Electricity revision material

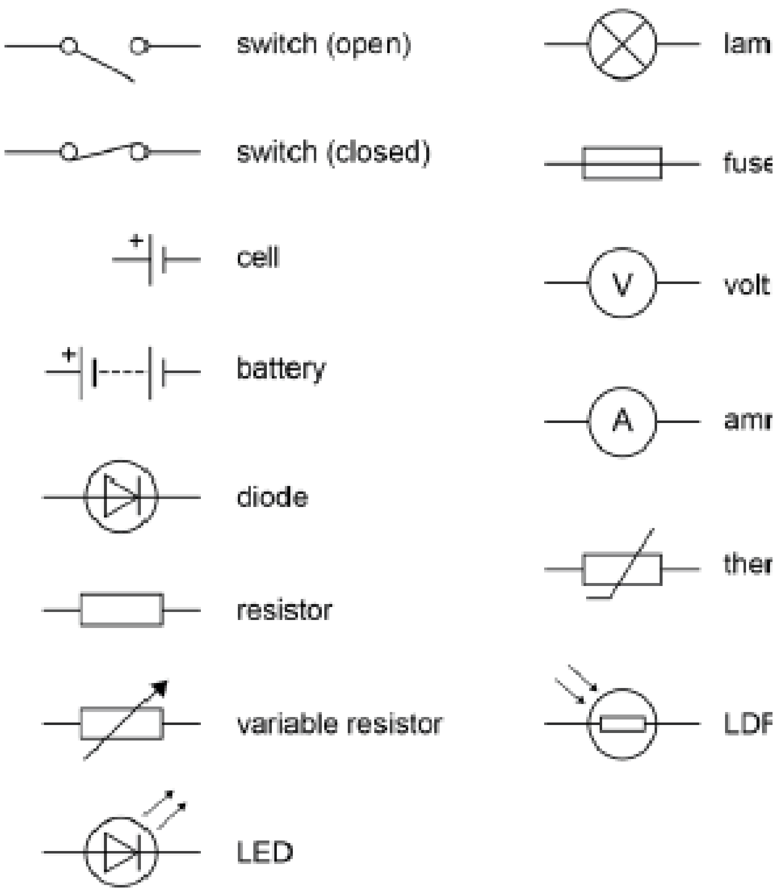
Content will be tested on **Physics Paper 1**

Checklist

Electricity		
Describe what is meant by an electric current and calculate it using Q=It		
Describe what is meant by resistance and calculate values for it using Ohm's Law		
Calculate current, voltage and resistance in series and parallel circuits		
Recognise, describe and explain the shape of current-voltage graphs for a filament bulb, ohmic resistor and a diode		
Use and recognise the symbols for all the circuit components covered		
Recognise, describe and explain the shape of resistance- light level graph for a light dependent resistor		
Describe and explain uses of LDRs – e.g switching on lights when it gets dark		
Recognise, describe and explain the shape of resistance- temperature graph for a thermistor		
Label the features and describe the safe operation of a 3 pin plug		
Explain the difference between direct and alternating pd		
Calculate electrical power and energy transferred for given appliances		
Describe the features of the National Grid		

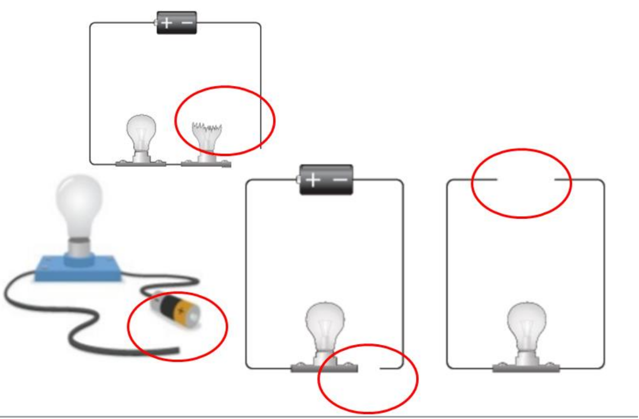
4.2.1 Current, potential difference and resistance.

You will be expected to know the following standard circuit diagrams symbols. Make sure you can draw them and interpret circuit diagrams that may include them.



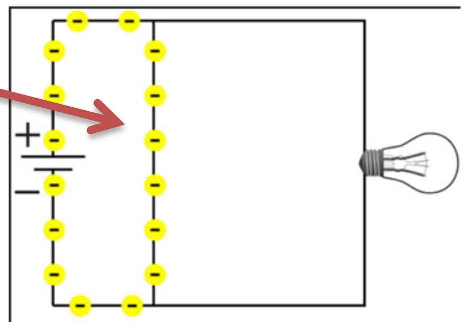
For **electrical charge to flow**, you require the following:

- The circuit must be closed (no open switches)
- There must be source of potential difference (battery / cell)

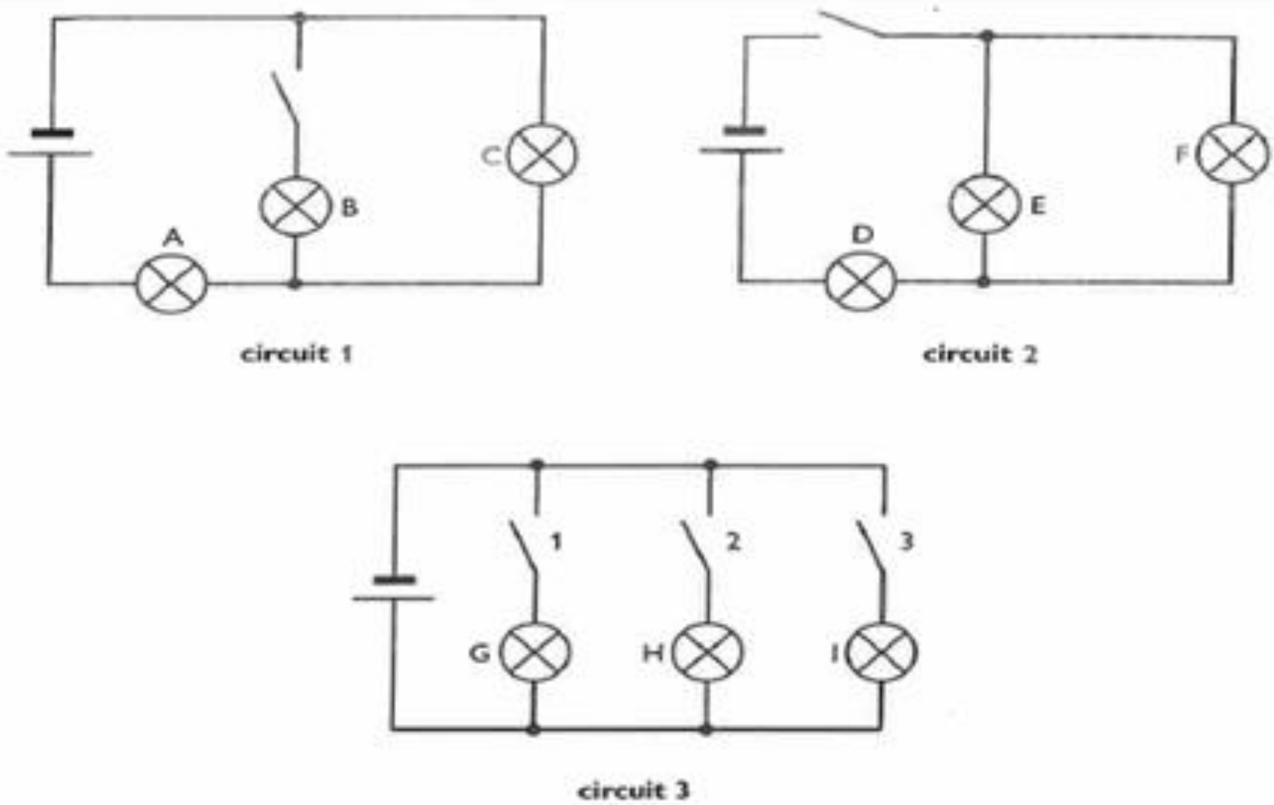


Example: look at these circuits:

- In addition, there must be no short circuits (current take the path of the least resistance) = too much current = components break



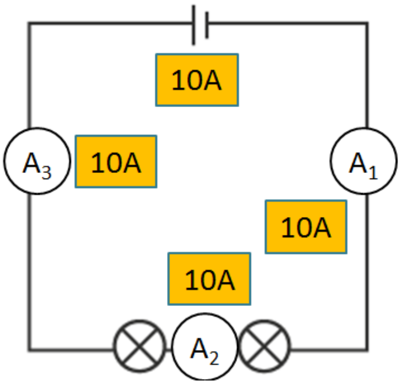
Look at the circuits below and work out what happens when the switches are open and closed.



1. Which lamps are lit in **circuit 1**?
2. Which lamps will be lit in **circuit 1** if you close the switch?
3. Which lamps are lit in **circuit 2**?
4. Which lamps will be lit in **circuit 2** if you close the switch?
5. Copy and complete this table for **circuit 3**.

Switches closed	Lamps lit
1	
2	
3	
1, 2	
1, 3	
2, 3	
1, 2, 3	

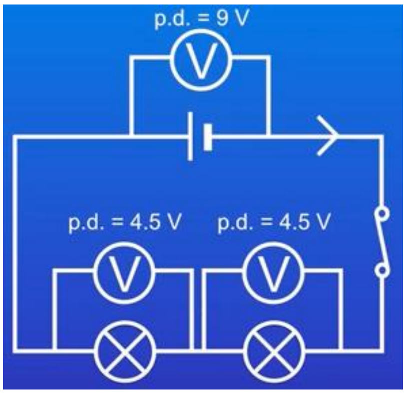
4.2.2 Series and parallel circuits



Series circuit - key points:

- Closed circuit
- Current only follows a single path.
- The current is the same everywhere.
    - $I_1 = I_2 = I_3$
    - Where I is current.

