed v. The height of the ceiling from the floor is h. A person sends a light pulse from the floor to the mirror so that after reflection it reaches the person in time T. If T measured by the person on the train is T_1 and by a person on the ground is T_2 then (c is the speed of light)

(a) $T_1 = T_2 = \frac{2h}{c}$

(b) $T_1 = \frac{2h}{c},\ T_2 = \frac{2h/c}{\sqrt{1-v^2/c^2}}$

(c) $T_1 = T_2 = \frac{2h/c}{\sqrt{1-v^2/c^2}}$

(d) $T_1 = \frac{2h/c}{\sqrt{1-v^2/c^2}},\ T_2 = \frac{2h}{c}$

Q4. A fluid mass is in a cylindrical bucket rotating about its vertical axis. The pressure in the fluid

(a) Increases with the radial distance as r^4

(b) Decreases with the radial distance as $1/r$

(c) Increases with the radial distance as r^2

(d) Decreases with the radial distance as r

Q5. The Lagrangian of a particle moving under the influence of a force is given as $m\dot{x}^2 - ax + \frac{bx^2}{2}$. The force on the particle is:

(a) $a - bx$ (b) $-a + bx$ (c) $a + bx$ (d) $-a - bx$

Q6. Kepler's second law of planetary motion is a result of:

(a) force $\propto r^{-2}$ (b) conservation of energy

(c) conservation of angular momentum (d) mass of the sun >> mass of the planets

Q7. Wien's formula for black-body radiation is valid for

(a) high frequencies and high temperatures

(b) low frequencies and high temperatures

(c) high frequencies and low temperatures

(d) low frequencies and low temperatures

Q8. Dulong and Petit law for specific heat of solids is based on

(a) equipartition of energy

(b) Planck's formula for radiation

(c) atomic vibrations being quantised

(d) experimental evidence at low temperatures

Q9. Which of the following has units of magnetic dipole moment (standard symbols are used)

(a) $\frac{h}{em_e}$ (b) $\frac{em_e}{h}$ (c) $\frac{m_e h}{e}$ (d) $\frac{eh}{m_e}$

Q10. The de-Broglie wavelength formula is confirmed by

(a) Compton scattering (b) Davisson-Germer experiment

(c) Frank-Hertz experiment (d) Stern-Gerlach experiment

Q11. Charges $+Q$ and $-Q$ are fixed on the x axis at positions $x = -a$ and $x = +a$, respectively. The electric field at $y = b$ due to these charges is

(a) $\frac{Q}{4\pi\varepsilon_0}\frac{2b}{\left(a^2+b^2\right)^{3/2}}\hat{x}$ (b) $\frac{Q}{4\pi\varepsilon_0}\frac{2b}{\left(a^2+b^2\right)^{3/2}}\hat{y}$

(c) $\frac{Q}{4\pi\varepsilon_0}\frac{2a}{\left(a^2+b^2\right)^{3/2}}\hat{x}$ (d) $\frac{Q}{4\pi\varepsilon_0}\frac{2a}{\left(a^2+b^2\right)^{3/2}}\hat{y}$

Q12. A solid sphere carries a permanent electric polarization $\vec{P} = P\hat{z}$. The electric field just outside its equator in the plane perpendicular to $\hat{z}$ is

(a) $\frac{P}{\varepsilon_0}\hat{z}$ (b) $-\frac{P}{3\varepsilon_0}\hat{z}$ (c) $-\frac{P}{2\varepsilon_0}\hat{z}$ (d) $-\frac{2P}{3\varepsilon_0}\hat{z}$

Q13. Value of magnetic susceptibility of a superconductor is

(a) -1 (b) 0 (c) 1 (d) $-\mu_0$

Q14. A charged particle of charge q is moving along the z axis with constant speed $v(v << \text{speed of light})$. It passes through the origin at time $t = 0$. At a later time t, the displacement current density at the origin is

(a) $\frac{1}{4\pi\varepsilon_0}\frac{q}{v^2t^2}\hat{z}$ (b) $-\frac{1}{2\pi\varepsilon_0}\frac{q}{v^2t^3}\hat{z}$ (c) $\frac{1}{2\pi\varepsilon_0}\frac{q}{v^2t^3}\hat{z}$ (d) $-\frac{1}{4\pi\varepsilon_0}\frac{q}{v^2t^3}\hat{z}$

