Edexcel Physics IGCSE

Chapter 5: Solids, Liquids and Gases

Practical Notes

Investigate Density Using Direct Measurements of Mass and Volume

Equipment

- Balance
- Ruler
- Regular solid (e.g. a cube)
- Irregular solid (e.g. an oddly-shaped stone)
- Measuring cylinder

Method

1. Use the balance to determine the mass of the regular and irregular solids.
    - Ensure the balance is zeroed before placing the solids on top.
    - If the mass is displayed in grams, divide it by 1000 to get the mass in kilograms.
2. Use the balance again to determine the mass of the liquid.
    - Place the **empty** measuring cylinder on the balance and zero it.
    - Fill the cylinder with water and take the reading (this can be any volume of liquid but ensure that whatever volume you use is recorded).
3. Use a ruler to measure the height, width and depth of the cube and multiply them to obtain the volume of the cube.
    - For another shape, take the appropriate measurements to calculate its volume (i.e. radius and height of a cylinder for $\pi r^2 h$).
    - Ensure all measurements are in metres.
4. Start with a known volume of water in the measuring cylinder and place the stone (or other irregular solid) into the water and measure the new volume.
    - Ensure no water splashes out of the cylinder, the amount of liquid inside must remain constant.
    - The **change in volume** of the water is equal to the volume of the solid.
    - Convert from ml to m^3 by dividing by a million (1,000,000).
5. Use the formula $density = \frac{mass}{volume}$ to calculate the densities of the solids and the liquid.
    - Mass must be in kg and volume must be in m^3.

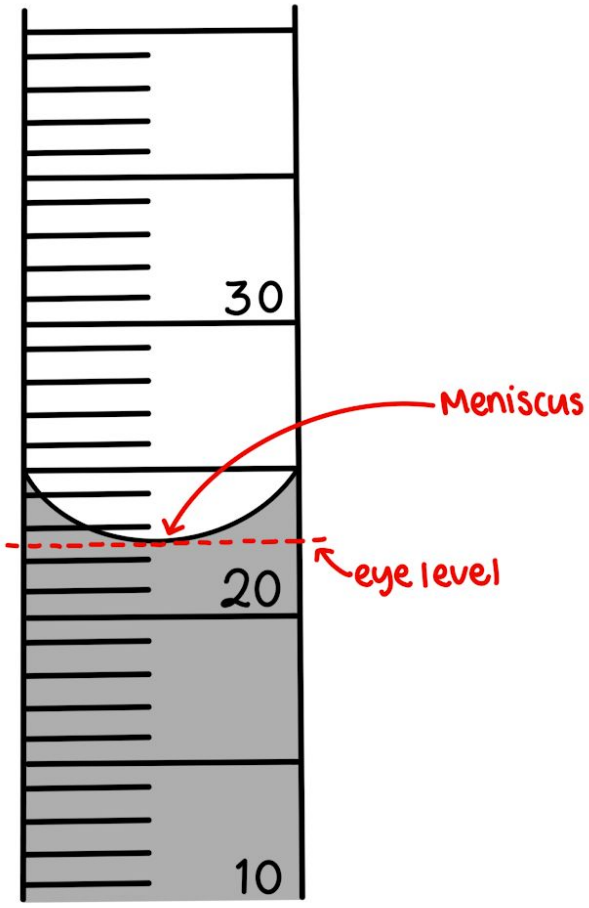
Tips

- Take all measurements for the liquid from the **meniscus**.
    - Water sits higher at the edges of a container compared to the centre. The meniscus is the **lowest point** of the water (the centre).
- When using a measuring cylinder, ensure the cylinder is on a level surface and take readings from eye-level to avoid parallax error.
- For solids that float, you can either push the solid down into the water until it is just fully submerged, or you can weigh it down with something of a known volume and subtract that value from the change in volume (this way is more accurate).

Safety Precautions

- Take care when pouring the water into the measuring cylinder to ensure that none of the water gets onto the electronic balance. Water can break the balance or cause a fire if it comes into contact with any of the wires.

