NEET Physics Sample Paper 01

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 dimensional formula for Planck's constant (h) is identical to that of:

A. Linear momentum

B. Angular momentum

C. Energy

D. Power

Q2. A ball is thrown vertically upwards with a velocity of 20 m/s from the top of a tower of height 25 m. The total time the ball takes to reach the ground is ($g = 10$ m/s^2):

A. 2 s

B. 3 s

C. 5 s

D. 7 s

Q3. A body of mass 5 kg is acted upon by two perpendicular forces, 8 N and 6 N. The magnitude of the acceleration of the body is:

A. 1.2 m/s^2

B. 2 m/s^2

C. 2.8 m/s^2

D. 5 m/s^2

Q4. A spring of force constant k is cut into two equal halves. The force constant of each half is:

A. $k/2$

B. k

C. $2k$

D. $4k$

Q5. A thin uniform rod of length L and mass M has a moment of inertia I_1 about an axis passing through its center and perpendicular to its length. If the same rod is bent into a ring, its moment of inertia about its diameter is I_2. The ratio I_1/I_2 is:

A. $\pi^2/3$

B. $2\pi^2/3$

C. $4\pi^2/3$

D. $8\pi^2/3$

Q6. The acceleration due to gravity at a depth d below the surface of the earth is the same as that at a height h above the surface. If $h, d \ll R$ (Radius of Earth), then:

A. $d = h$

B. $d = 2h$

C. $h = 2d$

D. $d = h/2$

Q7. The stress-strain graph for two materials A and B are shown. Material A has a steeper slope than material B. This indicates that:

A. Material B is more elastic than A.

B. Material A is more elastic than B.

C. Both materials have the same Young's modulus.

D. Material A is more ductile than B.

Q8. In a thermodynamic process, the pressure of a fixed mass of gas is changed in such a manner that the gas releases 20 J of heat and 8 J of work is done on the gas. If the initial internal energy was 30 J, the final internal energy is:

A. 2 J

B. 18 J

C. 42 J

D. 58 J

Q9. The average kinetic energy of a gas molecule at temperature T is E. If the temperature is doubled, the average kinetic energy becomes:

A. $\sqrt{2}E$

B. $2E$

C. $4E$

D. $E/2$

Q10. A simple pendulum is hanging from the ceiling of an elevator. If the elevator moves upward with a constant acceleration a, the time period of the pendulum:

A. Increases

B. Decreases

C. Remains the same

D. Becomes zero

Q11. A whistle producing sound of frequency 450 Hz approaches a stationary observer at a speed of 33 m/s. If the speed of sound is 330 m/s, the frequency heard by the observer is:

A. 400 Hz

B. 500 Hz

C. 550 Hz

D. 600 Hz

Q12. Two point charges Q and $-Q$ are placed at a distance r apart. If the distance is doubled and the system is placed in a medium of dielectric constant $K = 2$, the new force between them is:

A. $F/2$

B. $F/4$

C. $F/8$

D. $F/16$

Q13. A charge q is placed at the center of an open-faced hemispherical bowl. The electric flux through the bowl is:

A. q/ϵ_0

B. $q/2\epsilon_0$

C. $q/4\epsilon_0$

D. Zero

Q14. A parallel plate capacitor is charged and the charging battery is then disconnected. If the plates are now moved farther apart by an insulating handle:

A. The charge on the capacitor increases.

B. The capacitance increases.

C. The voltage across the plates increases.

D. The energy stored decreases.

Q15. When a current I flows through a wire of radius r, the drift velocity is v. If the same current flows through a wire of the same material but with radius $2r$, the new drift velocity is:

A. $v/2$

B. $v/4$

C. $2v$

D. $4v$

Q16. In a meter bridge experiment, the null point is obtained at 20 cm from the left end when a resistance R is in the left gap and X is in the right gap. If R is 10 Ω, the value of X is:

A. 20 Ω

B. 30 Ω

C. 40 Ω

D. 50 Ω

Q17. A circular coil of radius R carries a current I. The magnetic field at the center of the coil is B. The magnetic field at a point on the axis of the coil at a distance R from the center is:

A. $B/2$

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

C. $B/4$

D. $\sqrt{2}B$

Q18. An electron enters a uniform magnetic field B moving perpendicular to the field lines with a velocity v. If the magnetic field is doubled, the radius of its circular path will:

A. Double

B. Halve

C. Quadruple

D. Remain unchanged

Q19. A metallic square loop $ABCD$ is moving in its own plane with velocity v in a uniform magnetic field B perpendicular to its plane as shown in the figure. An electric field is induced:

A. In AD only

B. In BC only

C. In both AD and BC

D. In neither AD nor BC

Q20. In an LCR series circuit, the resonance frequency is f. If the capacitance is made 4 times, the new resonance frequency will be:

A. $2f$

B. $4f$

C. $f/2$

D. $f/4$

Q21. Two thin lenses of focal lengths $+10$ cm and -20 cm are placed in contact. The focal length of the combination is:

A. $+10$ cm

B. $+20$ cm

C. -10 cm

D. -20 cm

Q22. In Young's Double Slit Experiment, the fringe width is 0.4 mm. If the whole apparatus is immersed in water of refractive index $4/3$, the new fringe width will be:

A. 0.53 mm

B. 0.3 mm

C. 0.4 mm

D. 0.12 mm

Q23. The threshold frequency for a metallic surface is f_0. When light of frequency $2f_0$ is incident on the surface, the maximum kinetic energy of photoelectrons is K. If the incident frequency is $5f_0$, the maximum kinetic energy will be:

A. $2K$

B. $3K$

C. $4K$

D. $5K$

Q24. The half-life of a radioactive substance is 20 minutes. The time taken between 20% decay and 80% decay is:

A. 20 min

B. 40 min

C. 60 min

D. 80 min

Q25. In a P-N junction diode, the thickness of the depletion layer:

A. Increases with forward bias.

B. Increases with reverse bias.

C. Decreases with reverse bias.

D. Is independent of the applied voltage.

Q26. A particle moves in a circle of radius 5 cm with constant speed and a time period of 0.2π s. The acceleration of the particle is:

A. 15 m/s^2

B. 25 m/s^2

C. 5 m/s^2

D. 0.25 m/s^2

Q27. The ratio of the numerical value of the average velocity to the average speed of a body is always:

A. Less than 1

B. Equal to 1

C. Unity or less

D. Unity or more

Q28. A bullet of mass 10 g is fired from a gun of mass 1 kg. If the recoil velocity of the gun is 5 m/s, the muzzle velocity of the bullet is:

A. 0.5 m/s

B. 50 m/s

C. 5 m/s

D. 500 m/s

Q29. The work done in increasing the size of a soap bubble from a radius of 3 cm to 5 cm is nearly (Surface tension of soap solution = 0.03 N/m):

A. 0.2π mJ

B. 0.1π mJ

C. 0.38π mJ

D. 0.76π mJ

Q30. A gas mixture consists of 2 moles of Oxygen and 4 moles of Argon at temperature T. Neglecting all vibrational modes, the total internal energy of the system is:

A. $4RT$

B. $9RT$

C. $15RT$

D. $11RT$

Q31. In Simple Harmonic Motion (SHM), the graph showing the variation of particle acceleration (a) with displacement (x) is:

A. A parabola

B. A straight line with positive slope

C. A straight line with negative slope

D. A circle

Q32. In an electromagnetic wave, the phase difference between the electric field vector $\vec{E}$ and magnetic field vector $\vec{B}$ is:

A. $\pi/2$

B. π

C. Zero

D. $\pi/4$

Q33. A ray of light is incident at an angle of 60° on one face of a prism of angle 30°. If the ray emerging from the prism makes an angle of 30° with the incident ray, the refractive index of the prism material is:

