

## NEET Physics Sample Paper 02

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 percentage errors in the measurement of mass and volume are 2% and 3% respectively. The maximum percentage error in the measurement of density is:

- A. 1%
- B. 5%
- C. 6%
- D. 1.5%

**Q2.** A projectile is thrown at an angle  $\theta$  with the horizontal. At the highest point of its trajectory, the angle between its velocity and acceleration is:

- A.  $0^\circ$
- B.  $45^\circ$
- C.  $90^\circ$
- D.  $180^\circ$

**Q3.** Two masses  $m_1 = 5$  kg and  $m_2 = 10$  kg are connected by a massless string passing over a frictionless pulley. The acceleration of the system when released is ( $g = 10$  m/s<sup>2</sup>):

- A.  $g$
- B.  $g/2$
- C.  $g/3$
- D.  $g/4$

**Q4.** A body of mass  $m$  is tied to one end of a string and whirled in a vertical circle of radius  $R$ . The minimum velocity required at the lowest point to just complete the circle is:

- A.  $\sqrt{gR}$

B.  $\sqrt{3gR}$

C.  $\sqrt{5gR}$

D.  $2\sqrt{gR}$

**Q5.** A solid sphere of mass  $M$  and radius  $R$  rolls without slipping down an inclined plane of height  $h$ . The velocity of the sphere when it reaches the bottom is:

A.  $\sqrt{2gh}$

B.  $\sqrt{\frac{4}{3}gh}$

C.  $\sqrt{\frac{10}{7}gh}$

D.  $\sqrt{gh}$

**Q6.** The period of revolution of a satellite in an orbit of radius  $r$  is  $T$ . For an orbit of radius  $4r$ , the period of revolution will be:

A.  $4T$

B.  $8T$

C.  $16T$

D.  $64T$

**Q7.** Poisson's ratio for most materials generally lies between:

A.  $-1$  to  $+1$

B.  $0$  to  $0.5$

C.  $0.5$  to  $1$

D. Any value

**Q8.** In an adiabatic process, the pressure  $P$  and volume  $V$  of an ideal gas are related as  $PV^\gamma = \text{constant}$ . During an adiabatic compression, the temperature of the gas:

A. Decreases

B. Increases

C. Remains constant

D. Becomes zero

**Q9.** The number of degrees of freedom for a triatomic non-linear gas molecule at moderate temperatures is:

- A. 3
- B. 5
- C. 6
- D. 7

**Q10.** A simple pendulum has a time period  $T$  on the surface of the Earth. If it is taken to the Moon where the acceleration due to gravity is  $g/6$ , the new time period is:

- A.  $T/6$
- B.  $6T$
- C.  $\sqrt{6}T$
- D.  $T/\sqrt{6}$

**Q11.** Choose the correct statement regarding an isolated system:

- A. The total energy can change.
- B. The total charge in any isolated system remains constant.
- C. The system must be in a vacuum.
- D. Entropy always decreases.

**Q12.** An isolated sphere has a capacitance of 60 pF. The radius of the sphere is approximately:

- A. 0.54 m
- B. 5.4 cm
- C. 54 cm
- D. 540 cm

**Q13.** Kirchhoff's Second Law for electrical circuits is based on the law of conservation of:

- A. Charge
- B. Energy
- C. Momentum
- D. Mass

**Q14.** The drift velocity of electrons in a conductor is typically of the order of:

- A.  $10^8$  m/s
- B.  $10^4$  m/s
- C.  $10^{-4}$  m/s
- D. 3 m/s

**Q15.** The magnetic field at the center of a circular current-carrying loop of radius  $R$  is  $B$ . If the radius is doubled while the current remains same, the magnetic field becomes:

- A.  $2B$
- B.  $B/2$
- C.  $B/4$
- D.  $4B$

**Q16.** Which of the following is NOT an application of eddy currents?

- A. Transformers
- B. Speedometers
- C. Magnetic Brakes
- D. Induction furnace

**Q17.** The self-inductance of a long solenoid is  $L$ . If the number of turns per unit length is doubled, its self-inductance becomes:

