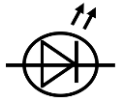
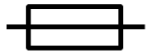
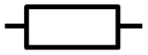
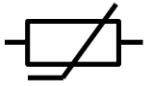
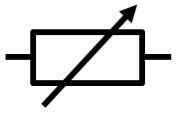
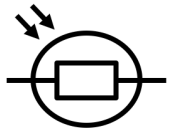
Electricity

Paper 1

2.1.1 Circuit Diagram Symbols

Component	Symbol	Component	Symbol
Open Switch		LED	
Closed Switch		Lamp	
Cell		Fuse	
Battery		Voltmeter	
Diode		Ammeter	
Resistor		Thermistor	
Variable Resistor		LDR	

CS/F CS/H SS/F SS/H

2.1.2 Electrical Charge and Current

Think
Pair
Share

What is electric current?

You may need to convert units!

Amperes
A

Charge Flow= Current x Time

Q = I x t

Coulombs C

Seconds
s

Key Term	Definition
Electric Current	

CS/F CS/H SS/F SS/H

2.1.2 Electrical Charge and Current

A torch worked for 14,400seconds before needing to be replaced. The current in the LED was 50mA. Calculate the charge flow. (3)

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Show all of your working out.

CS/F CS/H SS/F SS/H

2.1.2 Electrical Charge and Current

Calculate the time when charge flow is 8C and current is 2mA. (3)

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Substitute before you do any rearranging. 1 mark for doing this.

Show each step that you do.

CS/F CS/H SS/F SS/H

2.1.3 Current, Resistance and PD

Think
Pair
Share

What does current through a component depend on?

The current through a component depends on both the resistance of the component and the potential difference across it.

The greater the resistance of the component the smaller the current for a given potential difference.

You may need to convert units!

Amperes
A

Potential Difference = Current x Resistance

V = I x R

Volts V

Ohms
Ω

CS/F CS/H SS/F SS/H

2.1.3 Current, Resistance and PD

A filament lamp has a current of 800mA through it and its resistance is 2.5Ω. Calculate the potential difference. (3)

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Show all of your working out.

CS/F CS/H SS/F SS/H

2.1.3 Current, Resistance and PD

A hob draws a current of 26 A from the 230 V mains electricity supply. Calculate the resistance. (3)

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Substitute before you do any rearranging. 1 mark for doing this.

Show each step that you do.

CS/F CS/H SS/F SS/H

2.1.3 Current, Resistance and PD

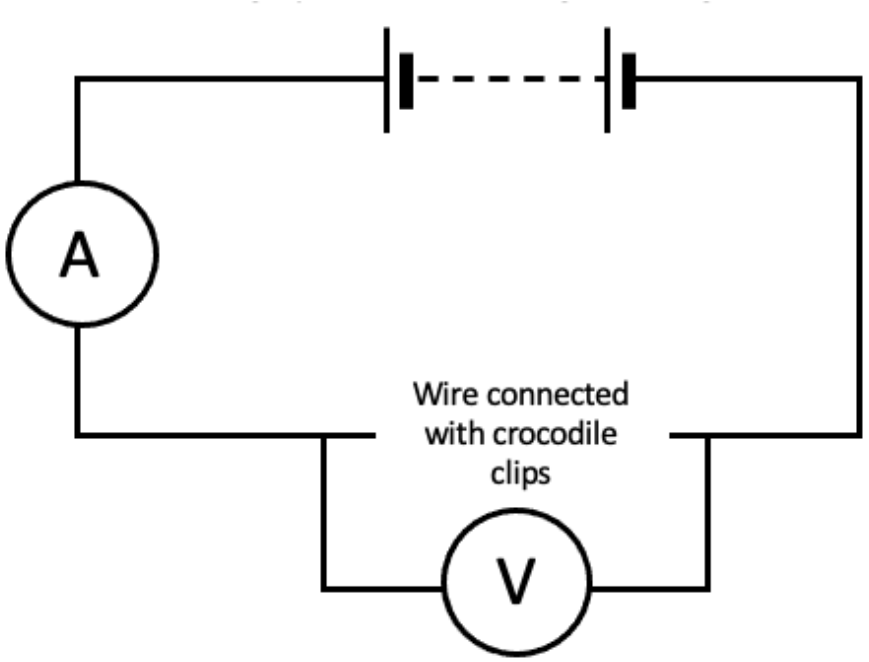
Think Pair Share

How can we investigate the relationship between the length of a wire and its resistance?

Set up equipment as shown in the diagram.

Place the crocodile clips 10cm apart on the length of the wire.

Record the current and voltage.



CS/F CS/H SS/F SS/H

2.1.3 Current, Resistance and PD

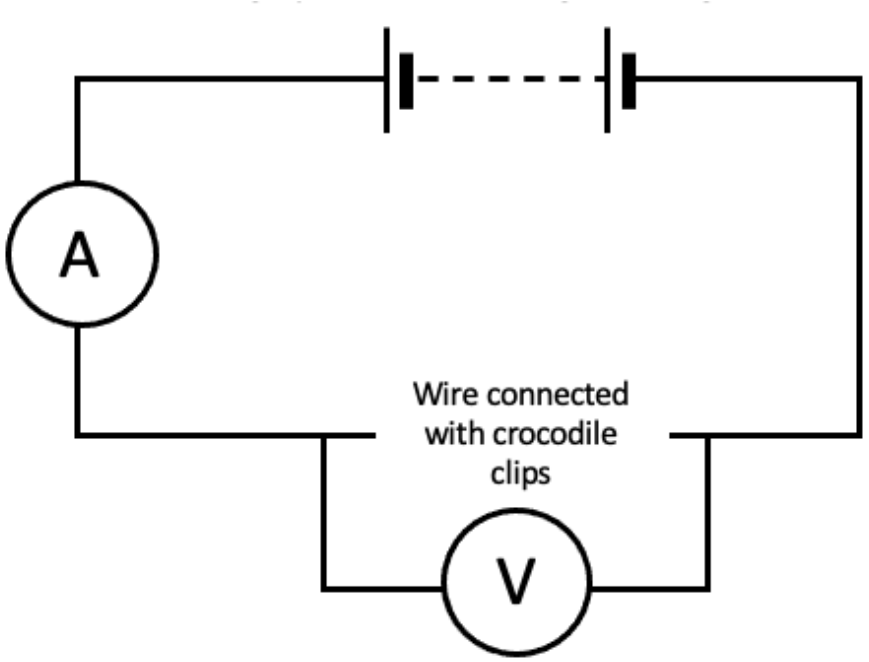
Think
Pair
Share

How can we investigate the relationship between the length of a wire and its resistance?

Calculate resistance using the formula resistance = potential difference/current

Repeat for different lengths of wire at 10cm intervals.

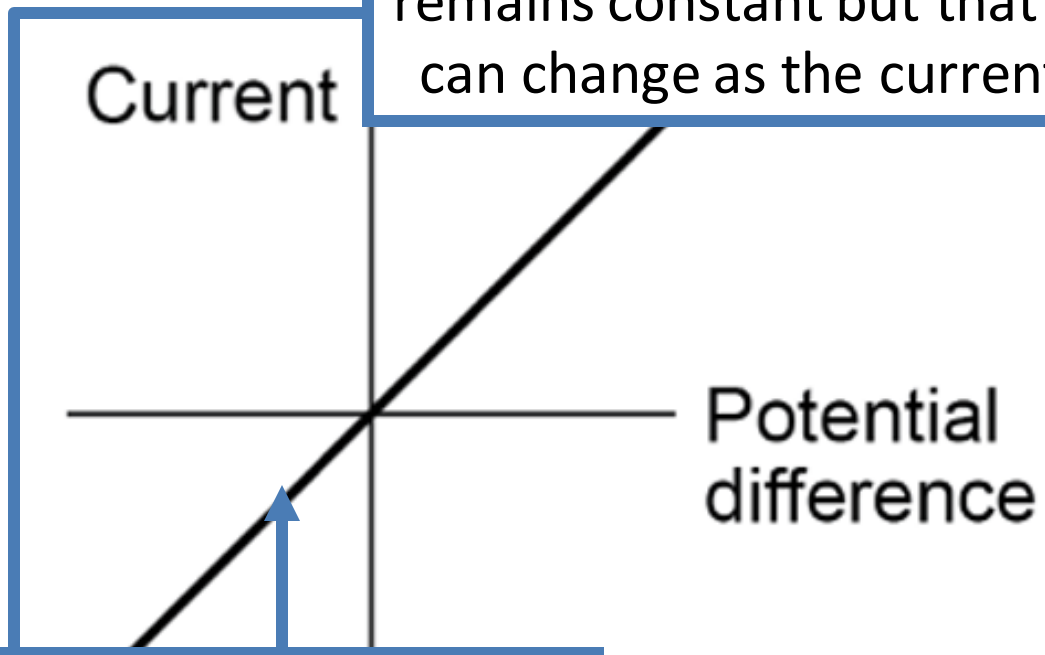
Plot a graph of resistance against length.



CS/F CS/H SS/F SS/H

2.1.4 Resistors

For some resistors, the value of *R* remains constant but that in others it can change as the current changes.



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

This means that the resistance remains constant as the current changes.

