# JEE Main Physics
# Sample Paper – 18

Duration: 60 Minutes | Maximum Marks: 100

## Instructions

- **Section A** contains **20 Multiple Choice Questions (MCQ)**. Each correct answer carries **+4 marks**; each wrong answer carries $-1$ **mark**. Unattempted questions carry **0 marks**.
- **Section B** contains **10 Numerical Value Questions (NVQ)**. Attempt **any 5**. Each correct answer carries **+4 marks**. There is **no negative marking** in Section B.
- The syllabus is based on **NCERT Physics (Class XI & XII)**.
- **No personal calculators** are allowed. An on-screen virtual calculator is provided.

## SECTION A – Multiple Choice Questions (Q1–Q20)

**Q1.** Two cars A and B are moving in the **same direction** on a straight road. Car A moves at $v_1 = 60$ km/h and car B moves at $v_2 = 40$ km/h. What is the velocity of car A **relative to** car B?

(A) $100$ km/h

(B) $-20$ km/h

(C) $20$ km/h

(D) $0$ km/h

**Q2.** A block is placed on a rough inclined plane of angle $\theta = 30^\circ$. The coefficient of static friction between the block and the plane is $\mu_s = \dfrac{1}{\sqrt{3}}$. Which statement is correct?

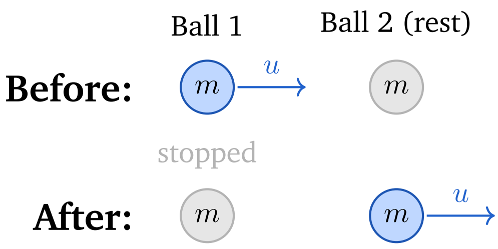
(A) The block just begins to slide at $\theta = 30^\circ$ since $\tan 30^\circ = \dfrac{1}{\sqrt{3}} = \mu_s$.

(B) The block slides only when $\theta > 45^\circ$.

(C) The block never slides on this surface.

(D) The block slides at $\theta = 60^\circ$.

**Q3.** In a perfectly elastic head-on collision between two balls of **equal mass**, ball 1 (moving at speed $u$) strikes ball 2 (at rest). Which of the following correctly describes the outcome?




(A) Both balls move with speed $u/2$ after the collision.

(B) Ball 1 continues with speed $u$; ball 2 remains at rest.

(C) Both balls come to rest.

(D) Kinetic energy is completely transferred to ball 2; ball 1 stops.

**Q4.** A uniform rod of mass $M$ and length $L$ has moment of inertia $I_{cm} = \dfrac{ML^2}{12}$ about an axis through its centre perpendicular to its length. Using the **parallel axes theorem**, the moment of inertia about an axis through one **end** perpendicular to the rod is:

(A) $\dfrac{ML^2}{12}$

(B) $\dfrac{ML^2}{3}$

(C) $\dfrac{ML^2}{6}$

(D) $\dfrac{ML^2}{4}$

**Q5.** The minimum speed required by an object at the surface of Earth to escape Earth's gravitational field (escape velocity) is:

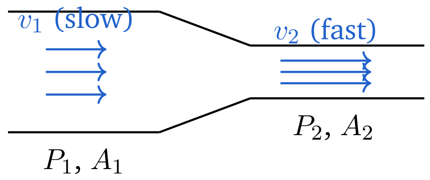
(A) $\sqrt{gR}$

(B) $2\sqrt{gR}$

(C) $\sqrt{2gR}$

(D) $\frac{1}{2}\sqrt{gR}$

**Q6.** Consider an ideal (non-viscous, incompressible) fluid flowing through the horizontal pipe shown below. Bernoulli's equation, $P + \frac{1}{2}\rho v^2 + \rho g h =$ const, represents:




(A) Conservation of energy per unit volume of the flowing fluid.

(B) Conservation of mass (continuity equation).

(C) Conservation of linear momentum.

(D) Conservation of angular momentum.

