JNU MSc 2019

Q1. Longitudinal waves are

(a) Plane polarized (b) Circularly polarized

(c) Elliptically polarized (d) Unpolarized

Q2. One nanometer is equal to

(a) $0.1\,\mathring{A}$ (b) $10\,\mathring{A}$ (c) $100\,\mathring{A}$ (d) $1000\,\mathring{A}$

Q3. According to the Dulong-Petit law, the atomic heat which is a product of atomic weight and specific heat, of most of the elements in solid state

(a) Is constant (b) Increases with atomic number

(c) Decrease with atomic number (d) Does not dened on atomic weight

Q4. An X -ray beam consists of

(a) Electrons (b) Protons (c) Neutrons (d) Photons

Q5. A thermocouple is a device to measure

(a) Pressure (b) Volume (c) Density (d) Temperature

Q6. What would be the frequency of the photon produced when an electron of energy $20\ keV$ is brought to rest in a collision with a heavy nucleus?

(a) $4.84\times10^{18}\ Hz$ (b) $5\times10^{18}\ Hz$

(c) $4.23\times10^{18}\ Hz$ (d) $3.84\times10^{18}\ Hz$

Q7. Consider a planet of mass m, in circular motion with angular momentum, L. The planet orbits a star of mass, M and the orbit radius is r. If the radius of the orbit is changed from r to $\frac{r}{2}$, what would be the new value of angular momentum?

(a) L (b) $L/2$ (c) $\frac{L}{\sqrt{2}}$ (d) $\sqrt{2}L$

Q8. At time $t=0$, a series RC circuit is connected to an emf of $9V$. How long will it take for the capacitor to reach $8V$?

(a) RC (b) $\frac{1}{RC}$ (c) $RC\ln 9$ (d) $\ln 9$

Q9. Which of the following quantities has the same physical dimension as that of $\frac{h}{e^2}$, where h is Planck's constant and e is electronic charge?

(a) Magnetic flux (b) Electrical resistance

(c) Magnetic field (d) Electrical resistivity

Q10. For a hydrogen atom the spacing between successive energy levels is given by $\Delta_n = E_{n+1} - E_n$, where n is the quantum number. Which of the following statements is true?

(a) Δ_n is constant (b) Δ_n increases as n increases

(c) Δ_n decreases as n increases (d) Δ_n increases and then decreases with n

Q11. Consider a momentum conservation experiment where two masses m_1 and m_2 are collided head-on with velocities v_1 and v_2, respectively, the measured values are $m_1 = 200 \pm 2g, v_1 = 5.5 \pm 0.1 m/s$ and $v_2 = 10 \pm 0.4 m/s$. What is the fractional error associated with mass m_2 of the other body

(a) ± 7.7 (b) ± 0.77 (c) ± 10.1 (d) ± 0.07

Q12. A sinusoidal wave moving along a string in the x-direction is described by

$$y(x,t) = 0.002 \sin(10x - 120t)$$

What is the propagation speed of the wave?

(a) 12 m/s (b) $10 m/s$ (c) $120 m/s$ (d) $1200 m/s$

Q13. The black body radiation emitted from a cavity of volume V at temperature T has chemical potential equal to (N is the number of photons emitted)

(a) N (b) 0 (c) $\frac{1}{T}$ (d) $\frac{V}{T}$

Q14. A $100W$ electric bulb has an efficiency of 2.5%. Assuming it is a point source, the intensity at a distance of $3m$ will be

(a) $2.5 W/m^2$ (b) $25 W/m^2$

(c) $0.025 W/m^2$ (d) $0.022 W/m^2$

Q15. An electron has a speed of $300\,m/s$, accurate to 0.01%. With what accuracy can we determine the position of the electron? (mass of electron $=9.1\times10^{-31}\,kg$, Planck's constant $=6.6\times10^{34}\,J\cdot s$)

(a) $2.4\,nm$ (b) $2.4\,\mu m$ (c) $2.4\,mm$ (d) $2.4\,cm$

Q16. A burst of 10^{14} electrons uniformly accelerated to an energy of $15\,MeV$ is stopped by a copper target block of mass $100\,g$. Assuming the block is thermally insulated, what is the rise in its temperature? (specific heat of copper is $0.09\,cal/g\,K$)

(a) $6.3\,K$ (b) $0.4\,K$ (c) $1.7\,K$ (d) $5.1\,K$

Q17. The function $y=ax^2-bx+c$, where a,b and c are positive and constants, has a minima at $x=$

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

Q18. During radioactive decay a nucleus emits a gamma ray with energy of $1.35\,MeV$. What is the wavelength of this photon?

(a) $920\,fm$ (b) $920\,nm$ (c) $920\,pm$ (d) $920\,\overset{0}{\text{A}}$

Q19. The adiabatic compressibility of an ideal gas is equal to (P is pressure and V is volume)

(a) $\frac{1}{P}$ (b) $\frac{P}{V}$ (c) P (d) $\frac{V}{P}$

Q20. The angle between the vectors $\vec{a}=\hat{i}+\hat{j}$ and $\vec{b}=\hat{i}+\hat{j}+\hat{k}$ is

(a) 0^0 (b) 45^0 (c) $\cos^{-1}\left(\frac{1}{3}\right)$ (d) $\cos^{-1}\left(\sqrt{\frac{2}{3}}\right)$

Q21. A $2\,mW$ laser light is emitted at a frequency of $6\times10^{14}\,Hz$. How many photons on average are emitted by this source per second? (Plank's constant$=6.6\times10^{-34}\,J\cdot s$)

(a) 1×10^{15} (b) 2×10^{15} (c) 3×10^{15} (d) 5×10^{15}

Q22. A particle of mass m moves in a circle of radius r with uniform angular speed ω. The work done by the centripetal force in half of a complete rotation is

(a) 0 (b) $2\pi m\omega^2 r^2$ (c) $\frac{\pi m\omega^2 r^2}{2}$ (d) $2\pi m\omega^2$

Q23. Resistances R_1 and R_2 are connected in parallel and I is the total current flowing in the circuit. I_1 is the current flowing through R_1. Which of the following conditions will produce minimum joule heating in the circuit?