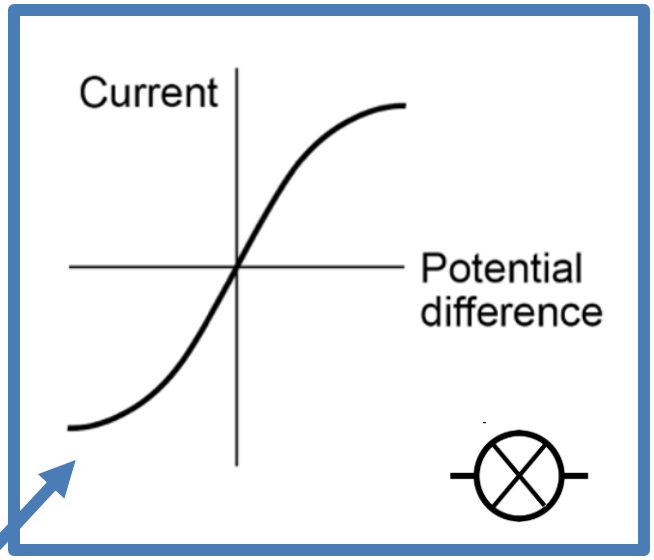
CS/F CS/H SS/F SS/H

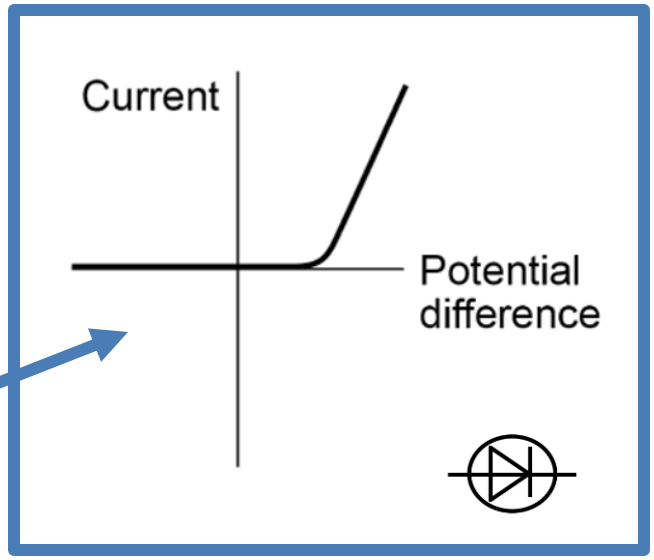
2.1.4 Resistors

The resistance of components such as lamps, diodes, thermistors and LDRs is not constant; it changes with the current through the component.

The resistance of a **filament lamp** increases as the temperature of the filament increases.

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

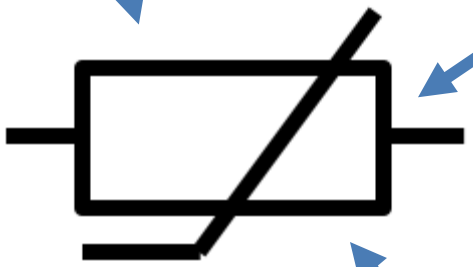




CS/F CS/H SS/F SS/H

2.1.4 Resistors

The resistance of a thermistor decreases as the temperature increases.



At high temperatures, the resistance of a thermistor is low and more current can flow through them.

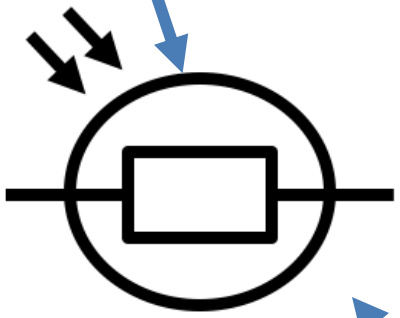
At high temperatures, the resistance of a thermistor is low and more current can flow through them.

Thermistors are used in thermostats.

CS/F CS/H SS/F SS/H

2.1.4 Resistors

The resistance of an LDR decreases as light intensity increases.



In the dark and at low light levels, the resistance of an LDR is high and little current can flow through it.

In bright light, the resistance of an LDR is low and more current can flow through it

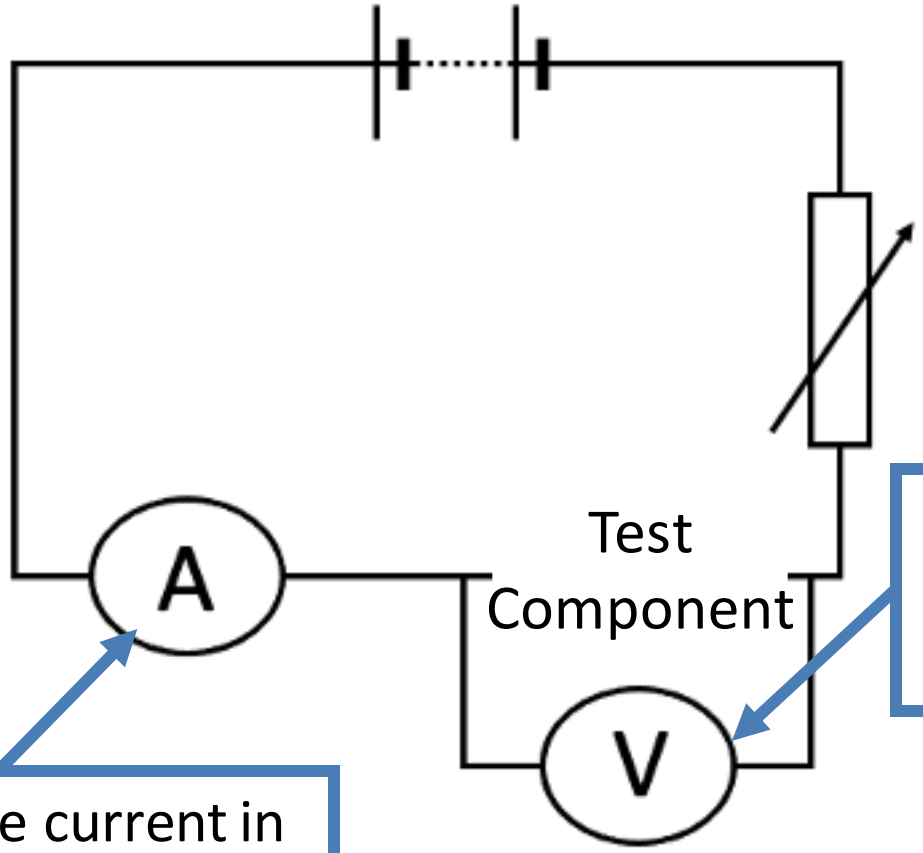
LDR's are used in circuits to switch on lights when it gets dark.

CS/F CS/H SS/F SS/H

2.1.4 Resistors

Think
Pair
Share

How can we determine the resistance of a component in a circuit?



Measure the current in the circuit using an ammeter.

Measure the voltage across the component.

CS/F CS/H SS/F SS/H

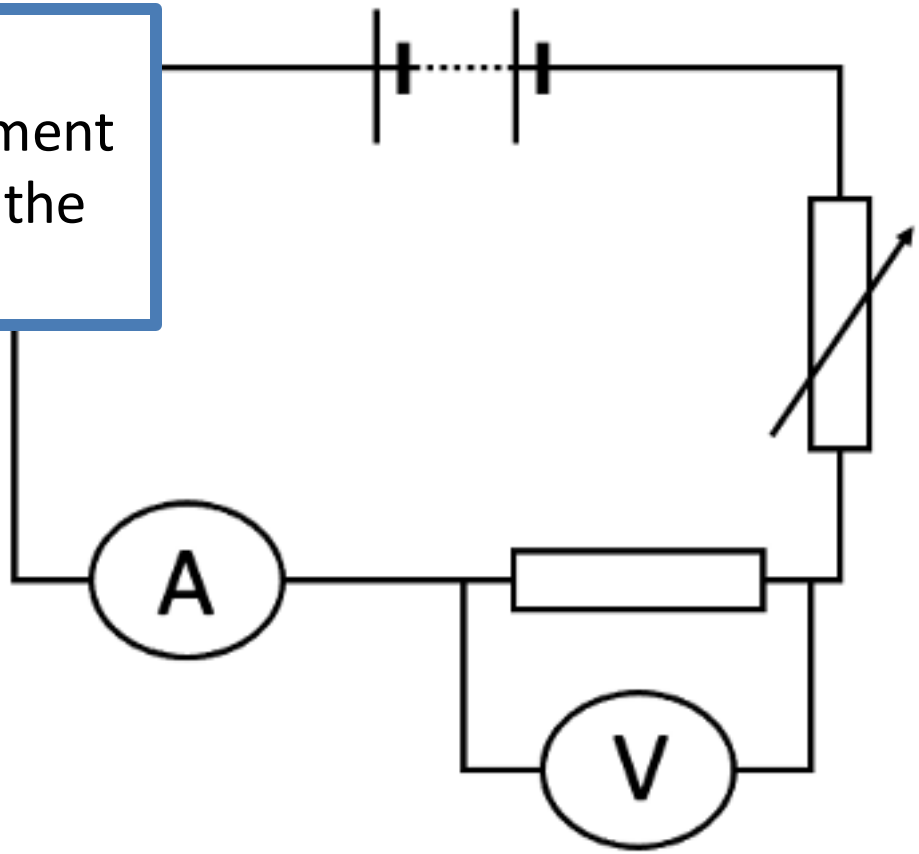
2.1.4 Resistors

Think Pair Share

How can we investigate the IV characteristics of a resistor?

1

Set up equipment as shown in the diagram.



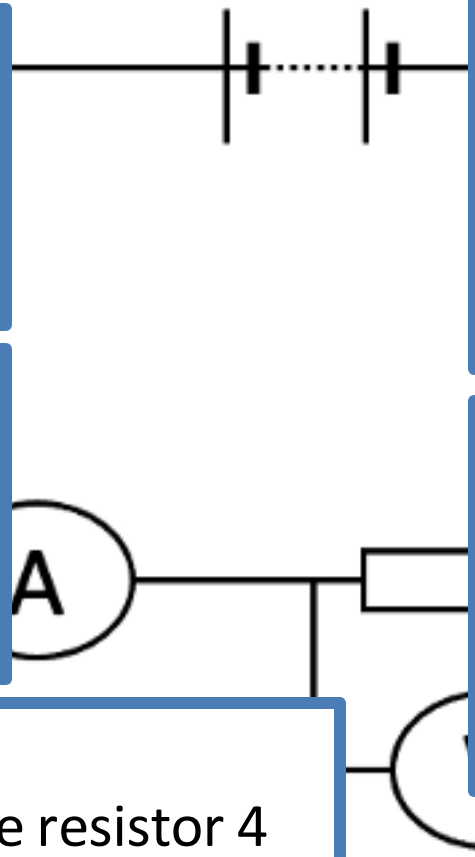
CS/F CS/H SS/F SS/H

2.1.4 Resistors

Think Pair Share

How can we investigate the IV characteristics of a resistor?