**Q7.** In thermodynamics, which physical quantity is a measure of the **disorder** or **randomness** of a system?

(A) Enthalpy

(B) Internal energy

(C) Gibbs free energy

(D) Entropy

**Q8.** The mean free path of gas molecules is given by $\lambda_{mfp} = \dfrac{1}{\sqrt{2}\,\pi d^2 n}$, where $d$ is the molecular diameter and $n$ is the number density. Which of the following is correct?

(A) $\lambda_{mfp}$ decreases when temperature increases at constant pressure.

(B) $\lambda_{mfp}$ increases when pressure decreases at constant temperature.

(C) $\lambda_{mfp}$ is independent of molecular size.

(D) $\lambda_{mfp}$ is proportional to the square of pressure.

**Q9.** A particle of mass $m$ undergoes simple harmonic motion described by $x = A\sin(\omega t + \phi)$. Its total mechanical energy is:

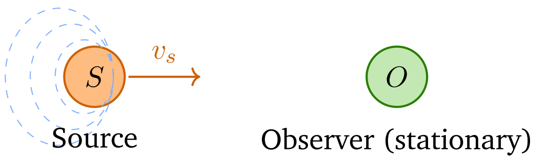
(A) $\dfrac{1}{2}m\omega^2 x^2$

(B) $\frac{1}{2}m\omega^2(A^2 - x^2)$

(C) $\frac{1}{2}m\omega^2 A^2$

(D) $m\omega^2 A^2$

**Q10.** A sound source emitting frequency $f$ moves **toward** a stationary observer at speed $v_s$. The speed of sound in the medium is $v$. The Doppler-shifted frequency heard by the observer is:




(A) $f' = f\,\frac{v}{v - v_s}$

(B) $f' = f\,\frac{v}{v + v_s}$

(C) $f' = f\,\frac{v - v_s}{v}$

(D) $f' = f\,\frac{v + v_s}{v}$

**Q11.** The work done in moving a charge $q$ through a potential difference $\Delta V$ in an electric field is:

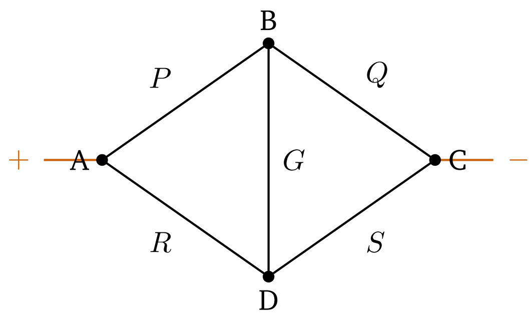
(A) $W = q/\Delta V$

(B) $W = \Delta V/q$

(C) $W = q^2\Delta V$

(D) $W = q\,\Delta V$

**Q12.** In the Wheatstone bridge circuit shown, the galvanometer reads zero (balanced condition). If the four resistances are $P$, $Q$, $R$, $S$ as labelled, the balance condition is:



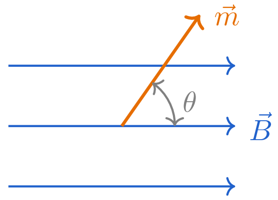

(A) $P/Q = S/R$

(B) $P/Q = R/S$

(C) $P \cdot S = Q \cdot R$

(D) Both (B) and (C) are equivalent

**Q13.** A magnetic dipole of moment $\vec{m}$ is placed in a uniform magnetic field $\vec{B}$, making an angle $\theta$ with the field. The torque experienced by the dipole is:




(A) $\tau = mB\cos\theta$

(B) $\tau = mB$

(C) $\tau = mB\sin\theta$

(D) $\tau = m^2B\sin\theta$

**Q14.** Two coils have mutual inductance $M$. When the current in coil 1 changes at a rate $dI_1/dt$, the EMF induced in coil 2 is:

(A) $\varepsilon_2 = -M\,\dfrac{dI_1}{dt}$

(B) $\varepsilon_2 = +M\,\dfrac{dI_1}{dt}$

(C) $\varepsilon_2 = M\,I_1$

(D) $\varepsilon_2 = -M\,I_1^2$

**Q15.** Which of the following types of electromagnetic radiation has the **shortest wavelength**?

(A) Radio waves

(B) Microwaves

(C) X-rays

(D) Gamma rays

**Q16.** The lens maker's equation for a thin lens of refractive index $n$ with radii of curvature $R_1$ and $R_2$ (using the standard sign convention) is:

(A) $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

(B) $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

(C) $\frac{1}{f} = n\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

(D) $\frac{1}{f} = (n+1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

**Q17.** In Young's Double Slit Experiment (YDSE), the condition for the $m$-th **dark** fringe (destructive interference) is that the path difference $\Delta$ equals:

(A) $m\lambda$

(B) $(2m)\frac{\lambda}{2}$

(C) $(2m-1)\frac{\lambda}{2}$

(D) $(m+1)\lambda$

**Q18.** According to Einstein's photoelectric equation, the maximum kinetic energy of the photoelectrons emitted when radiation of frequency $\nu$ falls on a metal of work function $\phi_0$ is:

(A) $K_{max} = h\nu - \phi_0$

(B) $K_{max} = h\nu + \phi_0$

(C) $K_{max} = \phi_0 - h\nu$

(D) $K_{max} = h\nu / \phi_0$

**Q19.** The radius $R$ of an atomic nucleus of mass number $A$ is related to $A$ by:

(A) $R = R_0\, A$

(B) $R = R_0\, A^{2/3}$

(C) $R = R_0\, A^2$

(D) $R = R_0\, A^{1/3}$, where $R_0 = 1.2 \times 10^{-15}$ m

**Q20.** A NAND gate is called a **universal gate** because:

(A) It is the fastest digital gate available.

(B) All Boolean functions (AND, OR, NOT, etc.) can be realised using only NAND gates.

(C) It consumes the least power among all gates.

(D) It has the lowest propagation delay.

## SECTION B – Numerical Value Questions (Q21–Q30)

**Attempt any 5**

**Q21.** A car starts from rest and accelerates uniformly at $a = 5\ \mathrm{m/s^2}$. Find the distance (in metres) covered by the car in $t = 4\ \mathrm{s}$.

**Q22.** A wheel starts from rest and reaches an angular velocity of $20\pi\ \mathrm{rad/s}$ in $10\ \mathrm{s}$. Find the angular acceleration of the wheel in $\mathrm{rad/s^2}$. (Express your answer in terms of $\pi$ or as a decimal to two decimal places.)

**Q23.** For a perfectly elastic collision between two bodies, the **coefficient of restitution** $e$ is defined as the ratio of the speed of separation to the speed of approach. What is the value of $e$ for a perfectly elastic collision?

**Q24.** Two resistors $R_1 = 6\ \Omega$ and $R_2 = 3\ \Omega$ are connected in **parallel**. Find the equivalent resistance (in $\Omega$) of the combination.

**Q25.** A charged particle having charge $q = 2\ \mu\mathrm{C}$ is placed in a uniform electric field of magnitude $E = 5 \times 10^5\ \mathrm{N/C}$. Find the magnitude of the electrostatic force (in newtons) acting on the particle.

**Q26.** An inductor of inductance $L = 0.2\ \mathrm{H}$ carries a current $I = 5\ \mathrm{A}$. Find the energy stored (in joules) in the magnetic field of the inductor.

**Q27.** In a YDSE setup, monochromatic light of wavelength $\lambda = 600\ \mathrm{nm}$ is used. The slit separation is $d = 0.3\ \mathrm{mm}$ and the screen is placed at a distance $D = 1\ \mathrm{m}$ from the slits. Find the fringe width (in mm).

**Q28.** A radioactive nucleus has a half-life of $20$ days. Find the fraction of the original number of nuclei remaining after $60$ days.

**Q29.** A diverging lens has a focal length of $f = -25\ \mathrm{cm}$. What is the power (in dioptres, D) of this lens?

**Q30.** Find the frequency (in units of $10^{15}\ \mathrm{Hz}$) of a photon whose energy is $6.6 \times 10^{-19}\ \mathrm{J}$. (Given: $h = 6.6 \times 10^{-34}\ \mathrm{J \cdot s}$)

## SOLUTIONS

**Sol. 1.**

**Solution**

**Topic: Kinematics – Relative Velocity**

Both cars move in the *same direction*.

