Solutions

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

2.1

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

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

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 $v^2 = 2g\Delta h$

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

- $v = \mathbf{10}$ 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 J)/(500 J) × 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) $\frac{1}{2}mv^2 = 7.2$ J

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

- $v = \mathbf{6.0}$ 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