TALLENTEX Physics

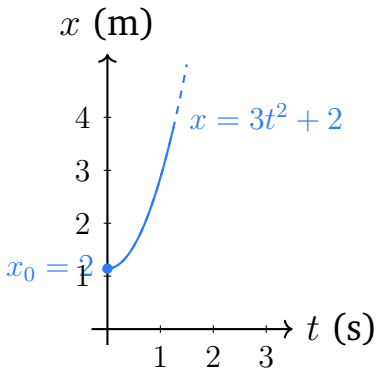
Sample Paper – 7

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 position-time (x-t) graph of a moving object is a parabola described by $x = 3t^2 + 2$ (where x is in metres and t in seconds), as shown below. The initial velocity of the object at $t = 0$ is:



(A) 2 m/s

(B) 3 m/s

(C) 0 m/s

(D) 6 m/s

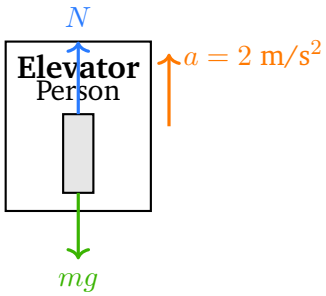
Q2. Train P moves towards the north at 80 km/h, and train Q moves towards the south at 60 km/h on parallel tracks. The speed of train Q as observed from train P is:

(A) 20 km/h
(B) 80 km/h
(C) 60 km/h
(D) 140 km/h

Q3. An athlete runs once around a circular track of circumference 400 m in 50 s. His average speed is:

(A) 8 m/s
(B) 0 m/s
(C) 4 m/s
(D) 20 m/s

Q4. An elevator of mass 600 kg accelerates upward at 2 m/s^2. The force exerted by the elevator floor on a passenger of mass 60 kg inside it is: (take $g = 10$ m/s^2)



(A) 600 N
(B) 720 N
(C) 480 N
(D) 660 N

Q5. The angle whose tangent gives the coefficient of static friction between two surfaces is called:

(A) Angle of repose
(B) Angle of deviation
(C) Angle of friction
(D) Critical angle

Q6. The value of acceleration due to gravity g at a height h above the Earth's surface (where $h \ll R$) is approximately: (R = radius of Earth, g_0 = surface value of g)

(A) $g_0\left(1 + \dfrac{2h}{R}\right)$
(B) $\dfrac{g_0 R^2}{(R+h)^2}$ (exact formula, not an approximation for $h \ll R$)
(C) $\dfrac{g_0}{4}$ at height $h = R$
(D) $g_0\left(1 - \dfrac{2h}{R}\right)$

Q7. Pascal's Law states that pressure applied to an enclosed fluid is:

(A) Transmitted equally in all directions and to all parts of the fluid and the walls of the container
(B) Concentrated only at the point of application
(C) Proportional to the depth of the fluid
(D) Transmitted only in the vertical direction

Q8. Two bodies of masses 4 kg and 6 kg moving at 3 m/s and 2 m/s respectively in the same direction collide and stick together. The loss of kinetic energy in this perfectly inelastic collision is:

(A) 0 J
(B) 1.2 J
(C) 3 J
(D) 5 J

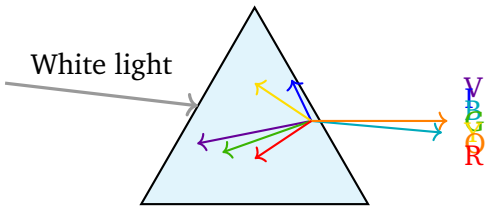
Q9. A lever of the first class has an effort arm of 60 cm and a load arm of 20 cm. A load of 300 N is to be lifted. The effort required is:

(A) 300 N
(B) 50 N
(C) 100 N
(D) 200 N

Q10. The loudness of a sound primarily depends upon the:

(A) Frequency of vibration
(B) Wavelength of sound
(C) Speed of sound
(D) Amplitude of vibration

Q11. When white light is passed through a glass prism, it splits into its constituent colours (as shown in the figure). This phenomenon is called:



(A) Dispersion of light
(B) Refraction of light
(C) Diffraction of light
(D) Polarisation of light

Q12. A concave (diverging) lens always forms an image that is:

(A) Real and inverted
(B) Virtual, erect, and diminished
(C) Real and erect
(D) Virtual and magnified

Q13. Which of the following statements about a capacitor is correct?

