

Mandatory Experiments
(Electricity)

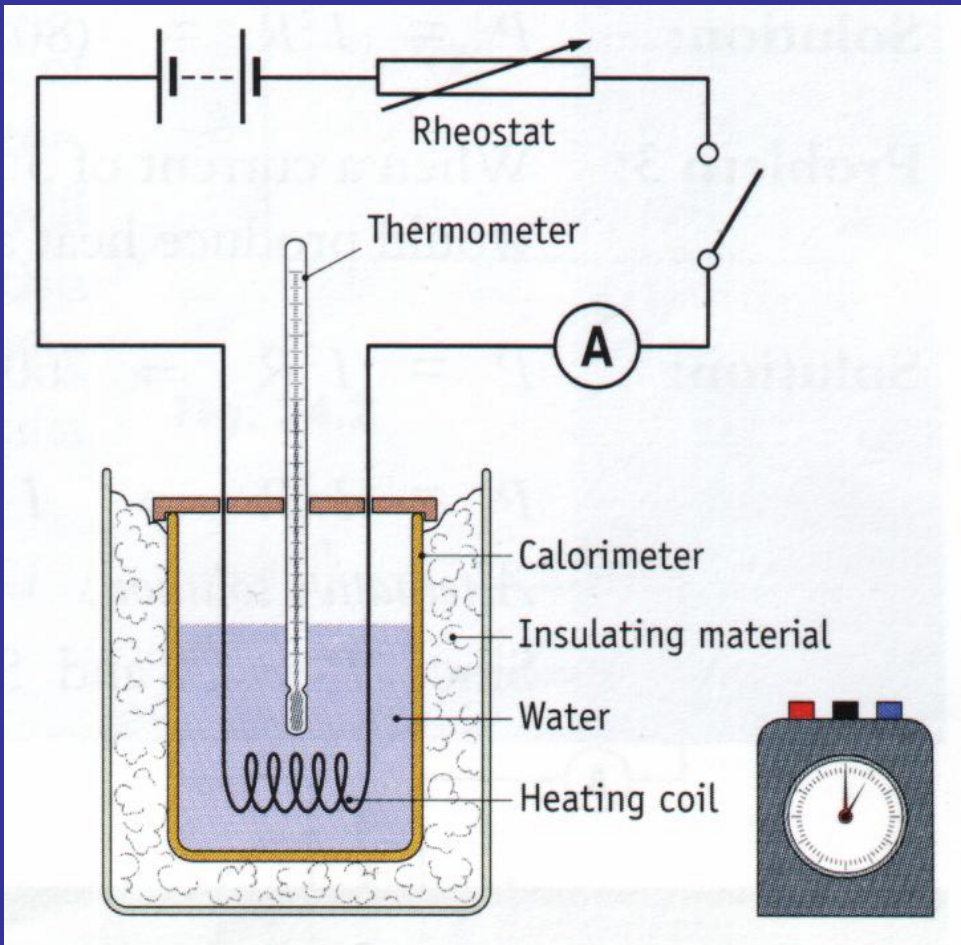
- Electricity 1** **Verify Joule's Law**
- Electricity 2** **Measure Resistivity**
- Electricity 3** **Variation of Resistance with Temperature for a Metal**
- Electricity 4** **Variation of Resistance with Temperature for a Thermistor**
- Electricity 5A** **Variation of Current with PD for a Metal**
- Electricity 5B** **Variation of Current with PD for a Filament Bulb**
- Electricity 5C** **Variation of Current with PD for Copper Sulphate**
- Electricity 5D** **Variation of Current with PD for a Diode**

Electricity 1

Verify Joule's Law

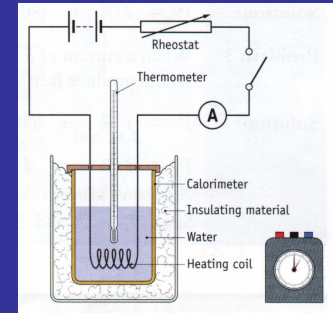
To Verify Joule's Law

Apparatus



- **Calorimeter + water + lagging + stirrer**
- **Heating coil**
- **Thermometer**
- **Battery + ammeter + rheostat + switch**
- **Stopwatch**

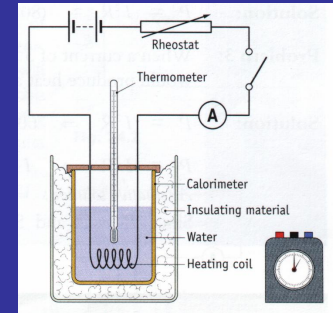
Joule's Law



Procedure

- Switch on ... constant current for 10 mins. ... temp. rises
- Measure (2) ...
- How are these measured?
- Repeat ... other ... Why repeat?