- A voltmeter is used to measure the p.d.
- What do you notice about the p.d. readings:



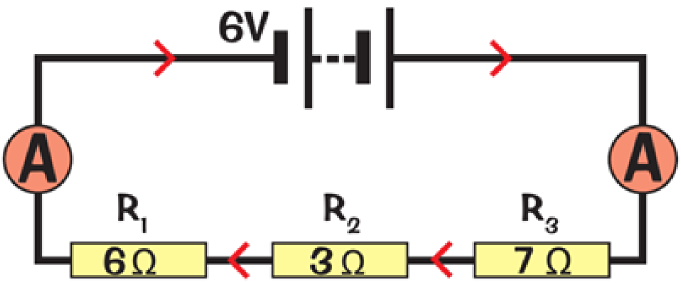
- The p.d in a series circuit is split between each component but will always equal the PD across the cell.

- $V_1 = V_2 + V_3 + \ldots\ldots$

Keynote: Resistance in Series Circuits

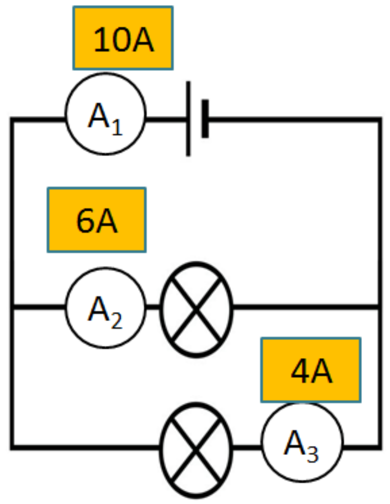
- **Resistances in series circuit are added up, so the total resistance increases.**
- If the **total resistance of the circuit increases** the **flow of electric current decreases**.

$$R = R_1 + R_2 + R_3 + \ldots$$



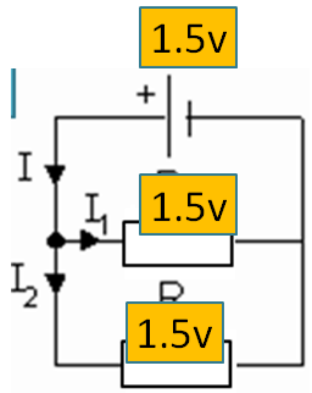
Total resistance = 6 + 3 + 7 = 16Ω

Parallel circuits – key points



- Branched circuit
- Current splits into multiple paths.

- Total current into a junction = total current in each of the branches.
    - **$I = I_1 + I_2 + \ldots$etc**



- The potential difference is the same across each branch.
    - **$V_1 = V_2 + V_3 + \ldots\ldots\ldots$**
    -

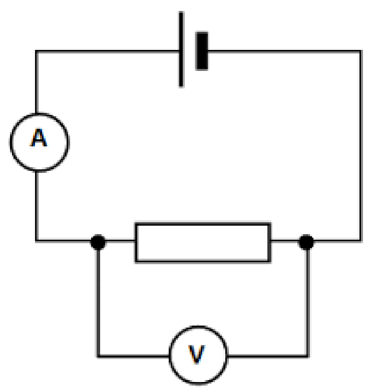
Total resistance in a parallel circuit is less than the branch with the smallest resistance.

- Two resistors in parallel will have a smaller overall resistance than just one.
- Because charge has more than one branch to take, so only some charge will flow along each branch,

- calculate the effective resistance of two or more resistors in parallel using the equation $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \ldots$

Using an ammeter and a Voltmeter in circuits

- **Ammeters** are used to measure the current, in Amperes A, in any individual branch. **We say that it is connected in series.**
- **Voltmeters** are used to measure the potential difference, in Volts V, across any component. **We say it is connected in parallel.**



4.2.1.2 Electric charge and current

Electric current is a flow of electrical charge. The size of the electric current is the rate of flow of electrical charge.

Charge flow, current and time are linked by the equation:

$$Q=It$$

Where **Q** is the **charge flow**, in **coulombs**, **I** is the **current**, in **amperes A** and **t** is the **time** in **seconds s.**

Key points:

In a single closed loop, the current has the same value at any point.

Current (I) through a component depends on both the resistance of the component and the potential difference (V) across the component.

Current, potential difference or resistance can be calculated using the equation:

$$V=IR$$

V= potential difference in volts V; I =current in amperes A ; R= resistance in ohms Ω

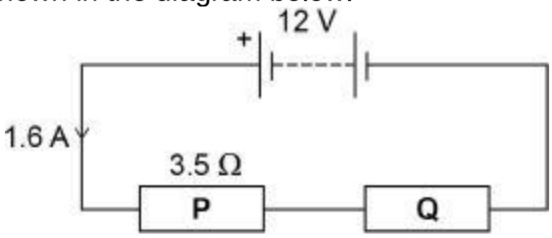
Exam practice 1

Q1.(a) Draw a diagram to show how 1.5 V cells should be connected together to give a potential difference of 4.5 V.

Use the correct circuit symbol for a cell.

(2)

A student built the circuit shown in the diagram below.



(b) Calculate the total resistance of the circuit in the diagram above.

Use the equation:

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

___

___

___

Total resistance = ______________________ Ω

(2)

(c) The resistance of **P** is 3.5 Ω.

Calculate the resistance of **Q**.

___

___

___

Resistance of **Q** = ______________________ Ω

(1)

(d) The student connects the two resistors in the diagram above in parallel.

What happens to the total resistance of the circuit?

Tick **one** box.

It decreases ☐

It increases ☐

It does not change ☐

(1)

Give a reason for your answer.

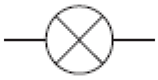
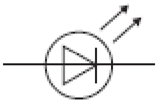
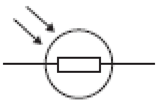
___

___

___

(1)

Q2.(a) Draw **one** line from each circuit symbol to its correct name.

Circuit symbol	**Name**
	Diode
	Light-dependent resistor (LDR)
	Lamp
	Light-emitting diode (LED)

(3)

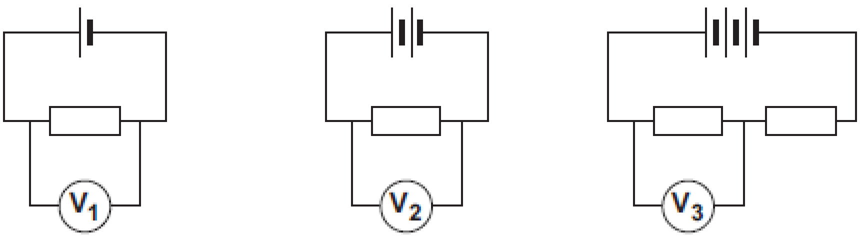
(b) **Figure 1** shows three circuits.

The resistors in the circuits are identical.

Each of the cells has a potential difference of 1.5 volts.

Figure 1

Circuit 1 **Circuit 2** **Circuit 3**



(i) Use the correct answer from the box to complete the sentence.

half	**twice**	**the same as**

The resistance of **circuit 1** is ________________ the resistance of **circuit 3**.

(1)

(ii) Calculate the reading on voltmeter $\mathbf{V_2}$.

____

Voltmeter reading $\mathbf{V_2}$ = _______________ V

(1)

(iii) Which voltmeter, $\mathbf{V_1}$, $\mathbf{V_2}$ or $\mathbf{V_3}$, will give the lowest reading?

Draw a ring around the correct answer.

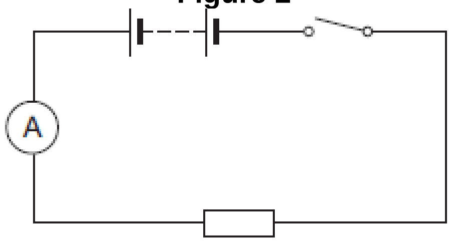
$\mathbf{V_1}$ $\mathbf{V_2}$ $\mathbf{V_3}$

(1)

(c) A student wanted to find out how the number of resistors affects the current in a series circuit.

Figure 2 shows the circuit used by the student.

Figure 2



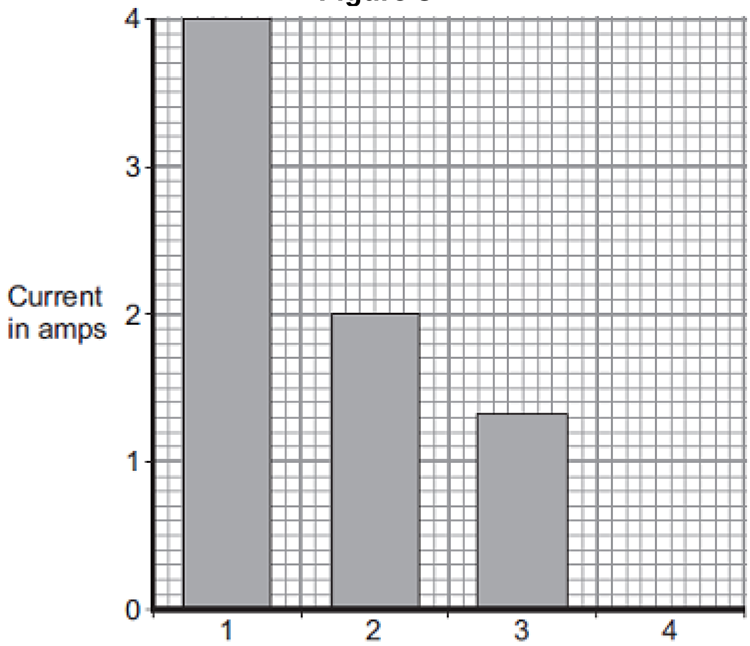
The student started with one resistor and then added more identical resistors to the circuit.

Each time a resistor was added, the student closed the switch and took the ammeter reading.

The student used a total of 4 resistors.