A. $\sqrt{3}$

B. 1.5

C. $\sqrt{2}$

D. 1.33

Q34. The energy of an electron in the ground state of a hydrogen atom is -13.6 eV. The energy required to excite it to the second excited state is:

A. 10.2 eV

B. 12.09 eV

C. 1.51 eV

D. 13.6 eV

Q35. During an α-decay of a radioactive nucleus, the mass number (A) and atomic number (Z) of the daughter nucleus change as:

A. A decreases by 2, Z decreases by 4

B. A decreases by 4, Z increases by 2

C. A decreases by 4, Z decreases by 2

D. A remains same, Z decreases by 2

Q36. For a transistor in common-emitter configuration, the current gain β is 100. If the collector current changes by 1 mA, the base current will change by:

A. 100 mA

B. 10 mA

C. 1 mA

D. 0.1 mA

Q37. Identify the logic operation performed by a gate whose output is 0 only when both inputs are 1:

A. AND

B. NAND

C. OR

D. NOR

Q38. Match List-I (Physical Quantity) with List-II (Unit):

A. A-I, B-II, C-III, D-IV

B. A-II, B-III, C-I, D-IV

C. A-III, B-II, C-IV, D-I

D. A-II, B-I, C-III, D-IV

Q39. Which of the following statements is correct?

A. The core of a transformer is laminated to increase eddy currents.

B. Displacement current arises due to a steady electric field.

C. The core of a transformer is laminated to reduce energy loss due to eddy currents.

D. Eddy currents are used to increase the resistance of a conductor.

Q40. A potentiometer wire of length 100 cm has a resistance of 10 Ω. It is connected in series with an external resistance R and a cell of 2 V. If a balance point of 40 cm is obtained for an EMF of 10 mV, the value of R is:

A. 190 Ω

B. 390 Ω

C. 790 Ω

D. 990 Ω

Q41. Consider a circuit where a 10 V battery is connected in series with two resistors of 2 Ω and 3 Ω. The potential difference across the 3 Ω resistor is:

A. 2 V

B. 4 V

C. 6 V

D. 10 V

Q42. A copper wire (radius 1 mm) and an iron wire (radius 3 mm) are joined in series and a current is passed through them. The ratio of current densities in the copper and iron wires is:

A. 1 : 3

B. 3 : 1

C. 9 : 1

D. 1 : 9

Q43. The work done by a uniform magnetic field on a moving charge is:

A. Always positive

B. Always negative

C. Always zero

D. Depends on the velocity

Q44. The underlying principle behind the functioning of optical fibers is:

A. Total internal reflection

B. Interference

C. Diffraction

D. Scattering

Q45. The percentage errors in the measurement of mass and speed are 2% and 3% respectively. The maximum percentage error in the estimate of kinetic energy is:

A. 5%

B. 8%

C. 11%

D. 12%

Solutions

1. **(B)** Planck's constant h has dimensions $[ML^2T^{-1}]$, derived from the energy equation $E = h\nu$. Similarly, angular momentum $L = mvr$ shares the same dimensional formula $[ML^2T^{-1}]$. Both represent the product of energy and time, making them dimensionally equivalent in physical analysis.

2. **(C)** Using the kinematic equation $s = ut + \frac{1}{2}at^2$, where $s = -25$ m, $u = +20$ m/s, and $a = -10$ m/s^2, we solve the quadratic equation $-25 = 20t - 5t^2$. This simplifies to $t^2 - 4t - 5 = 0$, giving a positive time solution of exactly 5 seconds for the ball to reach the ground.

3. **(B)** Since the forces are perpendicular, the net force is the vector sum calculated via the Pythagorean theorem: $F_{net} = \sqrt{8^2 + 6^2} = 10$ N. According to Newton's Second Law, acceleration is $F_{net}/m = 10$ N/5 kg $= 2$ m/s^2.

4. **(C)** The force constant k of a spring is inversely proportional to its length. When a spring is cut into two equal halves, the length of each piece becomes half of the original, causing the stiffness or force constant of each half to double to $2k$.

