TALLENTEX Physics

Sample Paper – 6

Duration: 23 Minutes **Maximum Marks: 60**

Instructions

- This paper contains **15** Multiple Choice Questions (Single Correct Answer), modelled on the Physics portion of **TALLENTEX** entrance.
- Each correct answer carries **+4 marks**. There is **a penalty of** -1 **mark** for incorrect answers. Unattempted questions carry no penalty.
- Only **one** option is correct. Choose carefully.
- Syllabus: **NCERT Class 8 and Class 9 Physics**
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

Q1. A body starts from rest and moves with a uniform acceleration of $6\,\mathrm{m/s^2}$. Using the formula $s_n = u + a\left(n - \frac{1}{2}\right)$, the displacement of the body in the **5th second** of its motion is:

(A) $15\,\mathrm{m}$

(B) $27\,\mathrm{m}$

(C) $30\,\mathrm{m}$

(D) $24\,\mathrm{m}$

Q2. For a projectile launched from the ground with initial speed u at an angle θ with the horizontal, the horizontal range $R = \dfrac{u^2 \sin 2\theta}{g}$ is maximum when θ equals:

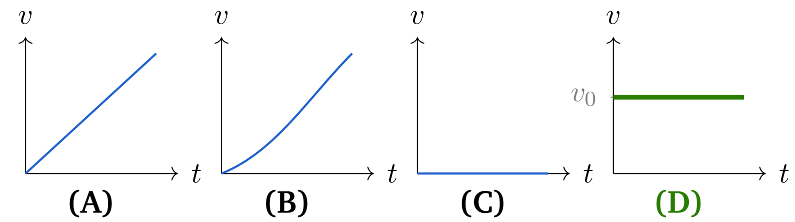
(A) 30

(B) 60

(C) 45

(D) 90

Q3. Which of the following velocity-time (v-t) graphs correctly represents **uniform motion** (constant, non-zero velocity)?



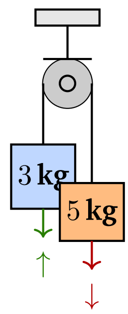
(A) Graph A: inclined straight line

(B) Graph B: curved line

(C) Graph C: line along the time-axis ($v = 0$)

(D) Graph D: horizontal line at constant $v = v_0 > 0$

Q4. In an Atwood machine, masses of $3\,\text{kg}$ and $5\,\text{kg}$ are connected by a light inextensible string over a frictionless pulley as shown. Taking $g = 10\,\text{m/s}^2$, the acceleration of the system is:



(A) $2.5\,\text{m/s}^2$

(B) $5\,\text{m/s}^2$

(C) $1.25\,\text{m/s}^2$

(D) $10\,\text{m/s}^2$

Q5. A horizontal force of $25\,\text{N}$ is just sufficient to move a wooden block on a level floor. If the weight of the block is $50\,\text{N}$, the coefficient of static friction between the block and the floor is:

(A) 0.25

(B) 0.5

(C) 1.25

(D) 2.0

Q6. The acceleration due to gravity on Earth's surface is g. A satellite orbits Earth at a height where the gravitational acceleration has reduced to $\frac{g}{4}$. If the radius of Earth is R, the orbital radius of the satellite is:

(A) $\frac{R}{2}$

(B) R

(C) $2R$

(D) $4R$

Q7. A metal block of volume $200\,\text{cm}^3$ is completely submerged in water (density $= 1000\,\text{kg/m}^3$). Taking $g = 10\,\text{m/s}^2$, the buoyant force (upthrust) acting on the block is:

(A) $0.2\,\text{N}$

(B) $20\,\text{N}$

(C) $200\,\text{N}$

(D) $2\,\text{N}$

Q8. A spring of spring constant $k = 500\,\text{N/m}$ is compressed by $0.1\,\text{m}$ from its natural length. The elastic potential energy stored in the spring is:

(A) $2.5\,\text{J}$

(B) $5\,\text{J}$

(C) $0.25\,\text{J}$

(D) $50\,\text{J}$

Q9. An engine of a train exerts a constant driving force of $40\,000\,\text{N}$ and the train moves at a uniform speed of $25\,\text{m/s}$. The power developed by the engine is:

(A) 400 kW

(B) 1 MW

(C) 1.6 MW

(D) 4 MW

Q10. The phenomenon in which sound **persists** after the source stops, due to repeated reflections from the walls of an enclosed space, is called:

(A) Refraction

(B) Diffraction

(C) Reverberation

(D) Resonance

Q11. A ray of light travels from a denser medium to a rarer medium. **Total internal reflection** occurs when the angle of incidence is:

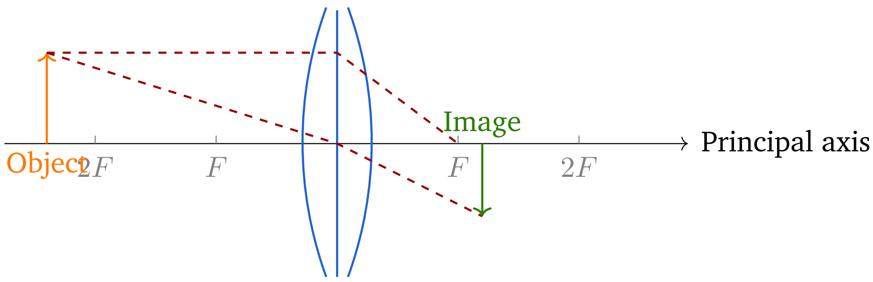
(A) Less than the critical angle

(B) Equal to 45

(C) Equal to 90

(D) Greater than the critical angle

Q12. A convex lens has a focal length of 20 cm. An object is placed 60 cm in front of the lens on the principal axis. Using the lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$, the image distance v is:



(A) 30 cm

(B) 60 cm

(C) $20\,\mathrm{cm}$

(D) $-60\,\mathrm{cm}$

Q13. A wire of resistivity ρ has length L and uniform cross-sectional area A. Its electrical resistance R is given by:

(A) $R = \dfrac{\rho A}{L}$

(B) $R = \dfrac{\rho L}{A}$

(C) $R = \dfrac{L}{\rho A}$

(D) $R = \dfrac{\rho}{LA}$

Q14. A cell of EMF $6\,\mathrm{V}$ and internal resistance $0.5\,\Omega$ is connected to an external resistance of $2.5\,\Omega$. The terminal voltage across the external resistance is:

(A) $6\,\mathrm{V}$

(B) $4\,\mathrm{V}$

(C) $5\,\mathrm{V}$

(D) $3\,\mathrm{V}$

Q15. The working principle of a **DC electric motor** is based on:

(A) Electromagnetic induction

(B) Mutual inductance

(C) Self-inductance

(D) Force on a current-carrying conductor in a magnetic field ($F = BIL$)

Answer Key — TALLENTEX Physics Sample Paper 6

(Click a question number to jump to its solution)

Detailed Solutions

Q1.

Solution

Concept — Displacement in the nth second of uniform acceleration: The formula for displacement covered in the nth second is

$$s_n = u + a\left(n - \tfrac{1}{2}\right)$$

where u is initial velocity and a is acceleration.

Step 1 — Identify given values: $u = 0$ (starts from rest), $a = 6\,\mathrm{m/s^2}$, $n = 5$.

Step 2 — Apply the formula:

$$s_5 = 0 + 6\left(5 - \frac{1}{2}\right) = 6 \times 4.5 = \mathbf{27}\,\mathrm{m}$$

Why other options are wrong:

- Option A ($15\,\mathrm{m}$): Result of using $n = 2.5$ incorrectly.
- Option C ($30\,\mathrm{m}$): Uses $s = ut + \frac{1}{2}at^2$ for $t = \sqrt{10}$, not the 5th second.
- Option D ($24\,\mathrm{m}$): Corresponds to the 4th second: $6(4 - 0.5) = 21\,\mathrm{m}$ — not 5th.

Final Answer: $27\,\mathbf{m} \Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q 1

Q2.

Solution

Concept — Range of a projectile: The horizontal range of a projectile is

$$R = \frac{u^2 \sin 2\theta}{g}$$

R is maximum when $\sin 2\theta$ is maximum, i.e., $\sin 2\theta = 1 \Rightarrow 2\theta = 90 \Rightarrow \theta = 45$.

Step 1 — Maximise the range: $\sin 2\theta$ achieves its maximum value of 1 at $2\theta = 90$.