Figure 3 shows three of the results obtained by the student.

Figure 3



(i) To get valid results, the student kept one variable the same throughout the experiment.

Which variable did the student keep the same?

____

(1)

(ii) The bar chart in **Figure 3** is not complete. The result using 4 resistors is not shown.

Complete the bar chart to show the current in the circuit when 4 resistors were used.

(2)

(iii) What conclusion should the student make from the bar chart?

____

____ **(1)**

Q3.(a) Electrical circuits often contain resistors.

The diagram shows **two** resistors joined in series.

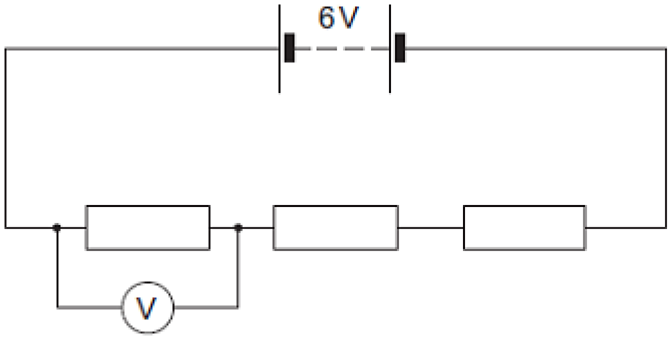
Calculate the total resistance of the **two** resistors.

____

Total resistance = ______________________________ Ω

(1)

(b) A circuit was set up as shown in the diagram. The three resistors are identical.



(i) Calculate the reading on the voltmeter.

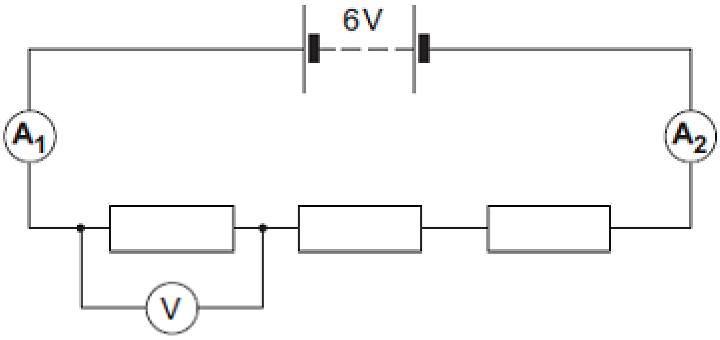
____

____

Reading on voltmeter = ______________________________ V

(2)

(ii) The same circuit has now been set up with two ammeters.



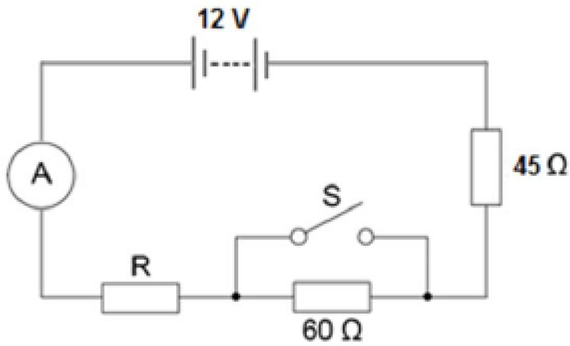
Draw a ring around the correct answer in the box to complete the sentence.

The reading on ammeter A_2 will be	smaller than equal to greater than	the reading on ammeter A_1.

(1)

(Total 4 marks)

Q4. A student set up the electrical circuit shown in the figure below.



(a) The ammeter displays a reading of 0.10 A.

Calculate the potential difference across the 45 Ω resistor.

___

___

Potential difference = ___ V

(2)

(b) Calculate the resistance of the resistor labelled **R**.

___

___

___

Resistance = ___ Ω

(3)

(c) State what happens to the total resistance of the circuit and the current through the circuit when switch **S** is closed.

___

___

___

___

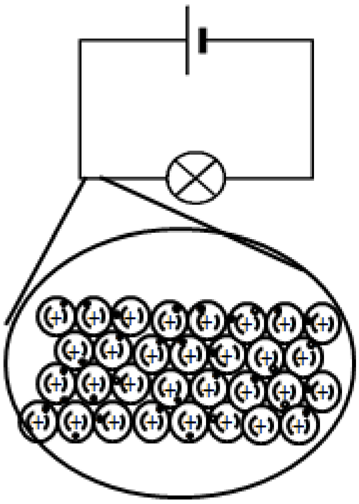
(2)

(Total 7 marks)

4.2.1.3 Current resistance and potential difference and 4.2.1.4 resistors

The current (I) through a component depends on both the resistance ® of the component and the potential difference (V) across the component. The greater the resistance of the component the small the current for a given potential difference (pd) across the component.

What causes resistance?



Metal atoms (ions) in a wire have delocalised electrons which are free to move and carry the electric current around the circuit.

The electrons moving around the circuit collide with the ions. **This is called resistance.**

Components with high resistance (e.g. filament bulbs) often get hot. This is because when the electrons collide with the ions they transfer energy as heat (and light), this then causes the ions to vibrate more increasing the resistance by making it harder for the electrons to pass through without collisions.

Potential difference, current and resistance are all related by the equation;

$$V = I \times R$$

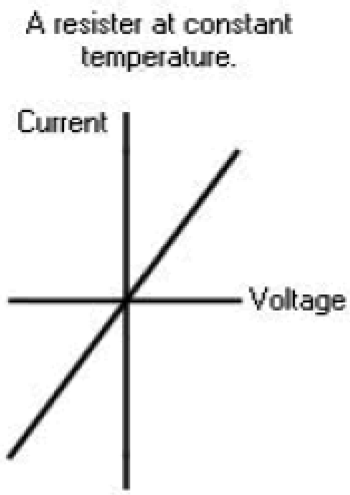
- V = potential difference in volts, V
- I = current in amps, A
- R = resistance in ohms, Ω

If the resistance is <u>constant</u>, an ohmic conductor, current is <u>directly proportional</u> to the potential difference, in this case the graph is linear.

Exam skill/understanding:

Why does this show a directly proportional relationship?

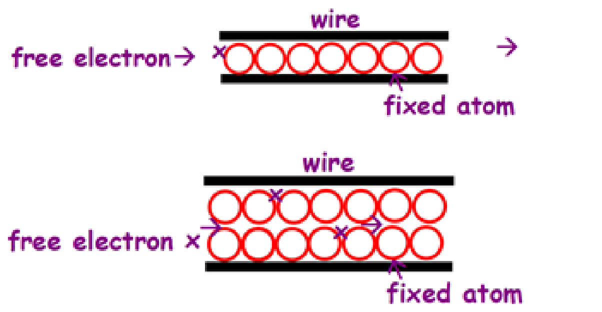
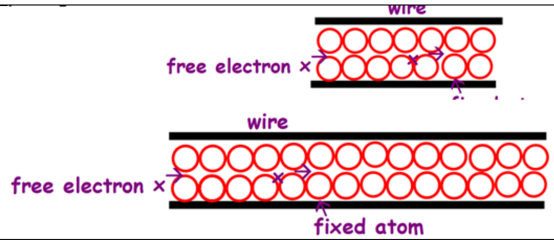
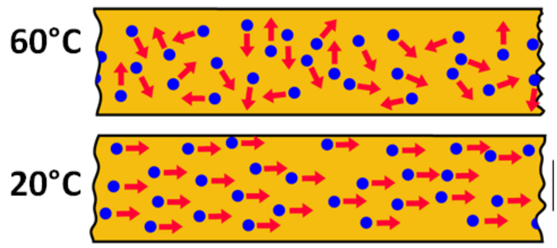
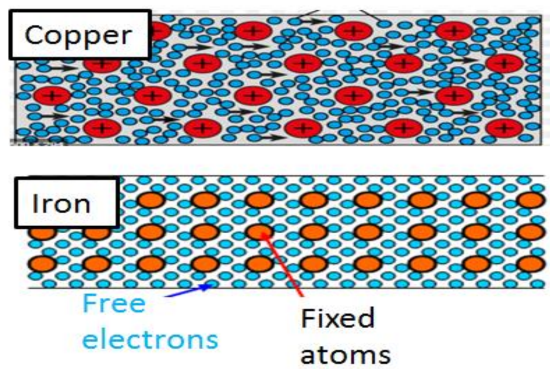
- Line goes through 0,0
- Line goes up equally i.e. as current double, voltage double.



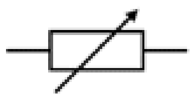
How does the resistance change?

All materials have some resistance, but certain materials resist the flow of electric current more or less than other materials do. Materials such as plastics have high resistance to electric current. They are called **electric insulators.** Materials such as metals have low resistance to electric current. They are called **electric conductors.**

Factors that affect resistance include:

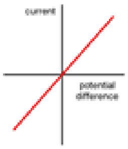
Diameter	A wide wire has less resistance than a narrow wire of the same material. Electricity flowing through a wire is like water flowing through a hose. More water can flow through a wide hose than a narrow hose. In a similar way, more current can flow through a wide wire than a narrow wire.	
Length	A longer wire has more resistance than a shorter wire. Current must travel farther through a longer wire, so there are more chances for it to collide with particles of matter.	
Temperature	A cooler wire has less resistance than a warmer wire. Cooler particles have less kinetic energy, so they move more slowly. Therefore, they are less likely to collide with moving electrons in current.	
Material	Different metals have different electrical resistance. E.g. iron has more electrical resistant than copper.	

A variable resistor can alter the resistance in a circuit and is useful for things like controlling volume or light dimmer switches

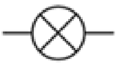


Other key resistors include:

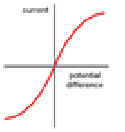
The current through a **resistor** (at a constant temperature) is directly proportional to the potential difference across a resistor.