Relative velocity of A with respect to B:

$$v_{AB} = v_1 - v_2 = 60 \text{ km/h} - 40 \text{ km/h} = 20 \text{ km/h}$$

The positive value indicates car A appears to move *forward* at 20 km/h as seen from car B.

**Answer: (C)**

**Sol. 2.**

**Solution**

**Topic: Laws of Motion – Static Friction on Incline**

A block on an inclined plane is on the verge of sliding when:

$$\tan\theta = \mu_s$$

Here $\mu_s = \dfrac{1}{\sqrt{3}}$ and $\tan 30^\circ = \dfrac{1}{\sqrt{3}}$.
Therefore, the block is on the verge of sliding at $\theta = 30^\circ$. It just begins to slide at this angle.

**Answer: (A)**

**Sol. 3.**

**Solution**

**Topic: Work–Energy Theorem – Elastic Collision Between Equal Masses**

For a perfectly elastic head-on collision between two objects of equal mass $m$, where object 1 moves at speed $u$ and object 2 is at rest, the conservation of momentum and kinetic energy gives:

$$v_1' = 0, \qquad v_2' = u$$

Ball 1 comes to a complete stop, and ball 2 moves with the initial speed $u$ of ball 1. This means the *entire* kinetic energy $\frac{1}{2}mu^2$ is transferred from ball 1 to ball 2.

**Answer: (D)**

**Sol. 4.**

**Solution**

**Topic: Rotational Motion – Parallel Axes Theorem**

The moment of inertia of the rod about its centre:

$$I_{cm} = \frac{ML^2}{12}$$

The distance from the centre to one end: $d = L/2$.

By the parallel axes theorem:

$$I_{end} = I_{cm} + Md^2 = \frac{ML^2}{12} + M\left(\frac{L}{2}\right)^2 = \frac{ML^2}{12} + \frac{ML^2}{4} = \frac{ML^2}{12} + \frac{3ML^2}{12} = \frac{ML^2}{3}$$

**Answer: (B)**

**Sol. 5.**

**Solution**

**Topic: Gravitation – Escape Velocity**

Escape velocity is the minimum speed needed to escape Earth's gravitational pull from the surface. Setting kinetic energy equal to the magnitude of gravitational potential energy:

$$\frac{1}{2}mv_e^2 = \frac{GMm}{R}$$

Since $g = GM/R^2$, we have $GM = gR^2$:

$$v_e = \sqrt{\frac{2GM}{R}} = \sqrt{2gR}$$

**Answer: (C)**

**Sol. 6.**

**Solution**

**Topic: Fluid Mechanics – Bernoulli's Equation**

Bernoulli's equation:

$$P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$$

Each term has units of $\mathrm{Pa} = \mathrm{J/m^3}$ (energy per unit volume):

- $P \to$ pressure energy per unit volume
- $\frac{1}{2}\rho v^2 \to$ kinetic energy per unit volume
- $\rho gh \to$ potential energy per unit volume

Therefore Bernoulli's equation is a statement of **conservation of energy per unit**

**volume** for an ideal fluid.

**Answer: (A)**

**Sol. 7.**

**Solution**

**Topic: Thermodynamics – Entropy**

In classical thermodynamics, **entropy** ($S$) is the state function that quantifies the disorder or randomness of a system. The second law of thermodynamics states that the entropy of an isolated system can only increase or remain constant ($\Delta S \geq 0$). Statistically (Boltzmann), $S = k_B \ln W$, where $W$ is the number of microstates.

**Answer: (D)**

**Sol. 8.**

**Solution**

**Topic: Kinetic Theory – Mean Free Path**

The mean free path is:

$$\lambda_{mfp} = \frac{1}{\sqrt{2}\,\pi d^2 n}$$

where $n$ is the number density. From the ideal gas law, $n = P/(k_B T)$. Therefore:

$$\lambda_{mfp} = \frac{k_B T}{\sqrt{2}\,\pi d^2 P}$$

At constant temperature, $\lambda_{mfp} \propto 1/P$. Hence, when pressure *decreases*, the mean free path *increases*.

