REQUIRED PRACTICAL 1
SPECIFIC HEAT CAPACITY

Learning Objectives -

- Heat up blocks of different metals using an electric heater
- Measure the mass and temperature of the block
- Calculate the work done by the heater
- Plot a graph of temperature change against work done and use the gradient to calculate specific heat capacity of the metal.

Links the decrease of the metal energy store (work done) to the increase in temperature and subsequent thermal energy stored.

Equipment & Apparatus

Method:

1) Measure the mass of the copper block in kg.

2) Wrap the insulation around the block.

3) Place the immersion heater into the larger hole of the block.

4) Connect ammeter, power pack and heater in series.

5) Connect the voltmeter across the heater.

6) Use the pipette to put a small amount of water in the other hole.

7) Put the thermometer in the same hole.

8) Set the power back to 12V. Switch it on. — This will turn on the heater

9) Record the ammeter and voltmeter readings.

10) Take the starting temperature reading and start the stopwatch. — These shouldn't change

11) Record the temperature every minute for 10 minutes.

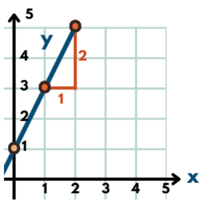
12) Calculate the power of the heater in watts.
   - Power (watts) = potential difference (V) x current (I)

13) Calculate energy transferred (work done, J) by the heater.
   - Work done (joules, J) = Time (seconds, S) x Power (watts, W)

14) Plot a graph of temperature (°C) against work done (J).

15) Draw a line of best fit. — The beginning of the graph may be curved

16) Calculate the gradient of the straight part of the graph.
   - Gradient = $\frac{\text{change in temperature rise (°C)}}{\text{work done (J)}}$ = $\frac{\text{change in y}}{\text{change in x}}$



17) Calculate the heat capacity of the copper block.
   - Heat capacity = 1 / gradient — The amount of heat energy (J) needed to increase the temperature by 1°C

18) Calculate the specific heat capacity of the copper block.
   - The amount of heat energy (J) needed to increase the temperature of 1kg copper by 1°C
   - Specific heat capacity = $\frac{\text{Energy transferred (J)}}{\text{mass (kg) x temperature change (°C)}}$

19) Repeat steps 1-18 with aluminium and iron blocks.

Type of metal block	Specific heat capacity (J/Kg/°C)
Copper	385
Aluminium	913
Iron	500

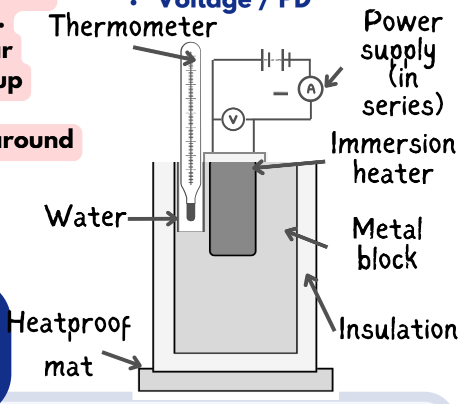
Safety:

- Do not touch the block or heater when hot - if burnt, run area under cold water for at least five minutes.
- Keep the block on the heatproof mat and allow time for equipment to cool before deconstructing.
- Avoid water spills near power supply - clean up spills.
- Wear eye protection around hot water

Independent variable
- Time

Dependent variable
- Change in temperature

Control variables:
- Block materials
- Current
- Voltage / PD



Conclusion

From AQA:"'William thinks that denser materials have higher specific heat capacities. Using the density values of the metals below and the values of specific heat capacity that you have calculated, do you agree with him?'

Type of metal block	Density (g/cm^3)
Copper	8.96
Aluminium	2.70
Iron	7.87

Example: No - copper has the highest density of 8.96g/cm³ but the lowest specific heat capacity of 385J/Kg/°C. Also, aluminium has the lowest density of 2.70g/cm³ but the lowest specific heat capacity of 913 J/Kg/°C. So, this hypothesis would be rejected as results suggest the less dense materials have a higher specific heat capacities.

Evaluation

Random errors
- Some heat will dissipate into the surroundings
  - Insulation minimises loss,
  - Actual specific heat capacity is likely higher
- Errors in measurements from ammeter, voltmeter and stopwatch
  - Use a joulemeter to calculate energy directly
- Human error of temperature reading

Systematic errors
- Zero error - could occur if the ammeter and voltmeter are not initially set to zero.

Exam Style Questions - Specific Heat Capacity

1. What is the independent variable in this experiment? (1 mark)

2. State two control variables in this experiment. (2 marks)

3. Why is the block wrapped in insulation? (1 mark)

4. What measurements are needed to calculate power? (2 marks)

5. Describe how to calculate the energy transferred by the heater. (2 marks)

6. A student records a voltage of 12 V, a current of 2.0 A, and heats for 600 seconds. Calculate the energy transferred. (2 marks)

7. A graph is plotted with temperature (˚C) on the y-axis and energy transferred (J) on the x-axis. What is the gradient of the straight-line section used for? (1 mark)

8. Give one source of random error in this experiment and how it can be reduced. (2 marks)

9. A student wants to compare the specific heat capacity of copper and aluminium using the same method. Describe the method they would use and explain how they would ensure the comparison is valid. Include how they would use the results to calculate the specific heat capacity. (6 marks)

Exam Style Questions - Specific Heat Capacity

1. What is the independent variable in this experiment? (1 mark)

Mark One - The type of metal used

2. State two control variables in this experiment. (2 marks)

Mark One - Starting temperature
Mark Two - Voltage or current / mass of the block

3. Why is the block wrapped in insulation? (1 mark)

Mark One - To reduce heat loss to the surroundings

4. What measurements are needed to calculate power? (2 marks)

Mark One - Current
Mark Two - Potential difference (voltage)

5. Describe how to calculate the energy transferred by the heater. (2 marks)

Mark One - Use the equation: Energy transferred = Power × time
Mark Two - Power = Voltage × current

6. A student records a voltage of 12 V, a current of 2.0 A, and heats for 600 seconds. Calculate the energy transferred. (2 marks)

Mark One - Power = 12 × 2 = 24 W
Mark Two - Energy = 24 × 600 = 14,400 J

7. A graph is plotted with temperature (˚C) on the y-axis and energy transferred (J) on the x-axis. What is the gradient of the straight-line section used for? (1 mark)

Mark One - To calculate the specific heat capacity

8. Give one source of random error in this experiment and how it can be reduced. (2 marks)

Mark One - Heat lost to the surroundings
Mark Two - Use better insulation or a lid on the block

9. A student wants to compare the specific heat capacity of copper and aluminium using the same method. Describe the method they would use and explain how they would ensure the comparison is valid. Include how they would use the results to calculate the specific heat capacity. (6 marks)

Level 3 (5–6 marks)
- Describes a full valid method including: measuring mass, wrapping in insulation, inserting heater and thermometer, recording voltage and current, and logging temperature over time
- Explains how to calculate energy transferred and plot a graph
- Compares results fairly by controlling variables (same power/time/starting temp etc.)

Level 2 (3–4 marks)
- Describes a mostly complete method
- Includes how to calculate energy or how to use a graph
- Some mention of fair testing, may miss detail

Level 1 (1–2 marks)
- Describes basic idea (e.g. heat metal and measure temperature)
- Limited or no explanation of calculations or fair testing

0 marks
- No relevant content