TALLENTEX Physics

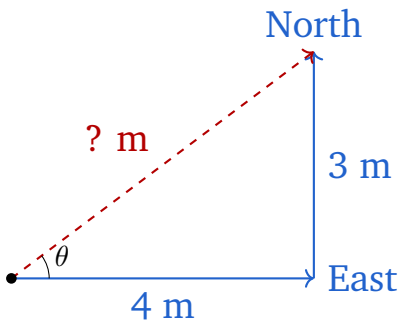
Sample Paper – 3

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 person walks 4 m due east and then 3 m due north (see figure). The magnitude of the total displacement is:



(A) 7 m

(B) 1 m

(C) 5 m

(D) 3 m

Q2. A car travels 60 km in the first 1.5 hours and then 40 km in the next 0.5 hours. The average speed of the car for the entire journey is:

(A) 30 km/h

(B) 60 km/h

(C) 40 km/h

(D) 50 km/h

Q3. A car starts from rest and accelerates uniformly at $10\,\text{m/s}^2$. Using $v^2 = u^2 + 2as$, its velocity after travelling 5 m is:

(A) 10 m/s

(B) 5 m/s

(C) 20 m/s

(D) $\sqrt{10}$ m/s

Q4. A bullet is fired from a rifle. If the force exerted by the rifle on the bullet is 2000 N forward, then the force exerted by the bullet on the rifle is:

(A) Zero

(B) 2000 N backward

(C) More than 2000 N

(D) Less than 2000 N

Q5. An object of mass 10 kg rests on a horizontal surface. The coefficient of static friction is 0.4 and $g = 10\,\text{m/s}^2$. The maximum static friction force is:

(A) 100 N

(B) 50 N

(C) 40 N

(D) 4 N

Q6. According to Kepler's Third Law, the square of the orbital period T of a planet is proportional to:

(A) The radius of the orbit

(B) The square of orbital speed

(C) The mass of the planet

(D) The cube of the semi-major axis of the orbit

Q7. At the centre of the Earth, the value of acceleration due to gravity is:

(A) Zero

(B) $9.8\,\text{m/s}^2$ (maximum value)

(C) Maximum among all points

(D) $4.9\,\text{m/s}^2$

Q8. A ball of mass 2 kg is dropped from a height of 5 m. Just before it hits the ground (taking $g = 10\,\text{m/s}^2$ and ignoring air resistance), its kinetic energy is:

(A) 50 J

(B) 100 J

(C) 200 J

(D) 25 J

Q9. The commercial unit of electrical energy used by electricity supply companies for billing purposes is:

(A) Joule

(B) Watt

(C) Kilowatt-hour (kWh)

(D) Calorie

Q10. The approximate speed of sound in air at room temperature (25°C) is:

(A) 300 m/s

(B) 650 m/s

(C) 1000 m/s

(D) 343 m/s

Q11. A concave mirror has a radius of curvature of 20 cm. Its focal length is:

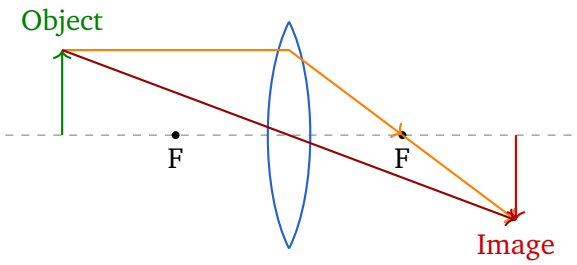
(A) 10 cm

(B) 20 cm

(C) 5 cm

(D) 40 cm

Q12. A convex lens of focal length 15 cm forms an image of an object placed 30 cm from the lens (see figure). The image distance is:



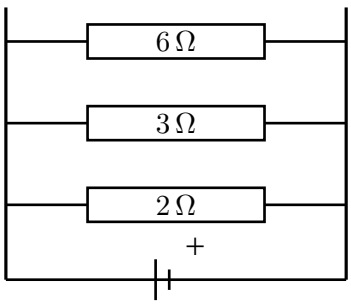
(A) 20 cm

(B) 30 cm

(C) 15 cm

(D) 10 cm

Q13. Three resistors of $6\,\Omega$, $3\,\Omega$, and $2\,\Omega$ are connected in parallel (see figure). The equivalent resistance of the combination is:



(A) 11 Ω

(B) 6 Ω

(C) 1 Ω

(D) 2 Ω

Q14. A resistor of $10\,\Omega$ carries a current of 2 A for 5 minutes. The heat generated in the resistor (using $H = I^2Rt$) is:

(A) 400 J

(B) 600 J

(C) 4000 J

(D) 12 000 J

Q15. A straight conductor of length 0.2 m carrying a current of 5 A is placed perpendicular to a uniform magnetic field of strength 2 T. The force experienced by the conductor ($F = BIL$) is:

(A) 2 N

(B) 0.5 N

(C) 4 N

(D) 20 N

Detailed Solutions

Q1.