An **LED (light emitting diode)** emits light when a current flows in the forward direction

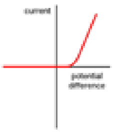


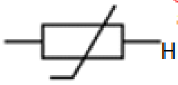
The resistance of a **bulb** increases as the temperature of the filament increases



An **LDR (light-dependent resistor)** resistance decreases as light intensity increases. (DARK = high resistance, low current, LIGHT = low resistance, high current)

The current through a **diode** flows in one direction. It has a very high resistance in the opposite direction.





A **thermistor's** resistance decreases as the temperature increases.(HIGH TEMP = low resistance, high current, LOW TEMP = high resistance, low current)

Required practical activity 3: investigate the factors affecting the resistance of electrical circuits.

There are a number of variations you should be aware of:

GCSE Required Practical – Physics 1 – Investigating Resistance

Resistance: how difficult it is for current to flow through part of the circuit.

What's the point of the practical?
To find out resistance of a wire.
(You could look at different lengths of wire, different thicknesses, or even different temperatures)

$$\text{resistance } (\Omega) = \frac{\text{potential difference (V)}}{\text{current (A)}}$$

Results:

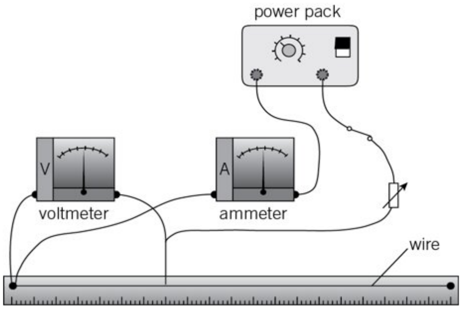
The longer the wire, the more resistance
The thicker the wire, the less resistance
The higher the temperature the more resistance

Example Apparatus

Voltmeter: measures the potential Difference

Ammeter: measures the current

Metre stick:
Measures the length of wire that the current is going through



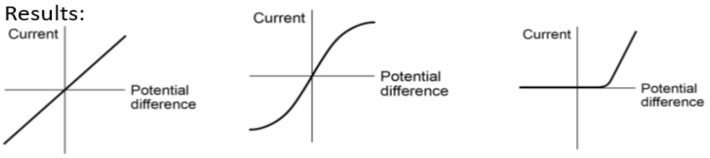
What may they ask us about?
- Why must the power pack be kept on a low potential difference / What are the hazards *(The wire will get very hot, could burn you)*
- Explain how the temperature affects the resistance (*as the wire gets hot, the ions inside the wire vibrate faster so there are more collisions with the electrons cannot flow as easily)*
- Why is it important to switch the electricity off in between each reading (*to let the wire cool down, as temperature affects resistance)*
- What sort of error could cause all the ammeter/voltmeter readings to be too high (*a zero error – the meters need to be set at zero to start with)*
- Resolution of measurements, repeatability, reproducibility, control variables etc etc

GCSE Required Practical – Physics 1 – Investigating Electrical Components (lamp, diode, resistor)

Component: part of a circuit   Current: the flow of charge   diode: only allows current to flow one way
Potential Difference (V): the energy transferred to part of a circuit by each coulomb of charge
Resistor: limits the current in a circuit

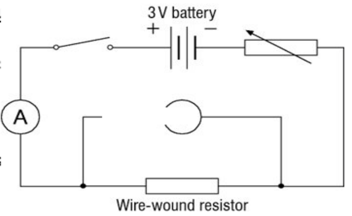
What's the point of the practical?
To find out how current and potential difference change in different components

Results:



Resistor   lamp   Diode

Example Apparatu



Voltmeter: measure the potential Difference

Ammeter: measures the current

Resistor: what we're testing. (can be replaced with a lamp, then a diode

What may they ask us about?
- Explain the pattern for each component (***resistor****: fixed resistance – more PD =more current.* ***Lamp:*** *more PD = more current but at high PD, the filament gets hot, ions vibrate so resistance increases and current levels off.* ***Diode****: current can only flow in one direction)*
- Resolution of measurements, repeatability, reproducibility, control variables etc etc

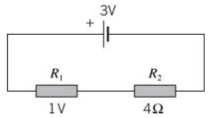
GCSE Required Practical – Physics 1 – Resistors in Series and Parallel

Resistor: limits the current in a circuit

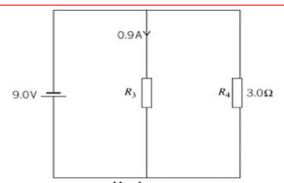
What's the point of the practical?
To find out what happens to the total resistance when resistors are put in series and in parallel

Results for series circuits
the total resistance is the same as both resistors added up. Each time you add a resistor, you get more resistance and less current

Example Apparatus



Series circuit



Parallel circuit

Results for parallel circuits
The total resistance is less than the smallest resistor. Each time you add more resistors, the current increases and the total resistance decreases. (the are more 'routes' overall for the current)

What may they ask us about?
- Why aren't your results completely accurate? (*because the meters aren't completely accurate, the power pack potential difference fluctuates slightly, the temperature of the wires changes which affects resistance)*
- What is the resolution of measurements? (*e.g. 0.41A, 0.32A, 0.39A are all to 0.01 resolution)*
- They may ask you to calculate resistance, current or PD. Or ask what happens if you add/take away resistors.

GCSE Required Practical – Physics 1 – Resistors in Series and Parallel

Resistor: limits the current in a circuit

What's the point of the practical?
To find out what happens to the total resistance when resistors are put in series and in parallel

Results for series circuits
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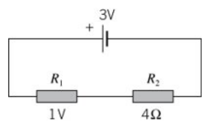
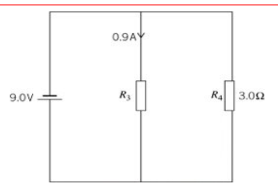
Example Apparatus



Series circuit



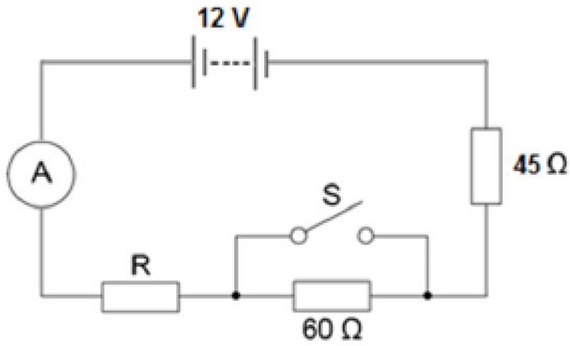
Parallel circuit

Results for parallel circuits
The total resistance is less than the smallest resistor. Each time you add more resistors, the current increases and the total resistance decreases. (the are more 'routes' overall for the current)

What may they ask us about?
- Why aren't your results completely accurate? (*because the meters aren't completely accurate, the power pack potential difference fluctuates slightly, the temperature of the wires changes which affects resistance)*
- What is the resolution of measurements? (*e.g. 0.41A, 0.32A, 0.39A are all to 0.01 resolution)*
- They may ask you to calculate resistance, current or PD. Or ask what happens if you add/take away resistors.

Exam practice 2

Q1. A student set up the electrical circuit shown in the figure below.



(a) The ammeter displays a reading of 0.10 A.

Calculate the potential difference across the 45 Ω resistor.

____

____

Potential difference = ________________________ V

(2)

(b) Calculate the resistance of the resistor labelled **R**.

____

____

____

Resistance = ________________________ Ω

(3)

(c) State what happens to the total resistance of the circuit and the current through the circuit when switch **S** is closed.

____

____

____

____

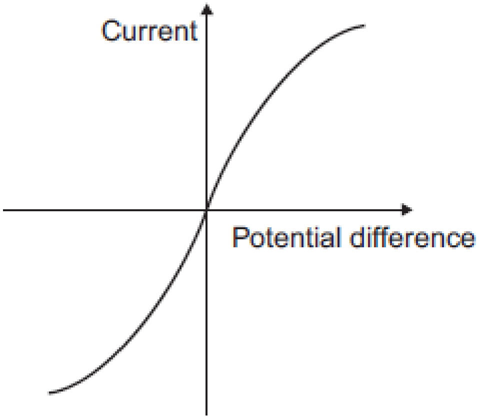
(2)

(Total 7 marks)

Q2. The current in a circuit depends on the potential difference provided by the cells and the total resistance of the circuit.

(a) **Figure 1** shows the graph of current against potential difference for a component.

Figure 1



What is the name of the component?

Draw a ring around the correct answer.

diode **filament bulb** **thermistor**

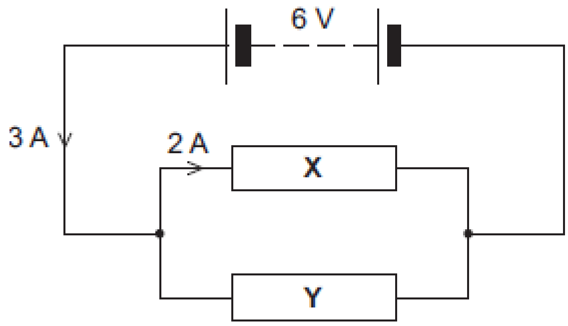
(1)

(b) **Figure 2** shows a circuit containing a 6 V battery.

Two resistors, **X** and **Y**, are connected in parallel.

The current in some parts of the circuit is shown.

Figure 2



(i) What is the potential difference across **X**?

Potential difference across **X** = _______________ V

(1)

(ii) Calculate the resistance of **X**.

___

___

Resistance of **X** = _______________ Ω

(2)

(iii) What is the current in **Y**?

Current in **Y** = _______________ A

(1)

(iv) Calculate the resistance of **Y**.

____

Resistance of **Y** = _______________ Ω

(1)

(v) When the temperature of resistor **X** increases, its resistance increases.

What would happen to the:

- potential difference across **X**
- current in **X**
- total current in the circuit?

