Energy in Circuits

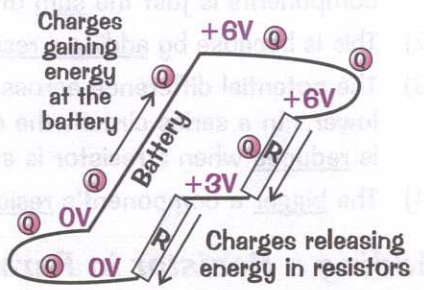
Electrical devices are built to transfer energy. But nothing is perfect and some of this transferred energy ends up in thermal stores. This isn't always a bad thing though — devices like toasters and heaters make use of it.

Energy Transferred Depends on Current, p.d. and Time

1) When an electrical charge goes through a change in potential difference, then energy is transferred (as work is done against resistance — p.185).
2) Energy is supplied to the charge at the power source to 'raise' it through a potential.
3) The charge gives up this energy when it 'falls' through any potential drop in components elsewhere in the circuit.
4) To find the energy transferred to an electrical component, you can use the equation:

$$E = I \times V \times t$$

Where E is energy transferred in joules (J), I is current in amps (A), V is p.d. in volts (V) and t is time in seconds (s).



This equation comes from combining two of the equations from the next page.

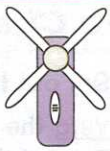
5) The larger the current through, or p.d. across, a component, the more energy is transferred to it.

Energy is Transferred from Cells and Other Sources

1) Electrical appliances are designed to transfer energy to components in the circuit when a current flows.

Kettles transfer energy electrically from the mains a.c. supply to the thermal energy store of the heating element inside the kettle.

Energy is transferred electrically from the battery of a handheld fan to the kinetic energy store of the fan's motor.



2) Of course, no appliance transfers all energy completely usefully. The higher the current, the more energy is transferred to the thermal energy stores of the components (and then the surroundings).
3) This heating usually increases the resistance of the components, like you saw on page 185.

Heating a Circuit isn't Always Bad

1) Heating up a component generally reduces its efficiency (p.158) — less energy is transferred to useful energy stores because more of it is being transferred to the thermal energy store of the component.
2) If the temperature gets too high, this can cause components in the circuit to melt — which means the circuit will stop working, or not work properly.

More on fuses on p.193.

3) Fuses use this effect to protect circuits — they melt and break the circuit if the current gets too high.
4) The heating effect of an electric current can have other advantages. For example, it's ace if you want to heat something. Toasters contain a coil of wire with a really high resistance. When a current passes through the coil, its temperature increases so much that it glows and gives off infrared radiation. This radiation transfers energy to the bread and cooks it.
5) Filament bulbs and electric heaters work in a similar way.

Have a break from all this work — or you'll have no energy left...

There's no escaping energy transfers I'm afraid. Practise using that equation then take a quick break to recharge.

Q1 A laptop charger is connected to a 230 V source for an hour. A current of 8.0 A flows through it. Calculate the energy transferred by the laptop charger. [2 marks]

Energy in Circuits

1 Which of the following describes the energy transferred to an electric heater connected to the mains? Grade 4-6

- ☐ **A** Energy is transferred electrically to the kinetic energy store of the heater.
- ☐ **B** Energy is transferred by heating to the electrostatic energy store of the heater.
- ☐ **C** Energy is transferred by heating to the gravitational potential energy store of the heater.
- ☐ **D** Energy is transferred electrically to the thermal energy store of the heater.

[Total 1 mark]

2 A hairdryer contains of a motor which turns a fan and a heating element. Grade 6-7

a) State **one** part of the hairdryer where the heating effect of a current is **useful**.

.....

[1]

b) State **one** part of the hairdryer where the heating effect of a current is **not useful**.

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[1]

c) The hairdryer becomes less efficient the longer it is left on for. Explain why.

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[3]

[Total 5 marks]

3 A kettle is filled with a litre of water from the cold tap. Grade 6-7

a) It takes 355 000 J of energy to bring a litre of water to the boil. The kettle is attached to the mains, at 230 V, and the current through the kettle is 12 A. Calculate how long it should take the kettle to boil, to the nearest second.

Time = ... s

[3]

b) State **one** assumption that you made in order to answer part a).

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[1]

[Total 4 marks]