1
Set up equipment as shown in the diagram.



2
Record the current and voltage.

3
Adjust the variable resistor 4 more times recording the new current and voltage each time.

4
Swap the leads on the battery so that the reading on the ammeter and voltmeter is negative.

5
Record the current and voltage 5 times adjusting the variable resistor between each reading.

CS/F CS/H SS/F SS/H

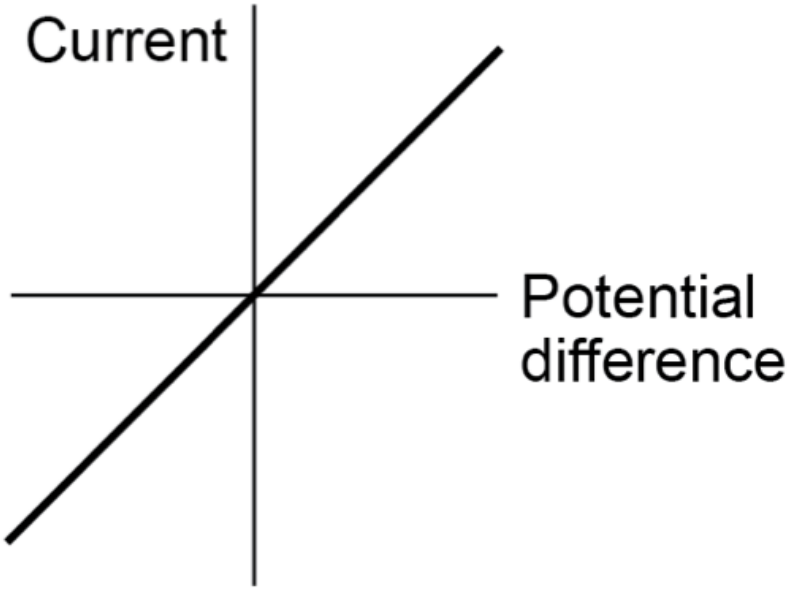
2.1.4 Resistors

Think
Pair
Share

How can we investigate the IV characteristics of a resistor?

6

Plot a graph of current against potential difference.



CS/F CS/H SS/F SS/H

2.1.4 Resistors

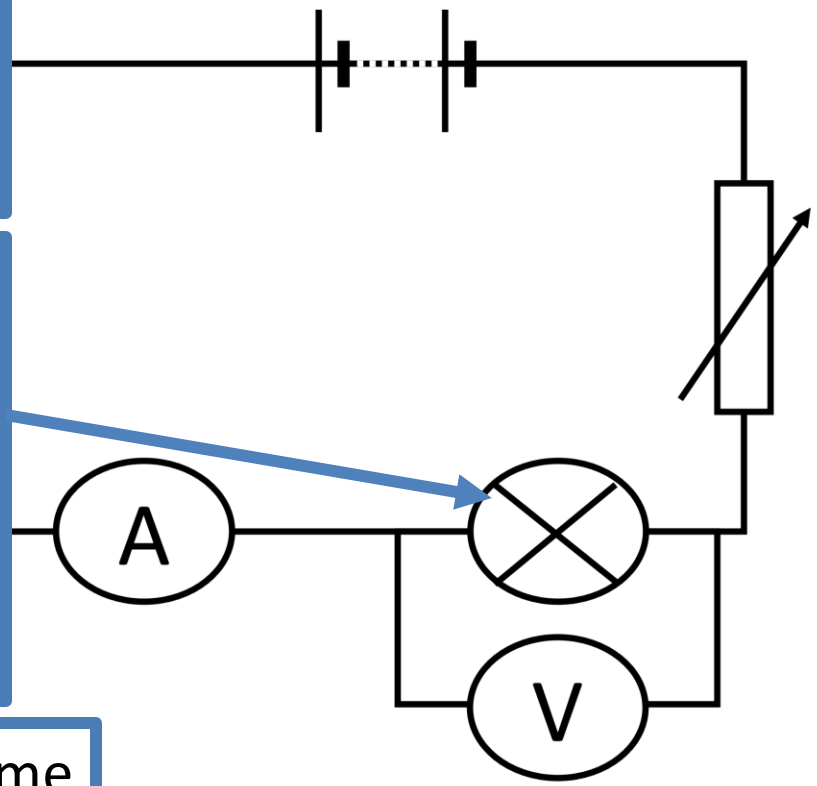
Think Pair Share

How can we investigate the IV characteristics of a filament lamp?

Set up equipment as shown in the diagram.

Notice it is the same as the earlier circuit with a filament lamp rather than a resistor.

Repeat using the same method that was used for the resistor.



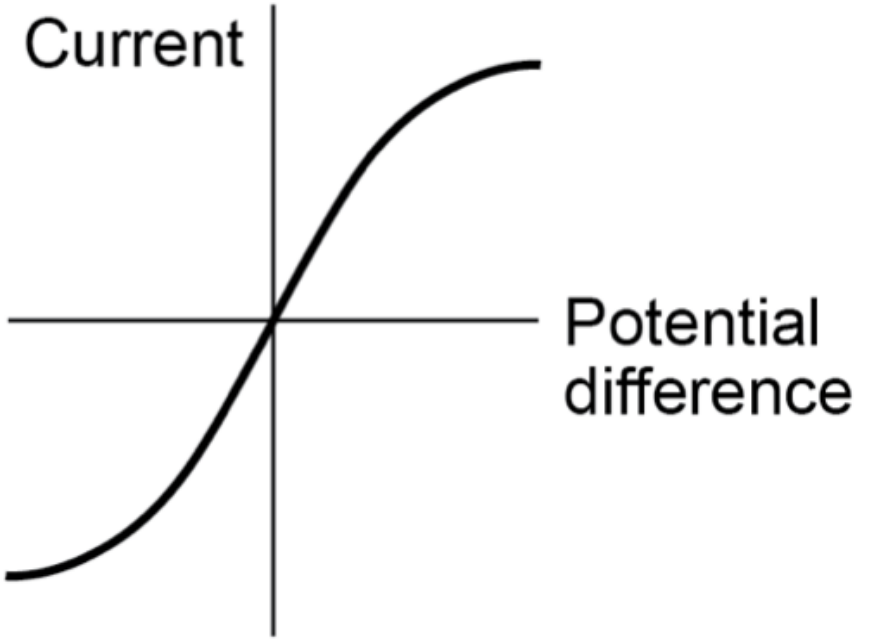
CS/F CS/H SS/F SS/H

2.1.4 Resistors

Think
Pair
Share

How can we investigate the IV characteristics of a filament lamp?

Plot a graph of current against potential difference.



CS/F CS/H SS/F SS/H

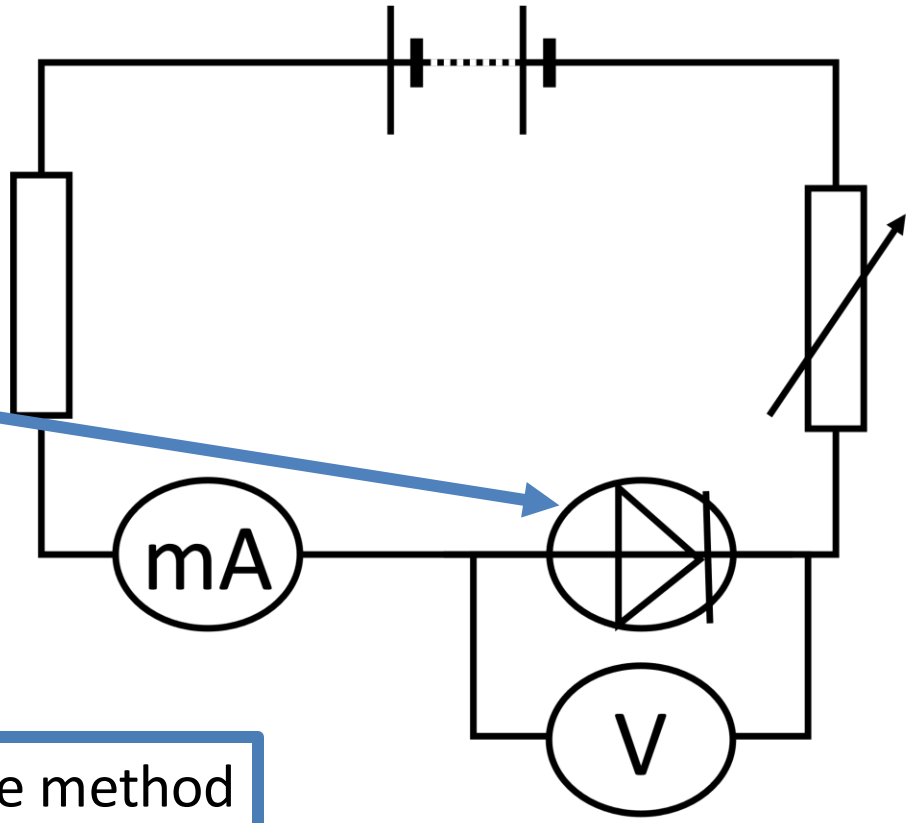
2.1.4 Resistors

Think Pair Share

How can we investigate the IV characteristics of a diode?

Set up equipment as shown in the diagram.

Notice it is the same as the earlier circuit with a diode rather than a resistor or a filament lamp.



Repeat using the same method that was used for the resistor and filament lamp.

