

Work done, energy conservation and power

Physics grades 11-12 (A Level · IB · Class 11-12) · Test answers (mark scheme)

The model answers show the full method and the final answer in bold. Marks are given for the method as well as the result, so a wrong answer with correct working still earns most of the marks. Check your units too.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB A.3

Question 1 Definitions (2 marks)

- Work done is the energy transferred by a force, equal to force $\times$ displacement in the direction of the force.
- The net work done on an object equals its change in kinetic energy.

Marking: 1 mark each; accept $W = F s \cos \theta$ with symbols defined for (a).

Question 2 Rope on a sack (3 marks)

- $W = F s \cos \theta = 90 \times 8.0 \times \cos 25^\circ = 720 \times 0.906 = \mathbf{653 \text{ J}}$.
- Friction does $-40 \times 8.0 = -320 \text{ J}$, so $W_{\text{net}} = 653 - 320 = \mathbf{333 \text{ J}}$.

Marking: (a) 1 mark for the cosine term, 1 for the result; (b) 1 mark.

Question 3 Carrying a box (2 marks)

The lifting force acts upwards, while the box moves horizontally. The force is at 90° to the displacement, so $\cos 90^\circ = 0$ and the work done is **zero**.

Marking: 1 mark for force perpendicular to displacement; 1 mark for $W = F s \cos 90^\circ = 0$.

Question 4 Smooth and rough ramp (3 marks)

- $m g h = \frac{1}{2} m v^2$, so $v = \sqrt{2 \times 9.81 \times 0.45} = \sqrt{8.829} = \mathbf{3.0 \text{ m/s}}$.
- $\text{KE} = 2.0 \times 9.81 \times 0.45 - 1.5 = 7.329 \text{ J}$, so $v = \sqrt{2 \times 7.329 \div 2.0} = \mathbf{2.7 \text{ m/s}}$.

Marking: (a) 1 for energy equation, 1 for result; (b) 1 for result.

Question 5 Hoist efficiency (3 marks)

- $P = F v = m g v = 120 \times 9.81 \times 0.50 = \mathbf{589 \text{ W}}$.
- Efficiency $= 589 \div 900 \times 100 \% = \mathbf{65 \%}$.

Marking: (a) 1 for $F = m g$, 1 for result; (b) 1 mark.

Question 6 Force-displacement graph (3 marks)

- a. Area = $30 \times 4 = \mathbf{120 \text{ J}}$.
- b. Area of trapezium = $\frac{1}{2} \times (30 + 10) \times 4 = \mathbf{80 \text{ J}}$.
- c. Total work = $200 \text{ J} = \frac{1}{2} \times 5.0 \times v^2$, so $v = \sqrt{80} = \mathbf{8.9 \text{ m/s}}$.

Marking: 1 mark for each part.

Question 7 Doubling the speed (2 marks)

The braking work $F d$ equals the kinetic energy, so $F d = \frac{1}{2} m v^2$. With the same F , d is proportional to v^2 . Doubling v multiplies v^2 by 4, so the distance is **four times** as large.

Marking: 1 mark for $F d = \frac{1}{2} m v^2$; 1 mark for $d \propto v^2$ and the factor 4.

Question 8 Heavy and light balls (2 marks)

$m g h = \frac{1}{2} m v^2$, so $v = \sqrt{2 g h}$ and the mass cancels. Both reach the ground with the same speed $\sqrt{2 \times 9.81 \times 4.0} = 8.9 \text{ m/s}$. The claim is **wrong**.

Marking: 1 mark for the energy equation with m cancelling; 1 mark for the conclusion.