Energy Transfers and Systems

Re-read pages 156 and 157 — energy is never used up, but it can always be talked about more...

Energy is Transferred Between Stores

First things first, here's a quick recap of the different energy stores that you need to know:

1) Kinetic energy stores ($KE = \frac{1}{2}mv^2$, p.156)
2) Thermal energy stores
3) Chemical energy stores
4) Gravitational potential energy stores ($\Delta GPE = mg\Delta h$, p.156)
5) Elastic potential energy stores
6) Electrostatic energy stores
7) Magnetic energy stores
8) Nuclear energy stores

Energy can be transferred between stores mechanically (by a force doing work — see next page), electrically (by a moving charge doing work), by heating or by radiation (e.g. light or sound).

When a System Changes, Energy is Transferred

1) A system is just a fancy word for a single object (e.g. the air in a piston) or a group of objects (e.g. two colliding vehicles) that you're interested in. You can define your system to be anything you like.
2) When a system changes, energy is transferred (p.157). It can be transferred into or away from the system, between different objects in the system or between different types of energy stores.
3) Whenever a system changes, some energy is dissipated and stored in less useful ways (p.158).
4) How you define your system changes how you describe the energy transfers that take place (see below). A closed system is one that's defined so that the net change in energy is zero (p.157).

Energy can be Transferred by Heating...

1) A pan of water is heated on a gas camping stove.
2) When the system is the pan of water, energy is transferred into the system by heating to the thermal energy stores of the pan and the water, which increases their temperature.
3) When the system is the camping stove and the pan, energy is transferred from the chemical energy store of the gas to the thermal energy stores of the pan and the water, increasing their temperature.

...by Forces Doing Work...

1) A box is lifted up off of the floor. The box is the system.
2) As the box is lifted, work is done (see next page) against gravity.
3) This causes energy to be transferred to the box's kinetic and gravitational potential energy stores.

If the box was dropped, the gravitational force would do work to transfer energy from the box's GPE store to its kinetic energy store.

...or by Electrical Equipment

1) Electrical devices work by transferring energy between different energy stores.
2) For example, electric irons transfer energy electrically from the mains power supply to the thermal energy store of their metal plates.

You can show energy transfers using diagrams — see p.157.

1) An electric toothbrush is a system. It transfers energy electrically from the chemical energy store of its battery to the kinetic energy store of its bristles.
2) Some of this energy is transferred out of the system to the surroundings by sound and by heating.

1) A hair dryer is a system. It transfers energy into the system electrically from the mains supply to the kinetic energy store of the fan inside of it.
2) It also transfers energy electrically to the thermal energy store of the heating element and some energy is transferred away by sound.

All this work, I can feel my energy stores being drained...

Make sure you understand exactly what a system contains before you describe any energy transfers.

Q1 Describe the energy transfers that occur when the wind causes a windmill to spin. [2 marks]

Energy Transfers and Systems

1 Which of the following is correct for a closed system? Grade 4-6

- ☐ **A** Energy into the system is always larger than energy out of the system.
- ☐ **B** Energy out of the system is always larger than energy into the system.
- ☐ **C** The net change of energy in a closed system is always zero.
- ☐ **D** Closed systems can only be changed by heating.

[Total 1 mark]

2 A filament bulb is connected to a battery, shown in **Figure 1**. You can assume that the wires connecting them have zero resistance. Complete the diagram in **Figure 2** to show the energy transfers that occur when the bulb in connected to the battery. Grade 4-6

Figure 1

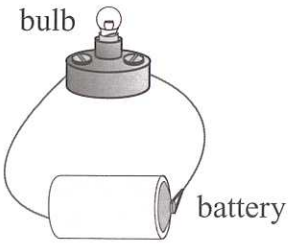
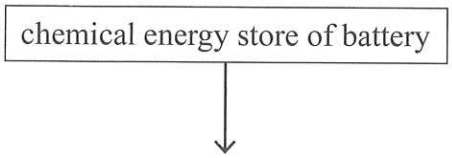


Figure 2



[Total 3 marks]

3 An 80.0 g apple is a one-object system. The apple is hanging from a branch. Grade 6-7

a) i) The apple falls from the branch. It reaches a speed of 7.00 m/s just before it hits the ground. Calculate the energy in the apple's kinetic energy store just before it hits the ground.

Energy = ... J
[3]

ii) State what causes the energy transfer within this system.

.....
[1]

b) Assuming that there was no air resistance, calculate the height the apple fell from. (Gravitational field strength = 10 N/kg.)

Height = ... m
[4]

[Total 7 marks]