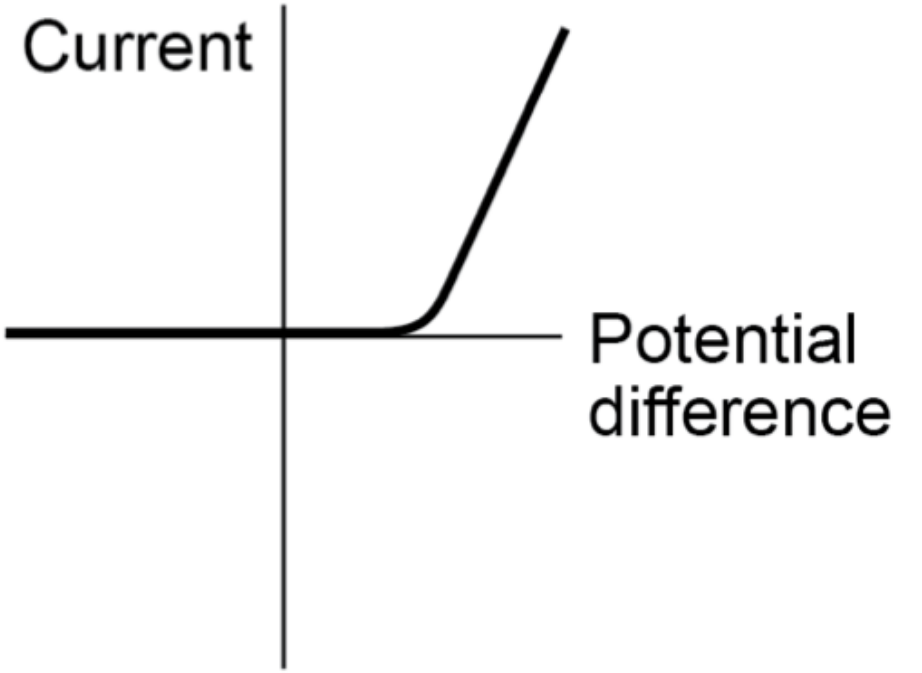
CS/F CS/H SS/F SS/H

2.1.4 Resistors

Think Pair Share

How can we investigate the IV characteristics of a diode?

Plot a graph of current against potential difference.



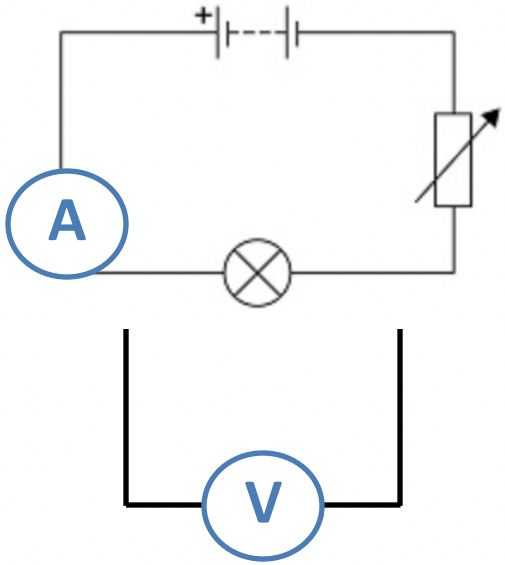
CS/F CS/H SS/F SS/H

Exam Practice

L2

A student investigated how the current in a filament lamp varied with the potential difference across the filament lamp.

The diagram below shows part of the circuit used.



(a) Complete above diagram by adding an ammeter and a voltmeter.

Use the correct circuit symbols.

(3)

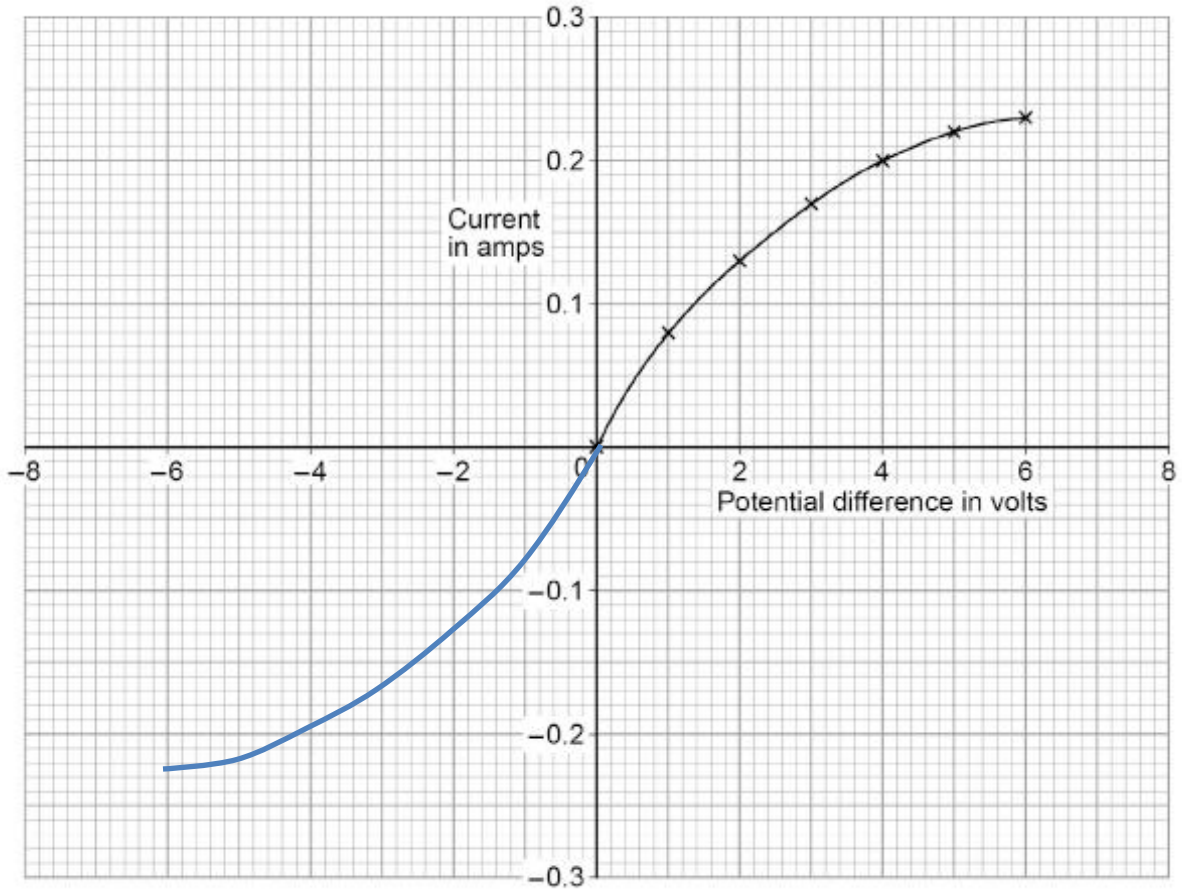
Exam Practice

L2

The student reversed the connections to the power supply and obtained negative values for the current and potential difference.

Draw a line on the graph to show the relationship between the negative values of current and potential difference.

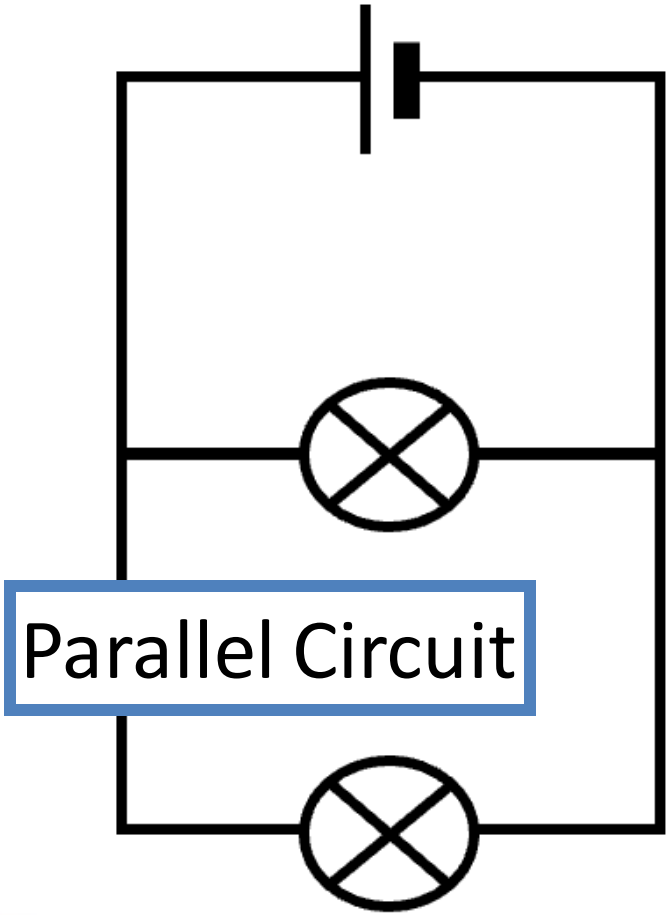
(2)



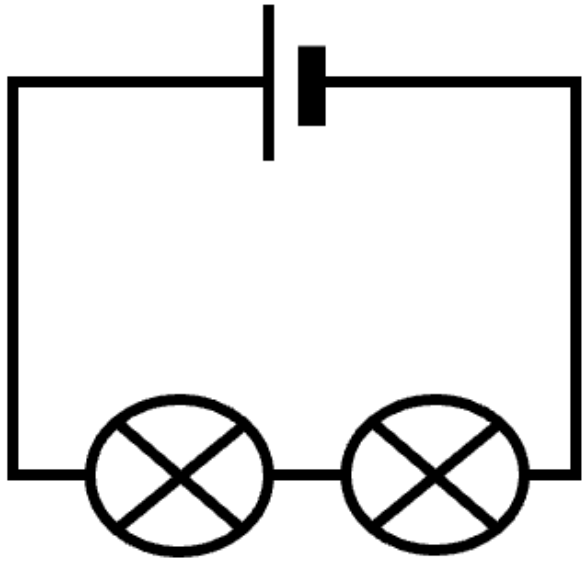
2.2 Series & Parallel Circuits

Think
Pair
Share

What are the similarities and differences between series and parallel circuits?



