7. SPECIFIC HEAT CAPACITY

1. Specific Heat Capacity (c)

Specific heat capacity is a measure of the heat energy needed to raise the temperature of a unit mass by one degrees Celsius (see data book).

Eg. **c = 4180J/kg^{0}C. for water** → this means that every kg of water requires 4180J of energy to increase in temperature by 1°C.

$$E_h = cm\Delta T$$

Symbol	Name	Unit	Unit Symbol
E_h	Energy	joules	J
c	Specific Heat Capacity	joules per kilogram degree Celsius	J/kg^{o}C
m	mass	kilograms	kg
ΔT	Change in Temperature	degrees Celsius	^{o}C

1. 2 kg of water is placed in a fridge to cool it to 5 ^{0}C. When it was placed in the fridge it was 25 ^{0}C. How much heat energy is removed from the water?

$$E_h = cm\Delta T$$
$$E_h = 4180 \times 2 \times (25 - 5)$$
$$E_h = 167200\text{J}$$
$$E_h = 1.67 \times 10^5 J$$

2. A 16 kg sample of metal requires 35.2 kJ to increase its temperature by 5 ^{0}C. What type of metal is it?

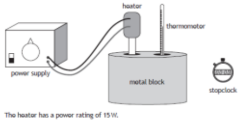
$$E_h = cm\Delta T$$
$$35.2 \times 10^3 = c \times 16 \times 5$$
$$c = 440\text{J}/kg°C$$

The metal is iron

2. Experiment

Describe how the experiment below could be used to find the specific heat capacity of a material. Suggest improvements to your experiment.

- The initial temperature of the block is measured on the thermometer.
- The heater is switched on from the power supply for 10 minutes.
- The final temperature is recorded from the thermometer.
- Using P=E/t calculate the energy provided by the heater to the block.
- Then use E_h=cmΔT, to calculate c.



*Remember to convert 10mins → seconds

*ΔT = final T – initial T

Improvements – insulating the metal block reducing heat loss to the surroundings (increasing final T) **OR** Switch heater on for shorter time (decreasing final T)

N5 Past Papers HW

2014 – Section 2 Q3
2016 – Section 2 Q3a,b
2017 – MC Q5

3. Heat and Temperature

✓ Heat is measured in joules and is a form of energy related to vibrations or total kinetic energy of particles in a substance.

✓ Temperature is measured in Kelvin or degrees Celsius and is an indication of how hot or cold a substance is. So temperature is a measure of the average/mean kinetic energy.

https://www.bbc.com/bitesize/guides/zwrxsbk/video
Scan QR code using your camera

4. Conservation of Energy Examples on next page

1. 1.5 kg of oil at 25 ^{0}C is mixed with 3.0 kg of oil at 55 ^{0}C. Assuming no heat energy is lost to the surroundings, what is the final temperature of all the oil?

Using conservation of energy the increase in heat energy of the colder oil must be the same as the decrease in heat energy of the warm oil.

$$\Delta E_1 = \Delta E_2$$
$$cm_1\Delta T_1 = cm_2\Delta T_2$$
$$m_1\Delta T_1 = m_2\Delta T_2$$
$$1.5 \times \Delta T_1 = 3 \times \Delta T_2$$
$$\Delta T_1 = 2 \times \Delta T_2$$

Therefore

$$25 + 2\Delta T_2 = 55 - \Delta T_2$$
$$3\Delta T_2 = 30$$
$$\Delta T_2 = 10\ ^oC$$

So the final temperature is 55 – 10 = 45ºC

The law of conservation of energy can be used with any type of energy, so it also allows us to investigate electrical appliances.

2. A kettle works on the UK mains (230 V) and a current of 12 A flows when it is switched on.

a) What is the power rating of the kettle?

b) How much energy would the kettle transform if it was switched on for 2 minutes?

c) What is the maximum mass of 20 ^{0}C water which could be heated to 99 ^{0}C in this time?

d) What assumptions did you make in part c?

a.

$V = 230$ V
$I = 12$ A
$P = ?$

$$P = IV$$
$$P = 12 \times 230$$
$$P = 2760\ W$$

b.

$P = 2760$ W
$t = 2 \times 60 = 120$ s
$E = ?$

$$P = E/t$$
$$2760 = E/120$$
$$E = 120 \times 2760$$
$$E = 331200\ J$$
$$E = 331\ kJ$$

c.

$m = ?$
$T_1 = 20\ ^oC$
$T_2 = 99\ ^oC$
$\Delta T = T_2 - T_1 = 79\ ^oC$
$c = 4180$ J/kg^{o}C
$E_h = 331$ kJ $= 331 \times 10^3$ J

$$E_h = cm\Delta T$$
$$331 \times 10^3 = 4180 \times m \times 79$$
$$m = 331 \times 10^3/330220$$
$$m = 1.002$$
$$m = 1\ kg$$

d. Assuming all energy supplied to kettle heats the water, none is lost to the surroundings.