(a) $I_1 = I\left(\frac{R_2}{R_1+R_2}\right)$ (b) $I_1 = I_2\left(\frac{R_2}{R_1+R_2}\right)$

(c) $I_1 = I_2\left(\frac{R_2}{R_1}\right)$ (d) $I_1 = I_2\left(\frac{R_1}{R_2}\right)$

Q24. In a two-level atom, the energy gap is E. The probability of finding the atom in the excited state at temperature T will be

(a) $\exp-\left(\frac{E}{k_B T}\right)$ (b) $\frac{1}{1+\exp-\left(\frac{E}{k_B T}\right)}$

(c) $\frac{\exp\left(\frac{E}{k_B T}\right)}{1+\exp-\left(\frac{E}{k_B T}\right)}$ (d) $\frac{\exp-\left(\frac{E}{k_B T}\right)}{1+\exp-\left(\frac{E}{k_B T}\right)}$

Q25. Consider a two-dimensional quantum harmonic oscillator with frequency ω. How many energy levels are there with energy $11\hbar\omega$?

(a) 5 (b) 8 (c) 11 (d) 21

Q26. What is the entropy change when $1kg$ of ice at $0^0 C$ melts reversibly to water at the same temperature? (Latent heat of melting of ice $= 79.6 cal/g$)

(a) $122 kJ\cdot K^{-1}$ (b) $12.2 kJ\cdot K^{-1}$ (c) $1.22 kJ\cdot K^{-1}$ (d) $0.122\ kJ\cdot K^{-1}$

Q27. The equation of motion of a particle of mass m in one-dimension is

$$m\frac{d^2x}{dt^2} = -ax - 3bx^2 - 4cx^3$$

where a, b and c are constants of appropriate dimension. The quantity that remains constant during its motion is

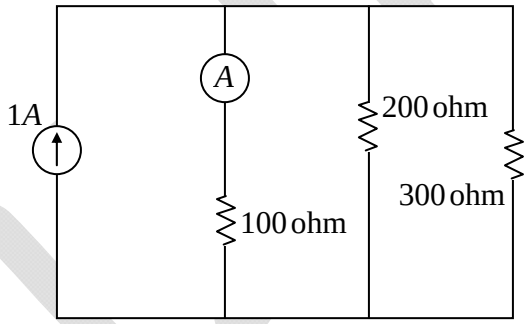
(a) $\frac{1}{2}m\dot{x}^2 + \frac{1}{2}ax^2 + bx^3 + cx^4$ (b) $\frac{1}{2}m\dot{x}^2 + ax^2 + bx^3 + cx^4$

(c) $\frac{1}{2}m\dot{x}^2 + \frac{1}{2}ax^2 + \frac{1}{3}bx^3 + cx^4$ (d) $\frac{1}{2}m\dot{x}^2 + ax^2 + \frac{1}{3}bx^3 + \frac{1}{4}cx^4$

Q28. The crystal structure of CsCl is a simple cubic lattice. Each unit cell of CsCl will contain

(a) 1 atom (b) 2 atoms (c) 3 atoms (d) 4 atoms

Q29. The reading in the ammeter A is



(a) $0.5454\,A$ (b) $5.5450\,A$ (c) $5.4555\,A$ (d) $1.5455\,A$

Q30. An ideal gas undergoes isothermal expansion at temperature T from volume V_1 to V_2. The entropy change per mole is

(a) $R\left(\frac{V_2}{V_1}\right)$ (b) $R\left(\frac{V_1}{V_2}\right)$ (c) $R\ln\left(\frac{V_2}{V_1}\right)$ (d) $R\ln\left(\frac{V_1}{V_2}\right)$

Q31. Which of the following is responsible for the existence of the Fermi surface in metals?

(a) Nuclear force

(b) Coulomb repulsion between electrons

(c) Bose-Einstein condensation

(d) Pauli exclusion principle

Q32. A sodium vapour lamp emits yellow light corresponding to two wavelengths 589 and $589.59\,nm$. What is the minimum number of rulings must a diffraction grating have to resolve these two lines in the first order?

(a) 589 (b) 700 (c) 900 (d) 1000

Q33. If $z = x + iy$, the value of $|\sin z|^2$ is

(a) $\sin^2 x + \sin^2 y$ (b) $\sin^2 x + \cos^2 y$

(c) $\sin^2 x + \sinh^2 y$ (d) $\sin^2 x + \cosh^2 y$

Q34. If a signal passing through a gate is inhibited by sending a LOW into one of the inputs, and the output is HIGH, the gate is

(a) an AND gate (b) a NAND gate

(c) a NOR gate (d) an OR gate

Q35. If $\hbar$ is the reduced Planck's constant, c is the speed of light, and G is the universal gravitational constant, which of the following has the dimension of length?

(a) $\frac{\hbar G}{c^2}$ (b) $\sqrt{\frac{\hbar c}{8\pi G}}$ (c) $\sqrt{\frac{\hbar G}{c^5}}$ (d) $\sqrt{\frac{\hbar G}{c^3}}$