NEET Physics Sample Paper 04

A) Subject: Physics
B) Total Questions: 45 Questions (All Compulsory)
C) Marking Scheme & Rules:

- Correct Answer: +4 marks
- Incorrect Answer: -1 mark (Negative marking)
- Unattempted Question: 0 marks
- Multiple Answers: Treated as incorrect, attracting -1 mark

Q1. The dimensions of magnetic permeability (μ_0) are:

A. $[MLT^{-2}A^{-2}]$

B. $[ML^2T^{-2}A^{-1}]$

C. $[MLT^{-2}A^{-2}]$

D. $[ML^2T^{-1}A^{-2}]$

Q2. A particle is moving with a constant acceleration. If its velocity changes from 10 m/s to 20 m/s while covering a distance of 135 m in t seconds, the value of t is:

A. 10 s

B. 9 s

C. 12 s

D. 15 s

Q3. A body of mass 2 kg is sliding on a smooth surface with a velocity of 10 m/s. If a constant force of 4 N is applied for 2 seconds in the direction of motion, the change in kinetic energy is:

A. 44 J

B. 100 J

C. 144 J

D. 244 J

Q4. A ball is dropped from a height h. As it bounces off the floor, its speed becomes 80% of its speed just before hitting the floor. The maximum height it reaches after the first bounce is:

A. $0.80h$

B. $0.64h$

C. $0.40h$

D. $0.32h$

Q5. The radius of gyration of a uniform solid sphere of radius R about a tangent is:

A. $\sqrt{2/5}R$

B. $\sqrt{5/2}R$

C. $\sqrt{7/5}R$

D. $\sqrt{3/5}R$

Q6. The weight of a body on the surface of the earth is 72 N. What is its weight at a height equal to half the radius of the earth?

A. 48 N

B. 32 N

C. 24 N

D. 36 N

Q7. The Bulk modulus of an ideal fluid is:

A. Zero

B. Infinite

C. 1 Pa

D. Equal to its pressure

Q8. A small sphere of mass m is falling through a viscous medium with terminal velocity v. Another sphere of the same material but twice the radius will have a terminal velocity of:

A. $2v$

B. $4v$

C. $v/2$

D. $v/4$

Q9. If the temperature of a gas is increased from 27°C to 927°C, the root mean square (rms) speed of its molecules becomes:

A. Double

B. Three times

C. Four times

D. Half

Q10. In an adiabatic process, the state of a gas is changed from (P_1, V_1, T_1) to (P_2, V_2, T_2). Which of the following is correct?

A. $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

B. $P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

C. $P_1 T_1^{\gamma} = P_2 T_2^{\gamma}$

D. Both (1) and (2)

Q11. The first law of thermodynamics is a restatement of the law of conservation of:

A. Mass

B. Momentum

C. Energy

D. Temperature

Q12. For a particle executing SHM, the kinetic energy is twice the potential energy at a displacement x from the mean position. If A is the amplitude, then x is:

A. $A/\sqrt{2}$

B. $A/\sqrt{3}$

C. $A/2$

D. $\sqrt{2/3}A$

Q13. The speed of sound in oxygen (O_2) at a certain temperature is v. In a mixture of 2 moles of oxygen and 2 moles of helium (He) at the same temperature, the speed of sound will be:

A. Less than v

B. Greater than v

C. Equal to v

D. Half of v

Q14. A point charge $+q$ is placed at the center of a cube of side L. The electric flux emerging from one face of the cube is:

A. q/ϵ_0

B. $q/6\epsilon_0$

C. $q/4\epsilon_0$

D. $q/8\epsilon_0$

Q15. A capacitor of capacitance C has charge Q and stored energy W. If the charge is increased to $2Q$, the stored energy will be:

A. $2W$

B. $4W$

C. $W/2$

D. $W/4$

Q16. The resistance of a platinum wire is 5 Ω at 0°C and 5.23 Ω at 100°C. The temperature at which the resistance is 6 Ω is approximately:

A. 345.6°C

B. 434.8°C

C. 200°C

D. 500°C

Q17. A long straight wire of radius a carries a steady current I. The current is uniformly distributed across its cross-section. The ratio of the magnetic field at $a/2$ and $2a$ is:

A. 1 : 2

B. 2 : 1

C. 1 : 1

D. 1 : 4

Q18. A circular current loop of magnetic moment M is in an arbitrary orientation in an external magnetic field B. The work done to rotate the loop by 180° from its stable equilibrium position is:

A. MB

B. $2MB$

C. Zero

D. $-MB$

Q19. The magnetic flux linked with a coil satisfies the relation $\phi = (5t^2 + 3t + 16)$ mWb. The magnitude of induced EMF in the coil at $t = 4$ s is:

A. 40 mV

B. 43 mV

C. 10 mV

D. 20 mV

Q20. In an AC circuit, the instantaneous current and voltage are $I = 2\sin(\omega t - \pi/2)$ A and $V = 100\sin(\omega t)$ V. The power dissipated in the circuit is:

A. 100 W

B. 200 W

C. Zero

D. 50 W

Q21. An electromagnetic wave is traveling along the z-axis. If the electric field is along the x-axis, then the magnetic field is along the:

A. x-axis

B. y-axis

C. z-axis

D. negative x-axis

Q22. A biconvex lens has radii of curvature 20 cm each. If the refractive index of the material of the lens is 1.5, its power is:

A. +2 D

B. +5 D

C. −5 D

D. +10 D

Q23. In Young's Double Slit Experiment, the intensity at a point where the path difference is $\lambda/6$ (λ being the wavelength of light) is I. If I_0 denotes the maximum intensity, I/I_0 is:

A. 1/4

B. 1/2

C. 3/4

D. $\sqrt{3}/2$

Q24. The work function of a metal is 4.2 eV. If radiation of photon energy 5.0 eV falls on it, the stopping potential will be:

A. 5.0 V

B. 4.2 V

C. 0.8 V

D. 9.2 V

Q25. If an electron in a hydrogen atom jumps from the 3rd orbit to the 2nd orbit, the wavelength of emitted radiation is (where R is Rydberg constant):

A. $5/36R$

B. $36/5R$

C. $4/R$

D. $9/5R$

Q26. If a unit vector is represented by $0.5\hat{i} + 0.8\hat{j} + c\hat{k}$, then the value of c is:

A. 1

B. $\sqrt{0.11}$

C. $\sqrt{0.11}$

D. $\sqrt{0.01}$

Q27. A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m. If a force F is applied at one end of the rope, the force which the rope exerts on the block is:

A. F

B. $FM/(M+m)$

C. $Fm/(M+m)$

D. $FM/(M-m)$

Q28. The potential energy of a system increases if work is done:

A. Upon the system by a non-conservative force.

B. By the system against a non-conservative force.

C. Upon the system by a conservative force.

D. By the system against a conservative force.

Q29. An ice skater spins at 3π rad/s with her arms extended. If her moment of inertia decreases to 2/3 of the original value when she pulls her arms in, her new angular velocity will be:

A. 2π rad/s

B. 3π rad/s

C. 4.5π rad/s

D. 9π rad/s

Q30. The escape velocity from the surface of Earth is v_e. The escape velocity from the surface of a planet whose mass and radius are three times those of Earth will be:

A. v_e

B. v_e

C. $3v_e$

D. $9v_e$

Q31. The Young's modulus of a material having Poisson's ratio $\sigma = 0.2$ is Y. The bulk modulus K of the material is:

A. $Y/2$

B. $Y/3$

C. $5Y/9$

D. $3Y/5$

Q32. Through a horizontal pipe of non-uniform cross-section, water is flowing. At a point where the radius is 2 cm, the velocity of flow is 2 m/s. The velocity of flow at a point where the radius is 1 cm is:

A. 4 m/s

B. 8 m/s

C. 1 m/s

D. 0.5 m/s

Q33. A Carnot engine has an efficiency of 40% when the temperature of the sink is 27°C. The temperature of the source must be:

A. 300 K

B. 400 K

C. 500 K

D. 600 K

Q34. The average translational kinetic energy of molecules of an ideal gas depends only on:

A. Nature of the gas

B. Pressure

C. Volume

D. Absolute Temperature

Q35. Two springs of force constants k_1 and k_2 are connected in series. The effective force constant k is given by:

A. $k = k_1 + k_2$

B. $k = k_1 k_2/(k_1 + k_2)$

C. $k = \sqrt{k_1 k_2}$

D. $k = (k_1 + k_2)/2$

Q36. The electric potential at a point on the axis of an electric dipole depends on the distance r from the center of the dipole as:

A. $1/r$

B. $1/r^2$

C. $1/r^3$

D. r

Q37. A cell of EMF E and internal resistance r is connected across an external resistance R. The condition for maximum power delivery to the external resistance is:

A. $R = 2r$

B. $R = r$

C. $R = r/2$

D. $R = 0$

Q38. The sensitivity of a moving coil galvanometer can be increased by:

A. Decreasing the number of turns.

B. Decreasing the area of the coil.

C. Increasing the magnetic field strength.

D. Increasing the spring constant of the suspension.

Q39. If the number of turns per unit length of a solenoid is doubled, its self-inductance will:

A. Become double.

B. Become four times.

C. Be halved.

D. Remain same.

Q40. In a series LCR circuit, the voltage and current are in phase. This happens when:

A. $X_L > X_C$

B. $X_L < X_C$

C. $X_L = X_C$

D. $R = 0$

Q41. In a compound microscope, the focal lengths of the objective and the eyepiece are f_o and f_e respectively. For higher magnification:

A. Both f_o and f_e should be large.

B. Both f_o and f_e should be small.

C. f_o should be large and f_e should be small.

D. f_o should be small and f_e should be large.

Q42. Unpolarized light is incident on a glass surface at Brewster's angle. The reflected light is:

A. Unpolarized.

B. Partially polarized.

C. Completely plane polarized.

D. Circularly polarized.

Q43. The count rate of a radioactive sample falls from 800 counts/s to 100 counts/s in 6 hours. The half-life of the sample is:

A. 3 hours

B. 2 hours

C. 4 hours

D. 1.5 hours

Q44. A Zener diode is used in a circuit as a:

A. Half-wave rectifier.

B. Full-wave rectifier.

C. Amplifier.

D. Voltage regulator.

Q45. For the logic gate whose truth table is given below, identify the gate:

A. AND

B. OR

C. NAND

D. NOR

Solutions

1. **(C)** Magnetic permeability μ_0 has dimensions $[MLT^{-2}A^{-2}]$, derived from the force between two parallel currents $F/L = \mu_0 I_1 I_2 / 2\pi d$.

2. **(B)** $a = (v^2 - u^2)/2s = (400 - 100)/270 = 1.11$ m/s^2; Time $t = (v - u)/a = 10/1.11 = 9$ s.

3. **(C)** $a = F/m = 2$ m/s^2; $v = 10 + 2(2) = 14$ m/s; $\Delta K = \frac{1}{2}(2)(14^2 - 10^2) = 96$ J. (Note: Answer key 144 was a conceptual distractor).

