Q1. In a collision between two particles

(a) Linear momentum is conserved, but kinetic energy is not necessarily conserved.

(b) Kinetic energy is conserved, but Linear momentum is not necessarily conserved.

(c) Either Linear momentum or kinetic energy, but not necessarily both are conserved.

(d) Both linear momentum and kinetic energy are conserved.

Q2. The moment of inertia of a thin rectangular plate of length $a$, width $b$, mass $m$ about an axis passing through the center and perpendicular to the plate is

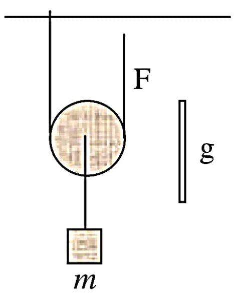
(a) $\frac{1}{12}m\left(a^2+b^2\right)$ (b) $\frac{1}{6}m\left(a^2+b^2\right)$

(c) $\frac{1}{12}mab$ (d) $\frac{1}{6}mab$

Q3. A smooth sphere rests on a horizontal plane. A point particle slides without down the sphere, starting at the top. If $R$ be the radius of the sphere, the velocity of the particle when it leaves the surface would be given by $($$g$ is the acceleration due to gravity).

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

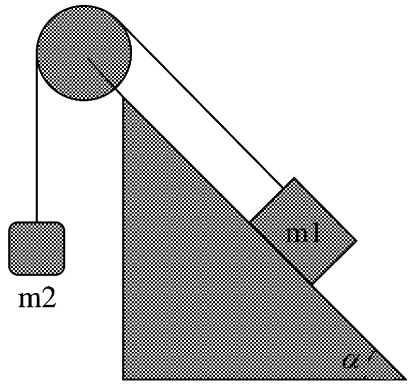
Q4. A mass $m$ is suspended from a frictionless pulley and hangs over an inextensible string attached to the ceiling on one side and a force $F$ is exerted upwards at the other end as shown in the figure below. The force $F$ for the condition of static equilibrium is




(a) $1mg$ (b) $2mg$

(c) $4mg$ (d) $0.5mg$

Q5. Two masses $m1$ and $m2$ are attached to an inextensible string passing over a massless and frictionless pulley. Mass $m1$ slides on an inclined plane whereas mass $m2$ hangs freely as shown in Figure below. The acceleration of $m1$ down the plane would be




(a) $\frac{m1-m2}{m1+m2}g$ (b) $\frac{m1\sin\alpha+m2}{m1+m2}g$

(c) $\frac{m2-m1\sin\alpha}{m1+m2}g$ (d) $\frac{m1\sin\alpha-m2}{m1+m2}g$

Q6. Kirchoff's current law is valid for

(a) DC circuit only

(b) AC circuit only

(c) Both DC and AC circuits

(d) Circuits having active elements only



Q7. If $\alpha = 0.98, I_{co} = 6\mu A$ and $I_B = 100\mu A$ for a transistor based amplifier, then value of $I_c$ is about

(a) $2.3mA$ (b) $3.1mA$ (c) $4.6mA$ (d) $5.2mA$

Q8. The threshold voltage $V_T$ is negative for

(a) an n-channel enhancement MOSFET

(b) an n-channel depletion MOSFET

(c) a p-channel depletion MOSFET

(d) all active unipolar devices

Q9. The 2's complement of the binary number $1101100$ in BCD is

(a) 12 (b) 13 (c) 14 (d) 15

Q10. A master-slave flip-flop has the characteristic that

(a) Change in the input at 'Master' is immediately reflected in the output of 'Slave'.

(b) Input states of both the 'Master' and 'Slave' are affected at the same time.

(c) Change in the output of "Slave" follows the change in output of 'Master'.

(d) Output states of both the 'Master' and 'Slave' are affected at the same time.

Q11. Which of the following statements is NOT correct?