Joule's Law

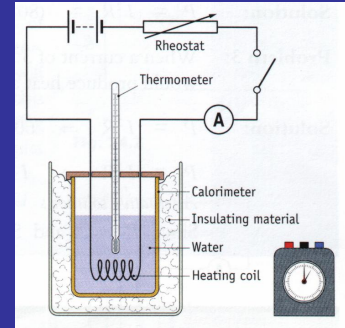


Procedure

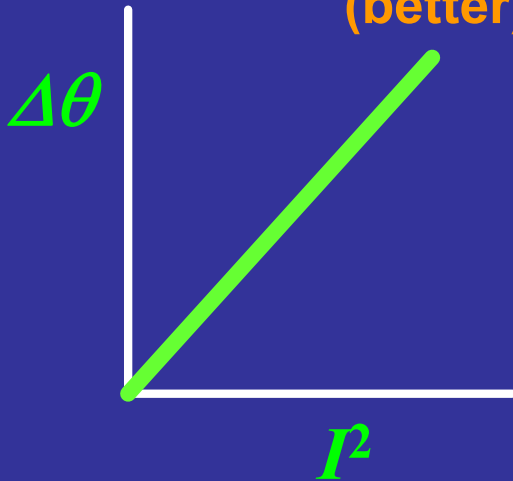
- Switch on ... constant current for 10 mins. ... temp. rises
- Measure (2) ... I (current) & $\Delta\theta$ (rise in temp.)
- I from ammeter
- $\Delta\theta =$ (final temp. – initial temp.) of water ... (thermometer)
- Repeat ... other currents (with same mass and time for each run) ...
- Why repeat? ... to graph

Joule's Law

Results



Method 1
(better)



“SLTO”

$$\Rightarrow \Delta\theta \propto I^2$$

$$\Rightarrow P \propto I^2$$

Method 2

$$\Delta\theta \div I^2 = \text{a constant}$$

$$\Rightarrow \Delta\theta \propto I^2$$

$$\Rightarrow P \propto I^2$$

Joule's Law

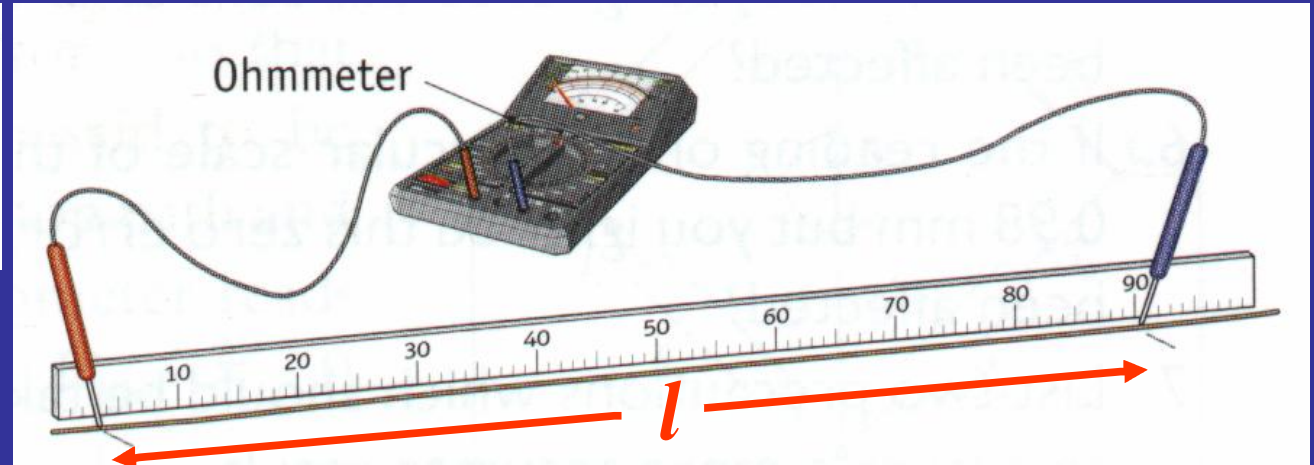
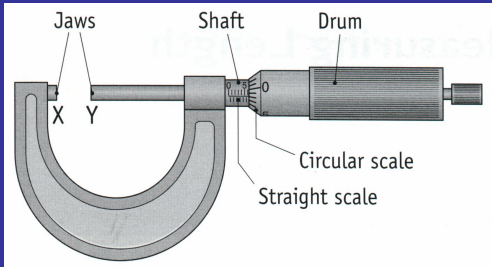
Precautions / Questions

1. Give three precautions taken to ensure an accurate result.
2. Name two things that are kept constant for each run.
3. Give three ways of reducing heat losses.
4. Use a more thermometer, one that reads to of a degree.
5. What is the function of the rheostat? (2)
6. Why should the water be stirred? When especially should the water be stirred?
7. Each run was 5 minutes. What would be the disadvantage of having, (i) 2 minute runs, (ii) 15 minutes runs?
8. Why must the same time be used for each run?
9. Why must the same mass of water be used for each run?
10. How is the resistance of the heating coil calculated from the graph?
(Assume all the heat from the heating coil is given to the water and none is given to the calorimeter.)
11. In what part of the water should the heating coil be placed?

Measure Resistivity

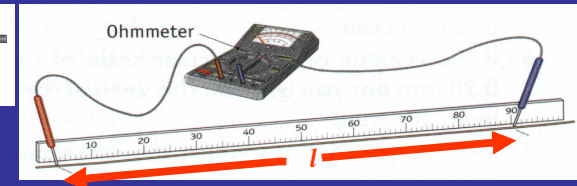
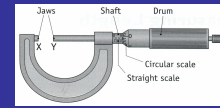
To Measure the Resistivity of a Wire

Apparatus



- **Wire**
- **Metre Stick**
- **Ohmmeter**
- **Micrometer Screw Gauge**

Resistivity



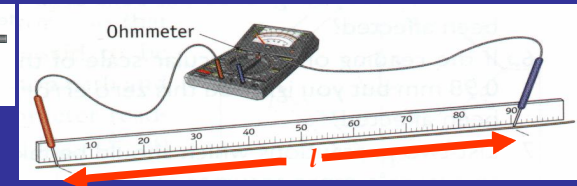
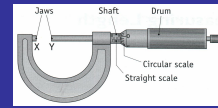
Procedure