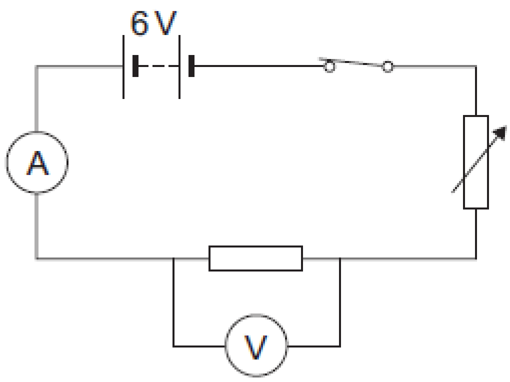
Tick (✓) **three** boxes.

	Decrease	**Stay the same**	**Increase**
Potential difference across **X**			
Current in **X**			
Total current in the circuit			

(3)

(Total 9 marks)

Q3. The diagram shows the circuit set up by a student.



(a) The student uses the circuit to test the following hypothesis:

'The current through a resistor is directly proportional to the potential difference across the resistor.'

(i) If the hypothesis is correct, what should the student predict will happen to the current through the resistor when the potential difference across the resistor is doubled?

____

____

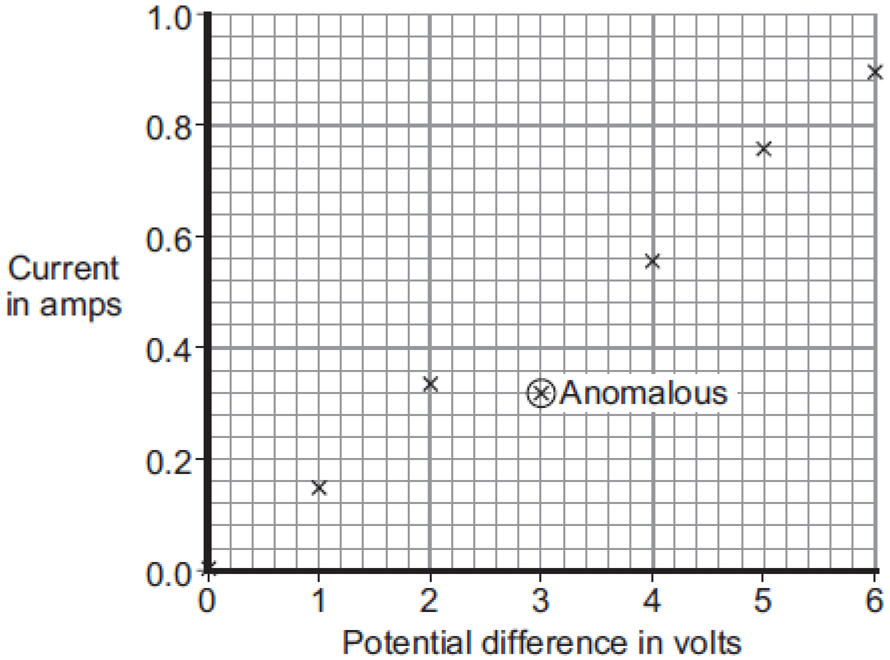
(1)

(ii) Name the component in the circuit used to change the potential difference across the resistor.

____

(1)

(b) The student used the data obtained to plot the points for a graph of current against potential difference.



(i) Why has the student plotted the points for a line graph and not drawn a bar chart?

____

____

(1)

(ii) One of the points has been identified by the student as being anomalous.

What is the most likely cause for this anomalous point?

____

____

(1)

(iii) Draw a line of best fit for these points.

(1)

(iv) Does the data the student obtained support the hypothesis?

Give a reason for your answer.

____

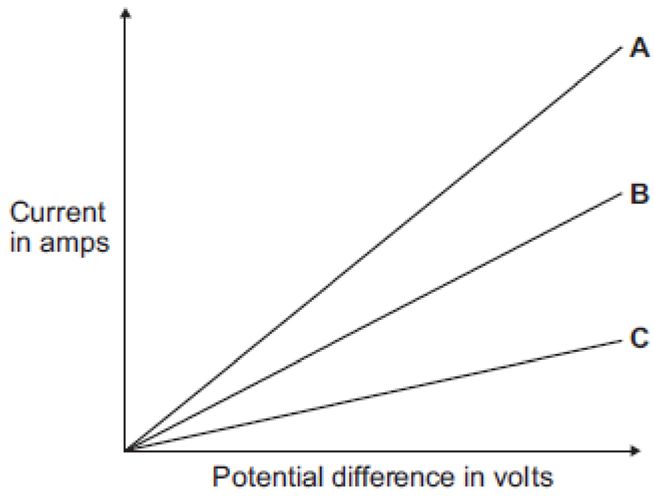
____

(1)

(Total 6 marks)

Q4.(a) **Figure 1** shows the current−potential difference graph for three wires, **A**, **B** and **C**.

Figure 1



(i) Using **Figure 1**, how can you tell that the temperature of each wire is constant?

____

____

(1)

(ii) Which **one** of the wires, **A**, **B** or **C**, has the greatest resistance?

Write the correct answer in the box. ☐

Give a reason for your answer.

____

____

____

(2)

(b) A student measured the resistance of four wires.

The table below shows the resistance of, and other data about, each of the four wires, **J**, **K**, **L** and **M**.

Wire	**Type of metal**	**Length in cm**	**Diameter in mm**	**Resistance in …….**
J	copper	50	0.17	0.36
K	copper	50	0.30	0.12
L	copper	100	0.30	0.24
M	constantan	100	0.30	7.00

(i) The last column of the table should include the unit of resistance.
What is the unit of resistance?

____

(1)

(ii) The resistance of a wire depends on many factors.

Look at the table. Which **two** wires from **J**, **K**, **L** and **M** show that the resistance of a wire depends on the **length** of the wire?

Wire ☐ and wire ☐

Give a reason for your answer.

____

____

____

(2)

(iii) A student looked at the data in the table and wrote this conclusion:

'The resistance of a wire depends on the type of metal from which the wire is made.'

The student could **not** be certain that her conclusion is true for **all** types of metal.

Suggest what extra data is needed for the student to be more certain that the conclusion is correct

____

____

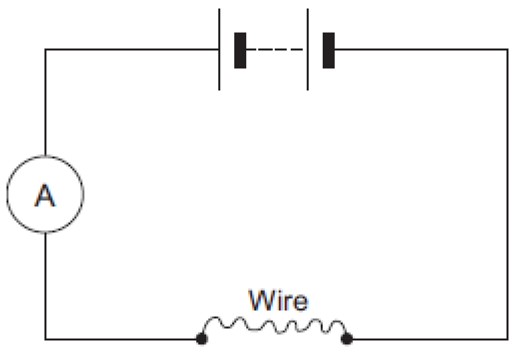
____

(1)

(c) The resistance of a wire can be calculated using the readings from an ammeter and a voltmeter.

(i) Complete **Figure 2** by drawing a voltmeter in the correct position in the circuit. Use the correct circuit symbol for a voltmeter.

Figure 2



(1)

(ii) In a circuit diagram, a wire can be represented by the symbol for a resistor.

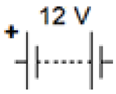
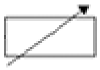
In the box below, draw the circuit symbol for a resistor.

(1)

(Total 9 marks)

Q5. A student wants to investigate how the current through a filament lamp affects its resistance.

(a) Use the circuit symbols in the boxes to draw a circuit diagram that she could use.

12 V battery	**variable resistor**	**filament lamp**	**voltmeter**	**ammeter**
				

(2)

(b) Describe how the student could use her circuit to investigate how the current through a filament lamp affects its resistance.

____

____

____

____

____

____

____

____

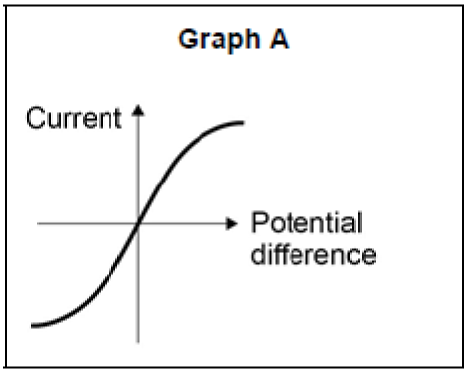
(4)

(e) The current-potential difference graphs of three components are shown in **Figure 2**.

Use answers from the box to identify each component.

diode	**filament lamp**	**light dependent resistor**
resistor at constant temperature		**thermistor**

Figure 2



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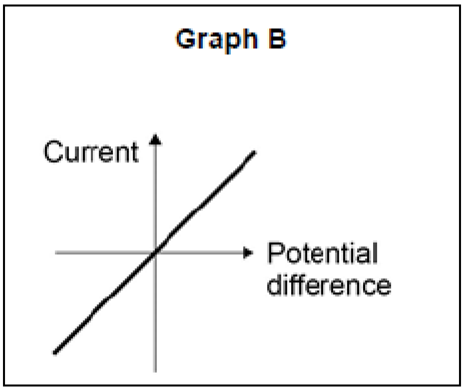

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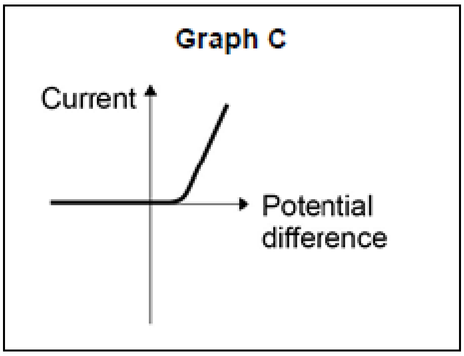


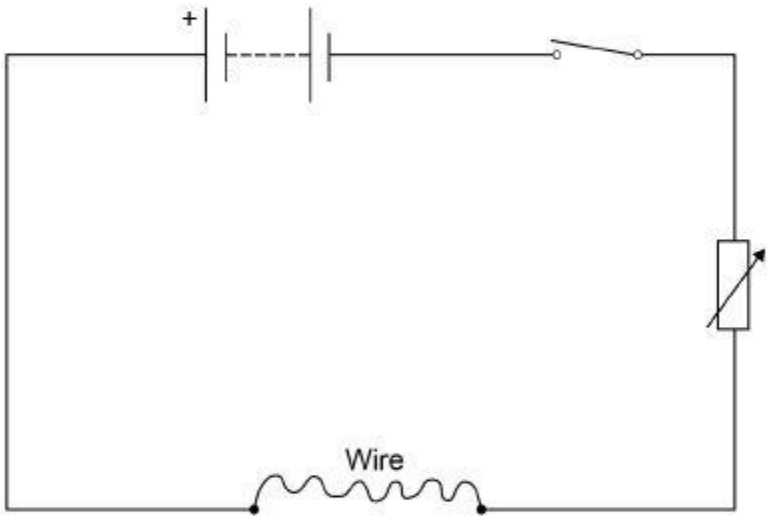
____

(3)
(Total 11 marks)

Q6. A student investigated how the resistance of a piece of nichrome wire varies with length.

