Chapter 5 — Work, Energy and Power

Constructed Response Questions (with Answers)

Class 9 Physics (New Syllabus) — Board Level

Q 5.1. Can the kinetic energy of a body ever be negative?

Ans: No. Kinetic energy $E_k = \frac{1}{2} m v^2$. Mass m is always positive, and v^2 (velocity squared) is always positive or zero even if the velocity is negative. Therefore, $\frac{1}{2}mv^2$ can never be negative; its smallest possible value is zero, when the body is at rest. Hence kinetic energy is always positive or zero, never negative.

Q 5.2. Which one has the greater kinetic energy: an object travelling with velocity v, or an object twice as heavy travelling with velocity ½v?

Ans: Object 1 (mass m, speed v): $E_{k1} = \frac{1}{2} m v^2$. Object 2 (mass 2m, speed v/2): $E_{k2} = \frac{1}{2} (2m) (v/2)^2 = \frac{1}{2} \times 2m \times v^2/4 = \frac{1}{4} m v^2$. So, $E_{k1} = \frac{1}{2}mv^2$ and $E_{k2} = \frac{1}{4}mv^2$; the first is twice the second. The lighter object moving with velocity v has the greater kinetic energy, because K.E. depends on the square of velocity, so velocity has a stronger effect than mass.

Q 5.3. A car is moving along a curved road at constant speed. Does its kinetic energy change?

Ans: No. Kinetic energy $E_k = \frac{1}{2} m v^2$ depends on the magnitude of velocity (speed), not on its direction. On the curved road only the direction of motion changes while the speed stays constant, so v is unchanged and the kinetic energy remains the same. (The velocity vector does change because of the change in direction, but K.E. is a scalar that depends only on speed.)

Q 5.4. Comment on the statement: "An object has one joule of potential energy."

Ans: Potential energy is meaningful only with respect to a chosen reference level, because $E_p = mgh$ and h is measured from that level. Saying an object simply "has one joule of P.E." is incomplete unless the reference position is stated — the same object has different P.E. relative to a table, the floor, or the ground. So, the statement is correct only if it means mgh = 1 J relative to a stated reference level.

Q 5.5. While driving on a motorway, the tyre of a vehicle sometimes bursts. What may be its cause?

Ans: As the vehicle moves, work is done against the friction between the tyre and the road, and this work is converted into heat energy. At high motorway speeds a large amount of heat is produced continuously, which raises the temperature and hence the pressure of the air inside the tyre. When this pressure becomes too great, the tyre bursts. It is a result of the conversion of mechanical energy into heat.

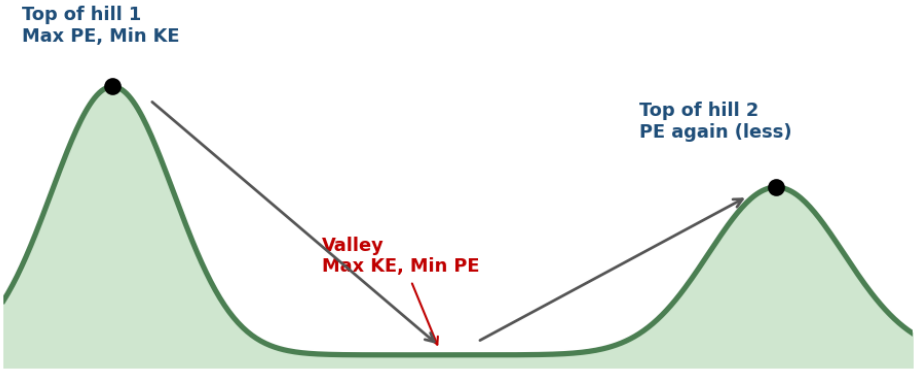
Q 5.6. While playing cricket on a street, the ball smashes a window pane. Describe the energy changes in this event.

Ans: The batsman's muscles use chemical energy (obtained from food) to do work on the ball, giving it kinetic energy. The moving ball carries this kinetic energy as it travels. On striking the window, the ball's kinetic energy is transferred to the glass, doing work that breaks it, and the rest is dissipated as sound and heat. In short: chemical energy → kinetic energy → work done on glass (breaking) + sound + heat.

Q 5.7. A man rowing a boat upstream is at rest with respect to the shore. Is he doing work?

Ans: With respect to the shore, the boat's displacement is zero because the man rows upstream just enough to balance the current, so it stays at the same position. Since $W = F \times S$ and $S = 0$ relative to the shore, the work done relative to the shore is zero. However, relative to the flowing water he is still doing work, because the water moves past him and he exerts force through a distance in that frame. So, the answer depends on the frame of reference: with respect to the shore, no work is done.

Q 5.8. A cyclist goes downhill from the top of a steep hill without pedalling and takes it to the top of the next hill. (i) Draw a diagram of what happened. (ii) Analyse this event in terms of potential and kinetic energy.



Ans: At the top of the first (higher) hill the cyclist is momentarily at rest at maximum height, so he has maximum potential energy and minimum kinetic energy. As he moves down without pedalling, his height decreases and potential energy is converted into kinetic energy — in the valley he has maximum kinetic energy and minimum potential energy (his greatest speed). Going up the next hill, kinetic energy is converted back into potential energy, so he slows down as he rises. Because some energy is continuously lost to friction and air resistance, the second hill must be lower than the first — he can never rise back to the same height.

Q 5.9. Is timber or wood a renewable source of heat energy? Comment.

Ans: Yes, wood (timber) is a renewable source of heat energy. Wood is a form of biomass, and burning it releases the stored chemical energy as heat. Trees are a natural resource that can be regrown — cut trees are replaced by planting and growing new ones within a reasonable time. As long as trees are replanted at the rate they are used, the supply is renewed, so wood is renewable. (However, if forests are cut faster than they can regrow, this benefit is lost and it leads to deforestation.)