Power in Circuits

You know that electrical devices transfer energy — well, their power determines how quickly this happens.

Energy Transferred Depends on Power

1) The total energy transferred by an appliance depends on how long the appliance is on for and its power.
2) The power of an appliance is the energy that it transfers per second. So the more energy it transfers in a given time, the higher its power.
3) The power of an appliance can be found using:

Power (W) = Energy transferred (J) ÷ Time (s)

$$P = \frac{E}{t}$$

4) Appliances are often given a power rating — they're labelled with the maximum safe power that they can operate at. You can usually take this to be their maximum operating power.
5) The power rating tells you the maximum amount of energy transferred between stores per second when the appliance is in use.

> Microwaves have a range of power ratings. A microwave with a power rating of 500 W will take longer to cook food than one with a power rating of 750 W. This is because the 500 W transfers less energy per second to the thermal energy store of the food, so it takes longer to cook.

6) This helps customers choose between models — the lower the power rating, the less electricity an appliance uses in a given time and so the cheaper it is to run.
7) But, a higher power doesn't necessarily mean that it transfers more energy usefully. An appliance may be more powerful than another, but less efficient, meaning that it might still only transfer the same amount of energy (or even less) to useful stores (see p.158).

Power Also Depends on Current and Potential Difference

1) The power transferred by an appliance depends on the potential difference (p.d.) across it, and the current flowing through it.
2) The p.d. tells you how much energy each unit of charge transfers (p.185), and the current tells you how much charge passes per unit time. So both will affect the rate that energy is transferred to an appliance, and the rate at which it transfers energy to other stores.
3) The power of an appliance can be found with:

Electrical power (W) = Current (A) × Potential difference (V)

$$P = IV$$

4) You can use this equation to work out the fuse (p.193) that should be used in an appliance. To work out the size of the fuse needed, you need to work out the current that the item will normally use:

> **EXAMPLE:** A 1 kW hair dryer is connected to a 230 V supply. Find the fuse needed.
>
> 1) Use the equation to find the normal current. $I = P \div V = 1000 \div 230 = 4.3$ A
> 2) A fuse is usually rated just a little higher than the normal current. So a 5 amp fuse is needed.

5) You can also find the power if you don't know the potential difference. To do this, stick $V = IR$ from page 185 into $P = IV$, which gives you:

$$P = I^2R$$

Where P is the electrical power in watts (W), I is current in amperes (A) and R is the resistance in ohms (Ω).

You have the power — now use your potential...

I'm afraid the best way to learn all of this is to just practise using those equations again and again. Sorry.

Q1 Calculate the difference in the amount of energy transferred by a 250 W TV and a 375 W TV when they are both used for two hours. [3 marks]

Power in Circuits

1 A child is playing with a toy car. The car is powered by a battery and has two speed settings — fast and slow. Grade 6-7

a) The child sets the speed to slow and drives the car for 20 seconds. The power of the car at this speed is 50 W. Calculate the energy transferred by the car.

Energy transferred = ... J
[3]

b) The child now sets the speed to fast. The power of the car at this speed is 75 W. Explain why the battery runs down more quickly when the car is set at a higher speed.

....

....
[2]

[Total 5 marks]

2 Fans use a motor to turn a set of blades. Grade 6-7

a) A 75 W ceiling fan in an office is powered by the mains supply at 230 V. Calculate the current supplied to the fan.

Current = ... A
[3]

b) A smaller fan on someone's desk runs from a computer's USB port. It has a power of 2.5 W, and draws a current of 0.50 A. Calculate its resistance.

Resistance = ... Ω
[3]

The ceiling fan from part a) breaks and the company investigate replacing it with a standing fan. They look at three models, A-C, summarised in **Figure 1**.

Figure 1

Model	Power rating / W	Customer reviews
A	50	very noisy
B	40	breaks frequently, a bit small
C	45	quiet and reliable

c) i) Give the model that transfers energy at the fastest rate. ....
[1]

ii) Explain why your answer to part c) i) may not be the most efficient fan for cooling the office.

....

....
[2]

[Total 9 marks]