Figure 1 shows part of the circuit the student used.

Figure 1



(a) Complete **Figure 1** by adding an ammeter and a voltmeter.

Use the correct circuit symbols.

(3)

(b) Describe how the student would obtain the data needed for the investigation.

Your answer should include a risk assessment for **one** hazard in the investigation.

____

____

____

____

____

____

____

____

____

____

____

____

(6)

(c) Why would switching off the circuit between readings have improved the accuracy of the student's investigation?

Tick **one** box.

The charge flow through the wire would not change. ☐

The potential difference of the battery would not increase. ☐

The power output of the battery would not increase. ☐

The temperature of the wire would not change. ☐

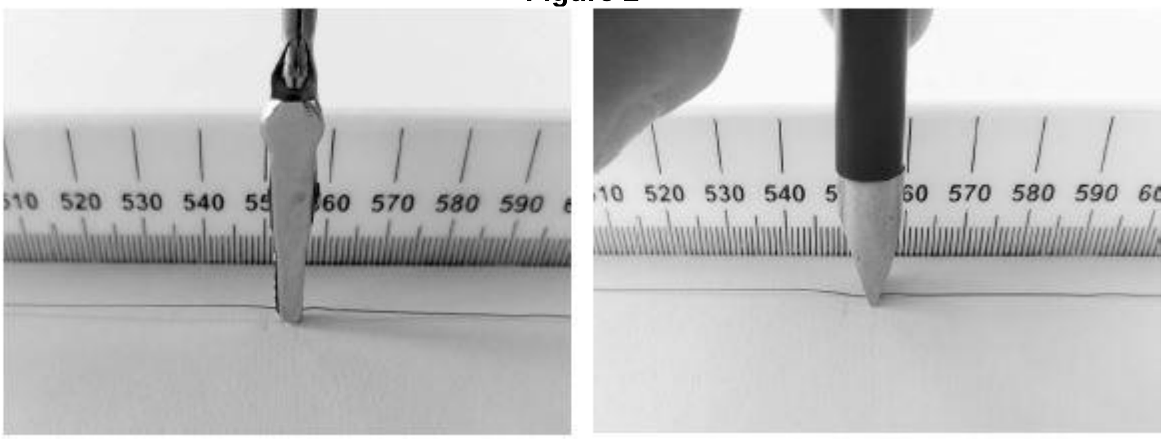
(1)

(d) The student used crocodile clips to make connections to the wire.

They could have used a piece of equipment called a 'jockey'.

Figure 2 shows a crocodile clip and a jockey in contact with a wire.

Figure 2



Crocodile clip Jockey

How would using the jockey have affected the accuracy and resolution of the student's results compared to using the crocodile clip?

Tick **two** boxes.

The accuracy of the student's results would be higher. ☐

The accuracy of the student's results would be lower. ☐

The accuracy of the student's results would be the same. ☐

The resolution of the length measurement would be higher. ☐

The resolution of the length measurement would be lower. ☐

The resolution of the length measurement would be the same. ☐

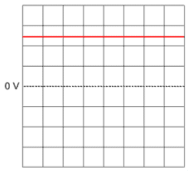
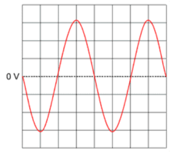
(2)

4.2.3 Domestic uses and safety.

Mains:

Household electricity has a potential difference of around **230V** and a frequency of **50 Hz (Hertz),** so changes direction 50 times in a second.

Current in a simple circuit is **direct (dc)** because it only flows in one direction, whereas current from the mains supply is **alternating current (ac)** because it alters direction.

Current type	**AC**	**DC**
Features	Current continuously varies, from positive to negative (charge changes direction)	The movement of charge in one direction only
Sources	Mains electricity	Cells and batteries
Oscilloscope pattern		

The **period** of an AC supply is the **time taken for one complete oscillation**. You can find this by looking at the time between one peak and the next.

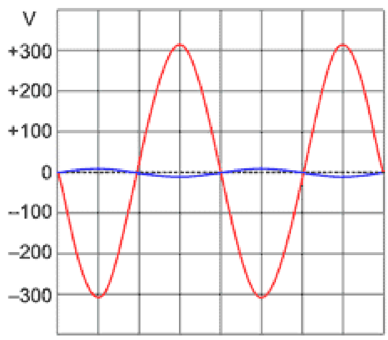
e.g. In the oscilloscope trace, one horizontal division represents 5 ms (five milliseconds).

There are four divisions between two adjacent peaks, so the period is: 4 × 5 = **20 ms**

The **frequency** of an AC supply is the **number of oscillations per second**. You can find it from the period: Frequency = 1 ÷ period

(Remember to convert to seconds if needed. In this example, 20 ms = 20 ÷ 1000 = **0.020** s.)

Frequency = 1 ÷ 0.020 = **50 Hz**

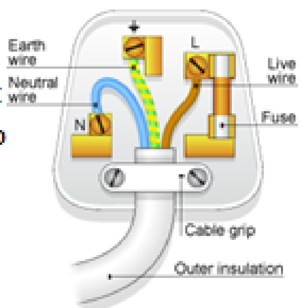


<u>Relating the oscilloscope pattern to mains:</u>

The live terminal (pin) potential difference varies between a high positive value and low positive value. The neutral terminal (pin) has a potential difference close to earth which is zero.

In a plug and cable;

Blue is neutral and goes on the **l**eft
Striped is Earth and goes to the **t**op
Brown is live and goes to the **r**ight



This is the symbol for a **fuse.**

A fuse will melt when the current is too high

A plug is designed with the following;

- Plastic casing outside is an insulator
- Brass pins are good conductors
- Fuse melts if the current is too high (thus breaking the circuit)
- Cables are made of copper because they are bendy and good conductors
- Cables have plastic coating because they are good insulators

Energy transfers in appliances

When an electrical charge flows through a resistor, the resistor gets hot.
A lot of energy is wasted in filament bulbs as heat.
Less energy is wasted in power-saving lamps such as Compact Fluorescent Lamps (CFLs).
There is also a choice when buying new appliances in how efficiently they transfer energy.

The rate at which energy is transferred by an appliance called the **power**

$$P = \frac{E}{t}$$

P = power in watts, W
E = energy in joules, J
t = time in seconds, s

$$P = I \times V$$

P = power in watts, W
I = current in amps, A
V = potential difference in volts, V

Energy transferred, potential difference and charge are all related by..

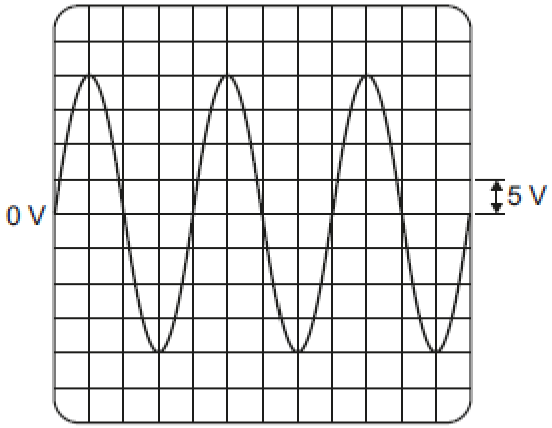
$$E = V \times Q$$

E = energy in joules, J
V = potential difference in volts, V
Q = charge in coulombs, C

Exam practice 3

Q1.(a) **Figure 1** shows the oscilloscope trace an alternating current (a.c.) electricity supply produces.

Figure 1



One vertical division on the oscilloscope screen represents 5 volts.

Calculate the peak potential difference of the electricity supply.

____

Peak potential difference = _________________________ V

(1)

(b) Use the correct answer from the box to complete the sentence.

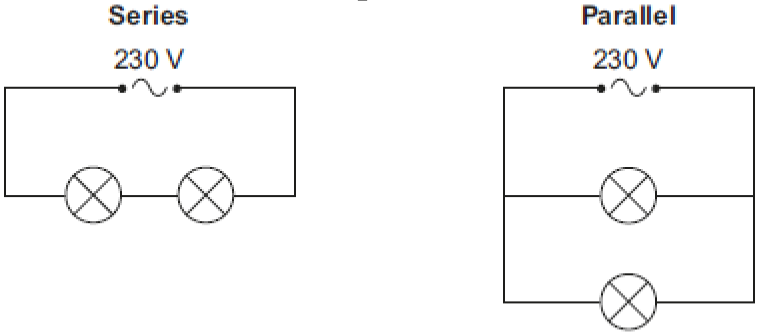
40	**50**	**60**

In the UK, the frequency of the a.c. mains electricity supply is ______ hertz.

(1)

(c) **Figure 2** shows how two lamps may be connected in series or in parallel to the 230 volt mains electricity supply.