- **Measure R**
- **How is R measured?**
- **Give 2 precautions ...**

- **Measure l**
- **How is l measured?**
- **Give 2 precautions ...**

- **Measure d**
- **How is d measured?**
- **Give 2 precautions ...**

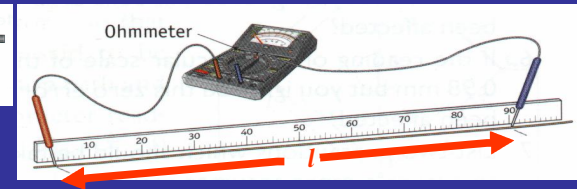
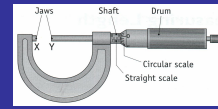
Resistivity



Procedure

- **Measure R**
- **How is R measured? ... ohmmeter**
- **Give 2 precautions**
... (suitable range, allow for resistance of leads, zero beforehand, etc.)
- **Measure l**
- **How is l measured? ... metre stick (“inside clips”)**
- **Give 2 precautions**
... (inside faces of clips, no kinks, straighten wire, etc.)
- **Measure d**
- **How is d measured? ... micrometer (wire in jaws, read both scales)**
- **Give 2 precautions**
... (zero error, slip-screw, average d , etc.)

Resistivity



Results

$$\rho = \frac{RA}{l}$$

where ...

$$A = \pi r^2$$

$$r = \frac{d}{2}$$

or

$$\rho = \frac{R\pi d^2}{4l}$$

Precautions / Questions

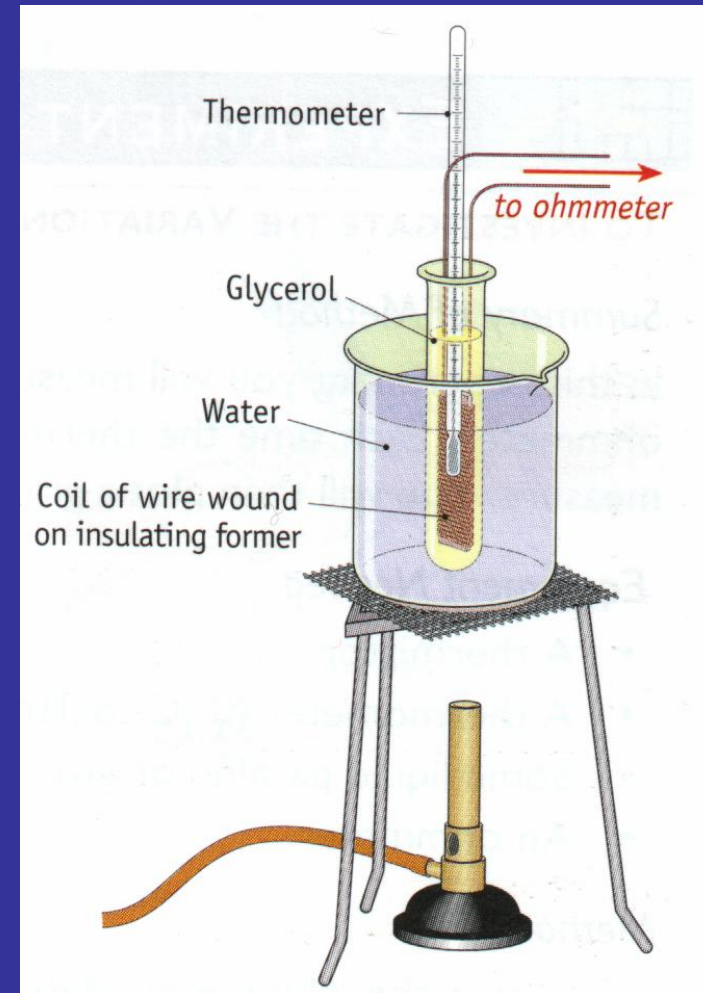
1. Give two precautions taken when measuring the length.
2. Give two precautions taken when measuring resistance.
3. Give two precautions taken when measuring the diameter.
4. When measuring length, why should the wire be, (i) taut, (ii) free of kinks?
5. Why is it better to use a longer length of wire? (2)
6. Between what parts of the wire is the length measured?
7. When measuring resistance, (i) use a suitable on the ohmmeter, (ii) allow for the resistance of the if using a digital ohmmeter, (iii) the meter if using a moving-coil ohmmeter.
8. When using the screw gauge to measure diameter, (i) the wire is placed, (ii) allowance is made for error, and (iii) correct tightness on the wire is achieved using the
9. Why is the diameter of the wire measured in several places? (2)
10. Why should the temperature of the wire be constant?
11. Avoid error when using the metre stick.