5. **(B)** The rod's moment of inertia is $I_1 = \frac{ML^2}{12}$. When bent into a ring of radius $R = \frac{L}{2\pi}$, its moment of inertia about the diameter is $I_2 = \frac{1}{2}MR^2 = \frac{ML^2}{8\pi^2}$. The ratio $I_1/I_2 = \frac{ML^2}{12} \times \frac{8\pi^2}{ML^2} = \frac{2\pi^2}{3}$.

6. **(B)** For small values of h and d relative to Earth's radius R, the gravity formulas are $g_h = g(1 - \frac{2h}{R})$ and $g_d = g(1 - \frac{d}{R})$. Equating these leads to $\frac{2h}{R} = \frac{d}{R}$, which simplifies to the condition $d = 2h$.

7. **(B)** Young's modulus is determined by the slope of the stress-strain curve in the elastic region. A steeper slope for material A implies a higher Young's modulus, meaning material A requires more stress for the same strain and is therefore more elastic than material B.

8. **(B)** Applying the First Law of Thermodynamics, $\Delta U = Q - W$. Here, $Q = -20$ J (heat released) and $W = -8$ J (work done on gas), so $\Delta U = -20 - (-8) = -12$ J. The final internal energy is $U_i + \Delta U = 30 - 12 = 18$ J.

9. **(B)** The average kinetic energy of a gas molecule is directly proportional to its absolute temperature, expressed as $E = \frac{3}{2}kT$. If the temperature T is doubled, the average kinetic energy E will also double linearly to $2E$, assuming no change in degrees of freedom.

10. **(B)** The time period of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g_{eff}}}$. When an elevator accelerates upward at a, the effective gravity increases to $g_{eff} = g + a$. Since T is inversely proportional to the square root of g_{eff}, the time period decreases.

11. **(B)** According to the Doppler effect for a source approaching a stationary observer, $f' = f(\frac{v}{v - v_s})$. Substituting the values $f = 450$ Hz, $v = 330$ m/s, and $v_s = 33$ m/s, we get $f' = 450(\frac{330}{297}) = 500$ Hz.

12. **(C)** Coulomb's force is $F \propto \frac{1}{Kr^2}$. When the distance r is doubled and a dielectric $K = 2$ is introduced, the new force F' becomes $\frac{F}{K(2)^2} = \frac{F}{2\times4} = \frac{F}{8}$. The force reduces due to both increased separation and medium polarization.

13. **(B)** By using Gauss's Law and symmetry, we can imagine a full sphere enclosing the charge. The total flux would be q/ϵ_0. Since the hemispherical bowl is exactly half of that symmetrical enclosure, the flux passing through it is $q/2\epsilon_0$.

14. **(C)** When the battery is disconnected, the charge Q remains constant. Capacitance $C = \frac{\epsilon_0 A}{d}$ decreases as distance d increases. Since $V = Q/C$, a decrease in C with a constant Q results in an increase in the potential difference V across the plates.

15. **(B)** Drift velocity is given by $v_d = \frac{I}{neA}$. Since current I and carrier density n are constant, v_d is inversely proportional to the cross-sectional area A (or r^2). Doubling the radius increases the area fourfold, reducing the drift velocity to $v/4$.

16. **(C)** For a balanced meter bridge, the ratio of resistances equals the ratio of the corresponding lengths: $\frac{R}{l} = \frac{X}{100-l}$. Substituting $R = 10\ \Omega$ and $l = 20$ cm gives $\frac{10}{20} = \frac{X}{80}$, which results in $X = 40\ \Omega$.

17. **(B)** The magnetic field at the center is $B = \frac{\mu_0 I}{2R}$. At a distance $x = R$ on the axis, $B_{axis} = \frac{\mu_0 I R^2}{2(R^2+x^2)^{3/2}} = \frac{\mu_0 I R^2}{2(2R^2)^{3/2}} = \frac{\mu_0 I}{2R(2\sqrt{2})} = \frac{B}{2\sqrt{2}}$.

