

Work, Energy and Power — CBSE Pattern Test 1

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

Test 1 — CBSE Pattern (90 minutes, 40 marks)

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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)

- The kinetic energy of a body of mass m moving with speed v is
 - $\frac{1}{2}mv^2$
 - mv^2
 - $\frac{1}{2}mv$
 - mv
- The work done by a conservative force along a closed path is
 - zero
 - positive
 - negative
 - infinite
- The SI unit of power is the
 - watt
 - joule
 - newton
 - pascal
- In a perfectly inelastic collision, the coefficient of restitution e is
 - zero
 - one
 - between 0 and 1
 - greater than 1
- A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. The work done in pulling the entire chain on to the table is ($g = 10 \text{ m/s}^2$)
 - 3.6 J
 - 1.8 J
 - 7.2 J
 - 5.4 J
- If the linear momentum of a body is increased by 50%, its kinetic energy increases by
 - 100%
 - 150%
 - 125%
 - 50%
- An athlete covers 100 m in 10 s. His kinetic energy can be estimated to be ($m = 60 \text{ kg}$)

- (A) 200 J – 500 J
 (B) 200 kJ – 500 kJ
 (C) 20 J – 50 J
 (D) 2000 J – 5000 J
8. A position-dependent force $F = 7 - 2x + 3x^2$ N displaces a body from $x = 0$ to $x = 5$ m. The work done in joules is
 (A) 135
 (B) 155
 (C) 175
 (D) 95
9. A child sits on a swing with minimum and maximum heights 0.75 m and 2 m above the ground. Its maximum speed is ($g = 10 \text{ m/s}^2$)
 (A) 10 m/s
 (B) 5 m/s
 (C) 2.5 m/s
 (D) 7.5 m/s
10. A ball dropped from height h has coefficient of restitution e . After one bounce the maximum height attained is
 (A) e^2h
 (B) eh
 (C) $2eh$
 (D) h/e

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

11. A force of 20 N acts on a body at 60° to the horizontal and moves it 5 m along the horizontal. Find the work done.
 12. A pump lifts 200 L of water per minute to a height of 10 m. Find the minimum power delivered ($g = 10 \text{ m/s}^2$).
 13. Two bodies of masses m and $4m$ have equal kinetic energies. Find the ratio of their momenta.
 14. A pendulum bob is released from the horizontal position (length 2 m) and, due to air resistance, loses 10% of its energy by the lowest point. Find its speed there ($g = 10 \text{ m/s}^2$).

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

15. State and prove the work–energy theorem for a variable force.
 16. 20 J of work is required to stretch a spring through 0.1 m. Find its force constant, and the work needed to stretch it a further 0.1 m.
 17. A car of mass 1000 kg moving at 18.0 km/h on a smooth road collides with a horizontally mounted spring of spring constant $6.25 \times 10^5 \text{ N/m}$. Find the maximum compression of the spring.
 18. Distinguish between conservative and non-conservative forces, and show that the work done by a conservative force is independent of path.

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

19. Derive expressions for the velocities of two bodies after a one-dimensional perfectly elastic collision and show that kinetic energy is conserved in the process.
 20. State the law of conservation of mechanical energy and prove it for a body falling freely under gravity.

Answer Key (Marking Scheme)

Q1 — (A) $\frac{1}{2}mv^2$. Q2 — (A) zero. Q3 — (A) watt. Q4 — (A) zero.

Q5 — (A) 3.6 J ($1.2 \text{ kg} \times 0.3 \text{ m} \times 10$). Q6 — (C) 125% ($p \rightarrow 1.5p \rightarrow 2.25K$). Q7 — (D) 2000 J – 5000 J ($v = 10 \text{ m/s}$, $K = \frac{1}{2} \times 60 \times 100 = 3000 \text{ J}$).

Q8 — (A) 135 J ($\int (7 - 2x + 3x^2) dx = 35 - 25 + 125$). Q9 — (B) 5 m/s ($v = \sqrt{2g \cdot \Delta h}$, $\Delta h = 1.25 \text{ m}$). Q10 — (A) e^2h .

Q11 — $W = Fs \cos 60^\circ = 20 \times 5 \times \frac{1}{2} = 50 \text{ J}$.

Q12 — $P = mgh/t = 200 \times 10 \times 10/60 \approx 333 \text{ W}$.

Q13 — $p_1 : p_2 = \sqrt{2mK} : \sqrt{2 \cdot 4m \cdot K} = 1 : 2$.

Q14 — K.E. = 0.9 mgl $\Rightarrow \sqrt{(1.8 \times 10 \times 2)} = 6 \text{ m/s}$.

Q15 — $W = \int F dx = \int m(dv/dt) dx = m \int v dv = \frac{1}{2}mv^2 - \frac{1}{2}mu^2 = \Delta K$; hence $W = \Delta K$ for variable forces too.

Q16 — $k = 2W/x^2 = 4000 \text{ N/m}$; further stretch $\Delta W = \frac{1}{2}k(x_2^2 - x_1^2) = \frac{1}{2} \times 4000 \times (0.04 - 0.01) = 60 \text{ J}$.

Q17 — $\frac{1}{2}mv^2 = \frac{1}{2}kx^2 \Rightarrow v = \sqrt{(m/k)} = 5 \times \sqrt{(1000/(6.25 \times 10^5))} = 5 \times 0.04 = 0.2 \text{ m}$.

Q18 — Conservative force: work independent of path, closed-loop work zero, e.g. gravity, spring force. Non-conservative: work depends on path, closed-loop work non-zero, e.g. friction. For a conservative force $F \cdot dr = 0$, so the work between two points is the same along any path.

Q19 — $v_1' = [(m_1 - m_2)u_1 + 2m_2u_2]/(m_1 + m_2)$; $v_2' = [(m_2 - m_1)u_2 + 2m_1u_1]/(m_1 + m_2)$; substituting back shows KE before = KE after, so kinetic energy is conserved.

Q20 — Total ME = $K + U = \frac{1}{2}mv^2 + mgh$ is constant for free fall: at height h , $\frac{1}{2}mu^2 + mgh$; at the ground $\frac{1}{2}mv^2 = mgh$ ($u = 0$).