Parallel Circuit



Series Circuit

CS/F CS/H SS/F SS/H

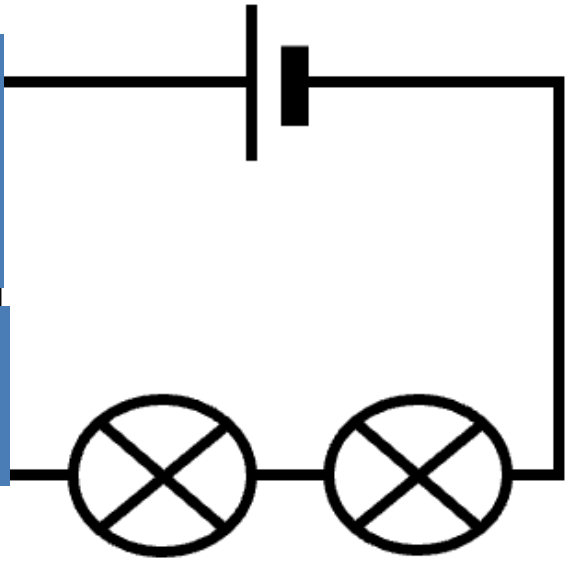
2.2 Series & Parallel Circuits

Think
Pair
Share

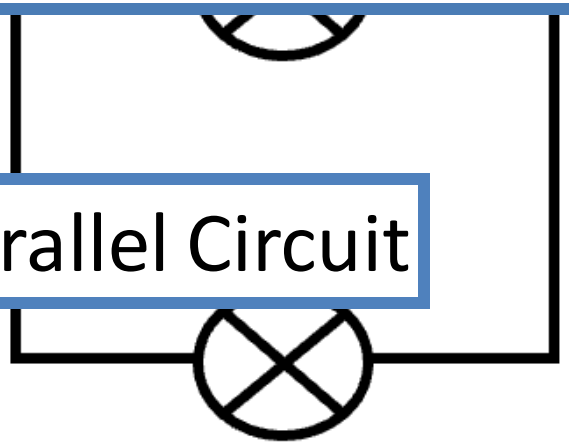
What are the similarities and differences between series and parallel circuits?

There are two ways of joining electrical components, in series and in parallel.

Some circuits include both series and parallel parts.



Parallel Circuit



Series Circuit

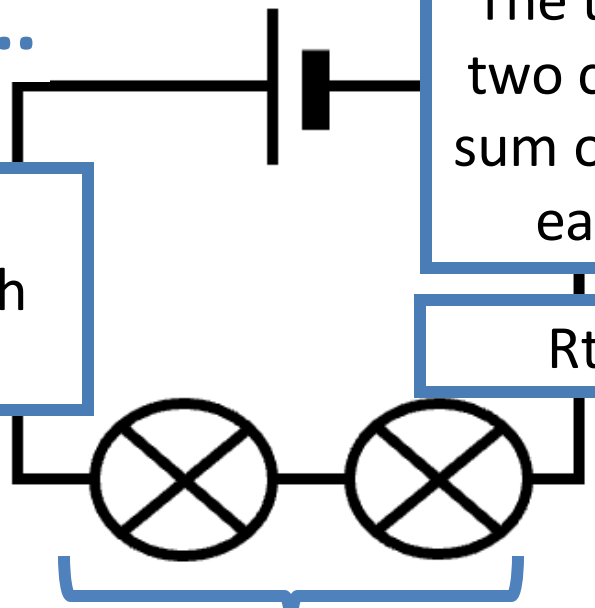
CS/F CS/H SS/F SS/H

2.2 Series & Parallel Circuits

Think
Pair
Share

What are the similarities and differences between series and parallel circuits?

In a series circuit..



The total resistance of two components is the sum of the resistance of each component.

Rtotal = R1 + R2

There is the same current through each component

The total potential difference of the power supply is shared between the components.

CS/F CS/H SS/F SS/H

2.2 Series & Parallel Circuits

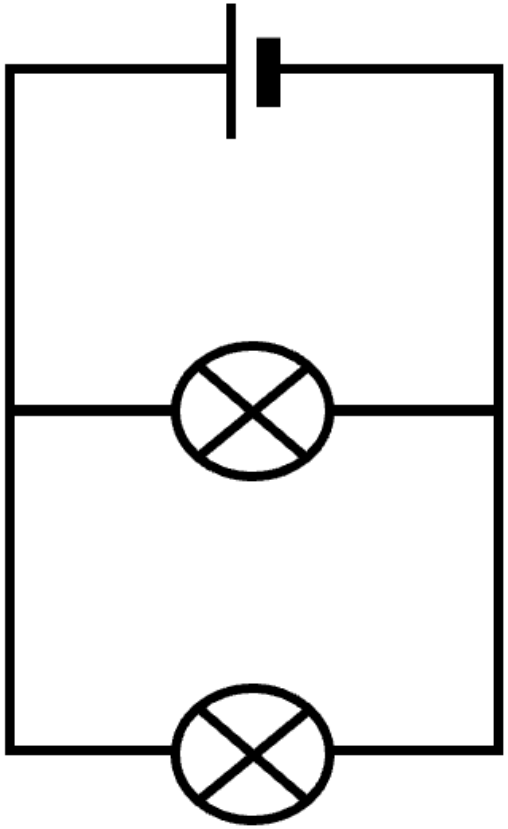
Think
Pair
Share

What are the similarities and differences between series and parallel circuits?

In a parallel circuit..

The potential difference across each component is the same.

The total current through the whole circuit is the sum of the currents through the separate components



The total resistance of two resistors is less than the resistance of the smallest individual resistor.

CS/F CS/H SS/F SS/H

2.3.1 Potential Difference

Think
Pair
Share

What is direct and alternating current?

Key Term	Definition	Example of Source
Direct Current		
Alternating Current		

CS/F CS/H SS/F SS/H

2.3.1 Potential Difference

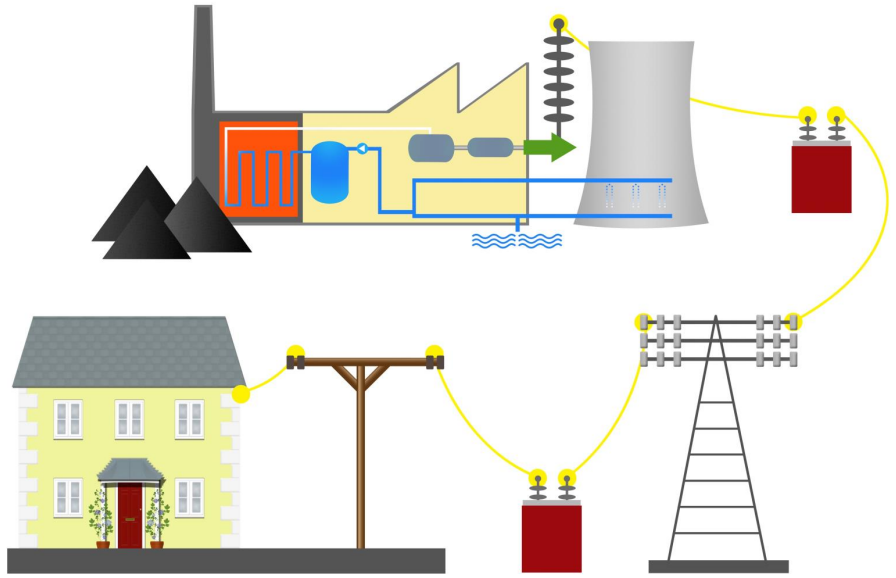
Think
Pair
Share

What is the potential difference and frequency of electricity in the UK?

Mains electricity in the UK is an ac supply.

It has a frequency of 50Hz.

Potential difference is 230V



CS/F CS/H SS/F SS/H

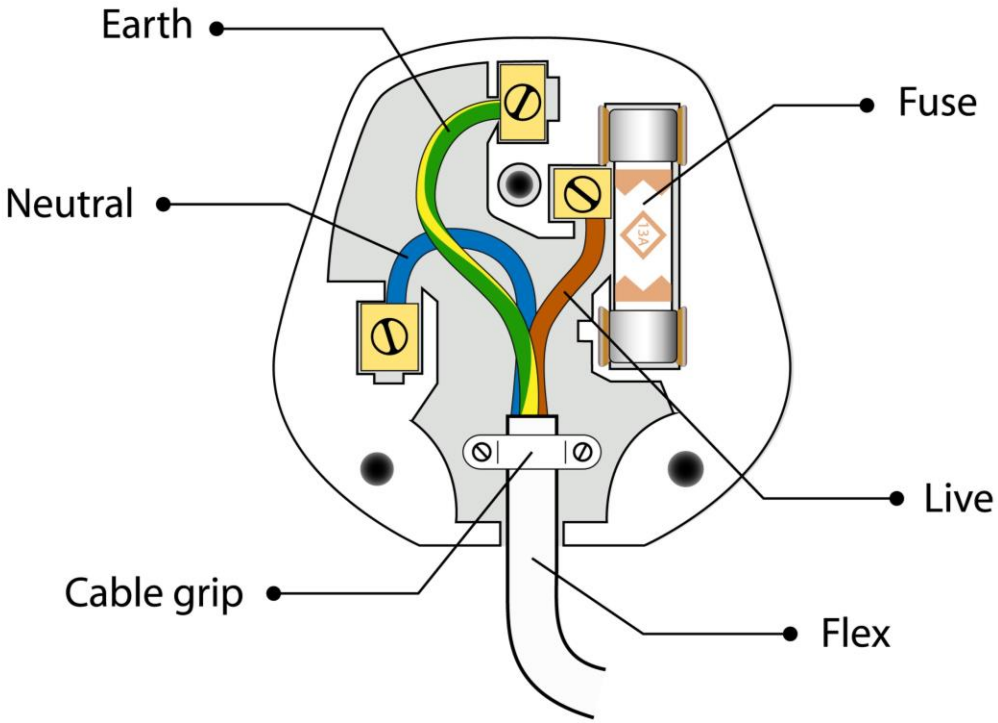
2.3.2 Mains Electricity

Think
Pair
Share

How does a plug work?

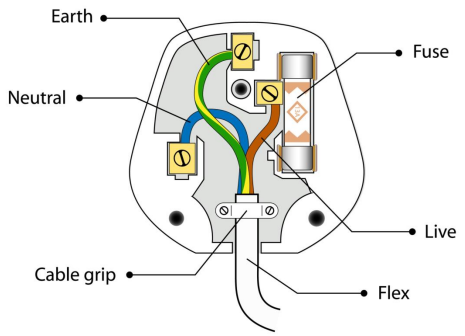
Most electrical appliances are connected to the mains using three-core cable.

The insulation covering each wire is colour coded for easy identification.



CS/F CS/H SS/F SS/H

2.3.2 Mains Electricity



Think
Pair
Share

How does a plug work?