Figure 2



(i) Calculate the potential difference across each lamp when the lamps are connected in **series**.
The lamps are identical.

____

Potential difference when in series = ___________ V

(1)

(ii) What is the potential difference across each lamp when the lamps are connected in **parallel**?

Tick (✔) **one** box.

115 V ☐ 230 V ☐ 460 V ☐

(1)

(iii) Give **one** advantage of connecting the lamps in parallel instead of in series.

___

___

(1)

Q2.(a) Describe the difference between an alternating current (a.c.) and a direct current (d.c.).

___

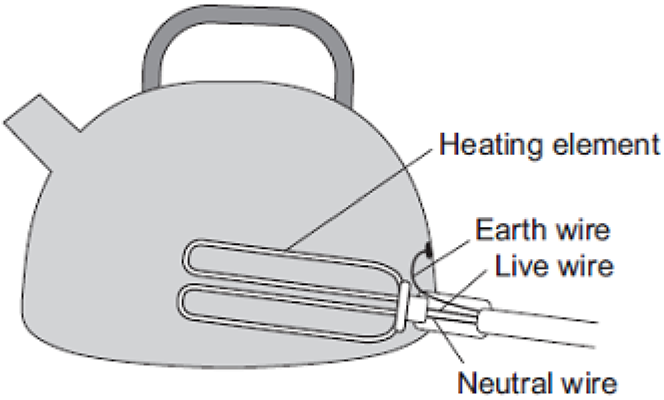
___

___

___

(2)

(b) The diagram shows how the electric supply cable is connected to an electric kettle. The earth wire is connected to the metal case of the kettle.



If a fault makes the metal case live, the earth wire and the fuse inside the plug protect anyone using the kettle from an electric shock.

Explain how.

___

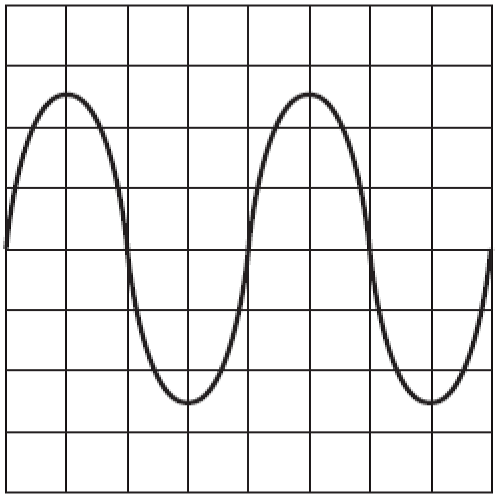
___

___

___

(2)
(Total 4 marks)

Q3. An oscilloscope is connected to an alternating current (a.c.) supply.
The diagram shows the trace produced on the oscilloscope screen.



Each horizontal division on the oscilloscope screen represents 0.002 s.

(a) Calculate the frequency of the alternating current supply.

Show clearly how you work out your answer and give the unit.

____

____

____

Frequency = ______________________________

(3)

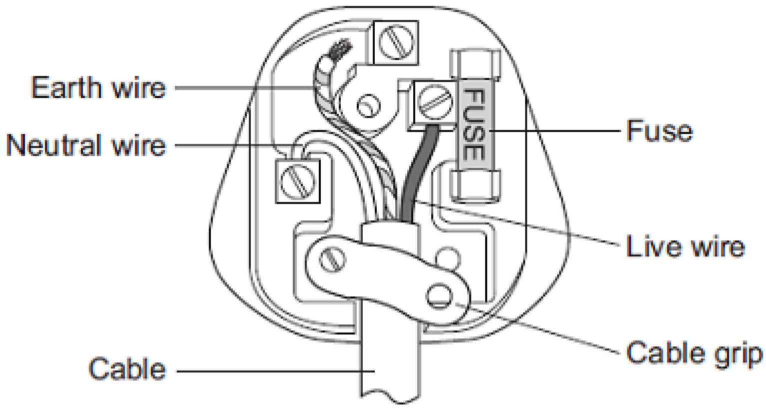
(b) What is the frequency of the a.c. mains electricity supply in the UK?

____

(1)
(Total 4 marks)

Q4.

(a) The diagram shows the inside of an incorrectly wired three-pin plug.



(i) What **two** changes need to be made so that the plug is wired correctly?

1. ____

2.

(2)

(ii) The fuse inside a plug is a safety device.

Explain what happens when too much current passes through a fuse.

(2)

Q5. An electrician is replacing an old electric shower with a new one.

The inside of the old shower is shown in the figure below.

(a) The electrician should **not** change the shower unless he switches off the mains electricity supply.

Explain why.

(2)

(b) The new shower has a power output of 10 690 W when it is connected to the 230 V mains electricity supply.

The equation which links current, potential difference and power is:

$$\text{current} = \frac{\text{power}}{\text{potential difference}}$$

Calculate the current passing through the new shower.

Give your answer to two significant figures.

____

____

____

Current = ______________________ A

(4)

(c) The new shower has a higher power rating than the old shower.

How does the power of the new shower affect the cost of using the shower?

Give a reason for your answer.

____

____

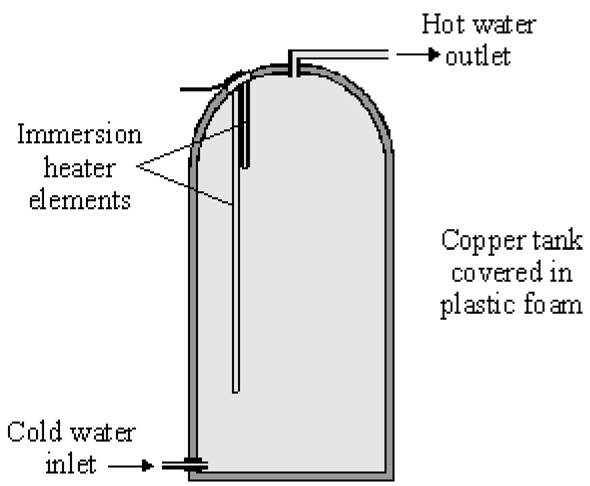
____

____

(2)

(Total 8 marks)

Q6. The diagram shows a type of electric immersion heater in a hot water tank. These hot water tanks are normally found in airing cupboards.



Information on the immersion heater states:

230 V
10 A

(a) (i) What is the equation which shows the relationship between power, current and voltage?

____

(1)

(ii) Calculate the power of the heater. Show clearly how you get to your answer and give the units.

____

Power = ______________________________

(2)

(b) (i) What rating of fuse should be in the immersion heater circuit?

____

(1)

(ii) There are three wires in the cable to the immersion heater. Two of the wires are connected to the immersion heater. The third wire is connected to the copper tank.

Explain the function of this third wire and the fuse in the circuit.

____

____

____

____

(3)

(c) (i) What is the equation which shows the relationship between resistance, current and voltage?

____

(1)

(ii) Calculate the resistance of the heater. Show clearly how you get to your answer and give the units.

____

Resistance = ______________________________

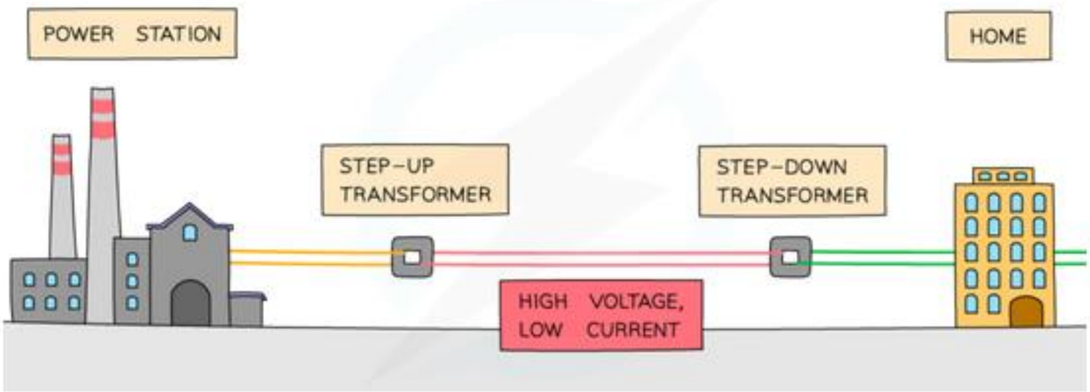
(2)

(Total 10 marks)

4.2.4.2 The national grid.

The national grid is a system of **cables** and **transformers**, linking power stations to consumers across the UK.

Electrical power is transferred from power stations to consumers using the National Grid.



Transformers – these **change the potential difference of an alternating current.** There are 2 types:

Step up transformer

- Increase the pd from the power station to the National Grid.
- So the power is constant (P=IV) current decreases so **less energy is lost** as heat to the surroundings.

Step down transformer

- Decrease pd
- From the National Grid to consumers
- For consumer safety

If you are interested…

- So why is '**low current and high voltage**' the desired choice for electrical power line transmission?
- The greater the current flowing through a wire, the greater the heat generated, which in the context of power lines means more waste heat energy the higher the current, which is why (ii) and (iv) are not employed.
    - Since **P = E/t =** $\mathbf{I^2R}$, the power loss is a function of I^2 for a fixed resistance - the National Grid cables.
    - This is a good numerical argument for minimising the current I.
- However, since **power = current x voltage**, to deliver a particular power rating, you must still increase one of the two variables and decrease the other.
- Therefore by using a **very high voltage** (eg 400 000 V, 400 kV) and **relatively low current** you maximise power transmission for the minimal heat loss of wasted electrical energy.
- So for a given power transmission increasing the p.d. and reducing the current makes the National Grid system as **efficient** it can be with the minimum of electrical energy lost to the thermal energy store of the surroundings.

Exam practice 4

Q1. Electricity is generated in power stations. It is then sent to all parts of the country through a network of cables.