(A) It converts alternating current (AC) to direct current (DC)
(B) It opposes any change in current (like an inductor)

(C) It stores electrical energy in the form of an electric field between its plates
(D) It generates electric current when connected to a circuit

Q14. In the domestic electric circuit, the fuse wire is always connected in:

(A) Parallel with the appliance
(B) Series with the neutral wire
(C) The earthing (ground) wire
(D) Series with the live (line) wire

Q15. Fleming's left-hand rule is used to find the direction of:

(A) Force experienced by a current-carrying conductor placed in a magnetic field
(B) Direction of induced current in a conductor
(C) Direction of induced EMF in a generator
(D) Magnetic field around a straight current-carrying wire

Solutions

Sample Paper – 7

Q1.

Solution

Concept — Kinematics: Differentiation of Position Function

The velocity of an object at any instant is the time-derivative of its position:

$$v = \frac{dx}{dt}$$

Step 1 — Differentiate $x = 3t^2 + 2$ with respect to t:

$$v = \frac{d}{dt}(3t^2 + 2) = 6t$$

Step 2 — Substitute $t = 0$:

$$v\big|_{t=0} = 6 \times 0 = 0 \text{ m/s}$$

The parabola starts from $x_0 = 2$ m with zero slope (tangent is horizontal at $t = 0$), confirming the initial velocity is zero.

Why other options are wrong:

- Option A (2 m/s): This is the initial position $x_0 = 2$ m, not a velocity.
- Option B (3 m/s): This is the coefficient in $3t^2$, not the velocity.
- Option D (6 m/s): This is $6t$ evaluated at $t = 1$ s, not at $t = 0$.

Final Answer: Initial velocity at $t = 0$ is 0 m/s $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q 1

Q2.

Solution

Concept — Relative Motion: Opposite Directions

When two objects move in opposite directions, their relative speed is the *sum* of their individual speeds.

Step 1 — Identify directions: Train P moves north at 80 km/h; Train Q moves

south at 60 km/h. These are opposite directions.

Step 2 — Apply the formula for relative speed:

$$v_{\text{relative}} = v_P + v_Q = 80 + 60 = 140 \text{ km/h}$$

Why other options are wrong:

- Option A (20 km/h): Obtained by subtracting speeds — valid only when both move in the *same* direction.
- Option B (80 km/h): Speed of P alone; ignores Q's contribution.
- Option C (60 km/h): Speed of Q alone; ignores P's contribution.

Final Answer: Speed of Q as observed from P $= 140$ km/h $\Rightarrow$ D

Answer: (D) Go Back to Q 2

Q3.

Solution

Concept — Average Speed vs. Average Velocity

Average speed = total *distance* ÷ total time. (Note: average *velocity* uses displacement, which is zero for a complete loop.)

Step 1 — Identify values:

$$\text{Total distance} = \text{circumference} = 400 \text{ m}, \quad t = 50 \text{ s}$$

Step 2 — Calculate average speed:

$$\bar{v}_{\text{speed}} = \frac{400 \text{ m}}{50 \text{ s}} = 8 \text{ m/s}$$

Why other options are wrong:

- Option B (0 m/s): This is the average *velocity* (displacement = 0 for a full loop), not average speed.
- Option C (4 m/s): Arithmetic error — perhaps using half the circumference.
- Option D (20 m/s): Incorrect unit conversion or arithmetic.

Final Answer: Average speed $= 8$ m/s $\Rightarrow$ A

Answer: (A) Go Back to Q 3

Q4.

Solution

Concept — Newton's Second Law: Apparent Weight in Accelerating Elevator

For a passenger inside a lift accelerating *upward*, the net upward force equals ma:

$$N - mg = ma \implies N = m(g + a)$$

Step 1 — Identify values:

$$m = 60 \text{ kg}, \quad g = 10 \text{ m/s}^2, \quad a = 2 \text{ m/s}^2 \text{ (upward)}$$

Step 2 — Calculate normal force N:

$$N = 60 \times (10 + 2) = 60 \times 12 = 720 \text{ N}$$

Why other options are wrong:

- Option A (600 N): This is $mg = 60 \times 10$ — the weight when the lift is stationary; ignores the upward acceleration.
- Option C (480 N): Would be the apparent weight if the lift accelerated *downward* at 2 m/s^2: $60 \times 8 = 480$.
- Option D (660 N): Arithmetic error; perhaps $600 + 60 = 660$.

Final Answer: Normal force on passenger $= 720$ **N** $\Rightarrow$ B

Answer: (B) Go Back to Q 4

Q5.

Solution

Concept — Friction: Angle of Friction

The *angle of friction* (ϕ) is the angle between the normal reaction and the resultant of normal reaction and frictional force, such that:

$$\tan\phi = \frac{f}{N} = \mu_s$$

where μ_s is the coefficient of static friction.