Solution

Concept — Motion (Distance vs Displacement): Displacement is the straight-line distance from the initial point to the final point, irrespective of the path taken.

Step 1 — Draw the path: The person walks 4 m east (horizontal) and then 3 m north (vertical), forming two sides of a right-angled triangle.

Step 2 — Apply Pythagoras' theorem:

$$d = \sqrt{4^2 + 3^2} = \sqrt{16 + 9} = \sqrt{25} = \boxed{5\,\text{m}}$$

Why other options are wrong:

- Option A (7 m): Simply adds the two distances ($4 + 3 = 7$), giving total path length (distance), not displacement.
- Option B (1 m): Subtracts the two distances ($4 - 3 = 1$), which has no physical meaning here.
- Option D (3 m): Only the northward component; ignores the eastward part of the journey.

Final Answer: Displacement = 5 m $\Rightarrow$ C

Answer: (C) Go Back to Q 1

Q2.

Solution

Concept — Average Speed: Average speed is defined as total distance divided by total time taken.

Step 1 — Calculate total distance and total time:

$$\text{Total distance} = 60\,\text{km} + 40\,\text{km} = 100\,\text{km}$$

$$\text{Total time} = 1.5\,\text{h} + 0.5\,\text{h} = 2\,\text{h}$$

Step 2 — Apply the formula:

$$v_{\text{avg}} = \frac{\text{Total distance}}{\text{Total time}} = \frac{100\,\text{km}}{2\,\text{h}} = \boxed{50\,\text{km/h}}$$

Why other options are wrong:

- Option A (30 km/h): Uses only the first leg: $60 \div 2 = 30$, ignoring the second leg.
- Option B (60 km/h): Speed during the first leg only, not the overall average.
- Option C (40 km/h): Speed during the second leg only ($40 \div 0.5 = 80$, or midpoint of 30 and 60 incorrectly taken as 40).

Final Answer: Average speed = 50 km/h $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q 2

Q3.

Solution

Concept — Equations of Motion: The third equation of motion $v^2 = u^2 + 2as$ relates initial velocity, final velocity, acceleration, and displacement.

Step 1 — Identify known quantities:

$$u = 0\,\text{m/s (starts from rest)}, \quad a = 10\,\text{m/s}^2, \quad s = 5\,\text{m}$$

Step 2 — Substitute and solve:

$$v^2 = u^2 + 2as = 0 + 2 \times 10 \times 5 = 100$$

$$v = \sqrt{100} = \boxed{10\,\text{m/s}}$$

Why other options are wrong:

- Option B (5 m/s): Uses $v = \sqrt{as} = \sqrt{50} \approx 7.07$, not 5 — an incorrect formula application.
- Option C (20 m/s): Takes $v^2 = 2as$ but doubles the result, giving $v^2 = 400$, error in arithmetic.
- Option D ($\sqrt{10}$ m/s): Uses $v = \sqrt{as}$ directly without the factor of 2, giving $\sqrt{50}$ — formula is wrong.

Final Answer: Velocity = 10 m/s $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q 3

Q4.

Solution

Concept — Newton's Third Law of Motion: For every action there is an equal and opposite reaction. Action and reaction forces are equal in magnitude and opposite in direction, acting on different bodies.

Step 1 — Identify the action–reaction pair:

- Action: Rifle exerts a force of 2000 N *forward* on the bullet.
- Reaction: Bullet exerts a force of 2000 N *backward* on the rifle (causing the recoil).

Why other options are wrong:

- Option A (Zero): Violates Newton's Third Law — the reaction force is never zero unless the action is zero.
- Option C (More than 2000 N): Action and reaction are *equal* in magnitude, never greater or smaller.
- Option D (Less than 2000 N): Same reasoning as C — reaction magnitude equals action magnitude.

Final Answer: 2000 N backward $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q 4

Q5.

Solution

Concept — Static Friction: The maximum static friction force is given by $f_{s,\max} = \mu_s \times N$, where N is the normal reaction force. For a horizontal surface, $N = mg$.

Step 1 — Calculate the normal force:

$$N = mg = 10\,\text{kg} \times 10\,\text{m/s}^2 = 100\,\text{N}$$

Step 2 — Calculate maximum static friction:

$$f_{s,\max} = \mu_s \times N = 0.4 \times 100 = \boxed{40\,\text{N}}$$

Why other options are wrong:

- Option A (100 N): Uses $N = mg$ without multiplying by μ_s; gives normal

force, not friction.