Wire	Colour	Description	Potential Difference
Live Wire			
Neutral Wire			
Earth Wire			

CS/F CS/H SS/F SS/H

2.3.2 Mains Electricity

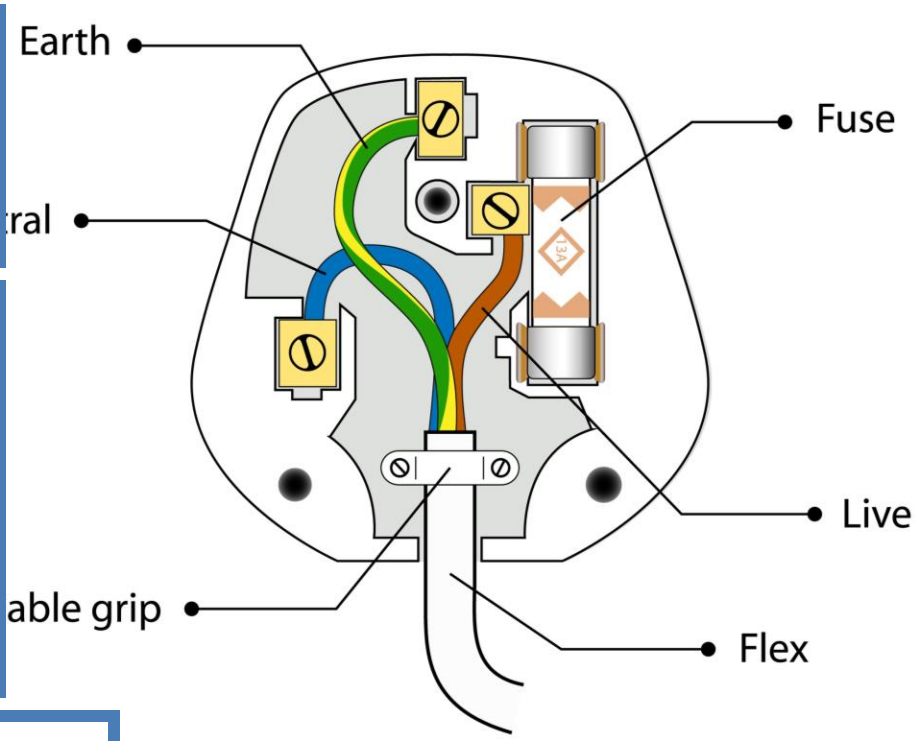
Think
Pair
Share

Why a live wire may be dangerous even when a switch is open?

A live wire may be dangerous even when a switch is open.

This is because if the circuit were to be accidently complete then there would be a large potential difference.

This large potential difference could then cause electrocution.



CS/F CS/H SS/F SS/H

2.3.2 Mains Electricity

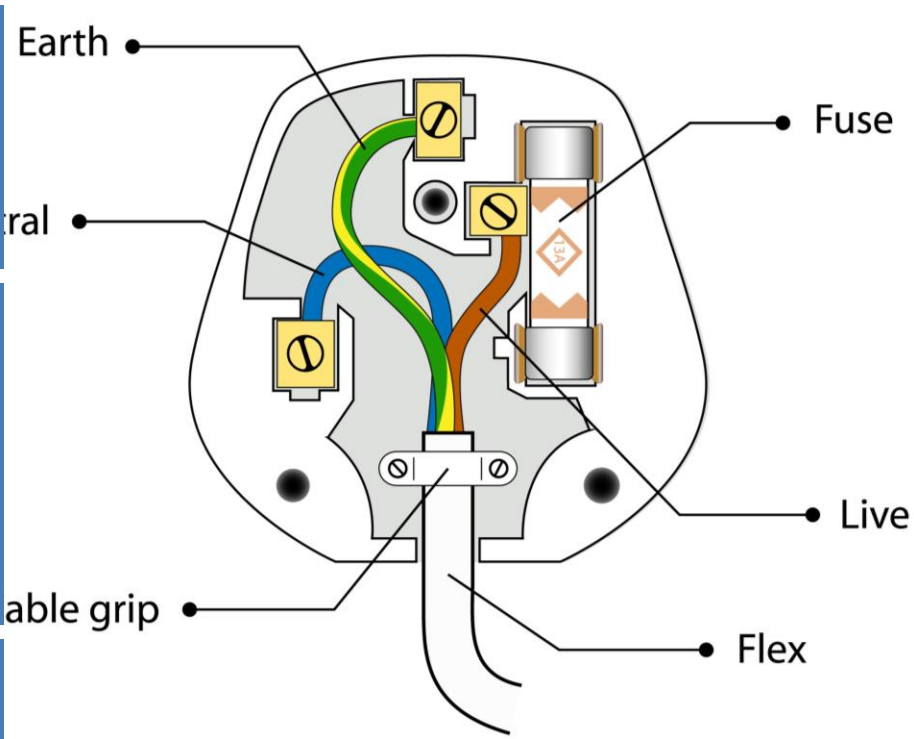
Think
Pair
Share

Why it is dangerous if a live wire and earth wire are connected?

A live wire and earth wire should not be connected together.

This is because if they were to touch there would be a complete circuit from the live circuit to the ground. T

This can cause shocks or fires.



CS/F CS/H SS/F SS/H

2.4.1 Power

Think
Pair
Share

How can we calculate power?

Amperes
A

Power = Potential Difference x Current

P = V x I

Watts W

Potential Difference
V

OR

Ohms
Ω

Power = (Current)^2 x Resistance

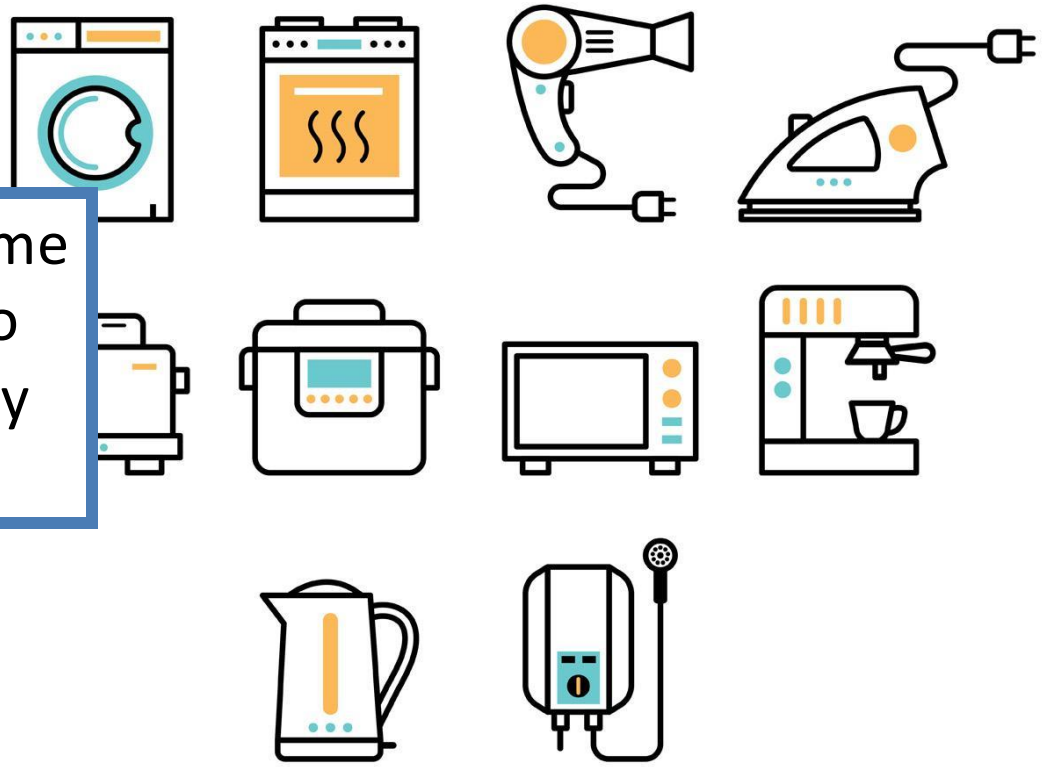
P = I^2 x R

CS/F CS/H SS/F SS/H

2.4.2 Energy Transfers in Appliances

Think
Pair
Share

What are domestic electrical appliances?



An object in the home that is designed to bring about energy transfers.

CS/F CS/H SS/F SS/H

2.4.2 Energy Transfers in Appliances

Think
Pair
Share

What does the amount of energy an appliance transfer depend on?

The energy an appliance transfers depends on the power of the appliance and the time it is turned on for.

CS/F CS/H SS/F SS/H

2.4.2 Energy Transfers in Appliances

Think
Pair
Share

What does the amount of energy an appliance transfer depend on?

You may need to convert units!

Watts
W

Energy Transferred = Power x Time

E = P x t

Joules
J

Seconds
s

CS/F CS/H SS/F SS/H

2.4.2 Energy Transfers in Appliances

A toaster is on for 1 minute and has a power rating of 800W. Calculate the energy transferred (4)

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Substitute before you do any rearranging.

Show each step that you do.

CS/F CS/H SS/F SS/H

2.4.2 Energy Transfers in Appliances

A 900W microwave transfers 1.2kJ of energy. Calculate how long its turned on for.

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Substitute before you do any rearranging.

Show each step that you do.

Answer to 2 s.f which is the same as the values in the qu.

CS/F CS/H SS/F SS/H

2.4.2 Energy Transfers in Appliances

Think
Pair
Share

What is electrical work?

This is one equation you can use to calculate work done by an electrical appliance.

Energy Transferred = Power x Time

Another is...

Key Term	Definition
Electrical Work	

2.4.2 Energy Transfers in Appliances

Think
Pair
Share

What is electrical work?

You may need to convert units!

Coulombs
C

Energy Transferred = Charge Flow x Potential Difference

E = Q x V

Joules
J

Volts
V

CS/F CS/H SS/F SS/H

2.4.2 Energy Transfers in Appliances

Calculate the energy transferred when charge flow is 30C and potential difference is 2kV. (4)

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Substitute before you do any rearranging.

Show each step that you do.

Answer to an appropriate no. of sig figs.

CS/F CS/H SS/F SS/H

2.4.2 Energy Transfers in Appliances

Calculate charge flow when potential difference is 12V and the energy transferred is 1.32kJ

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Substitute before you do any rearranging.

Show each step that you do. Do as much as the calculation that you can before rearranging.