Q15. A box of volume V is divided into two chambers of volume $\frac{V}{3}$ and $\frac{2V}{3}$ by a removable partition. Initially the smaller chamber is filled with n moles of an ideal gas at pressure P and the bigger chamber has vacuum. After the partition is removed, the gas expands and fills the entire box. In the process its pressure, temperature and entropy change by $\Delta P, \Delta T$ and ΔS, respectively. Then ($R =$ gas constant)

(a) $\Delta P = 0, \Delta S = nR\ln 3$ (b) $\Delta P = -\frac{1}{3}P,\ \Delta S = nR\ln 2$

(c) $\Delta P = -\frac{2}{3}P, \Delta S = nR\ln 3$ (d) $\Delta P < 0, \Delta T < 0$

Q16. Total work done in bringing a charge q from infinity to a point at a distance x from an infinite grounded plane (y - z plane) is

(a) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{2x}$ (b) $-\frac{1}{4\pi\varepsilon_0}\frac{q^2}{4x}$ (c) $-\frac{1}{4\pi\varepsilon_0}\frac{q^2}{2x}$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{4x}$

Q17. The current density in a wire of radius a has a functional dependence $\vec{j}(\vec{r}) = ks^2\hat{z}, s$ being the distance from the axis of the wire. The magnetic field inside the wire at a distance $s < a$ is

(a) $\frac{2\pi\mu_0 ka^4}{4}\hat{z}$ (b) $\frac{\mu_0 ks^3}{4}\hat{\phi}$ (c) $\frac{2\pi\mu_0 ks^4}{4}\hat{\phi}$ (d) $\frac{\mu_0 ka^3}{4}\hat{z}$

Q18. The potential at a point on the z - axis due to a disc of radius R cantered at the origin in the x - y plane with total charge Q uniformly distributed over the disc is

(a) $\frac{Q}{8\pi\varepsilon_0 R^2}\left(\sqrt{z^2+4R^2}-|z|\right)$ (b) $\frac{Q}{2\pi\varepsilon_0 R^2}\left(\sqrt{z^2+4R^2}-|z|\right)$

(c) $\frac{Q}{4\pi\varepsilon_0 R^2}\left(\sqrt{z^2+R^2}-|z|\right)$ (d) $\frac{3Q}{8\pi\varepsilon_0 R^2}\left(\sqrt{2z^2+3R^2}-|z|\right)$

Q19. A particle of rest mass m has momentum mc, where c is the speed of light. Its speed is

(a) c (b) $\frac{c}{\sqrt{2}}$ (c) $\frac{c}{2}$ (d) $\frac{c}{\left(2\sqrt{2}\right)}$

Q20. Six indistinguishable particles are put in four distinct boxes $X1, X2, X3$ and $X4$ with $X1$ and $X2$ containing two particles each and $X3$ and $X4$ containing one particle each. The number of ways that it can be done is

(a) 60 (b) 180 (c) 90 (d) 720

Q21. A particle of mass 2 kg is moving on the x - axis and its potential energy is $U(x) = 2\sin^2(\pi x)$. If the amplitude of its motion is small then the best approximate value for the time period of its oscillations is

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

Q22. For electromagnetic radiation in a large cavity, the number of modes per unit volume between frequency v and $v+dv$ is

(a) $\frac{8\pi v^2}{c^3}dv$ (b) $\frac{4\pi v^2}{c^3}dv$ (c) $\frac{8\pi v^2}{c}dv$ (d) $\frac{4\pi v^2}{c}dv$

Q23. In a Bose-Einstein gas at temperature T, the number of particles at energy level E is

(a) $\frac{1}{e^{E/kT}-1}$ (b) $\frac{1}{e^{(E-E_0)/kT}+1}$ (c) $\frac{1}{e^{(E-E_0)/kT}-1}$ (d) $e^{-E/kT}$

Q24. The average kinetic energy of a mass attached to a spring and oscillating with amplitude of $0.25m$ is $2J$. The spring constant is

