

Solutions

Each answer shows the steps, then the **result**.

2.1

- $E_k = \frac{1}{2}mv^2$

$$E_k = \frac{1}{2}(2.0 \text{ kg})(3.0 \text{ m/s})^2 = \mathbf{9.0 \text{ J}}$$

2.2

- $W = Fd$

$$W = (25 \text{ N})(4.0 \text{ m}) = \mathbf{100 \text{ J}}$$

2.3

- any three of: kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic, internal (thermal)
- any one of: by a force doing mechanical work; by an electric current; by heating; by waves

2.4

- $\Delta E_p = mg\Delta h$

$$\Delta E_p = (60 \text{ kg})(10 \text{ N/kg})(9.0 \text{ m}) = \mathbf{5400 \text{ J}}$$

2.5

- from the Sun, any two of: fossil fuels, biofuels, wind, waves, hydroelectric, solar
- not from the Sun, any two of: geothermal, nuclear, tidal

2.6

- $\frac{1}{2}mv^2 = mg\Delta h$, so $v^2 = 2g\Delta h$

$$v^2 = 2 \times (10 \text{ N/kg})(5.0 \text{ m}) = 100 \text{ m}^2/\text{s}^2$$

- $v = \mathbf{10 \text{ m/s}}$

2.7

- the tides follow a regular, predictable pattern, so tidal power is reliable, while the wind may drop

3.1 B

- efficiency = $(300 \text{ J})/(500 \text{ J}) \times 100\% = 60\%$, and the missing 200 J is transferred to the surroundings as heat (and sound)
- **A** breaks conservation of energy; **C** inverts the fraction; **D** subtracts the wrong way round

3.2

(a) the ball starts with energy in the gravitational potential store

- as it falls this is transferred to the kinetic store, which increases

- when it lands the kinetic energy is transferred to the internal (thermal) store of the ball and the ground

(b) $\Delta E_p = mg\Delta h$

$$\Delta E_p = (0.40 \text{ kg})(10 \text{ N/kg})(1.8 \text{ m}) = \mathbf{7.2 \text{ J}}$$

(c) $\frac{1}{2}mv^2 = 7.2 \text{ J}$

$$v^2 = \frac{2 \times 7.2 \text{ J}}{0.40 \text{ kg}} = 36 \text{ m}^2/\text{s}^2$$

- $v = \mathbf{6.0 \text{ m/s}}$

- (d) some energy is transferred to the air by air resistance, so less becomes kinetic energy

3.3

(a) $E_k = \frac{1}{2}mv^2$, so $m = 2E_k/v^2$

$$m = \frac{2 \times 11\,000 \text{ J}}{(6.3 \text{ m/s})^2} = \frac{22\,000 \text{ J}}{39.7 \text{ m}^2/\text{s}^2} = 554 \text{ kg} \approx \mathbf{550 \text{ kg}}$$

(b) efficiency = useful / total

$$\text{efficiency} = \frac{6000 \text{ J}}{11\,000 \text{ J}} \times 100\% = \mathbf{55\%}$$

- (c) not all the energy of the air is transferred to the blades: the air still moves after passing them

- energy is also transferred to the surroundings by friction and heating in the generator

- (d) any two comparisons, each developed: wind is renewable while coal will run out; wind is unreliable because it needs the wind to blow, while a coal station runs whenever it is needed; wind releases no carbon dioxide during use while coal releases carbon dioxide and other pollution

3.4

(a) $W = Fd$

$$W = (2400 \text{ N})(15 \text{ m}) = \mathbf{36\,000 \text{ J}}$$

(b) $P = W/t$

$$P = \frac{36\,000 \text{ J}}{12 \text{ s}} = \mathbf{3000 \text{ W}}$$

(c) efficiency = useful / total

$$\text{efficiency} = \frac{3000 \text{ W}}{5000 \text{ W}} \times 100\% = \mathbf{60\%}$$

- (d) the work done is unchanged at 36 000 J, because the force and the distance are the same

- the power doubles to 6000 W, because the same energy is transferred in half the time