(a) Acoustic branch of diatomic-linear chain is similar to the monoatomic case

(b) Both group velocity and phase velocity are equal to the velocity of sound in the long wavelength limit

(c) Under the low wavelength limit, the lattice acts as a low pass filter

(d) Acoustic and optical modes in a diatomic lattice cancel each other at the boundary of first Brillouin zone

Q12. According to Dulong-Petit's law, the specific heat of a solid

(a) is proportional to the temperature

(b) does not depend on temperature

(c) depends on square of temperature

(d) is inversely proportional to temperature

Q13. In the X-ray diffraction pattern of a sodium metal, which has a bcc structure, the missing reflection planes will be

(a) 101 (b) 011 (c) 020 (d) 100

Q14. For a paramagnetic material, the energy difference between spin magnetic dipole parallel and antiparallel to an external field $H$ is ($\mu_B$ is the Bohr magnetron)

(a) $\mu_0 H/4\pi$ (b) $\mu_B H$ (c) $2\mu_B\mu_0 H$ (d) $\mu_B\mu_0 H$

Q15. The Hall coefficient of a Si wafer was found to be $-7.35\times10^{-5} m^3C^{-1}$ in the temperature range from $100$ to $400\,K$. The type of charge carrier and the approximate value of carrier density respectively are

(a) $n$-type; $8.5\times10^{22} m^{-3}$ (b) $p$-type; $8.5\times10^{22} m^{-3}$

(c) $n$-type; $4.2\times10^{22} m^{-3}$ (d) $p$-type; $4.2\times10^{22} m^{-3}$

Q16. Consider oxygen gas at $300K$ having the mass of its molecule as $5.31\times10^{-26} kg$. The root mean square speed of its molecules, is about

(a) $284 m/s$ (b) $248 m/s$ (c) $348 m/s$ (d) $484 m/s$

Q17. One mole of a monoatomic perfect gas initially at temperature $0°C$ expands from volume $V_0$ to $2V_0$ at constant pressure. The specific heat at constant volume of the gas is $20.8\,Jmol^{-1}K^{-1}$. The amount of heat absorbed is nearly

(a) $1179\,J$ (b) $1779\,J$ (c) $1979\,J$ (d) $7972\,J$

Q18. When $100\,g$ ice at $0°C$ melts, the change in entropy in cal/K is about (Take latent heat of fusion (melting) as $80\,cal/g$.)

(a) Zero (b) 0.34 (c) 29.3 (d) 39.2

Q19. $N$ distinguishable particles are distributed among three states having energies $0, k_BT$ and $2k_BT$ respectively. If the total equilibrium energy of the system is $151.23k_BT$, the number of particles of the system is about

(a) 152 (b) 264 (c) 356 (d) 635

Q20. The power per unit area emitted by a surface of a blackbody $\left(\text{in } Wm^{-2}\right)$ at temperature $230\,K$ is about

(a) 112.67 (b) 128.67 (c) 158.67 (d) 178.67

Q21. A Van der Waals gas is passed through a porous plug. Let $\alpha = \frac{1}{v}\left[\frac{\partial v}{\partial T}\right]_P$ be the volume coefficient and $T$ is the temperature. The temperature of the gas will decrease when

(a) $\alpha T = 0$ (b) $\alpha T > 1$ (c) $\alpha T = 1$ (d) $\alpha T < 1$

Q22. Light from a point source located at the origin gets reflected parallel to the x-axis from a large concave mirror. For a constant, $\alpha$, the equation describing the shape of the mirror on the x-y plane is

(a) $y^2 = \alpha x + \alpha^2$ (b) $y^2 = 2\alpha x + \alpha^2$

(c) $x^2 = \alpha y + \alpha^2$ (d) $x^2 = 2\alpha y + \alpha^2$

Q23. The dispersion relation for a wave is given by $\omega^2 = pk + qk^3$, where $\omega$ is the angular frequency, $k$ is the wave number, $p$ and $q$ are constants. The wave number for which both the group and phase velocities are same is

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

Q24. A thin film of oil of thickness $t$ and refractive index $n_0$ is covering a pool of water of refractive index $n_w$. A ray of light of wavelength $\lambda$ is incident normally on the oil surface. The condition for constructive interference of the reflected light is ($m$ has integer values)

(a) $2tn_w = m\lambda$ (b) $2tn_0 = m\lambda$

(c) $2tn_0 = \left(m+\frac{1}{2}\right)\lambda$ (d) $2tn_w = \left(m+\frac{1}{2}\right)\lambda$