**Variation of Resistance
of a Metal
with Temperature**

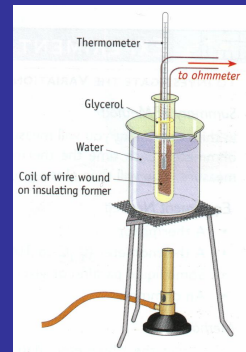
Variation of Resistance of a Metal with Temperature

Apparatus

- **Coil of wire**
- **in test-tube of glycerol**
- **in beaker of water**
- **Thermometer in the glycerol**
- **Ohmmeter attached to coil of wire**
- **Bunsen**



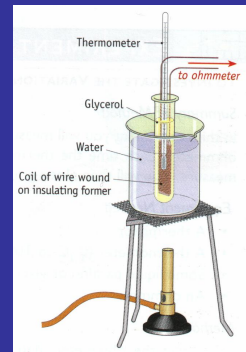
Metal: Resistance vs. Temperature



Procedure

- Heat slowly from 0 °C to 100 °C ... take readings
- Measure (2) ...
- How are these measured?
- Repeat ...other ... **Why repeat?**

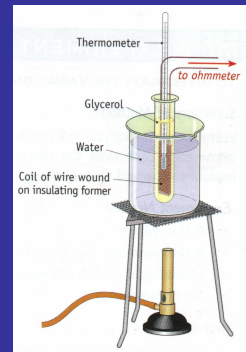
Metal: Resistance vs. Temperature



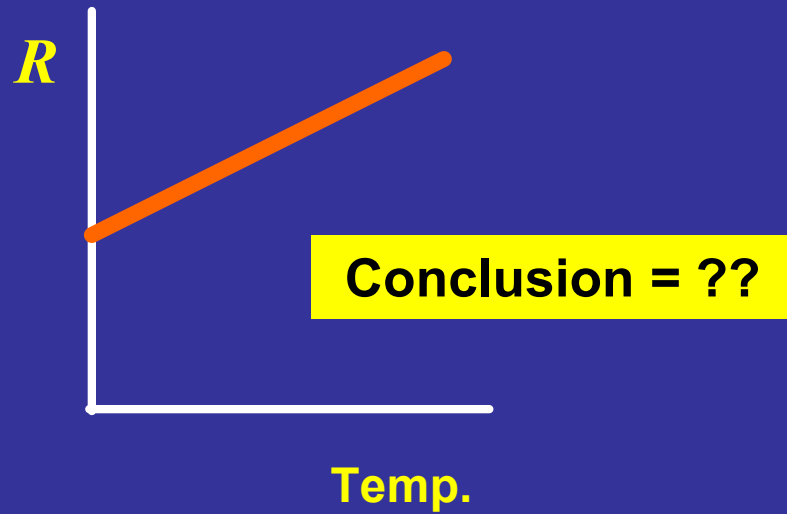
Procedure

- Heat slowly from 0 °C to 100 °C ... take readings
- Measure (2) ... **R & temp.**
- **R ... from ohmmeter**
Temp. ... from thermometer
- Repeat ... other temps. ...
Why repeat? ... to graph

Metal: Resistance vs. Temperature



Results



Precautions / Questions

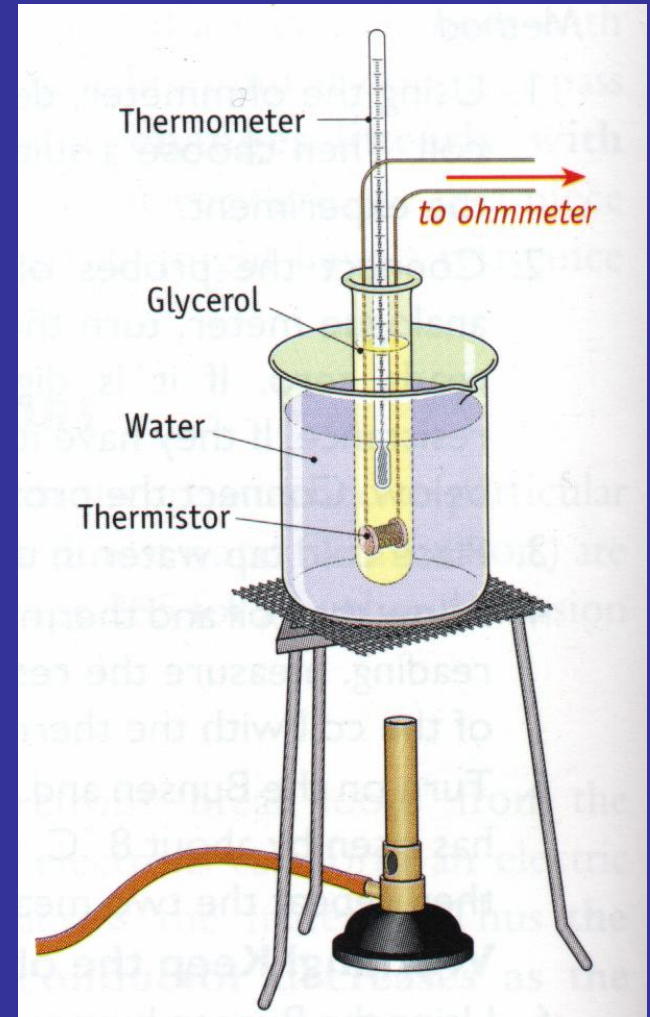
1. Give three precautions taken to ensure an accurate result.
2. Why is the liquid heated slowly?
3. Why is the liquid stirred?
4. Why is glycerol used, and not water?
5. Give one precaution taken in using the ohmmeter.
6. You should use a thermometer.
7. Why use a long length of wire in the coil?
8. Take readings while heating and while cooling the liquid. Use average R value.
9. Why should the probes of the ohmmeter be connected firmly to the coil?
10. How would you use the graph to measure the temperature of hot water?