(a) $256\,Nm^{-1}$ (b) $64Nm^{-1}$ (c) $512Nm^{-1}$ (d) $128Nm^{-1}$

Q25. A long current carrying wire of radius a is carrying current I. It is made of a material of electrical resistively ρ. Then the component of the Poynting vector at the surface of the wire and perpendicular to it has magnitude

(a) $\frac{\mu_0 I^2\rho}{2\pi a^3}$ (b) $\frac{I^2\rho}{2\pi^2 a^3}$ (c) $\frac{I^2\rho}{2\pi a^3}$ (d) $\frac{I^2\rho}{\pi^2 a^3}$

Q26. To estimate the thickness of a line drawn by a green pen, a student draws a line on a white sheet of paper and views it from a distance. The largest distance that she can see it is $5m$. Assuming that the diameter of the pupil of the eye is $4mm$ and the wavelength of light is $550\,nm$, the thickness of the line is in the range of

(a) $0.2\,mm - 0.4\,mm$ (b) $0.6\,mm - 0.8\,mm$
(c) $0.4\,mm - 0.6\,mm$ (d) $1.0\,mm - 1.2\,mm$

Q27. A diatomic molecule has mass M. Its ground-state electronic energy is E_e and lowest rotation energy is E_r. Taking the mass of the electron to be m, the relation between the electronic and rotational energy is

(a) $E_r \sim \frac{m}{M}E_e$ (b) $E_r \sim \sqrt{\frac{m}{M}}E_e$ (c) $E_r \sim E_e$ (d) $E_r \sim \sqrt{\frac{M}{m}}E_e$

Q28. A wire of cross-sectional area of $2\times10^{-6}\,m^2$ is carrying a current of $9.6\,A$. If the free electron density in the wire is $3\times10^{28}\,m^{-3}$, the drift speed of the electrons in the wire is

(a) $2.0\times10^{-9}\,ms^{-1}$ (b) $1.0\times10^{-3}\,ms^{-1}$
(c) $2.0\times10^{-3}\,ms^{-1}$ (d) $5.0\times10^{-4}\,ms^{-1}$

Q29. A nucleus with 25 nucleons has binding energy of $8\,MeV$ per nucleon. Mass defect for this nucleus is

(a) $1.4\times10^{-29}\,kg$ (b) $1.4\times10^{-26}\,kg$

(c) $3.5\times10^{-28}\,kg$ (d) $3.5\times10^{-25}\,kg$

Q30. A practical device making use of the matter waves is

(a) X-ray tube (b) Electron microscope

(c) TV tube (d) LASER

Q31. To perform Young's double slit experiment and observe fringes clearly, which of the following is the best option for the light source

(a) monochromatic light from a point source only

(b) monochromatic light but the source could be point source or an extended source

(c) monochromatic light from an extended source only

(d) light need not be monochromatic but the light should be a from a point source

Q32. A long solenoid of radius $0.01\,m$ and length $0.5\,m$ has total number of 500 turns. Its self inductance is close to

(a) $0.2\,mH$ (b) $0.02\,mH$ (c) $0.4\,mH$ (d) $0.04\,mH$

Q33. Which of the following nuclear reactions is correctly balanced

(a) ${}^{238}_{92}U+n\to{}^{239}_{93}U+e^-+\nu$ (b) ${}^{239}_{93}Np\to{}^{239}_{94}Pu+e^--\bar{\nu}$

(c) ${}^{238}_{92}U+n\to{}^{239}_{91}U+e^++\bar{\nu}$ (d) ${}^{239}_{93}Np\to{}^{239}_{94}Pu+e^-+\nu$

Q34. Gravitational potential energy of a geostationary satellite is (here $G=$ universal gravitational constant, $M_E=$ mass of the earth, $R_E=$ radius of the earth and $T=24$ hour)

(a) $-\left(\frac{2\pi GM_E}{T}\right)^{1/3}$ (b) $-\frac{2\pi GM_E}{R_E}$ (c) $-\left(\frac{2\pi GM_E}{T}\right)^{2/3}$ (d) $-\frac{2GM_E}{R_E}$

Q35. An example of barrier penetration is

(a) β decay (b) α decay

(c) γ decay (d) a semiconductor diode

Q36. A light beam of $400\ nm$ falls on the surface of a metal with work function $2.36\ eV$. The maximum energy of the photoelectrons coming out of the metal is chose to