Diagram



Obtain a Temperature-Time Graph to Show the Constant Temperature During a Change of State (Physics only)

Equipment

- Crushed ice
- Boiling tube
- Thermometer
- Bunsen burner
- Tripod
- Gauze
- Beaker
- Kettle
- Stopwatch

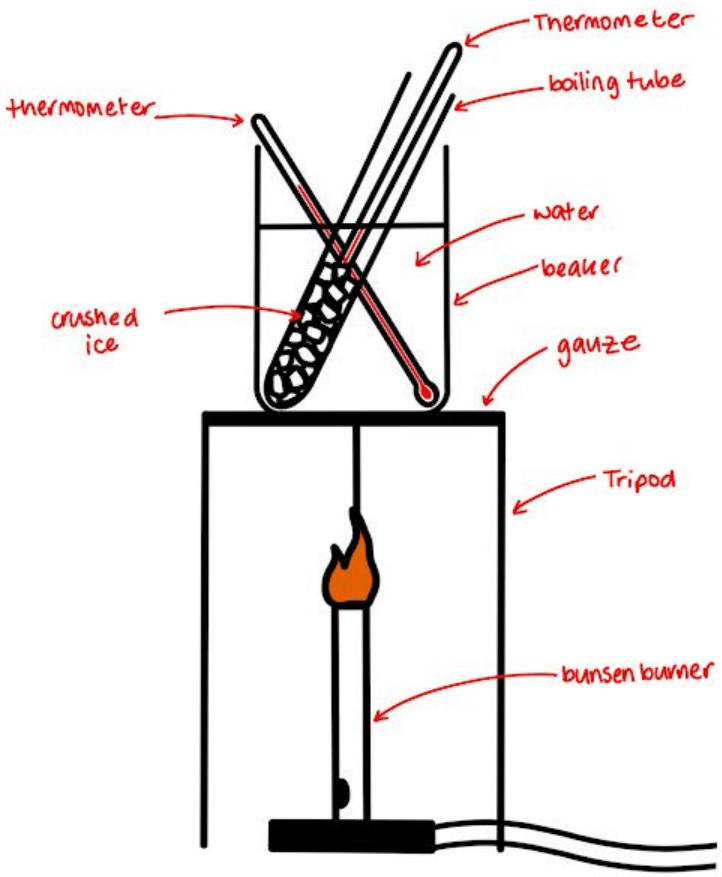
Method

1. Fill the beaker with boiling water and keep it warm using the Bunsen burner as shown in the diagram.
    - The water should remain at a constant temperature – you can ensure this by using a second thermometer in the water bath.
2. Fill a boiling tube with crushed ice and take the initial temperature.
3. Place the boiling tube in the beaker and start the stopwatch.
4. Record the temperature of the ice every 30 seconds until all of the ice has melted.
    - Continue taking readings until three minutes after all of the ice has visibly melted.
    - Take note of the state of the ice (solid or liquid) for every recorded temperature.
5. Plot a graph of temperature against time for the results. The graph should show a plateau when the ice is melting.
    - The energy is going towards breaking the bonds between the water atoms rather than increasing the temperature.

Safety Precautions

- Take care when pouring boiling water from the kettle into the beaker, and do not touch the beaker when it is full of hot water as it may cause burns.
- Ensure hair is tied back and no loose clothing is hanging near the flame when working with the Bunsen burner.
    - Blazers, lanyards and ties should be removed.
- Ensure the safety (orange) flame is on when you are not heating anything with the Bunsen burner, and do not leave the flame lit for longer than necessary so as to reduce the risk of causing a fire.
- Gas taps must be off when not connected to a lit Bunsen burner.