**Answer: (B)**

**Sol. 9.**

**Solution**

**Topic: SHM – Total Mechanical Energy**

For SHM, $x = A\sin(\omega t + \phi)$:

$$\begin{aligned} \text{Kinetic energy:} \quad & KE = \tfrac{1}{2}m\omega^2(A^2 - x^2) \\ \text{Potential energy:} \quad & PE = \tfrac{1}{2}m\omega^2 x^2 \end{aligned}$$

Total energy:

$$E = KE + PE = \tfrac{1}{2}m\omega^2(A^2 - x^2) + \tfrac{1}{2}m\omega^2 x^2 = \tfrac{1}{2}m\omega^2 A^2$$

The total energy is constant and depends only on the amplitude $A$, not on displacement $x$.

**Answer: (C)**

**Sol. 10.**

**Solution**

**Topic: Waves – Doppler Effect**

When the source moves *toward* a stationary observer, the wavefronts in front of the source are compressed, leading to an increase in observed frequency. The Doppler formula is:

$$f' = f\,\frac{v}{v - v_s}$$

Since $v - v_s < v$, we have $f' > f$ (frequency increases). Here $v$ is the speed of sound and $v_s$ is the speed of the source.

**Answer: (A)**

**Sol. 11.**

**Solution**

**Topic: Electrostatics – Work Done by Electric Field**

The work done in moving a charge $q$ through a potential difference $\Delta V$ in an electric field is:

$$W = q\,\Delta V$$

This is analogous to mechanical work: if a charge moves from a point at higher potential to lower potential, the field does positive work on a positive charge.

**Answer: (D)**

**Sol. 12.**

**Solution**

**Topic: Current Electricity – Wheatstone Bridge**

In a Wheatstone bridge with arms $P$, $Q$, $R$, $S$ (where $P$ and $Q$ are in the upper arms, $R$ and $S$ in the lower arms), the balanced condition (zero galvanometer deflection) requires the ratio of resistances in each branch to be equal:

$$\frac{P}{Q} = \frac{R}{S}$$

This follows from the condition that the potential at the junctions B and D be equal, so no current flows through the galvanometer.

Note: Option (C) $P \cdot S = Q \cdot R$ is a rearrangement of the same equation, but option (B) is the standard textbook form. Since option (D) says "both (B) and (C) are equivalent" is technically true, but the question asks for the balance condition and option (B) is the primary NCERT form. Answer is **(B)**.

**Answer: (B)**

**Sol. 13.**

**Solution**

**Topic: Magnetism – Torque on a Magnetic Dipole**

A magnetic dipole of moment $\vec{m}$ placed in a uniform magnetic field $\vec{B}$ at angle $\theta$ experiences a torque:

$$\vec{\tau} = \vec{m} \times \vec{B}$$

The magnitude is:

$$\tau = mB\sin\theta$$

The torque tends to align the dipole with the field direction. It is maximum at $\theta = 90^\circ$ and zero when the dipole is aligned with $\vec{B}$ ($\theta = 0^\circ$).

**Answer: (C)**

**Sol. 14.**

**Solution**

**Topic: Electromagnetic Induction – Mutual Inductance**

By Faraday's law of electromagnetic induction, the EMF induced in the secondary coil (coil 2) due to a changing current in the primary coil (coil 1) is:

$$\varepsilon_2 = -M\frac{dI_1}{dt}$$

The negative sign is due to Lenz's law: the induced EMF opposes the change that causes it. $M$ is the coefficient of mutual inductance, measured in henries (H).

**Answer: (A)**

**Sol. 15.**

**Solution**

**Topic: Electromagnetic Waves – Electromagnetic Spectrum**

The electromagnetic spectrum in order of *increasing frequency* (decreasing wavelength):

Radio $\rightarrow$ Microwave $\rightarrow$ Infrared $\rightarrow$ Visible $\rightarrow$ UV $\rightarrow$ X-ray $\rightarrow$ **Gamma**

Gamma rays have the *highest frequency* and hence the *shortest wavelength* ($\lambda < 10^{-11}$ m) among all EM waves.