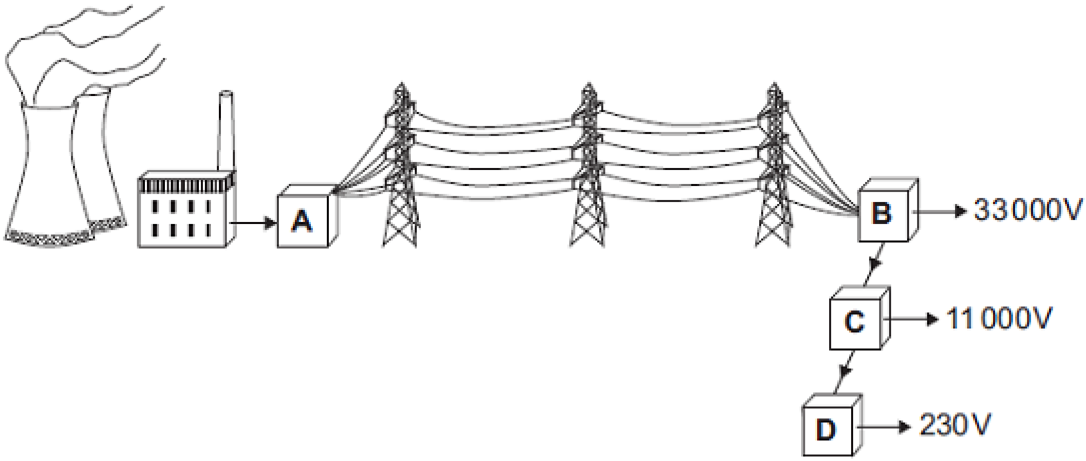
(a) Complete the following sentence by using **one** of the words in the box.

Grid	**Power**	**Supply**

The network is called the National ______________________________________ .

(1)

(b) In the diagram, **A**, **B**, **C** and **D** are transformers.



(i) Which transformer, **A**,**B**,**C** or **D**, is a step-up transformer?

Transformer _____________

(1)

(ii) Which transformer, **A**, **B**, **C** or **D** will supply homes, offices and shops?

Transformer _____________

(1)

(c) Complete the following sentence by drawing a ring around the correct line in the box.

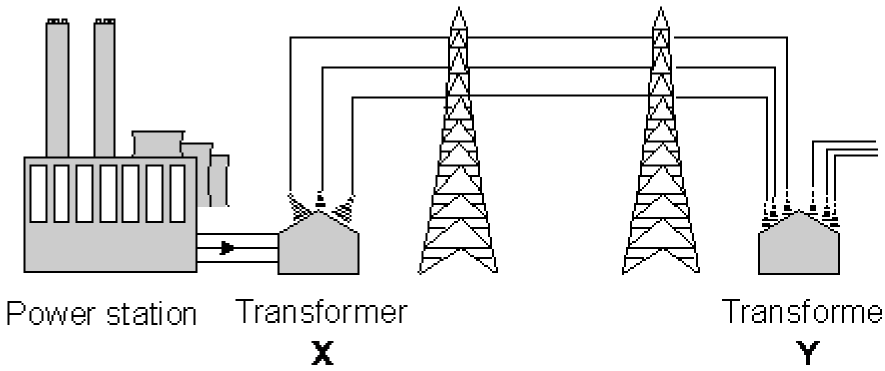
In a step-up transformer, the potential difference (p.d.) across the

primary coil is [less than / the same as / more than] the p.d. across the secondary coil.

(1)

(Total 4 marks)

Q2. The outline diagram below shows part of the National Grid. At **X** the transformer increases the voltage to a very high value. At **Y** the voltage is reduced to 240 V for use by consumers.



(i) At **X** a transformer increases the voltage. What happens to the current as the voltage is increased?

____

(1)

(ii) Why is electrical energy transmitted at very high voltages?

____

____

(1)

(iii) The transformer at **Y** reduces the voltage before it is supplied to houses. Why is this done?

____

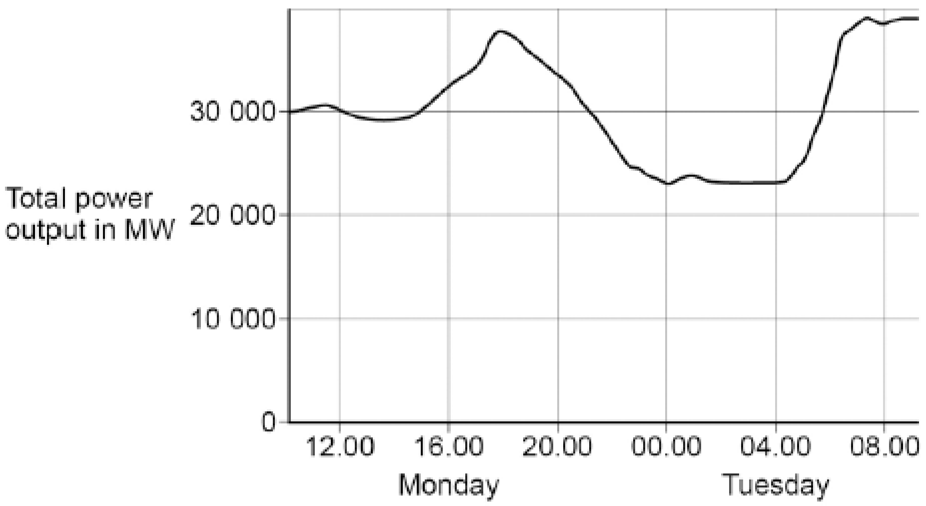
____

(1)

(Total 3 marks)

Q3. The National Grid ensures that the supply of electricity always meets the demand of the consumers.

The figure below shows how the output from fossil fuel power stations in the UK varied over a 24-hour period.



(a) Suggest **one** reason for the shape of the graph between 15.00 and 18.00 on Monday.

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(1)

(b) Gas fired power stations reduce their output when demand for electricity is low.

Suggest **one** time on the figure above when the demand for electricity was low.

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(1)

(c) The National Grid ensures that fossil fuel power stations in the UK only produce about 33% of the total electricity they could produce when operating at a maximum output.

Suggest **two** reasons why.

1. ____

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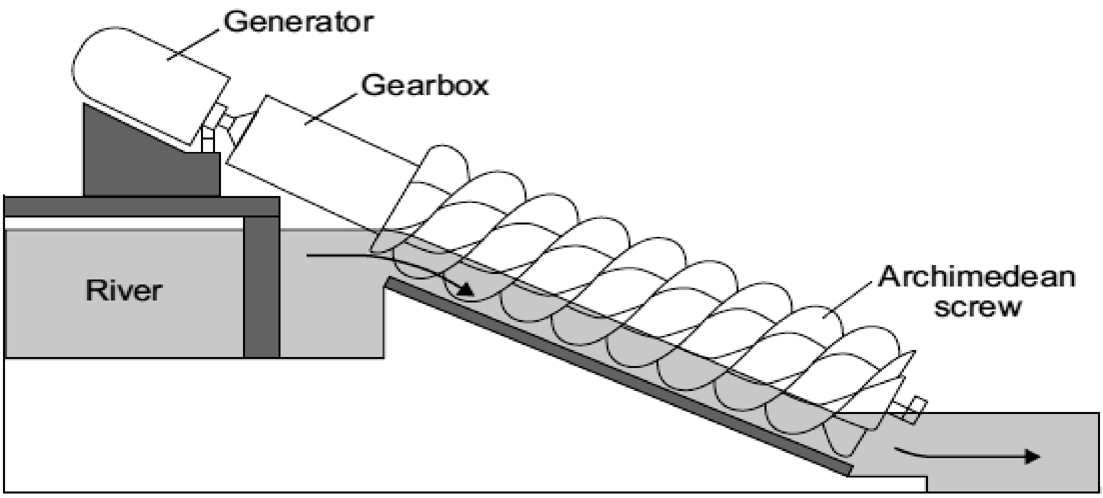
2. ____

____

(2)

(Total 4 marks)

Q4. The diagram shows a small-scale, *micro-hydroelectricity* generator which uses the energy of falling river water to generate electricity. The water causes a device, called an Archimedean screw, to rotate. The Archimedean screw is linked to the generator by a gearbox.



(a) Each second, the *micro-hydroelectricity* generator transforms 80 000 joules of gravitational potential energy into 60 000 joules of electrical energy.

(i) Fill in the missing word to complete the energy transformation diagram.

Gravitational potential energy of the falling water	→	__________ energy of the Archimedean screw	→	Electrical energy generated

(1)

(ii) Use the equation in the box to calculate the efficiency of the *micro-hydroelectricity* generator.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

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Efficiency = ________________________________

(2)

(c) The electricity generated by a micro-hydroelectric system is transferred via a transformer directly to local homes. The electricity generated by a conventional large-scale hydroelectric power station is transferred to the National Grid, which distributes the electricity to homes anywhere in the country.

(i) What is the National Grid?

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(1)

(ii) Explain why transferring the electricity directly to local homes is more efficient than using the National Grid to distribute the electricity.

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(2)
(Total 7 marks)

Q5. A small community of people live in an area in the mountains.
The houses are not connected to the National Grid.

The people plan to buy an electricity generating system that uses either the wind or the flowing water in a nearby river.

Figure 1 shows where these people live.

Figure 1

(a) It would not be economical to connect the houses to the National Grid.
Give **one** reason why.

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(1)

(b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Information about the two electricity generation systems is given in **Figure 2**.

Figure 2

The wind turbine costs £50 000 to buy and install.
The hydroelectric generator costs £20 000 to buy and install.
The average power output from the wind turbine is 10 kW.
The hydroelectric generator will produce a constant power output of 8 kW.

Compare the advantages and disadvantages of the two methods of generating electricity.

Use your knowledge of energy sources as well as information from **Figure 2**.

(6)
(Total 7 marks)