Diagram


Thermometer
boiling tube
thermometer
water
beaker
crushed ice
gauze
Tripod
bunsen burner

Investigate the Specific Heat Capacity of Materials (Physics Only)

Solid:

Equipment

- 1kg block of copper, iron, or aluminium, each with two holes (one for the thermometer and one for the heater)
- Thermometer
- Pipette
- 30 W heater
- 12 V power supply
- Insulation (lagging) to wrap the blocks
- Ammeter and voltmeter
- 4 mm leads
- Stopwatch
- Balance
- Heatproof mat

Method

1. Use the balance to determine the mass of the block (in case it is not exactly 1kg).
2. Use the pipette to add a drop of water to the thermometer hole to improve thermal contact, then measure the initial temperature of the block.
3. Switch on the power supply and determine the power of the heater (if not already known).
    - This can be done by using the ammeter and voltmeter to obtain values for the current and potential difference and using the formula $P = IV$.
4. Ensuring the block is insulated to reduce heat loss, heat the block for 10 minutes, recording the temperature every minute.
5. Plot a graph of temperature against the work done by the heater.
    - Find work done using the formula work done (J) = power (W) x time (s).
6. Take the gradient of the line of best fit and divide it by the mass of the block to find the specific heat capacity.

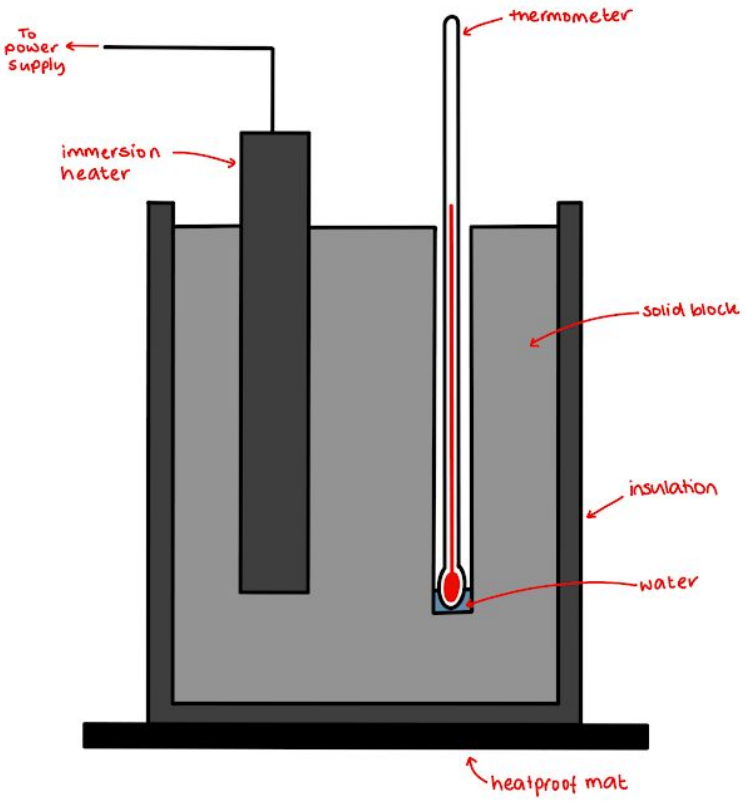
Tips

- There is some thermal inertia as the block begins to warm up, so to ensure that your graph gives a straight line, it is best to start after the block is already slightly warm (the initial temperature of the block should still be the temperature right before you start the stopwatch).

Safety Precautions

- Avoid touching the heater when it is on as it may cause a burn.
- Do not handle the block during or after heating.

Diagram


To power supply
thermometer
immersion heater
solid block
insulation
water
heatproof mat

Liquid (water):

Equipment

- Beaker
- Thermometer
- Stopwatch
- Joulemeter
- Immersion heater
- Cladding to insulate the beaker (e.g. foam)
- Balance
- Power pack

Method

1. Place the empty beaker on the balance and zero it.
2. Fill the beaker with water and record its mass.
3. Place the thermometer and the immersion heater in the water and then insulate the beaker with the cladding (ensure the top is also covered with a lid).
    - The immersion heater should also be connected to a joulemeter to measure the energy transferred during heating.
4. Record the initial temperature of the water and turn on the immersion heater.
5. Let the heater heat the water for an hour, or until there is a significant change in temperature, and then take the final temperature, as well as recording the value on the joulemeter.
    - The water should be continually stirred so that the heat is evenly distributed (this can be done using an electric stirrer).
6. Rearranging the formula $Q = mc\Delta T$ to $c = \frac{Q}{m\Delta T}$, you can input the values for mass, change in temperature, and energy transferred to obtain the specific heat capacity of water.

Diagram