Revision Notes for Intermediate 2

Physics

L Robinson

Note to student

The course

This book is designed to cover all relevant content statements of the Intermediate 2 Physics Arrangements.

The course consists of four units:

Mechanic and Heat	1 unit
Electricity and Electronics	1 unit
Waves and Optics	0.5 unit
Radioactivity	0.5 unit

Exam structure

Written Exam Paper 2 hours 100 marks

The marks are approximately equally split between Knowledge and Understanding and Problem Solving.

There are 20 marks for multiple choice questions.

The Practical Abilities Outcome is assessed within the centre.
You will have to carry out and write up one experiment from one of the units.

Using the book

You can indicate your knowledge of each statement with a tick in the ❑ at the left hand side.

Space has been left at the right hand side so that you can make additional notes.

You can also mark statements with a highlighter pen.

Exam advice

Make sure that you have a calculator, protractor, ruler, pen, pencil and rubber.

Draw a graph lightly in pencil; when you are certain it is correct, go over in ink.

In numerical questions always put the information into symbol form and check it is in basic units.

Remember to give units for all answers.

Working through past papers is an essential part of your preparation.

Revision Checklist

		Tick (√) when revised		
		1	2	3
Unit 1	**Mechanics and Heat**			
1.1	Kinematics			
1.2	Dynamics			
1.3	Momentum and energy			
1.4	Heat			
Unit 2	**Electricity and Electronics**			
2.1	Circuits			
2.2	Electrical energy			
2.3	Electromagnetism			
2.4	Electronic components			
Unit 3	**Waves and Optics**			
3.1	Waves			
3.2	Reflection			
3.3	Refraction			
Unit 4	**Radioactivity**			
4.1	Ionising radiations			
4.2	Dosimetry			
4.3	Half-life and safety			
4.4	Nuclear reactors			

UNIT 2 ELECTRICITY AND ELECTRONICS

2.1 CIRCUITS

- An electric current is caused by the movement of charges (negative electrons) round a circuit.
- **Conductors**, eg. metals such as copper and silver, have many electrons that are 'free' to move. Conductors allow a current to flow through them.
- **Insulators**, eg. rubber and plastic, have very few 'free' electrons and therefore do not allow a current to flow.
- Current has the symbol ***I***, and is measured in amperes (amps), **A**.
- Charge has the symbol ***Q***, and is measured in coulombs, **C**.
- The voltage of a supply is a measure of the energy given to the charges in a circuit,
  eg. a 1.5 V battery gives 1.5 J of energy to each coulomb of charge passing through it.
- Charge, current and time are related by the equation:

  $Q = I t$ where Q is the charge in C
  I is the current in A
  t is the time in s

- *Example*
  What is the current when 600 C of charge is transferred in 5 minutes?

  Step 1 Put the information into symbol form and change to basic units.

  $Q = 600$ C
  $t = 5$ mins $= 5 \times 60 = 300$ s

  Step 2 Choose the correct equation.

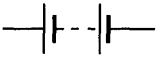
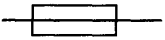
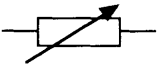
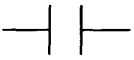
  $$Q = I t \quad \Rightarrow \quad I = \frac{Q}{t}$$

  Step 3 Put the numbers into the equation and calculate the answer.

  $$I = \frac{Q}{t} = \frac{600}{300} = 2 \text{ A}$$

  DO NOT FORGET UNITS.

Circuit symbols

- cell 
- battery 
- fuse 
- lamp 
- resistor 
- variable resistor 
- capacitor 
- diode 
- switch 

- Voltage has the symbol ***V***, and is measured in volts, **V**.

- The voltage of a supply is a measure of the energy given to the charges in the circuit.

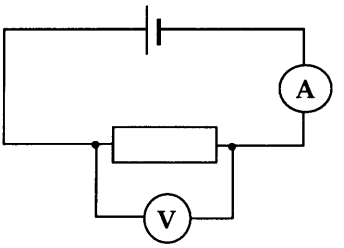
- Current is measured by an ammeter; voltage is measured by a voltmeter.

- The circuit symbols for an ammeter and a voltmeter are:

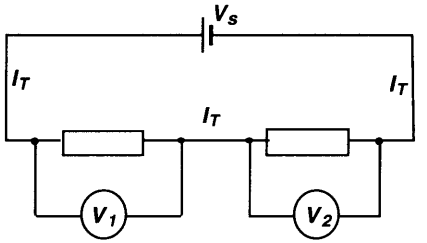
- An ammeter is always placed in series in the circuit.

- A voltmeter is always placed in parallel.

