

CLASS 9 PHYSICS

Federal Board Model Paper 2027 Step-by-Step Solutions

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Section B: Short Questions
Section C: Descriptive Questions
All OR alternatives included

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SECTION B — SHORT QUESTIONS**Q1. Differentiate between base quantities and derived quantities with one example of each.**

Base quantities are independent physical quantities that are not defined in terms of other physical quantities. Example: length, whose SI unit is metre (m).

Derived quantities are obtained by combining base quantities mathematically. Example: speed = distance ÷ time, whose SI unit is metre per second (m/s).

Base quantities	Derived quantities
Independent quantities	Obtained from base quantities
Example: length (m)	Example: speed (m/s)

OR: Differentiate between mass and weight (any three points).

Mass	Weight
Amount of matter in a body	Gravitational force acting on a body
SI unit: kilogram (kg)	SI unit: newton (N)
Remains constant at different locations	Changes with gravitational field strength

Weight: $W = mg$, where m is mass and g is gravitational acceleration.

Q2. A car starts from rest and reaches a velocity of 20 m/s in 5 seconds. Calculate its average velocity and total distance covered.

Given: $u = 0$ m/s, $v = 20$ m/s, $t = 5$ s. Assuming uniform acceleration:

Average velocity = $(u + v)/2 = (0 + 20)/2 = 10$ m/s.

Distance = average velocity × time = $10 \times 5 = 50$ m.

Final answers: average velocity = 10 m/s; total distance = 50 m.**OR: Prove that the pressure of a liquid of density ρ at depth h is $P = \rho gh$.**

Consider a liquid column of cross-sectional area A and height h .

Volume $V = Ah$.

Density $\rho = m/V$, so mass $m = \rho V = \rho Ah$.

Weight $F = mg = \rho Ahg$.

$$\text{Pressure } P = F/A = (\rho Ahg)/A = \rho gh.$$

Hence, $P = \rho gh$ is proved. This is the pressure due to the liquid column; atmospheric pressure is added when total pressure is required.

Q3. A bullet is fired from a gun. It penetrates into sand and then stops. Where does its kinetic energy go?

The moving bullet has kinetic energy, $E_k = \frac{1}{2}mv^2$. As it enters the sand, resistive forces do work on the bullet and bring it to rest. Its kinetic energy is converted mainly into internal energy (heating) of the bullet and sand, work done in displacing and compacting the sand, and a small amount of sound and deformation energy.

OR: Why is the spring constant of a steel spring greater than that of a rubber spring having the same number of turns and the same cross-sectional area?

The spring constant k measures stiffness. By Hooke's law, $F = kx$, so $k = F/x$. For springs with the same geometry, stiffness depends on the material's shear modulus. Steel has a much greater shear modulus than rubber, so it deforms less under the same force.

Therefore, $k(\text{steel}) > k(\text{rubber})$. The steel spring is stiffer and has a greater spring constant.

Q4. Can a body have zero velocity but non-zero acceleration? Explain with a physical example.

Yes. A ball thrown vertically upward has zero instantaneous velocity at its highest point, because it momentarily stops before moving downward. However, gravity continues to act downward throughout the motion.

At the highest point: $v = 0$, but $a = -g \approx -9.8 \text{ m/s}^2$ (downward).

OR: A solenoid has 50 cm length and 100 turns. Calculate the magnetic field strength if a current of 1.2 A passes through it.

Given: length $L = 50 \text{ cm} = 0.50 \text{ m}$, number of turns $N = 100$, current $I = 1.2 \text{ A}$. For a long air-core solenoid, $B = \mu_0 nI$, where $n = N/L$.

$$n = 100/0.50 = 200 \text{ turns/m.}$$

$$B = (4\pi \times 10^{-7})(200)(1.2) = 9.6\pi \times 10^{-5} \text{ T} \approx 3.02 \times 10^{-4} \text{ T.}$$

Final answer: $B \approx 3.02 \times 10^{-4} \text{ tesla (T)}$, assuming an air core.

Q5. Explain the motion of a rocket using the law of conservation of momentum.

Initially, the rocket and its fuel are at rest, so the total momentum is zero. When the fuel burns, hot gases are expelled backward at high speed. The gases gain backward momentum, and the rocket gains forward momentum.

$$p(\text{rocket}) + p(\text{gases}) = 0, \text{ so } p(\text{rocket}) = -p(\text{gases}).$$

The rocket moves forward because gases are expelled backward. This is an application of conservation of momentum.

OR: How can we increase the sensitivity and range of a liquid-in-glass thermometer?