**Answer: (D)**

**Sol. 16.**

**Solution**

**Topic: Ray Optics – Lens Maker's Equation**

For a thin lens with refractive index $n$ (relative to air), with radii of curvature $R_1$ (first surface) and $R_2$ (second surface), the lens maker's equation is:

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

This is derived from the refraction formula applied at each surface using the standard sign convention. For a biconvex lens, $R_1 > 0$ and $R_2 < 0$, giving $f > 0$ (converging).

**Answer: (B)**

**Sol. 17.**

**Solution**

**Topic: Wave Optics – Dark Fringes in YDSE**

In YDSE, destructive interference (dark fringes) occurs when the path difference $\Delta$ is an *odd multiple of half-wavelengths*:

$$\Delta = (2m-1)\frac{\lambda}{2}, \quad m = 1, 2, 3, \ldots$$

This gives path differences of $\lambda/2$, $3\lambda/2$, $5\lambda/2, \ldots$, leading to complete cancellation of the two waves.

**Answer: (C)**

**Sol. 18.**

**Solution**

**Topic: Dual Nature of Radiation – Photoelectric Effect**

Einstein's photoelectric equation states that the maximum kinetic energy of photoelectrons is:

$$K_{max} = h\nu - \phi_0$$

where:

- $h\nu$ = energy of the incident photon

- $\phi_0$ = work function of the metal (minimum energy needed to eject an electron)
- $K_{max}$ = maximum kinetic energy of the emitted electron

Photoelectric emission occurs only when $h\nu \geq \phi_0$ (i.e., $\nu \geq \nu_0 = \phi_0/h$, the threshold frequency).

**Answer: (A)**

**Sol. 19.**

**Solution**

**Topic: Nuclei – Nuclear Radius**

Experimental evidence (Rutherford scattering and electron scattering) shows that the nuclear radius $R$ follows the empirical formula:

$$R = R_0\, A^{1/3}$$

where $R_0 \approx 1.2 \times 10^{-15}$ m $= 1.2$ fm and $A$ is the mass number. This implies that nuclear matter has a nearly constant density, since:

$$V = \tfrac{4}{3}\pi R^3 \propto A \implies \rho = \frac{M}{V} \approx \text{constant}$$

**Answer: (D)**

**Sol. 20.**

**Solution**

**Topic: Semiconductors – Universal Gate**

A NAND gate is called a **universal gate** because any Boolean logic function – AND, OR, NOT, NOR, XNOR, etc. – can be implemented using only NAND gates. For example:

- NOT gate: connect both inputs of a NAND gate together $\Rightarrow$ output = $\overline{A}$
- AND gate: NAND followed by a NOT (another NAND with inputs tied)
- OR gate: invert both inputs (using NAND) then apply NAND

This functional completeness makes NAND (and similarly NOR) gates extremely important in digital electronics design.

**Answer: (B)**

## SECTION B SOLUTIONS – Numerical Value Questions

**Sol. 21.**

**Solution**

**Topic: Kinematics – Uniform Acceleration**

Using the second equation of motion (starting from rest, $u = 0$):

$$s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2}(5)(4)^2 = \frac{1}{2} \times 5 \times 16 = 40 \text{ m}$$

**Answer: (40)**

**Sol. 22.**

**Solution**

**Topic: Rotational Motion – Angular Acceleration**

Angular acceleration is:

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{20\pi - 0}{10} = 2\pi \text{ rad/s}^2 \approx 6.28 \text{ rad/s}^2$$

**Answer: ($2\pi$)**

**Sol. 23.**

**Solution**

**Topic: Work–Energy – Coefficient of Restitution**

The coefficient of restitution $e$ is defined as:

$$e = \frac{\text{speed of separation}}{\text{speed of approach}}$$

For a **perfectly elastic** collision, kinetic energy is fully conserved, and the relative speed of separation equals the relative speed of approach:

$$e = 1$$

(For a perfectly inelastic collision, $e = 0$.)