Step 2 — Solve for θ:

$$\theta = \frac{90}{2} = \mathbf{45}$$

Why other options are wrong:

- Option A (30): $\sin 60 = 0.866 < 1$ — range is not maximum.
- Option B (60): $\sin 120 = 0.866 < 1$ — same range as 30 but not maximum.
- Option D (90): $\sin 180 = 0$ — projectile goes straight up, zero horizontal range.

Final Answer: $45 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q 2

Q3.

Solution

Concept — Velocity-time graph for uniform motion: In uniform motion, velocity is constant (non-zero). On a v-t graph this appears as a *horizontal straight line* at $v = v_0 > 0$.

Analysis of each graph:

- Graph A: Inclined straight line $\rightarrow$ velocity increases linearly $\rightarrow$ uniform *acceleration*, not uniform motion.
- Graph B: Curved line $\rightarrow$ velocity changes non-uniformly $\rightarrow$ non-uniform acceleration.
- Graph C: Line along time-axis ($v = 0$) $\rightarrow$ object is at rest (not in motion at all).
- Graph D: Horizontal line at constant $v = v_0 > 0 \rightarrow$ **velocity is constant and non-zero** $\Rightarrow$ **uniform motion**.

Why other options are wrong:

- A and B represent acceleration (changing velocity), not uniform motion.
- C shows rest ($v = 0$), which is not uniform motion.

Final Answer: Graph D (horizontal line at constant $v > 0$) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q 3

Q4.

Solution

Concept — Atwood machine acceleration: For two masses m_1 and m_2 ($m_2 > m_1$) connected over a frictionless pulley:

$$a = \frac{(m_2 - m_1)\,g}{m_1 + m_2}$$

Step 1 — Identify values: $m_1 = 3\,\text{kg}$, $m_2 = 5\,\text{kg}$, $g = 10\,\text{m/s}^2$.

Step 2 — Calculate acceleration:

$$a = \frac{(5-3)\times 10}{3+5} = \frac{2\times 10}{8} = \frac{20}{8} = \mathbf{2.5\,m/s^2}$$

Why other options are wrong:

- Option B ($5\,\text{m/s}^2$): Uses $(m_2 - m_1)g/m_1$ — wrong denominator.
- Option C ($1.25\,\text{m/s}^2$): Halves the correct answer with an arithmetic slip.
- Option D ($10\,\text{m/s}^2$): This is g itself; the pulley constraint reduces acceleration below g.

Final Answer: $2.5\,\mathbf{m/s^2} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q 4

Q5.

Solution

Concept — Coefficient of static friction: At the point of motion, applied force equals maximum static friction:

$$F = \mu_s N \quad \Longrightarrow \quad \mu_s = \frac{F}{N}$$

where N is the normal reaction (equal to weight on a horizontal surface).

Step 1 — Identify values: $F = 25\,\text{N}, \quad N = W = 50\,\text{N}$.

Step 2 — Calculate μ_s:

$$\mu_s = \frac{25}{50} = \mathbf{0.5}$$

Why other options are wrong:

- Option A (0.25): Result of $\mu = F/(2W)$ — incorrect formula application.

- Option C (1.25): Inverts numerator and denominator then scales incorrectly.
- Option D (2.0): Uses $\mu = N/F = 50/25$ — ratio inverted.

Final Answer: $0.5 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q 5

Q6.

Solution

Concept — Variation of g with distance from Earth's centre: Gravitational acceleration at distance r from Earth's centre:

$$g_r = \frac{GM}{r^2} \quad \Rightarrow \quad g_r \propto \frac{1}{r^2}$$

Step 1 — Set up the ratio: If $g_r = g/4$ at orbital radius r:

$$\frac{g}{g/4} = \frac{r^2}{R^2} \quad \Longrightarrow \quad 4 = \frac{r^2}{R^2}$$

Step 2 — Solve for r:

$$r^2 = 4R^2 \quad \Longrightarrow \quad r = \mathbf{2R}$$

Why other options are wrong:

- Option A ($R/2$): g would increase (4 times larger), not decrease.
- Option B (R): At $r = R$, $g_r = g$ (surface value).
- Option D ($4R$): At $r = 4R$, $g_r = g/16$, not $g/4$.

Final Answer: $2R \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q 6

Q7.

