

# Answers

## Energy

### Energy stores and systems

- 1 First, choose the start and end point; second, find the energy stores at those points; third, show which stores empty and which stores fill up.
- 2
  - a Electrical working
  - b Heating by particles
  - c Mechanical working
  - d Heating by particles
- 3 Example 1: A weightlifter lifting a weight transfers energy via mechanical working; Example 2: A bonfire transfers energy via heating by radiation.

### Changes in energy stores

- 1 301.6 J
- 2 1123 J
- 3 Cyclist A's  $E_k$  is 9 times higher than the  $E_k$  for cyclist B. This is because their speed is 3 times that of cyclist B, and  $3^2 = 9$

### Energy changes in systems – specific heat capacity

- 1 94500 J
- 2 The thermal store will increase by 4200 J; as energy is conserved.
- 3 c

## Power

- 1 (b) 850 W; because it transfers more energy per second to the water.
- 2 11 J
- 3 6930 J

### Energy transfers in a system

- 1 Wear streamlined helmet and adjust body position to reduce air resistance; Lubrication between bike's chain and gears to reduce heating effects of friction; High pressure in tyres to reduce surface area of contact between the road and the tyres.
- 2 The infrared radiation from the heating elements in the toaster warms the surrounding air which rises; so not all the energy is transferred through heating by radiation to the toast.
- 3 Less fuel consumption; Tyres, brakes and other components do not get worn out as quickly.

## Efficiency

- 1 Because in any change within a system some energy is dissipated to the surroundings.
- 2 Because the useful energy transferred is the numerator of the fraction and the input energy is the denominator; Since the useful energy transferred can never be greater than the input energy, the fraction can never return a value greater than 1.
- 3 Being only 25% efficient means that our body needs to transfer 4 times more energy from the chemical store to do the mechanical work needed during exercise, e.g. to lift a weight.

### National and global energy resources

- 1 Renewable energy resources can be replaced (replenished); but non-renewable energy resources cannot be replaced and so will eventually run out if we keep using them.
- 2 Fossil fuels have high power output and are very reliable.
- 3 Accept any of the following: Large areas are needed to harness it; It has a low power output; It has a low conversion efficiency; It can only be harnessed during daylight hours.

### Review It!

- 1 Renewable: water waves, bio-fuel, hydroelectricity, the Sun, geothermal, the tides.  
Non-renewable: nuclear fuels, coal, oil, natural gas.

- 2 **a**  $kinetic\ energy = 0.5 \times mass \times (speed)^2$

$$E_k = \frac{1}{2} m v^2 \rightarrow m = \frac{2E_k}{v^2}$$

- b**  $elastic\ potential\ energy = 0.5 \times spring\ constant \times (extension)^2$

$$E_e = \frac{1}{2} k e^2 \rightarrow e = \sqrt{\frac{2E_e}{k}}$$

- c**  $g.p.e = mass \times gravitational\ field\ strength \times height$

$$E_p = m g h \rightarrow h = \frac{E_p}{m g}$$

- 3  $\Delta\theta$  is a temperature difference, and degrees Celsius and kelvin have the same magnitude; so using degrees Celsius or kelvin will affect the result of the calculation because the taking difference gives the same result; For example, the

temperature increase between  $2^\circ\text{C}$  and  $20^\circ\text{C}$  is  $\Delta\theta = 20 - 2 = 18^\circ\text{C}$ ; which expressed in kelvin becomes  $\Delta\theta = 293.15 - 275.15 = 18\text{ K}$ .

- 4 **a** Lift B has greater power than lift A; because it can lift the same load the same height in less time; The rate of energy transferred is higher for lift B.

- b** Energy transferred is

$$E_p = mgh \text{ and } P = \frac{E}{t} = \frac{mgh}{t}$$

$$h = \frac{Pt}{mg} = \frac{343 \times 15}{70 \times 9.8} = 7.5\text{ m}$$

So, each floor is  $\frac{7.5}{3} = 2.5\text{ m}$  high.

- 5 Aluminium has a higher thermal conductivity than plastic; so it will transfer energy by conduction to the ice cube at a higher rate than the plastic block; so the ice cube on the aluminium block will melt faster than the cube on the plastic block.
- 6 First we need to calculate the energy in the kinetic store when the car is at top speed.

$$E_k = \frac{1}{2} m v^2 = \frac{1}{2} 0.520 \times 2.2^2 = 1.26\text{ J}$$

So, at top speed the toy car transfers 1.26 J to the kinetic store each second; This means a useful power output of 1.26 W; So, to find the efficiency of the toy car:

$$\begin{aligned} \text{Efficiency} &= \frac{\text{Useful power output}}{\text{Total power input}} \\ &= \frac{1.26}{1.5} = 0.84 \end{aligned}$$

We can multiply by 100 to find the percentage efficiency, i.e. 84%.

## Electricity

### Standard circuit diagram symbols

- 1 Ammeters have hardly any resistance; but voltmeters have very high resistance.
- 2 Their I-V characteristics are very similar and they both let current flow only in one direction; However, LEDs emit light, while diodes do not.
- 3 A diode in series with an LDR.

### Electrical charge and current

- 1 An electrical current is the rate of flow of electrical charge.
- 2 Free electrons fill all the components of the circuit all the time, even when the circuit is open; So, when the circuit is closed all the free electrons will start drifting