Why other options are wrong:

- Option A (Angle of repose): The minimum angle of incline at which a body

just begins to slide — numerically equal to the angle of friction but conceptually different.
- Option B (Angle of deviation): A term used in optics for prisms; not related to friction.
- Option D (Critical angle): A concept in optics (total internal reflection); unrelated to friction.

Final Answer: The angle whose tangent gives μ_s is the *angle of friction* $\Rightarrow$ C

Answer: (C) Go Back to Q 5

Q6.

Solution

Concept — Gravitation: Variation of g with Altitude

The exact expression for g at height h above Earth's surface is:

$$g_h = \frac{g_0 R^2}{(R+h)^2} = g_0\left(1+\frac{h}{R}\right)^{-2}$$

For $h \ll R$, using the binomial approximation $(1+x)^{-2} \approx 1-2x$:

$$g_h \approx g_0\left(1-\frac{2h}{R}\right)$$

Why other options are wrong:

- Option A: $g_0(1+2h/R)$ implies g *increases* with altitude — physically incorrect.
- Option B: The exact formula $g_0R^2/(R+h)^2$ is correct but is *not* the approximate form asked for ($h \ll R$).
- Option C: At $h = R$, $g = g_0/4$ is correct (exact) but does not answer the general approximation question.

Final Answer: $g_h \approx g_0\left(1-\frac{2h}{R}\right) \Rightarrow$ D

Answer: (D) Go Back to Q 6

Q7.

Solution

Concept — Pascal's Law of Pressure Transmission

Pascal's Law: *Pressure applied to an enclosed, incompressible fluid is transmitted equally in all directions throughout the fluid and to the walls of the container.*

This is the working principle of hydraulic machines (hydraulic lift, hydraulic press, hydraulic brakes).

Why other options are wrong:

- Option B: Pressure is *not* confined to the point of application; it spreads throughout the fluid.
- Option C: Pressure *due to the weight of the fluid* varies with depth (hydrostatic pressure), but an *externally applied* pressure is transmitted undiminished.
- Option D: Transmission is isotropic (all directions), not merely vertical.

Final Answer: Pressure is transmitted equally in all directions $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q 7

Q8.

Solution

Concept — Conservation of Momentum; Kinetic Energy Loss in Perfectly Inelastic Collision

Step 1 — Find common velocity after collision (by momentum conservation):

$$p_i = m_1 v_1 + m_2 v_2 = (4)(3) + (6)(2) = 12 + 12 = 24 \text{ kg m/s}$$

$$v_f = \frac{p_i}{m_1 + m_2} = \frac{24}{10} = 2.4 \text{ m/s}$$

Step 2 — Calculate initial kinetic energy:

$$KE_i = \tfrac{1}{2}(4)(3)^2 + \tfrac{1}{2}(6)(2)^2 = 18 + 12 = 30 \text{ J}$$

Step 3 — Calculate final kinetic energy:

$$KE_f = \tfrac{1}{2}(10)(2.4)^2 = 5 \times 5.76 = 28.8 \text{ J}$$

Step 4 — Find the loss:

$$\Delta KE = 30 - 28.8 = 1.2 \text{ J}$$

Why other options are wrong:

- Option A (0 J): Only elastic collisions conserve kinetic energy.
- Option C (3 J) / Option D (5 J): Computational errors in applying momentum conservation or KE formula.

Final Answer: Loss of KE $= 1.2$ **J** $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q 8

Q9.

Solution

Concept — Simple Machines: Lever (Principle of Moments)

For a lever in equilibrium:

$$\text{Effort} \times \text{Effort Arm} = \text{Load} \times \text{Load Arm}$$

Step 1 — Identify values:

$$\text{Effort Arm} = 60 \text{ cm}, \quad \text{Load Arm} = 20 \text{ cm}, \quad \text{Load} = 300 \text{ N}$$

Step 2 — Solve for Effort:

$$E = \frac{\text{Load} \times \text{Load Arm}}{\text{Effort Arm}} = \frac{300 \times 20}{60} = \frac{6000}{60} = 100 \text{ N}$$

Mechanical Advantage $= \text{Load}/\text{Effort} = 300/100 = 3$, confirming the effort arm is $3\times$ the load arm.

Why other options are wrong:

- Option A (300 N): No mechanical advantage; effort = load (MA = 1).
- Option B (50 N): Would require effort arm = 120 cm, not 60 cm.
- Option D (200 N): Would require effort arm = 30 cm, not 60 cm.

Final Answer: Effort required $= 100$ **N** $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q 9

Q10.

Solution

Concept — Sound: Characteristics and Their Physical Causes

- **Loudness** (intensity perceived by ear) $\propto$ (amplitude)^2 — depends on *amplitude*.
- **Pitch** (shrillness) depends on *frequency*.
- **Timbre/Quality** depends on the waveform (harmonics).