Solution

Concept — Archimedes' Principle (Buoyant Force / Upthrust): The upthrust equals the weight of fluid displaced:

$$F_b = \rho_{\text{fluid}} \times V_{\text{submerged}} \times g$$

Step 1 — Convert volume to SI units:

$$V = 200\,\text{cm}^3 = 200 \times 10^{-6}\,\text{m}^3 = 2 \times 10^{-4}\,\text{m}^3$$

Step 2 — Calculate buoyant force:

$$F_b = 1000 \times 2 \times 10^{-4} \times 10 = 1000 \times 2 \times 10^{-3} = \mathbf{2\,N}$$

Why other options are wrong:

- Option A ($0.2\,\text{N}$): Forgets to multiply by g (i.e., uses ρV only, not $\rho V g$).
- Option B ($20\,\text{N}$): Off by a factor of 10 — likely uses $V = 2000\,\text{cm}^3$ in error.
- Option C ($200\,\text{N}$): Does not convert cm^3 to m^3 correctly.

Final Answer: $2\,\mathbf{N} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q 7

Q8.

Solution

Concept — Elastic Potential Energy of a Spring:

$$PE = \frac{1}{2}kx^2$$

where k is the spring constant and x is the compression/extension.

Step 1 — Identify values: $k = 500\,\text{N/m}, \quad x = 0.1\,\text{m}$.

Step 2 — Calculate PE:

$$PE = \frac{1}{2} \times 500 \times (0.1)^2 = \frac{1}{2} \times 500 \times 0.01 = \frac{1}{2} \times 5 = \mathbf{2.5\,J}$$

Why other options are wrong:

- Option B ($5\,\text{J}$): Omits the factor of $\frac{1}{2}$ in the formula.
- Option C ($0.25\,\text{J}$): Uses $x = 0.1\,\text{m}$ but also divides by an extra 10.
- Option D ($50\,\text{J}$): Neglects to square x and omits the $\frac{1}{2}$ factor.

Final Answer: $2.5\,\mathbf{J} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q 8

Q9.

Solution

Concept — Power of a force at uniform velocity: When a body moves at constant velocity, driving force equals resistive force. Power is:

$$P = F \times v$$

Step 1 — Identify values: $F = 40\,000\,\text{N} = 4 \times 10^4\,\text{N}, \quad v = 25\,\text{m/s}.$

Step 2 — Calculate power:

$$P = 4 \times 10^4 \times 25 = 10^6\,\text{W} = \mathbf{1}\,\text{MW}$$

Why other options are wrong:

- Option A ($400\,\text{kW}$): Uses $F = 16\,000\,\text{N}$ or wrong speed.
- Option C ($1.6\,\text{MW}$): Uses $v = 40\,\text{m/s}$ instead of $25\,\text{m/s}$.
- Option D ($4\,\text{MW}$): Multiplies by 100 instead of 25.

Final Answer: $1\,$**MW** $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q 9

Q10.

Solution

Concept — Persistence of sound in enclosed spaces: When sound is produced in a large enclosed room or hall, it bounces repeatedly off the walls, floor, and ceiling. Each reflection causes the sound to persist after the source stops. This prolongation is called **reverberation**.

Key distinction between options:

- **Refraction**: Bending of sound when it passes from one medium to another.
- **Diffraction**: Bending of sound around obstacles or through openings.
- **Reverberation**: Persistence of sound due to *multiple reflections* — this matches the definition.
- **Resonance**: Forced vibration when driving frequency equals natural frequency of body.

Why other options are wrong:

- Option A (Refraction): Does not involve multiple reflections in an enclosure.
- Option B (Diffraction): Relates to spreading, not persistence.
- Option D (Resonance): Requires matching of frequencies; unrelated to sound decay in halls.

Final Answer: Reverberation $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q 10

Q11.

Solution

Concept — Total Internal Reflection (TIR): TIR occurs when:

(a) Light travels from a *denser* medium to a *rarer* medium.
(b) The angle of incidence **exceeds** the critical angle θ_c.

At the critical angle, refracted ray grazes the interface (refraction angle $= 90$). Beyond θ_c, no refraction occurs — all light reflects back: Total Internal Reflection.

Why other options are wrong:

- Option A (less than critical angle): Refraction occurs normally; TIR does not happen.
- Option B (equal to 45): This is only the critical angle for specific media (e.g., glass-air for some glass types), not a general condition.
- Option C (equal to 90): At 90 incidence, light travels along the surface — physically unreachable for TIR trigger.