- A.  $2L$
- B.  $4L$
- C.  $L/2$
- D.  $L/4$

**Q18.** In an LCR series AC circuit at resonance, the phase difference between current and voltage is:

- A.  $\pi/2$
- B.  $\pi/4$
- C. Zero
- D.  $\pi$

**Q19.** The displacement current due to a time-varying electric field is given by:

A.  $\mu_0 \frac{d\phi_E}{dt}$

B.  $\epsilon_0 \frac{d\phi_E}{dt}$

C.  $\mu_0 \epsilon_0 \frac{d\phi_E}{dt}$

D.  $\frac{d\phi_E}{dt}$

**Q20.** The type of wavefront that emerges from a very distant point source of light is:

- A. Cylindrical
- B. Plane
- C. Diverging spherical
- D. Converging spherical

**Q21.** According to Brewster's Law, when light is incident at the polarizing angle  $i_p$  on a medium of refractive index  $\mu$ , then:

A.  $\mu = \sin i_p$

B.  $\mu = \cos i_p$

C.  $\mu = \tan i_p$

D.  $\mu = \cot i_p$

**Q22.** The stopping potential in a photoelectric experiment is independent of:

- A. Frequency of incident light
- B. Intensity of incident light
- C. Material of the cathode
- D. Wavelength of incident light

**Q23.** Which of the following statements is NOT correct regarding semiconductors?

- A. Pure silicon doped with a trivalent impurity gives p-type.
- B. Majority carriers in n-type semiconductors are holes.
- C. Minority carriers in p-type semiconductors are electrons.
- D. Resistivity of intrinsic semiconductors decreases with temperature.

**Q24.** Binding energy per nucleon is maximum for:

A.  ${}^4\text{He}$

- B.  $^{56}\text{Fe}$
- C.  $^{235}\text{U}$
- D.  $^2\text{H}$

**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 applied voltage

**Q26.** A ball is projected with a velocity  $u$  at an angle of  $45^\circ$  with the horizontal. The ratio of the maximum height reached by the ball to its horizontal range is:

- A. 1 : 1
- B. 1 : 2
- C. 1 : 4
- D. 1 :  $\sqrt{2}$

**Q27.** When a constant torque is applied to a body, it produces:

- A. Constant linear acceleration
- B. Constant angular acceleration
- C. Constant linear velocity
- D. Constant angular momentum

**Q28.** Two small spherical rain drops of radii in the ratio 1 : 2 fall from a very great height through the air. The ratio of their terminal velocities will be:

- A. 1 : 2
- B. 1 : 4
- C. 1 : 8
- D. 1 : 1

**Q29.** According to Stefan-Boltzmann law, the total energy radiated per unit area per unit time by a black body is proportional to:

- A.  $T$

- B.  $T^2$
- C.  $T^3$
- D.  $T^4$

**Q30.** Two sound waves of frequencies 500 Hz and 504 Hz are sounded together. The number of beats heard per second is:

- A. 0
- B. 2
- C. 4
- D. 8

**Q31.** A wire of resistance  $R$  is stretched to double its original length. The new resistance of the wire will be:

- A.  $2R$
- B.  $4R$
- C.  $R/2$
- D.  $R/4$

**Q32.** The magnetic susceptibility of a diamagnetic substance is:

- A. Small and negative
- B. Small and positive
- C. Large and positive
- D. Large and negative

**Q33.** A step-up transformer has a transformation ratio of 3 : 2. If the voltage in the primary coil is 30 V, then the voltage in the secondary coil is:

- A. 20 V
- B. 45 V
- C. 15 V
- D. 90 V

**Q34.** The energy of an electron in the  $n^{\text{th}}$  orbit of a hydrogen atom is given by  $E_n = -13.6/n^2$  eV. The energy required to excite an electron from the ground state to the first excited state is:

- A. 13.6 eV
- B. 3.4 eV
- C. 10.2 eV
- D. 1.51 eV

**Q35.** In a radioactive decay, a nucleus emits one  $\alpha$ -particle and two  $\beta^-$ -particles. The resulting daughter nucleus is an:

- A. Isotope of the parent
- B. Isobar of the parent
- C. Isotone of the parent
- D. Isomer of the parent

**Q36.** The Young's modulus of a material of a wire is  $Y$ . If the length of the wire is doubled and the radius is halved, the new Young's modulus will be:

- A.  $Y/4$
- B.  $4Y$
- C.  $Y$
- D.  $2Y$

**Q37.** A convex lens of focal length 20 cm is placed in contact with a concave lens of focal length 40 cm. The power of the combination is:

- A. +1.5 D
- B. +2.5 D
- C. -2.5 D
- D. +5 D

**Q38.** For the logic gate combination shown below, if inputs A and B are both 1, the output Y will be:[Logic Gate Description: Two inputs A and B connected to a NAND gate, followed by a NOT gate]

- A. 0
- B. 1
- C. 0.5
- D. Infinite

**Q39.** Match List-I with List-II regarding Bohr's atomic model:

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

**Q40.** Which of the following statements is correct for a moving charge in a uniform magnetic field?

- A. Its kinetic energy changes.
- B. Its momentum changes but its kinetic energy remains constant.
- C. Both momentum and kinetic energy remain constant.
- D. Neither momentum nor kinetic energy remains constant.