**Variation of Resistance
of a Thermistor
with Temperature**

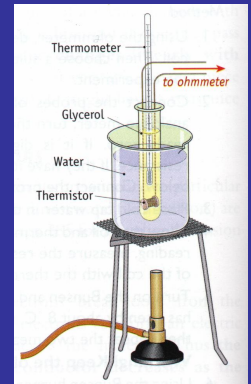
Variation of Resistance of a Thermistor with Temperature

Apparatus

- **Thermistor**
- **in test-tube of glycerol**
- **in beaker of water**
- **Thermometer in the glycerol**
- **Ohmmeter attached to thermistor**
- **Bunsen**



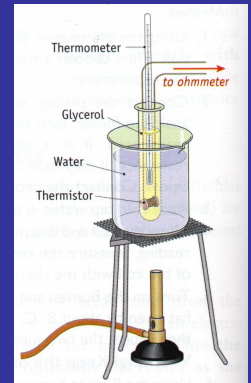
Thermistor: Resistance vs. Temperature



Procedure

- Heat slowly from 0 °C to 100 °C ... take readings
- Measure (2) ...
- How are these measured?
- Repeat ...other ... Why repeat?

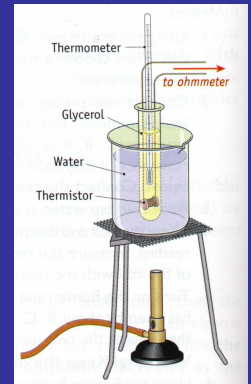
Thermistor: Resistance vs. Temperature



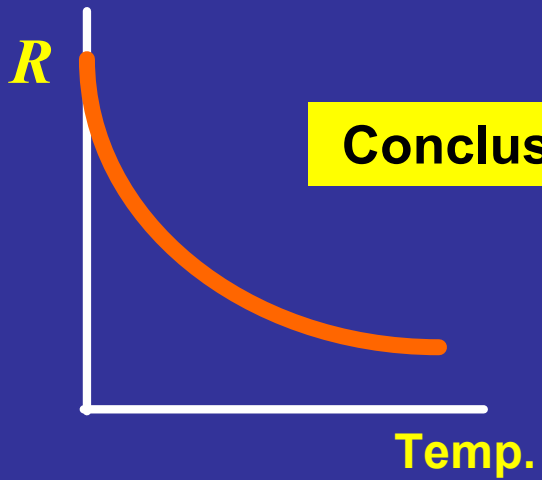
Procedure

- Heat slowly from 0 °C to 100 °C ... take readings
 - Measure (2) ... **R & temp.**
 - **R ... from ohmmeter**
Temp. ... from thermometer
 - Repeat ... other temps. ...
- Why repeat? ... to graph**

Thermistor: Resistance vs. Temperature



Results



Conclusion = ??

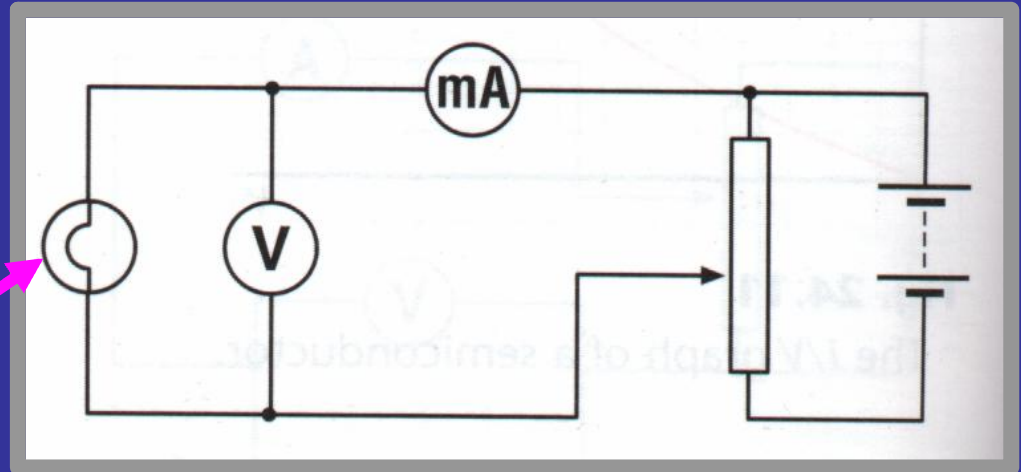
Precautions / Questions

1. Give three precautions taken to ensure an accurate result.
2. Why is the liquid heated slowly?
3. Why is the liquid stirred?
4. Why is glycerol used, and not water?
5. Give one precaution taken in using the ohmmeter.
6. You should use a thermometer.
7. Take readings while heating and while cooling the liquid. Use average R value.
8. How would you use the graph to measure the temperature of hot water?

Variation of Current with P.D. for
(i) a Metallic Conductor
(ii) a Filament Bulb

Variation of I with V for (i) a Metallic Conductor
(ii) a Filament Bulb

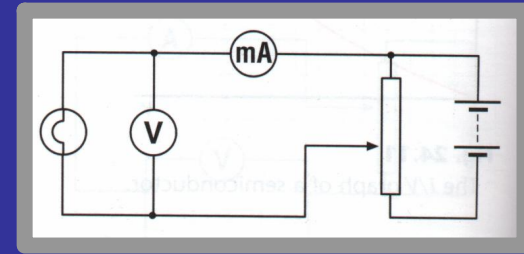
Apparatus



or Coil of wire
(metallic conductor)

- **Power Supply**
- **Potential Divider / Rheostat**
- **Milliammeter**
- **Voltmeter**
- **Wire or Filament Bulb**