**Answer: (1)**

**Sol. 24.**

**Solution**

**Topic: Current Electricity – Parallel Resistance**

For two resistors in parallel:

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{6} + \frac{1}{3} = \frac{1}{6} + \frac{2}{6} = \frac{3}{6} = \frac{1}{2}$$

$$R_{eq} = 2\ \Omega$$

Alternatively, using the product-over-sum formula: $R_{eq} = (6 \times 3)/(6+3) = 18/9 = 2\ \Omega$.

**Answer: (2)**

**Sol. 25.**

**Solution**

**Topic: Electrostatics – Force on a Charge**

The force on a charge $q$ in a uniform electric field $E$:

$$F = qE = (2 \times 10^{-6}\ \text{C}) \times (5 \times 10^{5}\ \text{N/C}) = 10^{-6+5} \times 2 \times 5\ \text{N} = 10 \times 10^{-1}\ \text{N} = 1\ \text{N}$$

**Answer: (1)**

**Sol. 26.**

**Solution**

**Topic: Electromagnetic Induction – Energy in Inductor**

Energy stored in an inductor:

$$U = \frac{1}{2}LI^2 = \frac{1}{2}(0.2\ \text{H})(5\ \text{A})^2 = \frac{1}{2}(0.2)(25) = \frac{5}{2} \times 0.2 \times 5 = 2.5\ \text{J}$$

**Answer: (2.5)**

**Sol. 27.**

**Solution**

**Topic: Wave Optics – Fringe Width in YDSE**

Fringe width formula:

$$\beta = \frac{\lambda D}{d} = \frac{(600 \times 10^{-9}\ \text{m})(1\ \text{m})}{0.3 \times 10^{-3}\ \text{m}} = \frac{6 \times 10^{-7}}{3 \times 10^{-4}}\ \text{m} = 2 \times 10^{-3}\ \text{m} = 2\ \text{mm}$$

**Answer: (2)**

**Sol. 28.**

**Solution**

**Topic: Nuclei – Radioactive Decay**

Number of half-lives in 60 days:

$$n = \frac{60 \text{ days}}{20 \text{ days}} = 3$$

Fraction remaining:

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^3 = \frac{1}{8} = 0.125$$

**Answer: (0.125)**

**Sol. 29.**

**Solution**

**Topic: Ray Optics – Power of a Lens**

Converting focal length to metres: $f = -25 \text{ cm} = -0.25 \text{ m}$.

Power of a lens:

$$P = \frac{1}{f \text{ (in m)}} = \frac{1}{-0.25} = -4 \text{ D}$$

The negative sign confirms this is a diverging (concave) lens.

**Answer: ($-4$)**

**Sol. 30.**

**Solution**

**Topic: Dual Nature – Photon Frequency**

Using Planck's relation $E = h\nu$:

$$\nu = \frac{E}{h} = \frac{6.6 \times 10^{-19} \text{ J}}{6.6 \times 10^{-34} \text{ J} \cdot \text{s}} = 10^{-19+34} \text{ Hz} = 10^{15} \text{ Hz}$$

The answer in units of $10^{15}$ Hz is **1**.

**Answer: ($10^{15}$)**

## Section A – Answer Key (Q1–Q20)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | C | 2 | A | 3 | D | 4 | B | 5 | C |
| 6 | A | 7 | D | 8 | B | 9 | C | 10 | A |
| 11 | D | 12 | B | 13 | C | 14 | A | 15 | D |
| 16 | B | 17 | C | 18 | A | 19 | D | 20 | B |

## Section B – Answer Key (Q21–Q30)

| | | | |
|---|---|---|---|
| 21 | 40 | 22 | $2\pi$ |
| 23 | 1 | 24 | 2 |
| 25 | 1 | 26 | 2.5 |
| 27 | 2 | 28 | 0.125 |
| 29 | $-4$ | 30 | $10^{15}$ |