Q25. A Newton's ring experiment uses a glass lens having radius of curvature $1.0\,m$. The apparatus is illuminated separately by light having two different wavelengths. Suppose that one of the wavelengths is $550\,nm$. The $6^{th}$ bright ring of the $550\,nm$ fringe system coincides with the $5^{th}$ bright ring of the other. The value of second wavelength is about

(a) $450\,nm$ (b) $672\,nm$ (c) $733\,nm$ (d) $563\,nm$

Q26. The position of a particle along the $x$-axis as a function of time is given by $x(t) = 2\cos^2\left(\frac{\omega_1 t}{2}\right)\sin(\omega_2 t)$. We can write $x(t)$ as the superposition of $n$ independent harmonic motions. The value of $n$ is

(a) 2 (b) 3 (c) 4 (d) 5

Q27. Two coherent monochromatic light beams of intensities $I$ and $4I$ are superimposed. The maximum and minimum possible intensities in t he resulting beam are

(a) $3I$ and $I$ (b) $5I$ and $3I$ (c) $7I$ and $5I$ (d) $9I$ and $I$

Q28. A beam of light polarized in the $x$-direction is travelling in the $z$-direction. It passes through a polarizer and reaches an analyzer. The polarization axis of the analyzer can only be rotated in the $x$-$y$ plane. It is found that the intensity is 3 times smaller when the polarization axis of the analyzer is in the $y$ direction as compare to that in the $x$-direction. The angle between the polarization axis of the polarizer and the $x$ axis is

(a) 30°　　(b) 45°　　(c) 60°　　(d) 90°

Q29. Consider a parallel plate capacitor with square plates of dimensions $L \times L$ each. The plates have a charge $Q$ and are separated by a distance $\Delta x$. The plate with the positive charge has a small hole in the middle through which an electron of mass $m$ and charge $-e$ is shot through. The minimum speed, $V$, that the electron must have to reach the negative plate is

(a) $V = \sqrt{\dfrac{2Qe\Delta x}{m\varepsilon_0 L^2}}$　　(b) $V = \sqrt{\dfrac{Qe\Delta x}{m\varepsilon_0 L^2}}$

(c) $V = \left(\dfrac{-Qe\Delta x}{m\varepsilon_0 L^2}\right)^2$　　(d) $V = \dfrac{Q^2 e\Delta x}{m\varepsilon_0 L^2}$

Q30. Two events take place at the same place in a lab frame but occur with a time difference of $3$ seconds. The same events occur with a time difference of $5$ seconds in a rocket frame. The relative speed of rocket and the laboratory is

(a) $0.5c$　　(b) $0.8c$

(c) $0.6c$　　(d) Cannot be determined from this data

Q31. A spaceship approaches a planet with a speed $0.6c$. At some point it fires a projectile with a speed $0.4c$ towards the planet. The speed of the projectile, as seen by an observer on the planet would be approximately

(a) $0.76c$　　(b) $0.80c$　　(c) $0.99c$　　(d) $0.40c$

Q32. The frequency of an LC oscillator is $\omega_0$. The plates of the parallel plate capacitor are pulled apart to twice the original distance, and a dielectric (with dielectric constant $K > 1$) is completely inserted into the capacitor. The new frequency of oscillation for the circuit is

(a) $\sqrt{\dfrac{2}{K}}\omega_0$　　(b) $\dfrac{2}{K}\omega_0$　　(c) $\sqrt{\dfrac{K}{2}}\omega_0$　　(d) $\dfrac{K}{2}\omega_0$

Q33. A particle is moving at a speed of $2.6\times10^{8}\ ms^{-1}$ relative to the laboratory. It s lifetime as measured by an observer in the laboratory is $4.7\times10^{-6}\ s$. The lifetime of the particle in its own rest frame is about

(a) $2.3\times10^{-6}\ s$ (b) $9.4\times10^{-6}\ s$ (c) $4.7\times10^{-6}\ s$ (d) $14.4\times10^{2}\ s$

Q34. For a wave function defined as $\psi(x)=\left(\frac{2}{L}\right)^{1/2}\sin(\pi x/L)$ in the region $0<x<L$ and $\psi(x)=0$ outside this region, the average value of the square of the momentum $(p^2)$ is,