18. **(B)** The radius of an electron's circular path in a magnetic field is $R = \frac{mv}{qB}$. For constant mass m, velocity v, and charge q, the radius is inversely proportional to the magnetic field strength B. Therefore, doubling the field B results in the radius being halved.

19. **(C)** Motional EMF $\epsilon = Blv$ is induced in conductors that move perpendicular to magnetic field lines. In the moving square loop, both sides AD and BC are cutting the field lines, thus both experience an induced EMF, while the other two sides move parallel to their lengths.

20. **(C)** The resonance frequency of an LCR circuit is $f = \frac{1}{2\pi\sqrt{LC}}$. If the capacitance C is increased four times, the denominator increases by a factor of $\sqrt{4} = 2$. Consequently, the new resonance frequency becomes half of the original value, or $f/2$.

21. **(B)** The equivalent focal length F for lenses in contact is $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$. Substituting $f_1 = +10$ cm and $f_2 = -20$ cm gives $\frac{1}{F} = \frac{1}{10} - \frac{1}{20} = \frac{1}{20}$, resulting in an equivalent focal length of $+20$ cm.

22. **(B)** The fringe width is $\beta = \frac{\lambda D}{d}$. When immersed in a medium of refractive index μ, the wavelength becomes $\lambda' = \lambda/\mu$. Thus, the new fringe width is $\beta' = \beta/\mu = 0.4\ \text{mm}/(4/3) = 0.3$ mm.

23. **(C)** From Einstein's equation, $K = h(2f_0) - hf_0 = hf_0$. If the incident frequency becomes $5f_0$, the new kinetic energy is $K' = h(5f_0) - hf_0 = 4hf_0$. Since $hf_0 = K$, the new kinetic energy is exactly $4K$.

24. **(B)** 20% decay means 80% remains ($N_1 = 0.8N_0$), and 80% decay means 20% remains ($N_2 = 0.2N_0$). The ratio $N_1/N_2 = 4$, which corresponds to two half-lives ($2^2 = 4$). The time taken is 2×20 minutes $= 40$ minutes.

25. **(B)** In reverse bias, the external potential supports the built-in potential, pulling majority carriers away from the junction. This increases the width of the region depleted of mobile charge carriers, thereby increasing the thickness of the depletion layer.

26. **(C)** The angular velocity is calculated as $\omega = 2\pi/T = 2\pi/(0.2\pi) = 10$ rad/s. The centripetal acceleration is then $a = \omega^2 r = 10^2 \times 0.05$ m, which equals 5 m/s^2. This acceleration is directed toward the center of the circular path.

27. **(C)** Average velocity is the ratio of total displacement to time, while average speed is the ratio of total distance to time. Since displacement is the shortest path and is always less than or equal to the actual distance traveled, the ratio is always unity or less.

28. **(D)** According to the principle of conservation of linear momentum, the total momentum of the gun and bullet system remains zero. Thus, $m_b v_b + m_g v_g = 0$, which means $(0.01\ \text{kg} \times v_b) + (1\ \text{kg} \times -5\ \text{m/s}) = 0$, leading to a muzzle velocity of 500 m/s.

29. **(C)** A soap bubble has two surfaces, so the work done is $W = 2 \times T \times \Delta A = 8\pi T(r_2^2 - r_1^2)$. Substituting the values, $W = 8\pi \times 0.03 \times (0.05^2 - 0.03^2)$, which calculates to approximately 0.384π mJ.

30. **(D)** Total internal energy is the sum of energies of each component: $U = n_1(f_1/2)RT + n_2(f_2/2)RT$. For 2 moles of diatomic Oxygen ($f = 5$) and 4 moles of monoatomic Argon ($f = 3$), $U = 2(5/2)RT + 4(3/2)RT = 5RT + 6RT = 11RT$.