Answer to 2 s.f which appropriate for values in the qu.

CS/F CS/H SS/F SS/H

2.4.2 Energy Transfers in Appliances

The equations we have discussed so far:

Power = Potential Difference x Current

Power = Current^2 x Resistance

Energy Transferred = Power x Time

Energy Transferred = Charge Flow x Potential Difference

Charge Flow = Current x Time

You may need to use a couple of these equations together to complete a calculation

CS/F CS/H SS/F SS/H

Exam Practice

L3

When the charger is connected to the battery, the potential difference across the battery is 15.0 V

The total energy stored when the battery is fully charged is 0.81 MJ

The average current used to charge the battery is 3.00 A

Calculate the time taken to fully charge the battery.

810,000J

Identify values given

Unit conversions

Identify equation 1

Substitute and do maths

Identify equation 2

Substitute and do maths

Power = Current x Potential Difference

Power = 3 x 15 = 45W

Energy Transferred = Power x Time

810,000 = 45 x t

t = 810,000 / 45

t = 18,000s

Time taken = _____ s

(6)

2.4.2 Energy Transfers in Appliances

Think
Pair
Share

What is the relationship between power ratings and the changes in stored energy?

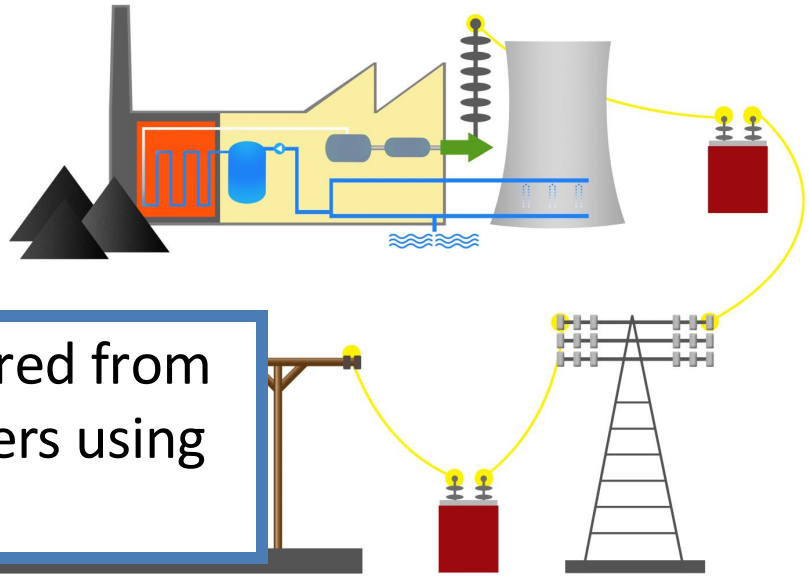
A device with a higher power rating will transfer stored energy to other types of energy at a faster rate.

CS/F CS/H SS/F SS/H

2.4.3 National Grid

Think
Pair
Share

What is the national grid?



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

Key Term	Definition
National Grid	

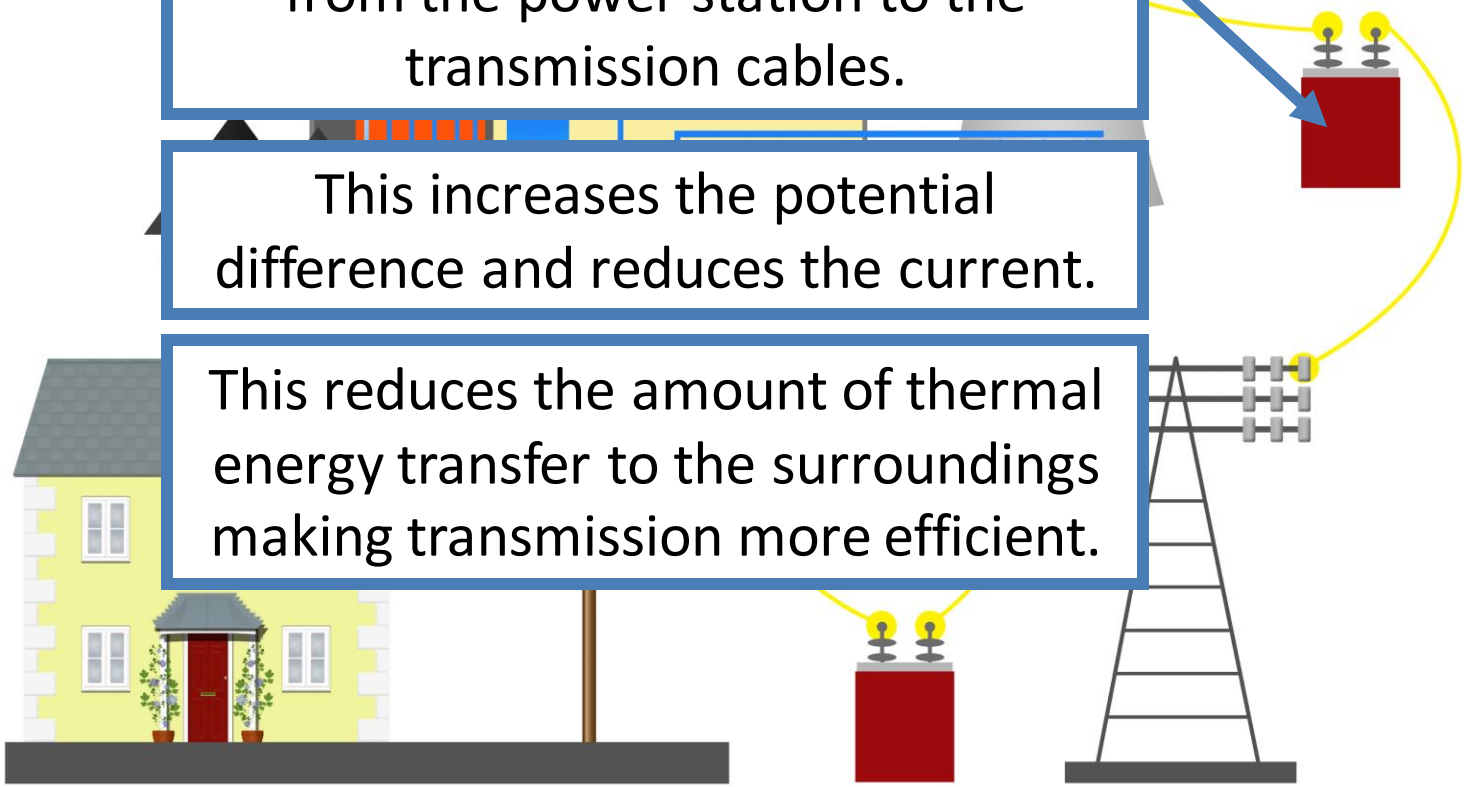
CS/F CS/H SS/F SS/H

2.4.3 National Grid

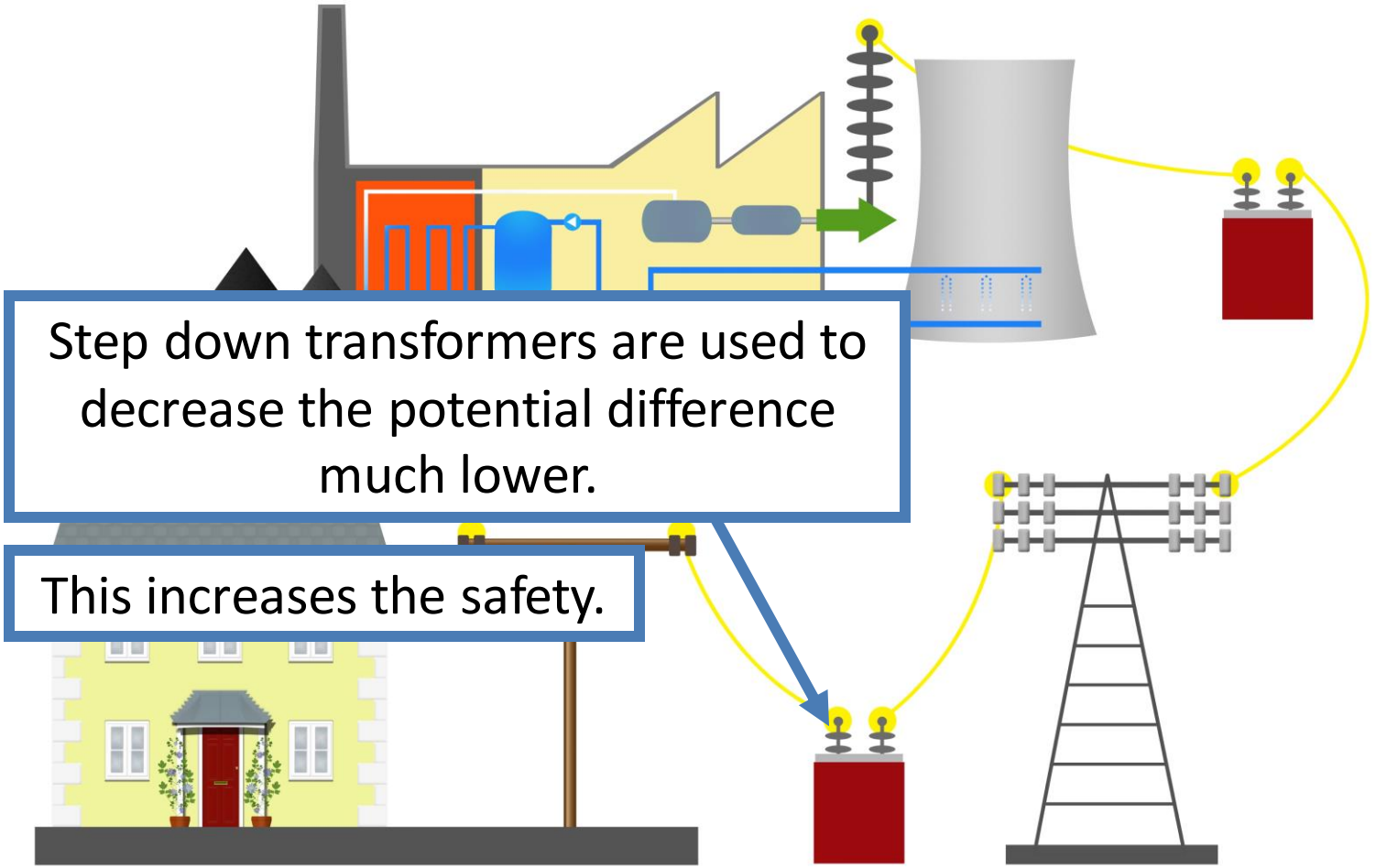
Step-up transformers are used to increase the potential difference from the power station to the transmission cables.

