Worksheet 1.3.2 Comparing rates of energy transfer

1 Comparing cooling >

a) Fill in the gaps in the following sentences:

If hot water is poured into a container the temperature of the water …… until it reaches room temperature. Energy …… in the water is transferred thermally by …… through the container to the air and other surroundings outside the container.

b) The thermal conductivity of a material is a measure of how quickly energy is transferred through it, e.g. expanded polystyrene = 0.1; glass = 1; copper = 390 (units: watts per metre per degree Celsius). The higher the thermal conductivity, the more quickly energy is transferred through the material.

Sketch cooling curves for equal volumes of water at 80 °C in:

i) a copper can

ii) a glass beaker

iii) an expanded polystyrene cup.

(All containers are about the same size, thickness and shape.)

2 Power >>

a) Electrical appliances have power ratings. Define ‘power’.

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b) How many joules of energy are transferred each second to a TV with a power rating of 65 watts?

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c) A consumer magazine produced a review of microwave ovens. It read:

> A microwave's power category is a rating from A to E, which is designed to show you how quickly or slowly your microwave will heat food. One rated E will heat your food more quickly than one rated A. You will find your oven's rating on the front, usually on the door.
>
> E is the most common rating. This means it should cook food at between 741 and 800 watts, but this is not always accurate. You may need to cook your food for longer than recommended to make sure it is piping hot throughout.

i) Why does a microwave with an E rating cook more quickly than one with an A rating?

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ii) Most microwave ovens have settings such as 'defrosting', 'warming', 'medium' and 'high'. What do you think changes when you select one of these settings?

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iii) Briefly outline a method to determine the accuracy of power ratings for microwave ovens.

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3 How much and how long? >>>

a) It takes 4.2 J to raise the temperature of 1 ml of water by 1 °C. What quantity of energy must be transferred to heat 300 ml of water from 20 °C to its boiling point?

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b) How long should it take a 2000 watt kettle to heat 300 ml of water from 20 °C to boiling? Explain why it is likely to take a little longer than the calculated time.

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c) Many electronic devices, such as TVs and computers, have a 'standby' option. Read the information on page 3 of this worksheet.

Summarise briefly the benefits and disadvantages of using standby modes on electronic devices.

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Domestic standby consumption of electricity is higher than previously estimated. On average, in the study, households spent £50–£86 a year on their appliances in standby state. This compares with an average annual electricity bill of £530. Total standby consumption can potentially be 16 per cent of domestic power demand. This is significantly higher than the 5 to 10 per cent previously estimated/modelled.

Standby power consumption, mainly associated with electronic devices including computers, has been observed in a much wider range of products than is generally acknowledged. 'Standby mode' is the mode in which an appliance is neither switched off, nor is in full-on mode. Depending on the device, this might include 'idle', 'energy saving', 'doze', 'standby', 'delay start' or 'suspended' modes.

The proportion of time that TVs were on standby depended, to a large extent, upon the technology type. CRT TVs were on standby for 11 per cent of the time, LCD TVs 8.7 per cent, and plasma screens just 0.4 per cent. The number of hours spent watching TV varied by technology type, too, but not so markedly. CRT TVs were in 'on mode' for 17.4 per cent of the time, LCD TVs 22.9 per cent and plasma screens 23.3 per cent. Average TV watching was observed to be six hours a day.

The table gives the average annual costs for the power consumption of different types of TV in the home.

TV technology	**Annual consumption (kWh)**	**Annual running cost (£)**
CRT – traditional	118	17
LCD – flat screen	199	29
Plasma – flat screen	658	95

Other consumer electronic devices play a lesser role, in terms of power use in the home. Examples of these gadgets: CD players, DVD recorders, Wii, X-Boxes, other games consoles, HiFi, radios, set-top boxes and VCR.

[The information above is from *Powering the nation – household electricity-using habits revealed*, a report by the Energy Saving Trust, the Department of Energy and Climate Change (DECC), and the Department for Environment, Food and Rural Affairs (Defra), published 26 June 2012.]

On its website, the Energy Saving Trust gives this advice:

Recent regulations specify that all electronic products sold within the EU after 2010 cannot have a standby power greater than 1 W, which means we won't have to worry as much in future about the standby consumption of our products. However, whilst the average standby consumption of new products is going down, households are being filled with more and more electronic gadgets, so it is still worth looking at your standby energy usage throughout your home.