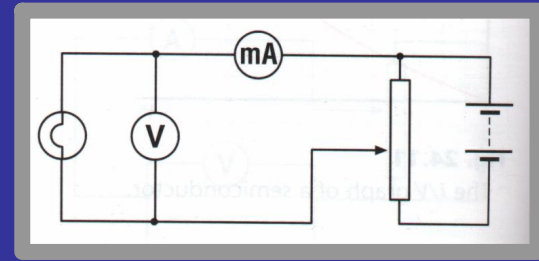
***I* vs. *V* for (i) Metal (ii) a Filament Bulb**



Procedure

- **Apply different *pd*'s (potential divider)**
... starting with $V = 0$... take readings
- **Measure (2) ... repeatedly**
- **How are these measured?**
- **Why repeat?**

I vs. V for (i) Metal (ii) a Filament Bulb

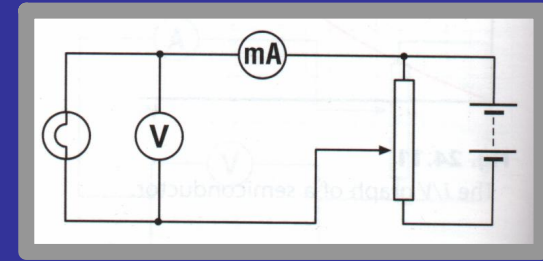


Procedure

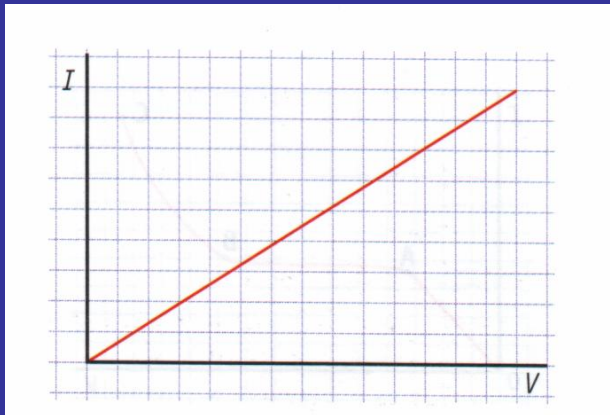
- Apply different pd 's (potential divider)
... take readings
- Measure (2) ... I & V repeatedly
- I from ammeter
- V from voltmeter
- Why repeat? ... to graph I vs. V

I vs. V for (i) Metal (ii) a Filament Bulb

Results

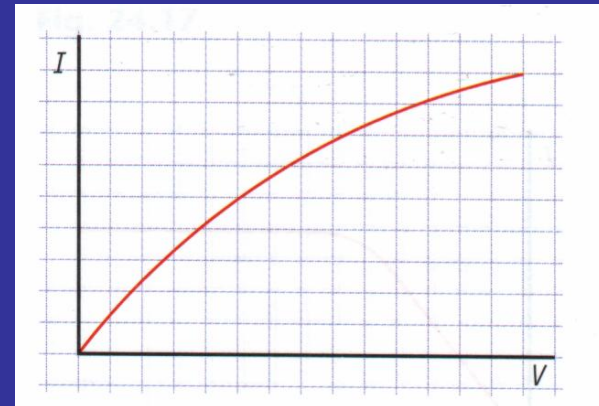


(i) A Metallic Conductor



Conclusion = ??

(ii) A Filament Bulb



Conclusion = ??

***I* vs. *V* for (i) Metal (ii) a Filament Bulb**

Precautions / Questions (Metallic Conductor)

1. Give two precautions taken to ensure an accurate result.
2. It is important to keep the temperature of the wire constant. How is this done? (2)
3. The voltmeter should have a high impe.....
4. Which gives a constant, multiplying or dividing V and I ? What does the constant represent?
5. What graph has resistance as its slope?
6. Why should reasonably small currents be used?
7. What are the charge carriers in the metal? (1)

Precautions / Questions (Filament Bulb)

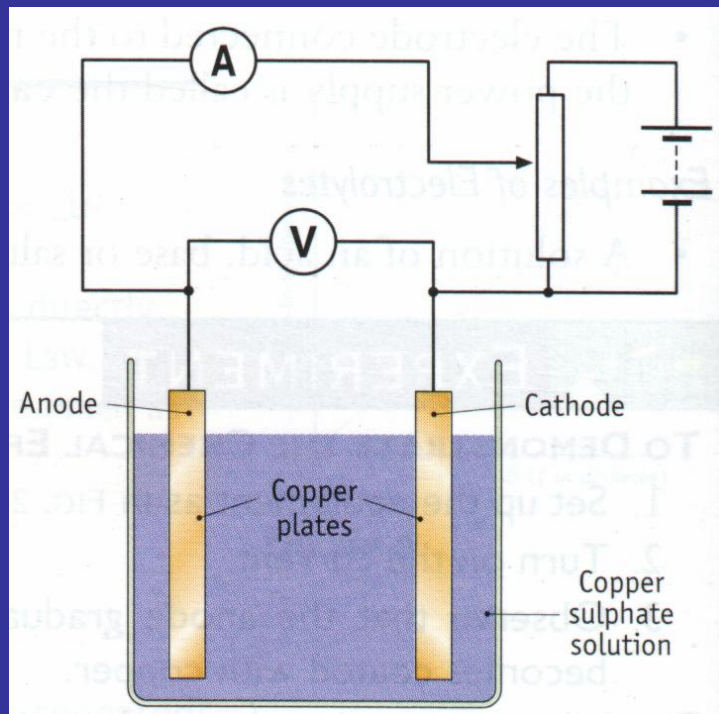
1. Give one precaution taken to ensure an accurate result.
2. The voltmeter should have a high impe.....
3. Explain why the current through a filament bulb is greater when it is just switched on than it is a few moments later.
4. What are the charge carriers in the filament bulb? (1)