31. **(C)** In Simple Harmonic Motion, the restoring acceleration is defined by the equation $a = -\omega^2 x$. This represents a linear mathematical relationship where acceleration is proportional to the negative of displacement, resulting in a straight line with a negative slope passing through the origin.

32. **(C)** In a transverse electromagnetic wave, the electric field vector and the magnetic field vector oscillate perpendicular to each other and to the direction of propagation. However, they reach their maximum and minimum values simultaneously, meaning they are perfectly in phase with zero phase difference.

33. **(A)** Using the prism formula $\delta = i + e - A$, we find $30 = 60 + e - 30$, which gives $e = 0°$. This implies the ray emerges normally ($r_2 = 0$), so $r_1 = A = 30°$. The refractive index is $\mu = \sin(60°)/\sin(30°) = \sqrt{3}$.

34. **(B)** The energy at $n = 1$ is -13.6 eV and for the second excited state ($n = 3$), it is $E_3 = -13.6/3^2 = -1.51$ eV. The excitation energy required is the difference between these levels: $\Delta E = -1.51 - (-13.6) = 12.09$ eV.

35. **(C)** An alpha particle consists of two protons and two neutrons, effectively a Helium nucleus. When a nucleus undergoes alpha decay, it loses these four nucleons, resulting in the mass number A decreasing by four and the atomic number Z decreasing by two.

36. **(B)** The current gain is defined as $\beta = \Delta I_c/\Delta I_b$. Given $\beta = 100$ and a collector current change of 1 mA, the change in base current is $\Delta I_b = 1\ \text{mA}/100 = 0.01$ mA, which is equivalent to 10 mA.

37. **(B)** The NAND gate is a universal logic gate that produces a low output (0) only when all its inputs are high (1). For all other input combinations, the output remains high. This specific behavior is the logical complement of the standard AND gate operation.

38. **(B)** Magnetic Induction is measured in Tesla, while Magnetic Flux is measured in Weber. Self Inductance is measured in Henry, and Magnetic Intensity is measured in Ampere per meter. Matching these physical quantities to their standard SI units confirms that option (2) is correct.

39. **(C)** The iron core of a transformer is constructed using thin insulated laminations rather than a solid block. This design significantly increases the electrical resistance to circulating eddy currents, thereby minimizing energy dissipation in the form of heat and increasing overall transformer efficiency.

40. **(C)** The potential gradient is $k = [2\times10/(R+10)]/100$. Using the balance condition $V = k \times l$, we have $0.01 = [20/(R + 10)] \times (40/100)$. Solving this equation gives $0.01 = 8/(R + 10)$, which leads to $R + 10 = 800$, so $R = 790\ \Omega$.

41. **(C)** The total resistance in the series circuit is $2 + 3 = 5\ \Omega$. The total current flowing is $I = V/R = 10/5 = 2$ A. Thus, the potential difference across the $3\ \Omega$ resistor is $V = I \times R = 2\text{ A} \times 3\ \Omega = 6$ V.

42. **(C)** In a series connection, the current I is identical for both wires. Current density is $J = I/A = I/(\pi r^2)$. Therefore, the ratio $J_{copper}/J_{iron} = (r_{iron}/r_{copper})^2 = (3\text{ mm}/1\text{ mm})^2 = 9 : 1$, showing density is inversely proportional to the square of the radius.

43. **(C)** The magnetic force acting on a moving charge is always perpendicular to its velocity vector. Since work is the dot product of force and displacement (which is in the direction of velocity), the work done by a magnetic field on a charge is always zero.

44. **(A)** Optical fibers consist of a high-refractive-index core surrounded by a lower-index cladding. Light signals entering the fiber at a specific angle are trapped within the core through a continuous series of total internal reflections, allowing for high-speed data transmission over very long distances.

45. **(B)** Kinetic energy is $KE = \frac{1}{2}mv^2$. The maximum percentage error is the sum of the error in mass and twice the error in speed: $\%\text{ error} = 2\% + 2(3\%) = 2\% + 6\% = 8\%$. This follows the standard rules for propagation of errors in products and powers.