

Energy needed to heat a substance (in joules) = specific heat capacity (in J/kg°C) × mass (in kg) × change in temperature (in °C)

The specific heat capacity of water is 4200 J/kg°C.

Example

A 2 kW (2000 W) electric kettle is switched on for 10 seconds.

- a) How much energy is transferred?
- b) If all this energy is given to 0.5 kg of water, what is the rise in temperature?

Answer

a) 2000 W = 2000 J/s = 2000 joules in each second
∴ Energy supplied = 2000 J/s × 10 s = 20 000 J

b) Energy needed = specific heat capacity × mass × change in temperature
20 000 = 4200 × 0.5 × rise in temperature
∴ rise in temperature = 9.5°C

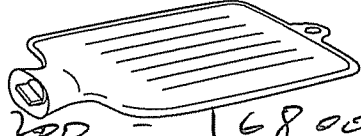
Questions

For each question show all your working clearly.

- 1. How much energy is needed to raise the temperature of 2 kg of copper by 10°C? (specific heat capacity of copper = 380 J/kg°C)

$$2 \times 10 \times 380 = 7600 \text{ J.}$$

- 2. A hot-water bottle is filled with 0.8 kg of water at 80°C. During the night it cools to 30°C. How much energy has it given out?

$$0.8 \times 50 \times 4200 = 168000 \text{ J.}$$


- 3. How much energy is needed to heat 2 kg of cooking oil in a chip-pan from 20°C to 120°C? (specific heat capacity of oil = 2000 J/kg°C)

$$2 \times 100 \times 2000 = 400,000 \text{ J.}$$

- 4. Andy has a bath and uses 100 kg of water, heated from 10°C to 40°C. How much energy does he use?
Becky has a shower and uses 20 kg of water heated from 10°C to 50°C. How much energy does she use?

$$100 \times 30 \times 4200 = 1,260,000 \text{ J}$$

$$20 \times 40 \times 4200 = 3,360,000 \text{ J}$$

- 5. A 3 kW electric immersion heater is switched on for 1000 s. It transfers the energy to 200 kg of water.

- a) How much energy is transferred?
- b) What is the rise in temperature of the water?

$$3000 \times 1000 = 3000000 \text{ J.}$$

$$\frac{3000000}{200 \times 4200} = 4^\circ\text{C.}$$

- 6. A 2 kW kettle contains 2 kg of water at 10°C. It is switched on for 420 seconds, and the temperature rises to 100°C.

- a) How much electrical energy is supplied?
- b) How much energy was given to the water?
- c) Why are these 2 answers not the same?
- d) What percentage of the energy supplied went to the water?
- e) How could this percentage (the efficiency) be increased?

$$2000 \times 420 = 840,000 \text{ J.}$$

~~2000000~~

$$2 \times 40 \times 4200 = 756000 \text{ J.}$$

heat lost

$$\frac{756}{840} = 90\%$$

114 840

insulation?