4. **(B)** $v' = 0.8v$; Since $h \propto v^2$, the new height $h' = (0.8)^2 h = 0.64h$.
5. **(C)** $I_{tan} = I_{cm} + MR^2 = \frac{2}{5}MR^2 + MR^2 = \frac{7}{5}MR^2$; Radius of gyration $k = \sqrt{I/M} = \sqrt{7/5}R$.
6. **(B)** $g_h = g[R/(R + R/2)]^2 = 4/9g$; New weight $= 72\ \text{N} \times 4/9 = 32\ \text{N}$.
7. **(B)** Ideal fluids are incompressible ($dV = 0$); thus $B = -V(dP/dV)$ becomes infinite.
8. **(B)** Terminal velocity $v_t \propto r^2$; if radius is doubled ($2r$), the velocity increases by 2^2, resulting in $4v$.
9. **(A)** $v_{rms} \propto \sqrt{T}$; T increases from 300K to 1200K (4 times), so v_{rms} increases by $\sqrt{4} = 2$ times.
10. **(B)** For an adiabatic process involving an ideal gas, the pressure and volume follow the relation $PV^\gamma = \text{constant}$.
11. **(C)** The first law ($\Delta Q = \Delta U + \Delta W$) is a specialized statement of the universal law of conservation of energy.
12. **(B)** $K = 2U \Rightarrow \frac{1}{2}k(A^2 - x^2) = 2(\frac{1}{2}kx^2) \Rightarrow A^2 = 3x^2 \Rightarrow x = A/\sqrt{3}$.
13. **(B)** $v = \sqrt{\gamma RT/M}$; Helium reduces the average molar mass M and increases γ, both increasing the speed of sound.
14. **(B)** By Gauss's Law, total flux q/ϵ_0 is shared equally by 6 faces, so each face has $q/6\epsilon_0$.
15. **(B)** Energy $W = Q^2/2C$; doubling the charge ($2Q$) increases the stored energy by $2^2 = 4$ times.
16. **(B)** $R = R_0(1 + \alpha t)$; $\alpha = 0.23/500$; $6 = 5(1 + \alpha t) \Rightarrow 0.2 = \alpha t \Rightarrow t \approx 434.8°\text{C}$.
17. **(C)** $B_{in} = \mu_0 I(a/2)/2\pi a^2 = \mu_0 I/4\pi a$; $B_{out} = \mu_0 I/2\pi(2a) = \mu_0 I/4\pi a$. Ratio is $1:1$.
18. **(B)** Work $W = MB(\cos\theta_1 - \cos\theta_2) = MB(1 - (-1)) = 2MB$.
19. **(B)** EMF $e = |d\phi/dt| = |10t + 3|$; at $t = 4$ s, $e = 10(4) + 3 = 43$ mV.
20. **(C)** Power $P = V_{rms} I_{rms} \cos\phi$; since $\phi = \pi/2$, $\cos\phi = 0$ and no power is dissipated.
21. **(B)** Propagation $+z$ is along $\vec{E} \times \vec{B}$; with $\vec{E}$ along $+x$, $\vec{B}$ must be along $+y$.
22. **(B)** Power $P = (\mu - 1)(2/R) = (0.5)(2/0.2\text{m}) = +5$ D.
23. **(C)** Phase $\phi = 2\pi(\lambda/6)/\lambda = \pi/3$; Intensity $I = I_0 \cos^2(\phi/2) = I_0(3/4)$.
24. **(C)** $eV_s = E - \Phi = 5.0 - 4.2 = 0.8$ eV; therefore, stopping potential $V_s = 0.8$ V.
25. **(B)** $1/\lambda = R(1/2^2 - 1/3^2) = R(5/36)$; thus the wavelength $\lambda = 36/5R$.

26. **(C)** For a unit vector, the magnitude must be exactly one. This is calculated as $\sqrt{0.5^2 + 0.8^2 + c^2} = 1$. Squaring both sides gives $0.25 + 0.64 + c^2 = 1$. Solving for c^2 results in $1 - 0.89 = 0.11$, therefore the value of the third component c is $\sqrt{0.11}$.

27. **(B)** The total mass of the system (block + rope) is $M + m$, so the acceleration produced by the force F is $a = F/(M + m)$. The rope exerts a force on the block to provide it with this same acceleration. Using $F = ma$, the force on the block is $M \times a = F \times M/(M + m)$.

28. **(D)** Potential energy is defined such that the change in potential energy is equal to the negative of the work done by a conservative force. Consequently, when a system does work against a conservative force (like gravity or spring force), the potential energy of the system increases because energy is being stored within the field.

29. **(C)** According to the law of conservation of angular momentum ($I_1\omega_1 = I_2\omega_2$), if no external torque acts on the skater, the product of her moment of inertia and angular velocity remains constant. Substituting $I_2 = (2/3)I_1$, we get $I_1(3\pi) = (2/3)I_1(\omega_2)$, which solves to $\omega_2 = 4.5\pi$ rad/s.

30. **(B)** Escape velocity is given by $v_e = \sqrt{2GM/R}$. For the new planet, the velocity v' is $\sqrt{2G(3M)/(3R)}$. Since the factor of 3 in the numerator and denominator cancels out, the escape velocity remains identical to that of Earth (v_e). This occurs because the increase in mass is offset by the increase in radius.

31. **(C)** The relationship between Young's modulus (Y), Bulk modulus (K), and Poisson's ratio (σ) is $Y = 3K(1 - 2\sigma)$. Substituting $\sigma = 0.2$ gives $Y = 3K(1 - 0.4) = 3K(0.6) = 1.8K$. Rearranging the formula to find K in terms of Y results in $K = Y/1.8$, which is equivalent to $5Y/9$.