($h = 6.63\times10^{-34}\ J.s, c = 3\times10^{8}\ ms^{-1}, |e| = 1.6\times10^{-19}\ C$)

(a) $4.0\ eV$ (b) $1.6\ eV$ (c) $3.2\ eV$ (d) $0.8\ eV$

Q37. Spherical particles of different radii are falling vertically in a viscous fluid. Their terminal velocities V_T depends on their radius a as

(a) $V_T \propto a$ (b) $V_T \propto a^3$ (c) $V_T \propto a^2$ (d) $V_T \propto a^{-1}$

Q38. Two polarizers $P1$ and $P2$ are kept next to each other with their polarization axes making an angle of 60^0 with each other. Linearly polarized light of intensity I_1, with its direction of polarization along the line bisecting the angle between the polarization axes of $P1$ and $P2$ passes through them. If the intensity of light after it has passed through the polarizers is I_2 then

(a) $I_2 = \frac{\sqrt{3}}{4}I_1$ (b) $I_2 = \frac{1}{16}I_1$ (c) $I_2 = \frac{3}{16}I_1$ (d) $I_2 = \frac{1}{4}I_1$

Q39. A rectangular frame of area A has total resistance R. One of its arms is fixed along the x-axis. At time $t = 0$, it is in the xy-plane. If we rotate it with angular speed ω in a uniform magnetic field $\vec{B} = B\hat{z}$, the average rate of heat produced in the rectangle will be

(a) $\frac{\omega AB}{R}$ (b) $\frac{(\omega AB)^2}{R}$ (c) $\frac{\omega AB}{2R}$ (d) $\frac{(\omega AB)^2}{2R}$

Q40. A lift originally moving downwards at a speed of $10ms^{-1}$ comes to rest with a constant acceleration in a distance of $25\ m$. The force with a person of mass $80\ kg$ press the floor of the lift during this time is (take gravitational acceleration $g = 9.8\ ms^{-2}$)

(a) $624\,N$ (b) $944\ N$ (c) $784\ N$ (d) $1004\ N$

Q41. A shaving concave mirror has radius of curvature of $50\ cm$. The distance from it at which a person should stand so that he sees his face at the comfortable viewing distance of $25\ cm$ is closed to

(a) $10\ cm$ (b) $20\ cm$ (c) $15\ cm$ (d) $25\ cm$

Q42. According to Einstein's theory of specific heat of solids, the specific heat at temperatures T close to $0K$ varies with T as (here C is a constant)

(a) T (b) e^{-CT} (c) T^3 (d) $e^{\frac{-C}{T}}$

Q43. In a Young's double slit experiment, when the two slits separated by $0.5\ mm$ are illuminated with a beam of $500\ nm$ produce a interference pattern. The number of maximum observed in the angular range $-45^0 < 0 < 45^0$

(a) 2001 (b) 1000 (c) 2000 (d) 1001

Q44. The magnetic field of an electromagnetic wave in a material is given by $B = B0\cos\left[\pi\left(0.04x + 10^7 t\right)\right]$. The refractive index of the material is

(a) 1.5 (b) 1 (c) 1.2 (d) 2

Q45. Continuous X-rays are generated from a X-ray tube operating at $30\ kV$. The cut-off wavelength o the X-rays approximately is

(a) $3\ nm$ (b) $2\ nm$ (c) $4\ nm$ (d) $5\ nm$

Q46. Two coherent sources of unequal intensities are used to create an interference pattern. The ratio of the maximum and minimum intensities in the resulting fringes, if the sources an intensity ratio of $\beta^2 < 1$ is

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

Q47. Te electronic density of states in a one dimensional material is proportional to (here ε denotes the energy)

(a) ε (b) $\frac{1}{\varepsilon}$ (c) $\varepsilon^{1/2}$ (d) $\frac{1}{\varepsilon^{1/2}}$

Q48. Given in the table below are the emissive powers of a black body at temperature $998\ K$ at different wavelengths:

$\lambda(\mu m)$	2.0	2.5	3.0	3.5	4.0	4.5
E_λ	7.2	10.0	10.5	10.0	9.0	7.2

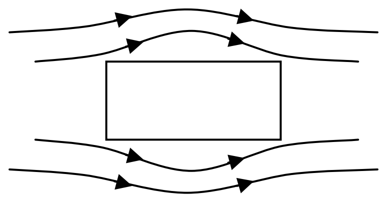
using this data, the wavelength (in μm) where the maximum of the emissive power would be at $T = 1259\ K$ is closed to

(a) 1.6 (b) 3.0 (c) 2.4 (d) 3.8

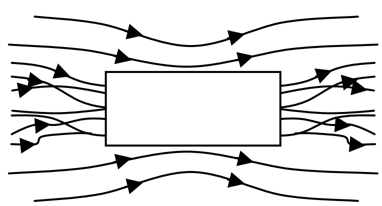
Q49. Look at the two columns given below. Column I lists the magnetic properties of material and Column II shows the magnetic lines around a bar of this material put in a uniform magnetic field

Column I Column II

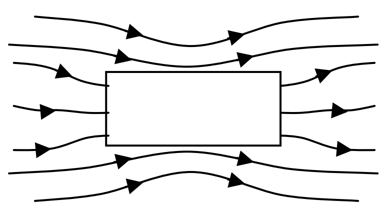
(1) Paramagnetic



(2) Diamagnetic



(3) Ferromagnetic



Which of the following gives proper correspondence between the two columns

(a) 1-I, 2-II, 3-III (b) 1-III, 2-I, 3-II (c) 1-II, 2-III, 3-I (d) 1-I, 2-III, 3-II

Q50. A ray of light is incident on a plane surface along a vector $\hat{i}+\hat{j}-\hat{k}$. The normal incidence point is along $\hat{i}+\hat{j}$. The vector along the reflected ray is

(a) $\hat{i}+\hat{j}-\hat{k}$ (b) $-\hat{i}-\hat{j}+\hat{k}$ (c) $-\hat{i}-\hat{j}-\hat{k}$ (d) $\hat{i}+\hat{j}$

Q51. One end of a uniform rope of mass m and length l is fixed and the rope is made to rotate on a frictionless table with angular speed ω. The tension in the rope as a function of the distance r from the centre (the point where the rope is fixed) is

(a) $m\left(1-\frac{r}{l}\right)r\omega^2$ (b) $m\left(1-\frac{r}{l}\right)\frac{(r+l)}{2}\omega^2$

(c) $m\left(1-\frac{r}{l}\right)(r+l)\omega^2$ (d) $m\left(1-\frac{r}{l}\right)\frac{(r-l)}{2}\omega^2$

Q52. A positronium is formed by a positron (same mass as the electron but positive charge) and an electron. Hence in applying the Bohr theory to calculate energies of positronium, reduced mass of electron-positron system is used in place of the electron mass. Thus, for a positronium the first excited-state energy is:

(a) $-13.6\,eV$ (b) $-3.4\,eV$ (c) $-6.8\,eV$ (d) $-1.7\,eV$

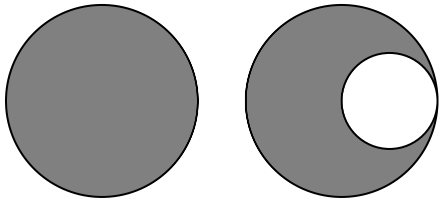
Q53. If an electron is to be found inside a nucleus, Z for the nucleus (take radius $R\approx 5\times10^{-15}\ m$), using non-relativistic energy expression, is close to

(a) 100 (b) 400 (c) 200 (d) 4000

Q54. A sphere of radius R carries total charge Q distributed over its volume such that the charge density as a function of distance r from its centre is $\rho(r)=\rho_0 r$. Total energy of the charge distribution is

(a) $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{R}$ (b) $\frac{1}{6\pi\varepsilon_0}\frac{Q^2}{R}$ (c) $\frac{1}{5\pi\varepsilon_0}\frac{Q^2}{R}$ (d) $\frac{1}{7\pi\varepsilon_0}\frac{Q^2}{R}$