Sensitivity is the change in length of the liquid column per unit temperature change. It can be increased by using a larger bulb, a narrower capillary tube, and a liquid with a higher coefficient of thermal expansion.

Sensitivity $S = \text{change in liquid-column length} / \text{change in temperature}$.

The range can be increased by using a longer capillary tube, a liquid with a lower coefficient of expansion, or a smaller bulb. These changes allow a larger temperature interval to be measured before the liquid reaches the top of the tube.

Q6. State what will happen to the rotational motion of a disc rotating freely in space, with no external moment acting on it. Provide a reason for your answer.

The disc continues rotating with constant angular velocity, provided no external torque acts and its moment of inertia remains constant.

Angular momentum $L = I\omega$; external torque $\tau = dL/dt$.

Since $\tau = 0$, angular momentum remains constant. If I is constant, ω is also constant.

OR: Two identical balls are rolling on a smooth floor. Ball A has twice the momentum of ball B. Both balls are stopped by applying the same force. Which ball will take more time to come to rest? Give mathematical explanation.

$F = \text{change in momentum} / \text{time}$, so stopping time $t = \text{initial momentum} / \text{stopping force}$.

$$t_A/t_B = (p_A/F)/(p_B/F) = p_A/p_B = 2p_B/p_B = 2.$$

Ball A takes twice as much time to stop as ball B, assuming the same constant stopping force acts on both.

SECTION C — DESCRIPTIVE QUESTIONS

Q7. Suggest any three ways to magnetize and demagnetize any material.**Three ways to magnetize a material**

1. Stroking method: Stroke a steel or iron bar repeatedly in the same direction with one pole of a magnet. Magnetic domains gradually align.
2. Electrical method: Place the material inside a coil and pass direct current through it. The coil produces a magnetic field that magnetizes the material.
3. Magnetic induction: Place an iron or steel object near a strong magnet. The magnet's field induces magnetic alignment in the object.

Three ways to demagnetize a material

1. Heating: Heat the magnet strongly. Thermal agitation disrupts the alignment of magnetic domains.
2. Hammering: Hammer the magnet repeatedly, preferably in a position that does not align it with Earth's magnetic field. Mechanical shocks disturb domain alignment.

3. Alternating magnetic field: Place the magnet in a coil carrying alternating current, then gradually reduce the current to zero or slowly withdraw the magnet from the field. This randomizes the domains.

OR: Describe three states of equilibrium. For each, give one clear daily-life example.

1. Stable equilibrium

An object is in stable equilibrium if, after a small displacement, it tends to return to its original position. Example: a ball at the bottom of a bowl.

2. Unstable equilibrium

An object is in unstable equilibrium if, after a small displacement, it moves farther away from its original position. Example: a ball balanced at the top of a hill.

3. Neutral equilibrium

An object is in neutral equilibrium if, after a small displacement, it remains in its new position. Example: a ball on a flat horizontal surface.

Q8. Define acceleration. What does it tell us about the motion of an object? If the slope of a speed-time graph for a moving object is steeper, what can you explain about the motion of the object?

Acceleration is the rate of change of velocity with time.

$$a = (v - u)/t.$$

Acceleration tells us how quickly velocity changes. It can represent an increase in speed, a decrease in speed (deceleration), or a change in direction.

$$\text{Slope of a speed-time graph} = \text{change in speed} / \text{change in time} = \text{acceleration}.$$

A steeper upward slope means greater positive acceleration and a more rapid increase in speed. A steeper downward slope means a greater rate of slowing down.

OR: State two real-life situations in which energy can be converted from one form to another. Describe the mechanism by which this conversion takes place in each system. Why is energy sometimes transferred to surroundings as heat?

1. Electric fan

Electrical energy → mechanical energy.

When current flows through the motor, its magnetic field produces a turning force on the rotor, rotating the shaft and blades. Some energy is also transferred as heat due to electrical resistance and friction, and some as sound.

2. Falling object

Gravitational potential energy → kinetic energy.

As an object falls, its height decreases and gravitational potential energy ($E_p = mgh$) decreases while kinetic energy ($E_k = \frac{1}{2}mv^2$) increases. Air resistance transfers some mechanical energy into internal energy of the air and object, and some into sound.

Why energy is transferred as heat

Friction, electrical resistance, and air resistance convert organized mechanical or electrical energy into random microscopic motion of particles. This increases the internal energy of the object and surroundings. Energy is not destroyed; it is transformed or transferred into other forms, including thermal energy.