**Q41.** A ray of light travels from an optically denser medium to a rarer medium. The critical angle for the two media is  $C$ . The maximum possible deviation of the ray can be:

- A.  $\pi - C$
- B.  $\pi/2 - C$
- C.  $\pi - 2C$
- D.  $2C$

**Q42.** Identify the correct statement regarding the displacement current:

- A. It is produced by a steady electric field.
- B. It flows in the wires of a circuit.
- C. It is proportional to the rate of change of electric flux.
- D. It does not follow the laws of electromagnetism.

**Q43.** The focal length of a concave mirror is 15 cm. For an object placed at a distance of 20 cm from the mirror, the image formed is:

- A. Virtual and erect
- B. Real and magnified
- C. Real and diminished
- D. Virtual and diminished

**Q44.** For total internal reflection to occur in an optical fiber:

- A.  $\mu_1 < \mu_2$
- B.  $\mu_1 > \mu_2$
- C.  $\mu_1 = \mu_2$
- D. Refractive indices do not matter

**Q45.** The critical angle for a core-cladding interface is given by:

- A.  $\sin^{-1}(\mu_1/\mu_2)$
  - B.  $\sin^{-1}(\mu_2/\mu_1)$
  - C.  $\cos^{-1}(\mu_2/\mu_1)$
  - D.  $\tan^{-1}(\mu_2/\mu_1)$
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## Solutions

1. **(B)** Density is calculated as the ratio of mass to volume ( $\rho = m/V$ ). In error analysis, the maximum possible percentage error in a quotient is the sum of the individual percentage errors of the components. Therefore,  $2\% + 3\% = 5\%$ , representing the total uncertainty in the density measurement.
2. **(C)** At the highest point of a projectile's flight, the vertical velocity component is zero, leaving only the horizontal velocity component. Since gravity (acceleration) acts vertically downward, the velocity vector and the acceleration vector are at a right angle, resulting in a  $90^\circ$  difference between them.
3. **(C)** The acceleration of an Atwood machine is determined by the formula  $a = (m_2 - m_1)g/(m_1 + m_2)$ . Substituting the masses 5 kg and 10 kg, we get  $(10 - 5)g/(10 + 5) = 5g/15 = g/3$ . This calculation assumes the string is massless and the pulley is frictionless.
4. **(C)** For an object to successfully complete a vertical circle, it must have a minimum speed of  $\sqrt{gR}$  at the highest point to prevent the string from slacking. By conservation of energy, this requirement translates to a minimum speed of  $\sqrt{5gR}$  at the lowest point of the circle.

5. (C) As a solid sphere rolls down an incline, its potential energy converts into both translational and rotational kinetic energy ( $Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2$ ). Using  $I = \frac{2}{5}MR^2$  for a solid sphere, the resulting velocity at the bottom is  $v = \sqrt{\frac{10}{7}gh}$ .
6. (B) According to Kepler's Third Law, the square of a satellite's orbital period is proportional to the cube of its orbital radius ( $T^2 \propto r^3$ ). If the radius increases to  $4r$ , the new period becomes  $T' = \sqrt{4^3}T = \sqrt{64}T = 8T$ , showing the slower orbit at larger distances.
7. (B) Poisson's ratio is defined as the ratio of lateral strain to longitudinal strain when a material is stretched. While the theoretical range is from  $-1$  to  $0.5$ , almost all real-world materials have values between  $0$  and  $0.5$ , reflecting how they narrow as they are pulled.
8. (B) During an adiabatic compression, work is done on the gas while no heat enters or leaves the system. This work increases the internal energy of the gas, which leads to a corresponding rise in temperature, as described by the first law of thermodynamics and adiabatic relations.
9. (C) A non-linear triatomic gas molecule can translate in three directions and rotate about three independent axes. This gives it a total of six degrees of freedom at moderate temperatures. Vibrational degrees of freedom are typically only active at much higher temperatures and are excluded here.
10. (C) The time period of a simple pendulum is given by  $T = 2\pi\sqrt{L/g}$ . On the Moon, where gravity is  $g/6$ , the period becomes  $T' = 2\pi\sqrt{L/(g/6)} = \sqrt{6} \times (2\pi\sqrt{L/g}) = \sqrt{6}T$ . This indicates that the pendulum swings more slowly in a weaker gravitational field.
11. (B) An isolated system is one that does not exchange matter or energy with its surroundings. A fundamental principle of electromagnetism is that the total electric charge within such a system remains constant over time, even if charges are moved or redistributed internally.
12. (A) The capacitance of an isolated spherical conductor is  $C = 4\pi\epsilon_0 R$ . Using  $C = 60$  pF and the constant  $1/(4\pi\epsilon_0) = 9 \times 10^9$  Nm<sup>2</sup>/C<sup>2</sup>, we find  $R = (9 \times 10^9) \times (60 \times 10^{-12}) = 0.54$  meters. This calculation assumes the sphere is in a vacuum.
13. (B) Kirchhoff's Second Law, also known as the loop rule, states that the total sum of voltage drops and rises around any closed loop in a circuit is zero. This is a direct application of the law of conservation of energy to electrical potential in a circuit.
14. (C) While the thermal speed of electrons is very high, their net movement through a conductor under an electric field is extremely slow due to frequent collisions with ions. This net drift velocity is typically on the order of  $10^{-4}$  meters per second in common metals.
15. (B) The magnetic field at the center of a circular loop is  $B = \mu_0 I / 2R$ . If the current  $I$  remains constant and the radius  $R$  is doubled, the magnetic field strength  $B$  is halved, demonstrating an inverse relationship between the field and the loop's radius.