- Option B (50 N): Takes half of mg without a physical reason.
- Option D (4 N): Divides mg by g again (effectively using $\mu_s \times m$), an incorrect approach.

Final Answer: Maximum static friction = 40 N $\Rightarrow$ C

Answer: (C) Go Back to Q 5

Q6.

Solution

Concept — Kepler's Third Law (Law of Periods): The square of the orbital period T of a planet is directly proportional to the cube of the semi-major axis a of its orbit:

$$T^2 \propto a^3$$

This was discovered empirically by Johannes Kepler and later derived theoretically by Newton from his law of gravitation.

Why other options are wrong:

- Option A (radius of orbit): $T^2 \propto r$ is not Kepler's Third Law; the exponent on r must be 3, not 1.
- Option B (square of orbital speed): Orbital speed is related to the period but $T^2 \propto v^2$ is not a stated Kepler law.
- Option C (mass of the planet): Kepler's Third Law does not involve the planet's own mass (it involves the central body's mass in Newton's version).

Final Answer: $T^2 \propto a^3$ **(cube of semi-major axis)** $\Rightarrow$ D

Answer: (D) Go Back to Q 6

Q7.

Solution

Concept — Variation of g Inside the Earth: The acceleration due to gravity at a depth d below the surface is $g_d = g\left(1 - \dfrac{d}{R}\right)$, where R is the radius of the Earth. At the centre, $d = R$, so:

$$g_{\text{centre}} = g\left(1 - \frac{R}{R}\right) = g \times 0 = \boxed{0}$$

Physically, at the centre the gravitational pulls from all directions cancel exactly by symmetry.

Why other options are wrong:

- Option B ($9.8\,\text{m/s}^2$): This is the surface value of g, not the value at the centre.
- Option C (Maximum among all points): g is maximum at the surface; it decreases both below and above the surface (for a uniform sphere).
- Option D ($4.9\,\text{m/s}^2$): This would be the value at depth $R/2$, not at the centre.

Final Answer: $g = 0$ **at the centre of the Earth** $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q 7

Q8.

Solution

Concept — Conservation of Mechanical Energy: When a body falls freely (ignoring air resistance), all its gravitational potential energy converts to kinetic energy just before it hits the ground.

$$KE = PE_{\text{lost}} = mgh$$

Step 1 — Substitute values:

$$KE = mgh = 2\,\text{kg} \times 10\,\text{m/s}^2 \times 5\,\text{m} = \boxed{100\,\text{J}}$$

Why other options are wrong:

- Option A (50 J): Uses $KE = \frac{1}{2}mgh$ — incorrectly applies the kinetic energy formula instead of energy conservation.
- Option C (200 J): Doubles the correct answer, possibly using $m = 4$ kg or $h = 10$ m by mistake.
- Option D (25 J): Halves the correct result with no physical justification.

Final Answer: KE = 100 J $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q 8

Q9.

Solution

Concept — Commercial Unit of Electrical Energy: The SI unit of energy is the joule, but it is too small for practical purposes in electricity billing. The commercial unit used by electricity boards is the **kilowatt-hour (kWh)**, also called a "unit" of electricity.

$$1\,\text{kWh} = 1\,\text{kW} \times 1\,\text{h} = 1000\,\text{W} \times 3600\,\text{s} = 3.6 \times 10^6\,\text{J}$$

Why other options are wrong:

- Option A (Joule): The SI unit of energy — too small for billing domestic electricity consumption.
- Option B (Watt): The SI unit of *power* (rate of energy use), not energy itself.
- Option D (Calorie): A unit of heat energy used in nutrition and chemistry, not for electrical billing.

Final Answer: Kilowatt-hour (kWh) $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q 9

Q10.

Solution

Concept — Speed of Sound in Air: The speed of sound in air depends on temperature. At 0C it is approximately 331 m/s, and it increases by about 0.6 m/s for every 1C rise.

$$v \approx 331 + 0.6 \times T = 331 + 0.6 \times 25 = 331 + 15 = \boxed{346\,\text{m/s} \approx 343\,\text{m/s}}$$

The standard value at room temperature (≈ 25C) is taken as **343 m/s**.

Why other options are wrong:

- Option A (300 m/s): Rough approximation valid near 0C, not at room temperature; also rounded too low.
- Option B (650 m/s): Closer to the speed of sound in water (≈ 1480 m/s), not air.
- Option C (1000 m/s): Speed of sound in steel or dense solids, not air.

Final Answer: 343 m/s $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q 10

Q11.