Q55. Consider the following two charge distributions. S_1 is uniformly charged solid sphere of radius R while S_2 is a sphere of radius R with a cavity of radius $\frac{R}{2}$ in it and carrying the same charge density as S_1 (see figure). The magnitude of the electric field at a distance of $\frac{R}{2}$ in S_1 is E_1 while it is E_2 at the centre of the cavity in S_2. Then



(a) $E_1 > E_2$ (b) $E_1 < E_2$ (c) $E_1 = E_2$ (d) $E_1 = 2E_2$

Q56. Consider electrons moving in zero potential and ignore interaction between them. If the density of electrons is n their energy per unit volume is proportional to

(a) $n^{1/3}$ (b) $n^{4/3}$ (c) $n^{2/3}$ (d) $n^{5/3}$

Q57. Dipole moment $\vec{p}$ due to the volume charge density $\rho(\vec{r}) = C\delta(r-R)\cos\theta$ is

(a) $\frac{4\pi}{3}CR^3\hat{r}$ (b) $\frac{4\pi}{3}CR^3\hat{x}$ (c) $\frac{4\pi}{3}CR^3\hat{z}$ (d) $\frac{4\pi}{3}CR^3\hat{\theta}$

Q58. An electromagnetic wave of amplitude E_I is incident normally from a nonmagnetic medium of dielectric constant K_1 on another dielectric medium K_2 that is separated from

(a) $E_I + E_R = E_T$ and $E_I - E_R = E_T\sqrt{\frac{K_2}{K_1}}$

(b) $E_I - E_R = E_T$ and $E_I + E_R = E_T\sqrt{\frac{K_1}{K_2}}$

(c) $E_I - E_R = E_T$ and $E_I + E_R = E_T\sqrt{\frac{K_2}{K_1}}$

(d) $E_I + E_R = E_T$ and $E_I - E_R = E_T\sqrt{\frac{K_1}{K_2}}$

Q59. If two thin wires of radii a_1 and a_2 are separated by distance $d\left(d >> a_1, a_2\right)$ and carry equal and opposite charge per unit length $\pm\lambda$, then the potential difference between the wires is

(a) $\frac{\lambda}{2\pi\varepsilon_0}\ln\frac{d}{a_1+a_2}$ (b) $\frac{\lambda}{2\pi\varepsilon_0}\ln\frac{d}{\sqrt{a_1a_2}}$

(c) $\frac{\lambda}{\pi\varepsilon_0}\ln\frac{d}{d-a_1-a_2}$ (d) $\frac{\lambda}{2\pi\varepsilon_0}\ln\sqrt{\frac{d}{a_1^2+a_2^2}}$

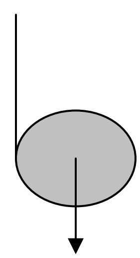
Q60. Transverse waves of small amplitude A and wavelength λ are travelling with speed v on a taut string along x direction. Its displacement as a function of distance x and time t is given as $y(x,t) = A\sin\left(\frac{2\pi}{\lambda}(x-vt)\right)$. If the speed of the point at x at time t is u then the slope of the string at that point at time t is

(a) $\frac{u}{v}$ (b) $\frac{y}{x}$ (c) $\frac{uy}{vx}$ (d) $\frac{u}{v}\left(\frac{y}{x}\right)^2$

Q61. Hydrogen gas of density $9\times10^{-2}\ kgm^{-3}$ is in a container at pressure of $1Pa$. The root mean square speed of its molecules in ms^{-1} is close to

(a) 320 (b) 980 (c) 550 (d) 1830

Q62. A long string is wound around a uniform disc of radius R, thickness t and mass m. When one end of the sting is held by hand the disc is released, the string starts unwinding and the disc starts moving vertically down as shown in the figure. During this motion, thee tension in the string is

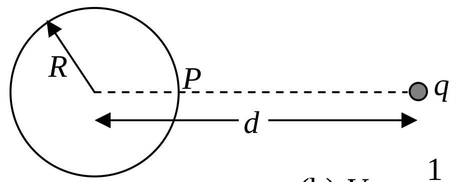


(a) mg (b) $\frac{mg}{3}$ (c) $\frac{mg}{2}$ (d) $\frac{mg}{4}$

Q63. Quality factor of a lightly damped oscillator is 100. If in N oscillations its amplitude reduces by a factor of 2 then the value of N is closed to