16. **(A)** Eddy currents cause undesirable heating and energy loss in the cores of electrical devices. In transformers, cores are laminated specifically to minimize these currents. In contrast, devices like speedometers and induction furnaces actively use eddy currents for their intended function.
17. **(B)** The self-inductance of a long solenoid is proportional to the square of the number of turns per unit length ( $L \propto n^2$ ). If the number of turns per unit length is doubled, the self-inductance increases by a factor of  $2^2$ , which is  $4L$ .
18. **(C)** Resonance in an LCR series circuit occurs when the inductive reactance and capacitive reactance cancel each other out. At this point, the circuit behaves as a purely resistive load, meaning the current and voltage are perfectly in phase with zero phase difference.
19. **(B)** Displacement current is a concept introduced by Maxwell to explain how magnetic fields are generated by changing electric fields. It is mathematically defined as the product of the permittivity of free space ( $\epsilon_0$ ) and the rate of change of electric flux ( $d\phi_E/dt$ ).
20. **(B)** As waves move away from a point source, the spherical wavefronts expand and their curvature decreases. At a very large distance from the source, the curvature of a small portion of the wavefront becomes negligible, effectively creating a plane wavefront for the observer.
21. **(C)** Brewster's Law relates the refractive index of a medium to the specific angle of incidence, called the polarizing angle, at which reflected light is completely polarized. The law states that the refractive index  $\mu$  is equal to the tangent of the polarizing angle  $i_p$ .
22. **(B)** In the photoelectric effect, the stopping potential corresponds to the maximum kinetic energy of the emitted electrons, which depends solely on the frequency of the light. It is independent of the light's intensity, which only changes the number of electrons emitted.
23. **(B)** In n-type semiconductors, the majority charge carriers are electrons provided by donor atoms, while holes are the minority carriers. The statement that holes are the majority carriers in n-type semiconductors is incorrect.
24. **(B)** Binding energy per nucleon is a measure of nuclear stability. Iron-56 ( $^{56}\text{Fe}$ ) has the highest binding energy per nucleon, making it the most stable nucleus. Nuclei that are significantly lighter or heavier are less stable and may undergo fusion or fission.
25. **(B)** In reverse bias, the external voltage pulls majority charge carriers away from the junction, which widens the region depleted of mobile carriers. This results in an increase in the thickness of the depletion layer, effectively preventing standard current flow.
26. **(C)** The maximum height  $H$  is given by  $u^2 \sin^2 \theta / 2g$  and the horizontal range  $R$  is  $u^2 \sin 2\theta / g$ . The ratio  $H/R$  simplifies to  $\tan \theta / 4$ . Since  $\tan 45^\circ = 1$ , the ratio becomes exactly 1 : 4.