Why other options are wrong:

- Option A (frequency): Frequency determines the *pitch*, not loudness.
- Option B (wavelength): Wavelength $= v/f$; it determines pitch indirectly.
- Option C (speed): Speed depends on the medium and temperature, not on loudness.

Final Answer: Loudness depends on the amplitude of vibration $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q 10

Q11.

Solution

Concept — Light: Dispersion through a Prism

When white light (a mixture of all visible wavelengths) enters a prism, each colour refracts by a different amount because the refractive index of glass depends on wavelength (higher frequency $\rightarrow$ greater bending). This splitting is called *dispersion*.

Order of colours (VIBGYOR): violet bends most, red bends least.

Why other options are wrong:

- Option B (Refraction): Refraction bends light but does *not* split white light unless the medium is dispersive; the specific splitting phenomenon is called dispersion.
- Option C (Diffraction): Bending of light around obstacles/edges; distinct from prism splitting.
- Option D (Polarisation): Restricts the plane of vibration of light; not related to colour splitting.

Final Answer: The phenomenon is *Dispersion of light* $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q 11

Q12.

Solution

Concept — Optics: Image Formation by a Diverging (Concave) Lens

A concave lens is a diverging lens. Its focal length is negative. Regardless of the position of the object, a concave lens *always* forms:

- **Virtual** (cannot be projected on a screen),
- **Erect** (same orientation as the object),
- **Diminished** (smaller than the object),
- located between the lens and the object (on the same side as the object).

Why other options are wrong:

- Option A (Real and inverted): This is the nature of images formed by a *convex* lens when the object is beyond the focal point.
- Option C (Real and erect): No simple thin lens forms a real erect image of a real object.
- Option D (Virtual and magnified): A *convex* lens (used as a magnifying glass) forms a virtual, erect, magnified image when the object is within the focal length.

Final Answer: A concave lens always forms a virtual, erect, and diminished image $\Rightarrow$ B

Answer: (B) Go Back to Q 12

Q13.

Solution

Concept — Electricity: Capacitor

A **capacitor** consists of two conducting plates separated by an insulating medium (dielectric). When charged, it stores electrical energy in the form of an **electric field** between the plates:

$$U = \frac{1}{2}CV^2 = \frac{Q^2}{2C}$$

Why other options are wrong:

- Option A (Converts AC to DC): This is the function of a *rectifier* (diode cir-

cuit).

- Option B (Opposes change in current): This describes an *inductor* (coil/solenoid), not a capacitor. A capacitor opposes change in *voltage*.
- Option D (Generates electric current): This describes a *battery* or *generator*; a capacitor only stores charge.

Final Answer: A capacitor stores electrical energy in an electric field between its plates $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q 13

Q14.

Solution

Concept — Domestic Electric Circuits: Fuse Wire

A fuse wire is a safety device made of a low-melting-point alloy. It is always connected in **series with the live (line) wire** so that when excess current flows (due to short circuit or overload), the fuse melts and breaks the *live* wire, disconnecting the appliance from the supply.

Why other options are wrong:

- Option A (Parallel with appliance): A parallel fuse would not break the circuit; all current would bypass through the fuse.
- Option B (Series with neutral wire): Connecting the fuse in the neutral wire is unsafe because even after the fuse blows the appliance remains at live potential.
- Option C (Earthing wire): The earth wire provides a path for fault current to ground; no fuse is placed here.

Final Answer: Fuse wire is connected in series with the live wire $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q 14

Q15.

Solution

Concept — Magnetism: Fleming's Left-Hand Rule

Fleming's Left-Hand Rule (also called the *Motor Rule*):

- Hold the left hand with the **fore**finger, **middle** finger, and **thumb** mutually perpendicular.

- Forefinger → direction of **Magnetic Field** (B).
- Middle finger → direction of **Current** (I).
- Thumb → direction of **Force/Motion** on the conductor (F).

It is the working principle of **electric motors**.

Why other options are wrong:

- Option B (Direction of induced current): Given by **Fleming's Right-Hand Rule** (Generator Rule).
- Option C (Direction of induced EMF): Also found using Fleming's Right-Hand Rule or Lenz's Law.
- Option D (Magnetic field around a straight wire): Given by the **Right-Hand Thumb Rule** (Ampere's Rule), not Fleming's left-hand rule.

Final Answer: Fleming's Left-Hand Rule gives the force on a current-carrying conductor in a magnetic field ⇒ A

Answer: (A) Go Back to Q 15

Answer Key — Sample Paper 7

Questions 1–15									
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

All solutions are hyperlinked — click any answer to jump to its solution.