Final Answer: Greater than the critical angle $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q 11

Q12.

Solution

Concept — Lens Formula:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

Using the standard *new Cartesian sign convention*: distances measured from optical centre; object on left $\Rightarrow u < 0$.

Step 1 — Assign signs: $u = -60\,\text{cm}$ (object on left side), $f = +20\,\text{cm}$ (convex lens).

Step 2 — Apply lens formula:

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{20} + \frac{1}{-60} = \frac{3}{60} - \frac{1}{60} = \frac{2}{60}$$

Step 3 — Solve for v:

$$v = \frac{60}{2} = \mathbf{30}\,\text{cm}$$

The positive value confirms the image is real and formed on the opposite side of the lens.

Why other options are wrong:

- Option B ($60\,\text{cm}$): Confuses image distance with object distance.
- Option C ($20\,\text{cm}$): This equals f, which would be for object at infinity.
- Option D ($-60\,\text{cm}$): A negative v implies virtual image (on same side as object), which does not apply here for a real object beyond $2F$.

Final Answer: $v = 30$ **cm** $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q 12

Q13.

Solution

Concept — Electrical Resistance and Resistivity: The resistance of a conductor is directly proportional to its length and inversely proportional to its cross-sectional area:

$$R = \rho\frac{L}{A}$$

where ρ (rho) is the resistivity (a material property, $\Omega \cdot \text{m}$), L is length (m), and A is cross-section (m^2).

Physical reasoning:

- Longer wire $\Rightarrow$ more collisions of electrons $\Rightarrow$ higher R (direct proportion).
- Larger area $\Rightarrow$ more parallel paths for current $\Rightarrow$ lower R (inverse proportion).

Why other options are wrong:

- Option A ($R = \rho A/L$): Inverts the area and length roles.

- Option C ($R = L/(\rho A)$): Treats resistivity as the denominator — incorrect dimensional analysis.
- Option D ($R = \rho/(LA)$): Incorrect form; dimensions do not give ohms.

Final Answer: $R = \dfrac{\rho L}{A} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q 13

Q14.

Solution

Concept — Terminal Voltage of a Cell: For a cell with EMF ε, internal resistance r, and external resistance R:

$$I = \frac{\varepsilon}{R + r}, \qquad V_{\text{terminal}} = I \times R = \varepsilon - Ir$$

Step 1 — Calculate current:

$$I = \frac{6}{2.5 + 0.5} = \frac{6}{3} = 2\,\text{A}$$

Step 2 — Calculate terminal voltage:

$$V_{\text{terminal}} = I \times R = 2 \times 2.5 = \mathbf{5}\,\text{V}$$

Verification: $V = \varepsilon - Ir = 6 - 2 \times 0.5 = 6 - 1 = 5\,\text{V}$ ✓

Why other options are wrong:

- Option A ($6\,\text{V}$): This is the EMF, not the terminal voltage (ignores internal resistance drop).
- Option B ($4\,\text{V}$): Corresponds to a voltage drop of $2\,\text{V}$ internally — over-estimates internal drop.
- Option D ($3\,\text{V}$): Halves the terminal voltage incorrectly.

Final Answer: $5\,\mathbf{V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q 14

Q15.

Solution

Concept — Working Principle of a DC Electric Motor: A DC electric motor converts electrical energy into mechanical energy. Its working principle is the **force experienced by a current-carrying conductor placed in a magnetic field** (given by $F = BIL\sin\theta$, or $\vec{F} = I\vec{L} \times \vec{B}$). This force causes the coil (armature) to rotate.

Key distinctions:

- **Electromagnetic induction** (Faraday's law): Used in *generators* — mechanical energy $\rightarrow$ electrical energy (opposite process).
- **Mutual inductance**: EMF induced in one coil due to changing current in another coil (principle of transformer).
- **Self-inductance**: EMF induced in the same coil when its own current changes.
- **Force on current-carrying conductor in a magnetic field**: ✓ This is the motor principle.

Why other options are wrong:

- Option A (electromagnetic induction): That is the generator principle, not the motor.
- Option B (mutual inductance): Relates to coupled inductors/transformers.
- Option C (self-inductance): Relates to back-EMF, not the primary driving principle.

Final Answer: Force on a current-carrying conductor in a magnetic field $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) **Go Back to Q 15**