- **Circuit diagram**



- There is only one path round a **series circuit**:

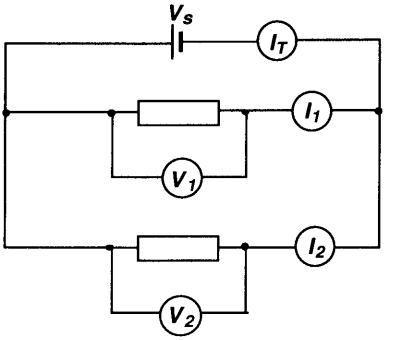


- The current is the same at all points in the series circuit.

- The supply voltage is equal to the sum of the voltages (potential differences) across the various components in a series circuit:

$$V_S = V_1 + V_2$$

- There is more than one path round a **parallel circuit**. The various paths are known as branches.



- The potential difference (voltage) across components in parallel is the same for each component.

$$V_S = V_1 = V_2$$

- The sum of the currents in parallel branches is equal to the current drawn from the supply:

$$I_T = I_1 + I_2$$

- Resistance has to do with the difficulty charges have in moving; it has the symbol R, and is measured in ohms, Ω.

- When the resistance in the circuit increases, the current in the circuit decreases.

- For a given resistor $\frac{V}{I}$ is approximately constant even when the current changes.
  $\frac{V}{I}$ is called the resistance of the resistor.

- **Ohm's law**

$$V = IR$$

where V is the voltage in V
I is the current in A
R is the resistance in Ω

- *Example*
  What current can a 230 V supply produce in a 1 kilohm resistor?

  Step 1 Put the information into symbol form and change to basic units.

  $V = 230$ V
  $R = 1\,k\Omega = 1000\,\Omega$

  Step 2 Choose the correct equation.

$$V = IR \Rightarrow I = \frac{V}{I}$$

  Step 3 Put the numbers into the equation and calculate the answer.

$$I = \frac{V}{I} = \frac{230}{1000} = \mathbf{0.23\ A}$$

DO NOT FORGET UNITS.

- To find the total resistance R_T of resistors R_1 and R_2 connected in series the following equation is used:

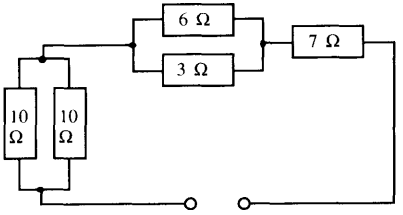
$$R_T = R_1 + R_2$$

- To find the total resistance R_T of resistors R_1 and R_2 connected in parallel the following equation is used:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

- If two identical resistors R are in parallel then R_T is $R/2$. If three identical resistors R are in parallel then R_T is $R/3$.

- *Example*
Find the total resistance of the following circuit.



Step 1 Replace the pairs of resistors in parallel with the single equivalent resistor.

The two 10 Ω resistors in parallel, since identical, can be replaced by one 5 Ω resistor.

For the 6 Ω and the 3 Ω resistors in parallel:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow \frac{1}{R_T} = \frac{1}{6} + \frac{1}{3}$$

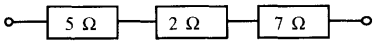
Put both over a common denominator.

$$\frac{1}{R_T} = \frac{1+2}{6} = \frac{3}{6}$$

Turn both sides the other way up.

$$\frac{R_T}{1} = \frac{6}{3} = 2\,\Omega$$

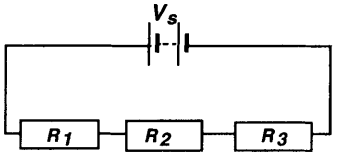
Step 2 The circuit now becomes:



Apply resistors in series formula:

$$R_T = R_1 + R_2 + R_3$$
$$= 5 + 2 + 7 = 14\,\Omega$$

- Resistors can be used to split the supply voltage.
- A potential divider circuit consists of a number of resistors, or a variable resistor, connected across a supply.

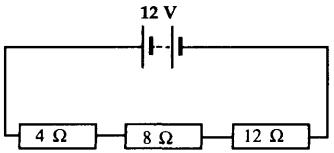


Total resistance $R_T = R_1 + R_2 + R_3$

$$V_{(R_1)} = \frac{R_1}{R_1 + R_2 + R_3} \times V_S$$

where $V_{(R_1)}$ is the voltage across R_1.

- *Example*



Total resistance = 4 + 8 + 12 = 24 Ω

Voltage across 4 Ω = $\frac{4}{24}$ x 12 = 2 V

Voltage across 8 Ω = $\frac{8}{24}$ x 12 = 4 V

Voltage across 12 Ω = $\frac{12}{24}$ x 12 = 6 V