Electricity 5C

**Variation of Current with P.D. for
Copper Sulphate
with Copper Electrodes**

Variation of I with V for Copper Sulphate (with Copper Electrodes)

Apparatus

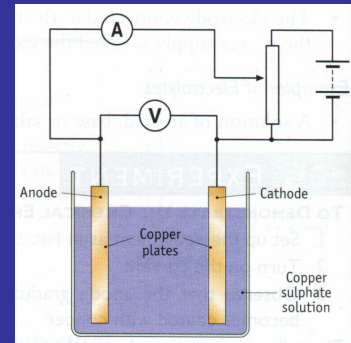


- **Power Supply**
- **Potential Divider / Rheostat**
- **Ammeter**
- **Voltmeter**
- **Copper Voltammeter**
(Copper Sulphate solution & Copper Electrodes)

***I* vs. *V* for Copper Sulphate**

Procedure

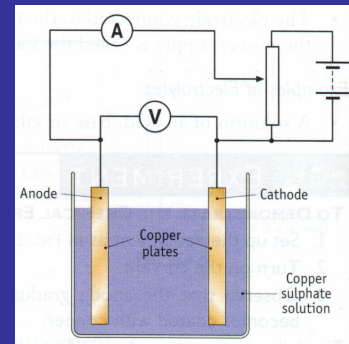
- **Apply different *pd*'s (potential divider)**
... starting with $V = 0$... take readings
- **Measure (2) ... repeatedly**
- **How are these measured?**
- **Why repeat?**



***I* vs. *V* for Copper Sulphate**

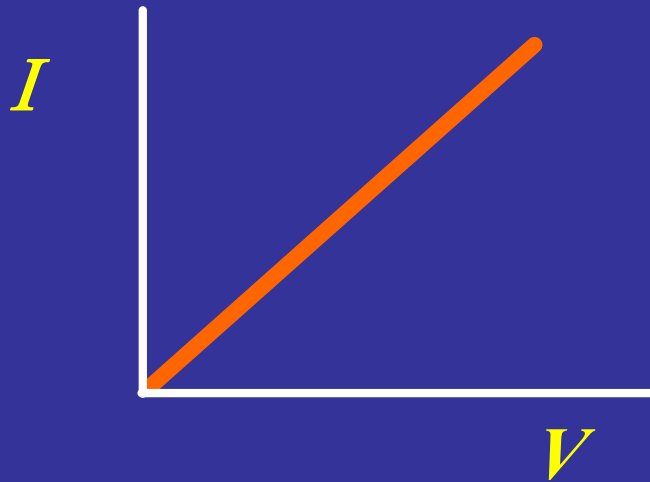
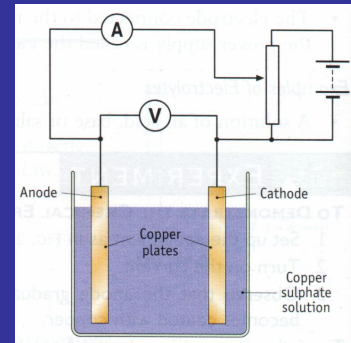
Procedure

- Apply different *pd*'s (potential divider)
... starting with $V = 0$... take readings
- Measure (2) ... *I* & *V* repeatedly
- *I* from ammeter
- *V* from voltmeter
- Why repeat? ... to graph *I* vs. *V*



I vs. V for Copper Sulphate

Results



Conclusion

SLTO → ??

Precautions / Questions

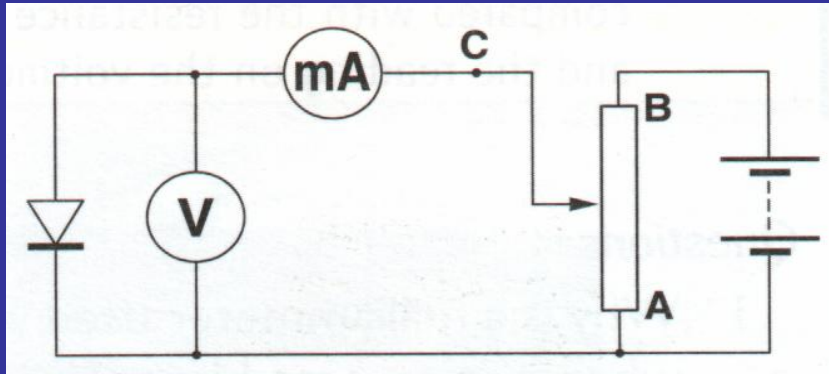
1. Give two precautions taken to ensure an accurate result.
2. The voltmeter should have a high impe.....
3. Which gives a constant, multiplying or dividing V and I ? What does the constant represent?
4. Why should you limit the size of the current?
5. Clean the electrodes beforehand.
6. What are the charge carriers in the copper sulphate? (2)
7. Sketch the graph you would get if inactive electrodes were used.

