

Work, Energy and Power — CBSE Pattern Test 2

Class 11 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

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General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

- A spring of force constant 800 N/m has an extension of 5 cm . The work done in extending it from 5 cm to 15 cm is
 (A) 8 J
 (B) 4 J
 (C) 16 J
 (D) 5 J
- A body of mass 50 kg at rest is accelerated to 20 m/s in 10 s . The work done is
 (A) $2 \times 10^4 \text{ J}$
 (B) 10^4 J
 (C) $5 \times 10^3 \text{ J}$
 (D) 10^3 J
- A particle is projected at 60° to the horizontal with kinetic energy E . Its kinetic energy at the highest point is
 (A) E
 (B) $E/2$
 (C) $E/4$
 (D) $3E/4$
- A 0.5 kg block moving at 2 m/s strikes a stationary 1 kg block and they move together. The energy loss during the collision is
 (A) 0.33 J
 (B) 1.00 J
 (C) 0.67 J
 (D) 0.50 J
- A 0.5 kg body moves with velocity $V = 5x^{3/2} \text{ m/s}$. The work done by the net force in displacing it from $x = 0$ to $x = 2 \text{ m}$ is
 (A) 100 J
 (B) 50 J
 (C) 25 J
 (D) 200 J
- Two bodies with kinetic energies in the ratio $4 : 1$ have equal linear momentum. The ratio of their masses is
 (A) $4 : 1$
 (B) $2 : 1$
 (C) $16 : 1$
 (D) $1 : 4$

7. 300 J of work is done in sliding a 2 kg block up an inclined plane of height 10 m. The work done against friction is ($g = 10 \text{ m/s}^2$)
- (A) 0 J
(B) 200 J
(C) 100 J
(D) 300 J
8. A mass of 5 kg moves along a circular path of radius 1 m at 300 rev/min. Its kinetic energy is
- (A) $250\pi^2 \text{ J}$
(B) $125\pi^2 \text{ J}$
(C) $500\pi^2 \text{ J}$
(D) $100\pi^2 \text{ J}$
9. Define an elastic collision.
10. A light and a heavy body have the same kinetic energy. Which has more momentum, and why?

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. A truck and a car moving with the same kinetic energy on a straight road have their engines switched off. Which one stops in a lesser distance, and why?
12. A ball at rest is dropped from a height of 12 m and loses 25% of its kinetic energy in striking the ground. Find the height to which it bounces, and account for the loss.
13. Two bodies of masses m and $4m$ have equal linear momenta. Find the ratio of their kinetic energies.
14. Two springs A and B are identical except that A is harder than B ($k_A > k_B$). If both are stretched by the same force, on which spring is more work done?

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. A bullet of mass 0.012 kg moving at 70 m/s strikes a wooden block of mass 0.4 kg suspended by wires and embeds in it. Calculate the height to which the block rises and the heat produced.
16. A railway carriage of mass 9000 kg moving at 36 km/h collides with a stationary carriage of the same mass, and the two couple and move together. Find their common speed, and state the type of collision.
17. A car of mass 2000 kg is lifted through 30 m by a crane in 1 min. A second crane does the same job in 2 min. Find the power supplied by each crane and state whether they consume the same fuel.
18. Prove that identical masses exchange their velocities after a head-on elastic collision.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. How does a perfectly inelastic collision differ from a perfectly elastic collision? Compare them with respect to conservation of linear momentum and conservation of kinetic energy.
20. Two particles of masses m_1 and m_2 with velocities u_1 and u_2 undergo a head-on elastic collision. Derive the relations for their final velocities, and discuss the special cases (i) $m_1 = m_2$, (ii) $m_1 \gg m_2$ with $u_2 = 0$, (iii) $m_1 \ll m_2$ with $u_1 = 0$.

Answer Key (Marking Scheme)

- Q1 — (A) 8 J ($\frac{1}{2} \times 800 \times (0.0225 - 0.0025)$). Q2 — (B) 10^4 J ($\frac{1}{2} \times 50 \times 400$). Q3 — (C) $E/4$ ($v \cos 60^\circ = v/2 \Rightarrow v^2$).
- Q4 — (C) 0.67 J ($v = 2/3 \text{ m/s}$; loss = $1 - \frac{1}{3}$). Q5 — (B) 50 J ($v_2 = 5 \times 2\sqrt{2} = 14.1 \text{ m/s}$; $W = \frac{1}{2} \times 0.5 \times 200$). Q6 — (D) $1 : 4$ ($K = p^2/2m$, same $p \Rightarrow 1/K$).

Q7 — (C) 100 J ($300 - mgh = 300 - 200$). Q8 — (A) $250\pi^2$ J ($v = 2\pi \times 5 = 10\pi$ m/s; $\frac{1}{2} \times 5 \times 100\pi^2$).

Q9 — An elastic collision is one in which both kinetic energy and linear momentum are conserved (no loss to heat or deformation).

Q10 — The heavier body has more momentum: $p = \sqrt{2mK}$, so for equal K the larger mass gives the larger momentum.

Q11 — The truck — for equal K.E. the stopping distance $s = K.E./(\mu mg)$ is smaller for the heavier truck.

Q12 — $h' = 0.75 \times 12 = 9$ m; the 25% is converted to heat and sound in the ground and in deforming the ball.

Q13 — $K_1 : K_2 = m_2 : m_1 = 4 : 1$ ($K = p^2/2m$, same p).

Q14 — More work is done on B (the softer spring): same force $\Delta V = F^2/2k$, smaller for the larger k.

Q15 — $v = (0.012 \times 70)/(0.412) \approx 2.04$ m/s; $h = v^2/2g \approx 0.21$ m; heat = $\frac{1}{2} \times 0.012 \times 70^2 - \frac{1}{2} \times 0.412 \times 2.04^2 \approx 29.4 - 0.86 \approx 28.5$ J.

Q16 — $v = 10/2 = 5$ m/s; perfectly inelastic collision (bodies couple and move together).

Q17 — Energy = $2000 \times 10 \times 30 = 6 \times 10^5$ J for both; $P_1 = 6 \times 10^5/60 = 10^4$ W (10 kW), $P_2 = 5$ kW; same energy Δ same fuel (neglecting losses), different power.

Q18 — For $m_1 = m_2$, $v_1' = [(0)u_1 + 2m \cdot u_2]/2m = u_2$ and $v_2' = u_1$ — the velocities are exchanged.

Q19 — Elastic: KE and momentum both conserved, $e = 1$, bodies separate. Perfectly inelastic: only momentum conserved, kinetic energy is lost (heat/sound/deformation), bodies move together with a common velocity, $e = 0$.

Q20 — $v_1' = [(m_1 - m_2)u_1 + 2m_2u_2]/(m_1 + m_2)$; $v_2' = [(m_2 - m_1)u_2 + 2m_1u_1]/(m_1 + m_2)$. Cases: (i) $m_1 = m_2$: $v_1' = u_2$, $v_2' = u_1$ (velocities exchanged); (ii) $m_1 \gg m_2$, $u_2 = 0$: $v_1' \approx u_1$, $v_2' \approx 2u_1$ (heavy body almost unaffected); (iii) $m_1 \ll m_2$, $u_1 = 0$: $v_1' \approx -u_1$, $v_2' \approx 0$ (light body rebounds, heavy body stays almost at rest).