(a) 13 (b) 23 (c) 18 (d) 27

Q64. A solid conducting sphere has radius R. It carries no charge. A point charge q is put at a distance from its centre. As a result, if electrostatic potential at point P (see figure) on the sphere is V then



(a) $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{(d-R)}$ (b) $V < \frac{1}{4\pi\varepsilon_0}\frac{q}{d}$

(c) $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{d}$ (d) $= \frac{1}{4\pi\varepsilon_0}\frac{q}{d} < V < \frac{1}{4\pi\varepsilon_0}\frac{q}{(d-R)}$

Q65. A Carnot engine is operating between reservoirs at temperature $1500K$ and T_1. It take heat Q from reservoir at $1500\ K$ and produces work $0.4Q$. A second Carnt engine works between reservoirs at T_1 and T_2. It takes all the heat rejected by the first Carnot engine and produces work $0.2Q$. Then T_1 and T_2 are

(a) $600\ K$ and $400\,K$ (b) $720\,K$ and $600\,\text{K}$

(c) $900\,K$ and $450\,\text{K}$ (d) $900\,K$ and $600\,\text{K}$

Q66. A parallel plate capacitor of capacitance C is made of large circular plates of radius R kept perpendicular to the z-axis. If a current $I(t) = I_0 \cos\omega t$ is passing through the capacitor, the magnetic field at distance $s\,(s<R)$ from the axis of the plate will be

(a) $\frac{\mu_0 I_0 s}{2\pi R^2}.\cos\omega t$ (b) $\frac{\mu_0 I_0 s}{\pi R^2}.\sin\omega t$

(c) $\frac{\mu_0 I_0 s}{\pi R^2}.\cos\omega t$ (d) $\frac{\mu_0 I_0 s}{2\pi R^2}.\sin\omega t$

Q67. At certain instant, a thin rod of length $0.3m$ and mass $0.4kg$ is rotaing in a horizontal plane with an angular speed of 60 radians per second on a pivor at its midpoint. If the pivot applies a frictional torque of $0.01\ Nm$ on the rod, how long will it take for the rod to stop?

(a) $45s$ (b) $27s$ (c) $36s$ (d) $18s$

Q68. Potential energy of a particle moving on the x-axis in a force field

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

Q69. Diamond has a fcc crystal structure with 8 atoms per unit cell. The packing fraction of diamond is

(a) 0.48 (b) 0.68 (c) 0.34 (d) 0.74

Q70. A soap bubble film (refractive index 1.5) when illuminated with $600\ nm$ light shows interferection on reflection. The minimum thickness of the film to show this phenomenon is

(a) 100 nm (b) 150 nm (c) 200 nm (d) 300 nm

Q71. Angle of minimum deviation for a glass prism with refractive index $=1.4$ is equal to the refracting angle of the prism. Angle of prism in degree is

(a) 60 (b) 30 (c) 45 (d) 90

Q72. The probability of a radioactive nucleus to survive one mean life is

(a) $\frac{1}{e}$ (b) $\frac{1}{(e+1)}$ (c) $1.\left(\frac{1}{e}\right)$ (d) e

Q73. Fermi energy (in eV) for a metal of electronic density $6\times10^{28}\ m^{-3}$ is close to

(a) 2.5 (b) 4.5 (c) 3.5 (d) 5.5

Q74. An electric dipole is in a nonuniform electric field pointing in x- direction and increasing with x- direction and increasing with x. If a dipole of dipole strength p is kept in the field making an angle θ with the x-axis, the force on the dipole is

(a) $p\frac{\partial E}{\partial x}\cos\theta$ (b) $p\frac{\partial E}{\partial x}\sin\theta$ (c) $-p\frac{\partial E}{\partial x}\cos\theta$ (d) $-p\frac{\partial E}{\partial x}\sin\theta$

Q75. A particle of mass 'm' travelling with speed 'V_0' enters a medium that applies on it a retardation force $-\lambda v$, where 'v' is its velocity. The distance travelled by particle before it stops is

(a) $\frac{v_0}{\lambda}$ (b) $\frac{v_0}{m\lambda}$ (c) $\frac{mv_0}{\lambda}$ (d) $\frac{mv_0}{\lambda^2}$