Electricity 5D

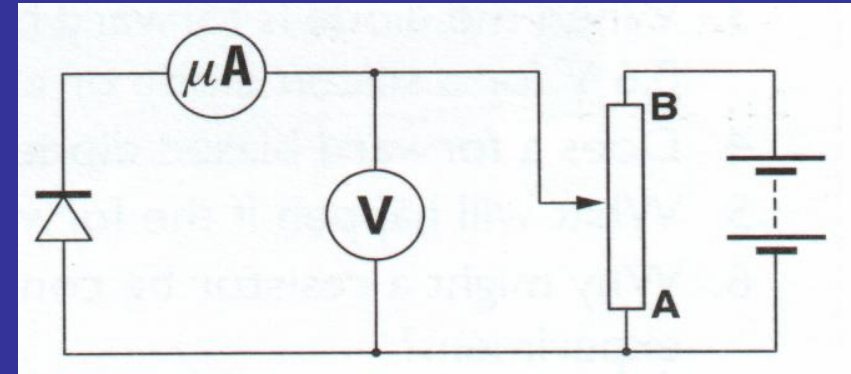
**Variation of Current with P.D. for
a Semiconductor Diode**

Variation of I with V for Copper Sulphate (with Copper Electrodes)

Apparatus



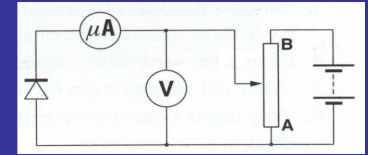
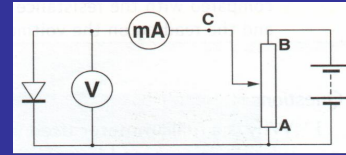
Forward biased



Reverse biased

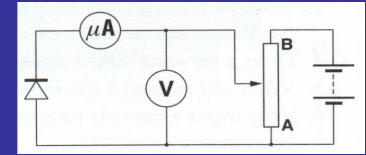
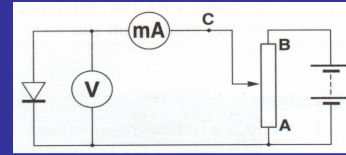
- **Power Supply**
- **Potential Divider / Rheostat**
- **Milliammeter (for forward bias)**
Microammeter (for reverse bias)
- **Voltmeter**
- **Copper Voltammeter**
(Copper Sulphate solution & Copper Electrodes)

I vs. V for Diode



Procedure

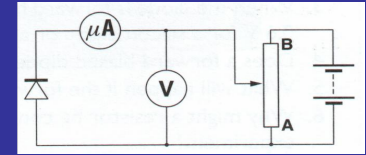
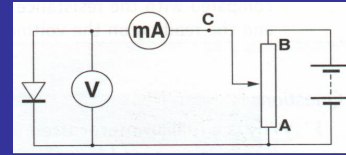
- **Apply different *pd*'s (potential divider)
... starting with $V = 0$... take readings**
- **Measure (2) ... repeatedly**
- **How are these measured?**
- **Why repeat?**



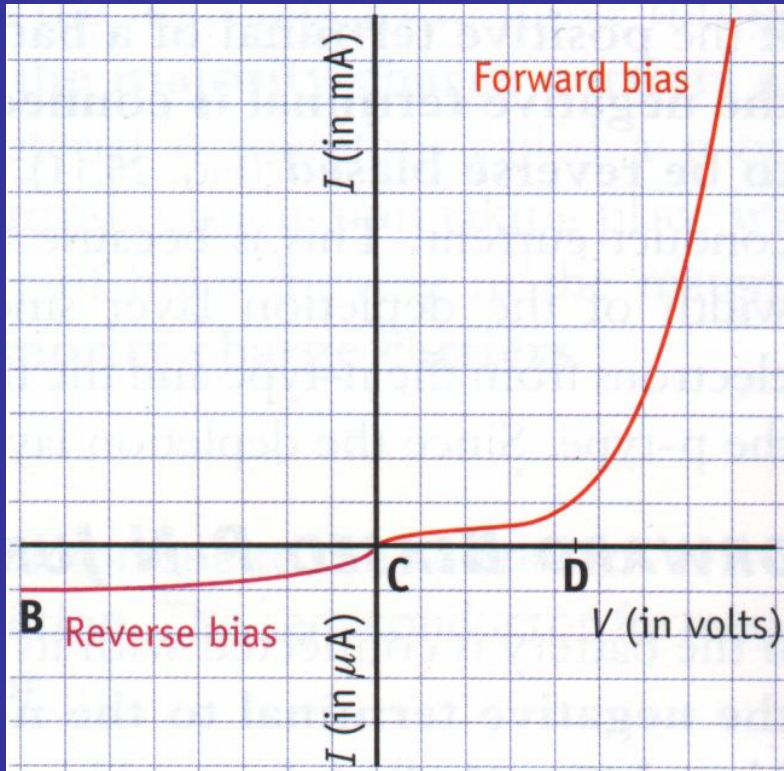
Procedure

- Apply different *pd*'s (potential divider)
... starting with $V = 0$... take readings
- Measure (2) ... I & V repeatedly
- I from Milliammeter (forward bias)
 I from Microammeter (reverse bias)
 V from Voltmeter
- Why repeat? ... to graph I vs. V

I vs. V for Diode



Results



Conclusion

= ?? for forward bias

= ?? for reverse bias

Precautions / Questions

1. Give two precautions taken to ensure an accurate result.
2. For forward bias why is a resistor placed in series with the diode?
3. Give three changes made for reverse bias.
4. What is done with the voltmeter for reverse bias?
5. Comment on the resistance of the diode when it is, (i) forward biased, (ii) reverse biased.
6. The voltmeter should have a high