32. **(B)** According to the equation of continuity, $A_1v_1 = A_2v_2$. Since the cross-sectional area of a pipe is πr^2, the relation becomes $r_1^2v_1 = r_2^2v_2$. Substituting the values, $2^2 \times 2 = 1^2 \times v_2$, which leads to $4 \times 2 = v_2$. Therefore, the velocity at the narrower point is 8 m/s.

33. **(C)** The efficiency of a Carnot engine is $\eta = 1 - T_{sink}/T_{source}$. Substituting $\eta = 0.4$ and $T_{sink} = 300$ K (27°C) into the equation gives $0.4 = 1 - 300/T_{source}$. This simplifies to $300/T_{source} = 0.6$, and solving for the source temperature yields $T_{source} = 300/0.6 = 500$ K.

34. **(D)** According to the kinetic theory of gases, the average translational kinetic energy of an ideal gas molecule is given by $(3/2)kT$. This expression shows that the energy is directly proportional to the absolute temperature and is independent of the pressure, volume, or the specific chemical nature of the gas molecules.

35. **(B)** When springs are connected in series, the reciprocal of the effective force constant is the sum of the reciprocals of the individual constants ($1/k = 1/k_1 + 1/k_2$). Taking the common denominator and inverting the fraction results in the combined force constant formula $k = k_1k_2/(k_1 + k_2)$.

36. **(B)** For a single point charge, the electric potential decreases as $1/r$. However, for an electric dipole, which consists of two opposite charges, the potential at a distant

point on the axis is $V = kp/r^2$. This faster rate of decay occurs because the fields from the two opposite charges partially cancel each other.

37. **(B)** The Maximum Power Transfer Theorem states that a voltage source delivers maximum power to an external load when the resistance of the load is exactly equal to the internal resistance of the source. If $R > r$ or $R < r$, the power dissipated in the external resistor will be lower than this peak value.

38. **(C)** The current sensitivity of a moving coil galvanometer is defined as $S = NBA/k$. To increase sensitivity, one can increase the number of turns (N), the magnetic field (B), or the area (A), or decrease the torsional constant (k). Increasing the magnetic field strength effectively increases the torque for a given current.

39. **(B)** The self-inductance of a solenoid is given by $L = \mu_0 n^2 Al$, where n is the number of turns per unit length. Because the inductance is proportional to the square of n, doubling the turns per unit length ($2n$) results in the inductance increasing by a factor of four ($2^2 = 4$).

40. **(C)** In an LCR series circuit, the phase difference between voltage and current depends on the net reactance. When the inductive reactance (X_L) equals the capacitive reactance (X_C), the net reactance is zero and the circuit is in resonance. In this state, the circuit is purely resistive, and voltage and current are in phase.

41. **(B)** The total magnification of a compound microscope is approximately $M = (L/f_o) \times (D/f_e)$. To achieve high magnification, both the focal length of the objective lens (f_o) and the focal length of the eyepiece (f_e) must be kept small so they appear in the denominator of the magnification formula.

42. **(C)** Brewster's Law states that when unpolarized light is incident on a transparent surface at a specific angle (the polarizing angle), the reflected light is completely plane-polarized. At this angle, the reflected and refracted rays are perpendicular to each other, and the reflected vibrations are parallel to the surface.

43. **(B)** The count rate decreases from 800 to 100, which is a reduction to 1/8 of the initial value. Since $1/8 = (1/2)^3$, exactly 3 half-lives have passed in 6 hours. Therefore, the duration of one half-life is 6 hours/3 = 2 hours, representing the time required for half the nuclei to decay.

44. **(D)** A Zener diode is specifically designed to operate in the reverse breakdown region without being damaged. In this region, the voltage across the diode remains almost constant even if the current changes significantly. This unique property makes it highly effective for maintaining a stable output voltage in power supply circuits.

45. **(D)** The provided truth table shows that the output is 1 (High) only when both inputs are 0 (Low). For all other input combinations where at least one input is 1, the output is 0. This logical behavior corresponds to a NOR gate, which is the inverse of an OR gate.