

Solutions

2.1 Known: mass and speed.

$$E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 1200 \text{ kg} \times (30 \text{ m/s})^2 = \mathbf{5.4 \times 10^5 \text{ J}}$$

(1 mark substitution, 1 mark answer with unit.)

2.2 Convert first: 4.0 cm = 0.040 m (C1).

$$E_e = \frac{1}{2}ke^2 = \frac{1}{2} \times 250 \text{ N/m} \times (0.040 \text{ m})^2 = \mathbf{0.20 \text{ J}}$$

(substitution 1, answer with unit 1.)

2.3 Convert: 8.4 kJ = 8400 J (C1). Rearrange then substitute.

$$E_p = mgh \quad \Rightarrow \quad h = \frac{E_p}{mg} = \frac{8400 \text{ J}}{65 \text{ kg} \times 9.8 \text{ N/kg}} = \mathbf{13 \text{ m}} \text{ (2 s.f.)}$$

(rearrangement 1, answer with unit 1.)

2.4 Known: mass and E_k ; v is wanted, so rearrange before substituting.

$$E_k = \frac{1}{2}mv^2 \quad \Rightarrow \quad v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2 \times 5.0 \text{ J}}{0.90 \text{ kg}}} = \mathbf{3.3 \text{ m/s}}$$

(1 mark method, 1 mark answer with unit.)

3.1 (a) Known: $k = 800 \text{ N/m}$, $e = 7.5 \text{ m}$ (already base units).

$$E_e = \frac{1}{2}ke^2 = \frac{1}{2} \times 800 \text{ N/m} \times (7.5 \text{ m})^2$$

$$E_e = \mathbf{22\,500 \text{ J}}$$

(substitution C1, square of 7.5 evaluated A1, answer with unit A1.) (b) The two identical cords store the same energy each.

$$E_{total} = 2 \times 22\,500 = \mathbf{45\,000 \text{ J}}$$

3.2 (a) Known: E_p , m , g ; rearrange for h .

$$E_p = mgh \quad \Rightarrow \quad h = \frac{E_p}{mg} = \frac{24\,000 \text{ J}}{240 \text{ kg} \times 9.8 \text{ N/kg}} = \mathbf{10 \text{ m}}$$

(rearrangement C1, substitution C1, answer with unit A1.) (b) As the pod rises it does work against air resistance, so some elastic potential energy is transferred to thermal stores of the air and the pod rather than to the gravitational potential store.

3.3 (a) Convert: 6.0 cm = 0.060 m (C1).

$$E_e = \frac{1}{2}ke^2 = \frac{1}{2} \times 320 \times (0.060)^2 = 0.576 \text{ J} \approx 0.58 \text{ J} \checkmark$$

(shown statement A1.) (b) All E_e becomes E_k at launch.

$$E_k = \frac{1}{2}mv^2 \quad \Rightarrow \quad v = \sqrt{2E_k/m} = \sqrt{2 \times 0.576/0.080} = \mathbf{3.8 \text{ m/s}} \text{ (2 s.f.)}$$

(equating C1, rearrangement C1, answer A1.) (c) Just before landing the ball's kinetic energy is given (0.63 J), not re-derived.

$$v = \sqrt{2E_k/m} = \sqrt{2 \times 0.63/0.080} = \mathbf{4.0} \text{ m/s (2 s.f.)}$$

(method C1, answer A1, 2 s.f. A1.) (d) On the way down the gravitational potential store empties as well: the ball has both the launch energy and the energy from falling 0.85 m, so the kinetic store (and the speed) at the floor is larger than at launch. Mentioning "energy gained = $mg \times 0.85 = 0.67 \text{ J}$, so E_k grows from 0.58 J to about 0.63 J once a little is dissipated" is a full-credit comparison.