

Energy conservation, bar charts and power

AP Physics 1 (algebra-based) · Test answers (mark scheme)

Model answers with the mark scheme. Award marks for correct method even where the final number is wrong by a slip, and apply the unit mark in every calculation.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 3

Question 1 Power and energy (2 marks)

- a. Power is the rate at which energy is transferred (or work is done), $P = \Delta E/t$.
b. $t = 2.0 \times 3600 = 7200 \text{ s}$; $E = Pt = 60 \times 7200 = \mathbf{4.3 \times 10^5 \text{ J}}$ (432 000 J).

Marking: 1 mark for the definition including the idea of rate; 1 mark for correct substitution and result with unit.

Question 2 Book on a shelf (2 marks)

- a. $\Delta U = mgh = 2.4 \times 9.81 \times 1.6 = \mathbf{38 \text{ J}}$ (37.7 J).
b. $mgh = \frac{1}{2}mv^2$, $v = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 1.6} = \mathbf{5.6 \text{ m/s}}$.

Marking: 1 mark for each part, with unit.

Question 3 Playground swing (3 marks)

- a. $mgh = \frac{1}{2}mv^2$, $v = \sqrt{2 \times 9.81 \times 0.80} = \sqrt{15.7} = \mathbf{4.0 \text{ m/s}}$.
b. $K = mgh = 40 \times 9.81 \times 0.80 = \mathbf{3.1 \times 10^2 \text{ J}}$ (314 J).

Marking: (a) 1 mark for setting U equal to K, 1 mark for the speed; (b) 1 mark.

Question 4 Dart gun (2 marks)

- a. $U_s = \frac{1}{2}kx^2 = \frac{1}{2} \times 300 \times (0.040)^2 = \mathbf{0.24 \text{ J}}$.
b. $\frac{1}{2}mv^2 = 0.24 \text{ J}$, $v = \sqrt{2 \times 0.24 \div 0.015} = \sqrt{32} = \mathbf{5.7 \text{ m/s}}$.

Marking: 1 mark for each part, with unit.

Question 5 Sliding crate (3 marks)

- a. $\Delta U = 8.0 \times 9.81 \times 1.5 = \mathbf{118 \text{ J}}$.
b. $\Delta K = \frac{1}{2} \times 8.0 \times (3.0)^2 = \mathbf{36 \text{ J}}$.
c. $E_{\text{int}} = 117.7 - 36 = \mathbf{82 \text{ J}}$.

Marking: 1 mark for each part; accept 81.7 J.

Question 6 Pump power (2 marks)

a. $\Delta U = mgh = 200 \times 9.81 \times 15 = 29\,430 \text{ J} \approx \mathbf{2.9 \times 10^4 \text{ J}}$.

b. $P = \Delta U/t = 29\,430 \div 120 = \mathbf{245 \text{ W}}$.

Marking: 1 mark for each part.

Question 7 Two ramps (3 marks)

a. The speeds are equal. Each block loses the same mgh (same mass, same height) and no friction acts, so all of it becomes kinetic energy and $v = \sqrt{2gh}$ in both cases.

b. **Block B** takes longer: its acceleration along the gentle ramp is smaller, so it reaches the same speed over a longer distance in more time.

Marking: (a) 1 mark for equal loss of potential energy, 1 mark for equal speeds; (b) 1 mark for B with the reason.

Question 8 Hoist with losses (3 marks)

a. $F = mg = 150 \times 9.81 = 1471.5 \text{ N}$; $P = Fv = 1471.5 \times 0.40 = \mathbf{589 \text{ W}}$.

b. $P_{\text{in}} = 588.6 \div 0.60 = \mathbf{981 \text{ W}}$.

Marking: (a) 1 mark for the force, 1 mark for the power; (b) 1 mark.