Solution

Concept — Relationship between Focal Length and Radius of Curvature: For a spherical mirror, the focal length f is half the radius of curvature R:

$$f = \frac{R}{2}$$

Step 1 — Substitute and solve:

$$f = \frac{R}{2} = \frac{20\,\text{cm}}{2} = \boxed{10\,\text{cm}}$$

Why other options are wrong:

- Option B (20 cm): Confuses focal length with radius of curvature; $f = R$, not $f = R/2$.
- Option C (5 cm): Halves the focal length again ($f = R/4$), applying the formula twice.
- Option D (40 cm): Doubles the radius of curvature instead of halving it.

Final Answer: Focal length = 10 cm $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q 11

Q12.

Solution

Concept — Lens Formula: For a thin lens, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, using the sign convention where distances are measured from the optical centre, and the incident light travels in the positive direction.

Step 1 — Assign signs:

$$u = -30\,\text{cm} \quad \text{(object on left)}, \qquad f = +15\,\text{cm} \quad \text{(convex lens)}$$

Step 2 — Apply the lens formula:

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{15} + \frac{1}{-30} = \frac{2}{30} - \frac{1}{30} = \frac{1}{30}$$

$$v = \boxed{+30\,\text{cm}} \quad \text{(real image, on the far side of the lens)}$$

Why other options are wrong:

- Option A (20 cm): Arithmetic error; perhaps used $\frac{1}{v} = \frac{1}{15} - \frac{1}{30}$ with wrong signs giving $\frac{1}{20}$.
- Option C (15 cm): Confuses image distance with focal length; object at $2f$ always gives image at $2f$.
- Option D (10 cm): Uses $\frac{1}{v} = \frac{1}{15} + \frac{1}{30}$ (forgetting the sign of u), giving $\frac{1}{10}$.

Final Answer: Image distance = 30 cm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q 12

Q13.

Solution

Concept — Resistors in Parallel: For resistors connected in parallel, the reciprocal of the equivalent resistance equals the sum of the reciprocals of individual resistances:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Step 1 — Substitute values:

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

Step 2 — Find equivalent resistance:

$$R_{\text{eq}} = \frac{1}{1} = \boxed{1\,\Omega}$$

Why other options are wrong:

- Option A (11 Ω): Adds the resistances as if they were in series ($6+3+2 = 11$).
- Option B (6 Ω): Takes only the largest resistor value, ignoring the others.
- Option D (2 Ω): Takes only the smallest resistor value; the equivalent resistance in parallel is always less than the smallest individual resistance.

Final Answer: Equivalent resistance = 1 $\Omega \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q 13

Q14.

Solution

Concept — Joule's Law of Heating: The heat generated in a resistor carrying current I for time t is:

$$H = I^2Rt$$

Step 1 — Convert time to seconds:

$$t = 5\,\text{min} = 5 \times 60 = 300\,\text{s}$$

Step 2 — Substitute and calculate:

$$H = I^2Rt = (2)^2 \times 10 \times 300 = 4 \times 10 \times 300 = \boxed{12\,000\,\text{J}}$$

Why other options are wrong:

- Option A (400 J): Uses $H = I^2R$ without including time ($t = 1$ s assumed): $4 \times 10 \times 10 = 400$, or forgets to convert minutes.
- Option B (600 J): Incorrect substitution; perhaps uses $H = IRt = 2 \times 10 \times 300/10$.
- Option C (4000 J): Uses $t = 5$ s (minutes not converted to seconds): $4 \times 10 \times 5 \times 20$, or other arithmetic error.

Final Answer: Heat generated = 12 000 J $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q 14

Q15.

Solution

Concept — Force on a Current-Carrying Conductor in a Magnetic Field: When a conductor of length L carrying current I is placed perpendicular to a uniform magnetic field B, the force on it is:

$$F = BIL$$

Step 1 — Substitute values:

$$F = BIL = 2\,\text{T} \times 5\,\text{A} \times 0.2\,\text{m} = \boxed{2\,\text{N}}$$

Why other options are wrong:

- Option B (0.5 N): Divides instead of multiplying; perhaps uses $F = I/(BL) = 5/(2 \times 0.2) = 12.5$ or an incorrect rearrangement.
- Option C (4 N): Doubles the correct answer, possibly using $L = 0.4$ m or $B = 4$ T by mistake.
- Option D (20 N): Uses $F = B \times I \times L$ but forgets the length factor ($F = 2 \times 5 \times 2 = 20$, mistakenly using B as L).

Final Answer: Force = 2 N $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q 15

Answer Key

1	C	2	D	3	A	4	B	5	C
6	D	7	A	8	B	9	C	10	D
11	A	12	B	13	C	14	D	15	A