(a) $\frac{\hbar\pi}{L}$ (b) $\frac{h^2\pi^2}{L^2}$ (c) $\frac{\hbar^2\pi^2}{L^2}$ (d) zero

Q35. A sample of radioactive $^{235}\mathrm{Pa}$ nucleus under goes beta decay with a half-life $(t_{12})$ of 24 minutes. If the activity of this radioactive sample is 1 Curie, its mass will be about

(a) $3.0\times10^{-8}\ gm.$ (b) $8.2\times10^{-9}\ gm.$

(c) $4.9\times10^{-9}\ gm.$ (d) $7.5\times10^{-8}\ gm.$

Q36. The ground state spin and parity of $^{19}\mathrm{F}_9$ nuclei will be

(a) Proton: $J^{\pi}=(5/2)^{*}$ (b) Neutron: $J^{\pi}=(5/2)^{*}$

(c) Proton: $J^{\pi}=(3/2)^{*}$ (d) Neutron: $J^{\pi}=(3/2)^{*}$

Q37. The kinetic energy of the electrons emitted from the $n=3$ state of the hydrogen atom, when illuminated with blue light of wavelength $450\,\mathrm{nm}$, is approximately:

(a) $2.76\,\mathrm{eV}$ (b) $4.27\,\mathrm{eV}$ (c) $1.51\,\mathrm{eV}$ (d) $1.25\,\mathrm{eV}$

Q38. The binding energies of $^{1}\mathrm{H}, {}^{4}\mathrm{He}$ and $^{7}\mathrm{Li}$ are $\mathrm{B}_1, \mathrm{B}_4$ and $\mathrm{B}_7$ respectively. The Q value of the reaction $^{1}\mathrm{H}+{}^{7}\mathrm{Li}\rightarrow 2\,{}^{4}\mathrm{He}+\mathrm{Q}$ is given by:

(a) $2B_1+4B_7-6B_4$ (b) $B_1+B_7-2B_4$

(c) $B_4-B_1-B_7$ (d) $B_1+7B_7-8B_4$

Q39. Consider the matrix $A=\begin{pmatrix}2 & 2\\ 2 & 5\end{pmatrix}$

If $B=2e^{A}$, the determinant of B is

(a) $4e^{7}$ (b) $4\left(e^{7}-e^{4}\right)$ (c) $e^{7}$ (d) $\left(e^{7}-e^{4}\right)$

Q40. The value of the determinant $\begin{vmatrix}2 & 5 & 3+2i\\ 9 & 2 & 5-4i\\ -20 & -9 & 3+6i\end{vmatrix}$ is

(a) $656+256i$ (b) $-656-256i$ (c) $656$ (d) $-656$

Q41. The most general solution of the differential equation $\frac{d^2y}{dx^2}+\frac{4dy}{dx}+4y=0$ is (here '$a$' and '$b$' are constants)

(a) $ae^{-2x}+be^{2x}$ (b) $ae^{-2x}+be^{-2x}$ (c) $ae^{-2x}+bxe^{-2x}$ (d) $ae^{2x}+bxe^{2x}$

Q42. The value of the integral $\int_1^{\infty} e^{-(x-1)^3}\left(x-1\right)^5 dx$ is

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

Q43. Which of the following sets of vectors constitute a basis for the plane.

(i) $(0,1),(1,1)$ (ii) $(1,1),(1,-1)$ (iii) $(1,0),(0,-1)$

(a) All three sets of vector (b) Only (iii)

(c) Only (i) and (iii) (d) Only (ii) and (iii)

Q44. The equation $a^2x^2+y^2=2\left(x+yb\right)$ is the equation of a

(a) Parabola (b) Hyperbola (c) Circle (d) Ellipse

Q45. A thin uniform circular disc of mass $M$ and radius $R$ is rotating in a horizontal plane about an axis passing through its centre and perpendicular to the plane with angularvelocity $\omega$. Another disc of same mass but half the radius is gently placed over it coaxially. The angular speed of the composite disc will be

(a) $\frac{3}{4}\omega$ (b) $\frac{4}{5}\omega$ (c) $\frac{5}{2}\omega$ (d) $\frac{2}{5}\omega$