27. **(B)** According to the rotational analogue of Newton's Second Law, torque is the product of the moment of inertia and angular acceleration ( $\tau = I\alpha$ ). If a constant torque is applied to a body, it must result in a constant angular acceleration.
28. **(B)** Terminal velocity of a spherical body falling through a viscous medium is directly proportional to the square of its radius ( $v_t \propto r^2$ ). Since the radii are in a 1 : 2 ratio, the ratio of their terminal velocities will be  $1^2 : 2^2$ , which is 1 : 4.
29. **(D)** The Stefan-Boltzmann Law states that the total radiant heat energy emitted from a surface is proportional to the fourth power of its absolute temperature ( $E = \sigma T^4$ ). This law is fundamental for understanding black-body radiation and heat transfer across various temperatures.
30. **(C)** The beat frequency is defined as the absolute difference between the frequencies of two interfering sound waves. Subtracting the lower frequency of 500 Hz from the higher frequency of 504 Hz results in exactly 4 beats heard by the listener per second.
31. **(B)** When a wire is stretched, its volume remains constant. Doubling the length ( $L' = 2L$ ) causes the cross-sectional area to halve ( $A' = A/2$ ). Since resistance  $R = \rho L/A$ , the new resistance becomes  $\rho(2L)/(A/2) = 4R$ , showing a four-fold increase.
32. **(A)** Diamagnetism is a fundamental property where a material creates an induced magnetic field in a direction opposite to an externally applied field. This behavior results in a magnetic susceptibility that is consistently small in magnitude and negative in sign.
33. **(B)** In a transformer, the ratio of voltages is equal to the transformation ratio ( $V_s/V_p = N_s/N_p$ ). Given a ratio of 3 : 2 and a primary voltage of 30 V, the secondary voltage is calculated as  $(3/2) \times 30 = 45$  Volts.
34. **(C)** The energy required for excitation is the difference between the final and initial states. The ground state ( $n = 1$ ) energy is  $-13.6$  eV and the first excited state ( $n = 2$ ) is  $-3.4$  eV. Subtracting these values gives an excitation energy of exactly 10.2 eV.
35. **(A)** An  $\alpha$ -emission reduces the atomic number by 2, while each of the two  $\beta^-$ -emissions increases it by 1. The net change in the atomic number is zero, meaning the daughter nucleus has the same atomic number as the parent, identifying it as an isotope.
36. **(C)** Young's modulus is an intensive property of a material, meaning it depends solely on the nature of the substance and not on its physical dimensions. Changing the length or radius of a wire will not alter its Young's modulus as long as the material remains the same.
37. **(B)** The power of a lens is the inverse of its focal length in meters ( $P = 1/f$ ). The total power is the sum of individual powers:  $1/0.2$  (convex)  $+ 1/(-0.4)$  (concave), which equals  $+5$  D  $- 2.5$  D, resulting in a net power of  $+2.5$  Diopters.

38. **(B)** A NAND gate with both inputs as 1 produces an output of 0. Passing this output through a NOT gate inverts it back to 1. Therefore, the overall combination behaves like an AND gate, yielding a high output of 1 for high inputs.
39. **(B)** In Bohr's atomic model, the kinetic energy  $K$  is positive, while the potential energy  $U$  is  $-2K$  and the total energy  $E$  is  $-K$ . These relationships correctly describe the electrostatic binding and motion of an electron within a stable hydrogen atom's quantized orbits.
40. **(B)** The magnetic force acts perpendicular to the velocity of a moving charge, meaning it changes the direction of motion but not the speed. Consequently, the momentum changes because the direction changes, but the kinetic energy remains constant since speed stays the same.
41. **(C)** The maximum deviation occurs during reflection at the critical angle. For a reflected ray, the angle of deviation is  $\pi - 2i$ . Substituting the critical angle  $C$  as the angle of incidence, the maximum possible deviation for the ray system is given by the expression  $\pi - 2C$ .
42. **(C)** Displacement current is a quantity appearing in Maxwell's equations that accounts for the magnetic effects produced by a changing electric field. It is directly proportional to the time rate of change of the electric flux through a given surface in space.
43. **(B)** For a concave mirror, when an object is placed between the center of curvature ( $C = 2f = 30$  cm) and the focal point ( $f = 15$  cm), the image formed is real, inverted, and larger than the object. Since 20 cm is in this range, the image is real and magnified.
44. **(B)** Total Internal Reflection (TIR) only occurs when light attempts to travel from a medium of higher refractive index to one of lower refractive index. In an optical fiber, the core material must have a higher refractive index than the cladding to trap the light inside.
45. **(B)** The critical angle  $\theta_c$  is the angle of incidence that results in an angle of refraction of  $90^\circ$ . Applying Snell's Law at the interface, we get  $\mu_1 \sin \theta_c = \mu_2 \sin 90^\circ$ , which simplifies to  $\theta_c = \sin^{-1}(\mu_2/\mu_1)$ .