This increases the potential difference and reduces the current.

This reduces the amount of thermal energy transfer to the surroundings making transmission more efficient.



2.4.3 National Grid



Step down transformers are used to decrease the potential difference much lower.

This increases the safety.

CS/F CS/H SS/F SS/H

Exam Practice

L2

Outline the advantages and disadvantages of both overhead transmission cables and underground transmission cables.

Overhead	Underground
Easier to maintain/repair	Harder to maintain repair
Cheaper	More expensive
Cables cooled by the air	Need cooling systems
Greater risk of electric shock	Lower risk of electrocution
Greater visual pollution	Cannot be seen
Hazard to aircraft	No hazard to aircraft

(6)

Exam Practice

L2

Explain how the step-up transformer increases the efficiency of the National Grid.

Decreases the current

Reducing energy loss

(2)

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

Safety

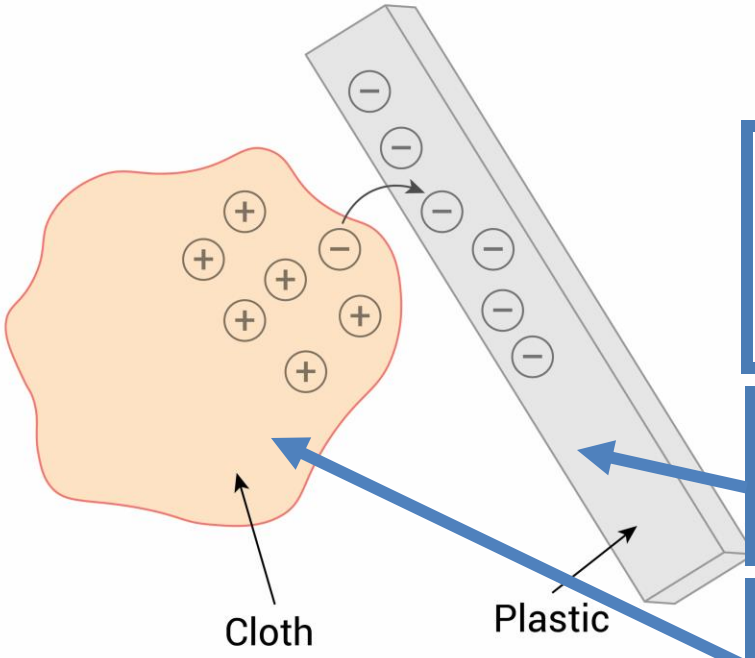
(1)

2.5.1 Static Charge

Think
Pair
Share

How may insulating materials become electrically charged?

When certain insulating materials are rubbed against each other they become electrically charged.



Negatively charged electrons are rubbed off one material and on to the other.

The material that gains electrons becomes negatively charged.

The material that loses electrons is left with an equal positive charge.

CS/F CS/H SS/F SS/H

2.5.1 Static Charge

Think
Pair
Share

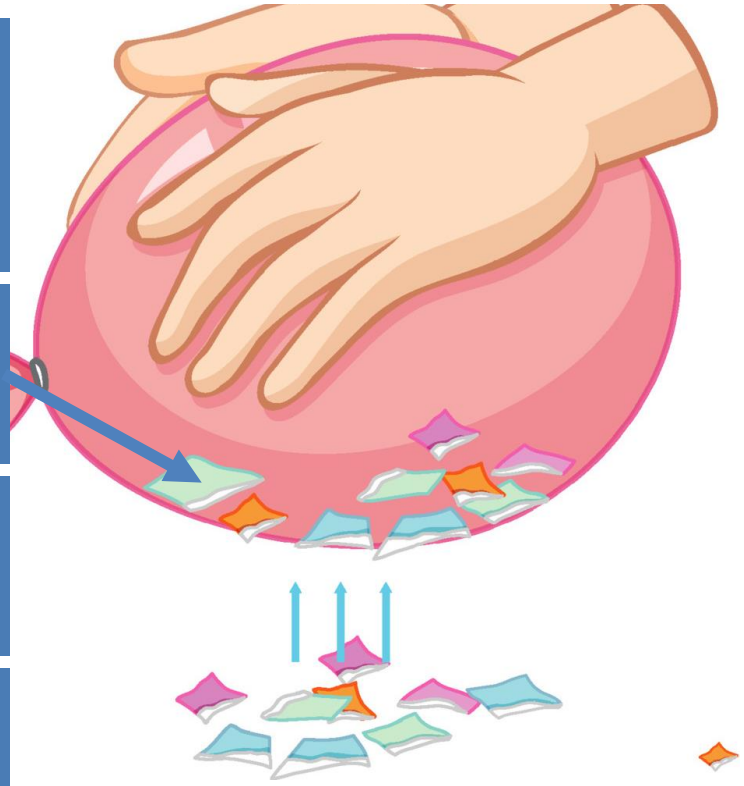
What happens when two electrically charged objects are brought close together?

When two electrically charged objects are brought close together they exert a force on each other.

Two objects that carry different types of charge attract.

Two objects that carry the same type of charge repel.

Attraction and repulsion between two charged objects are examples of non-contact force.



CS/F CS/H SS/F SS/H

2.5.1 Static Charge

Think
Pair
Share

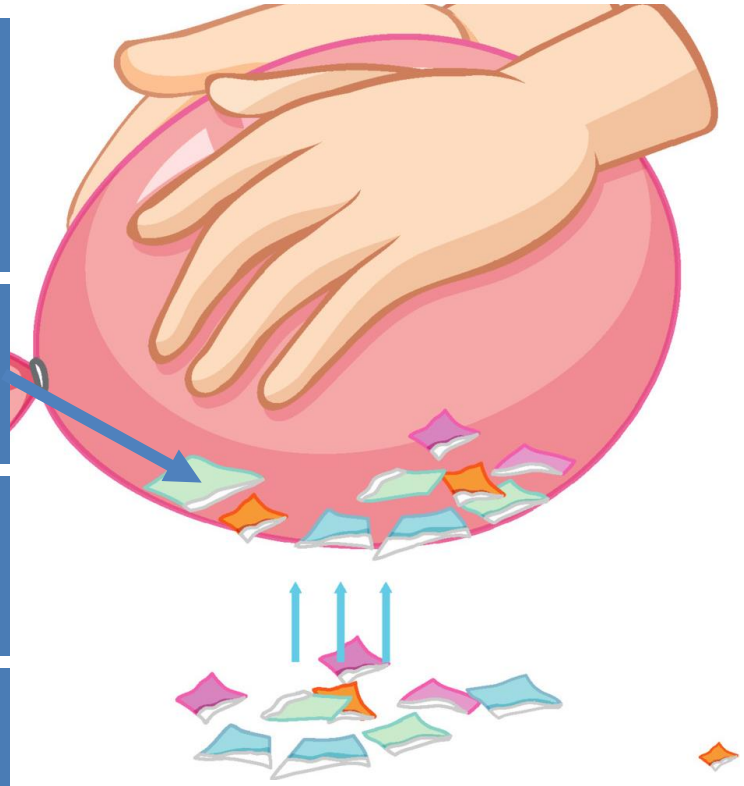
What happens when two electrically charged objects are brought close together?

When two electrically charged objects are brought close together they exert a force on each other.

Two objects that carry different types of charge attract.

Two objects that carry the same type of charge repel.

Attraction and repulsion between two charged objects are examples of non-contact force.

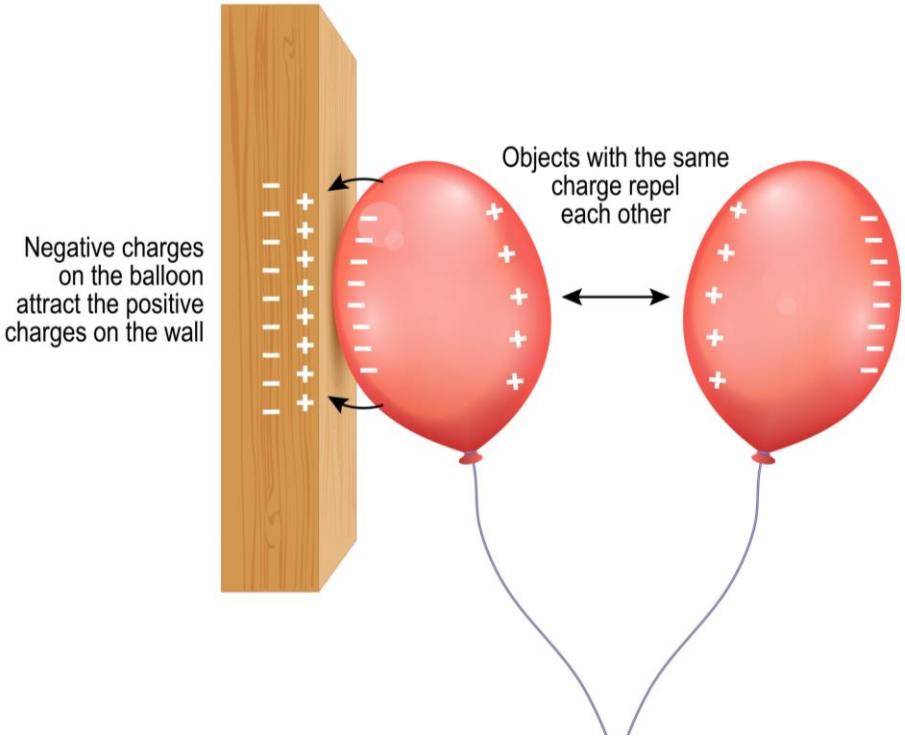


CS/F CS/H SS/F SS/H

2.5.1 Static Charge

Think
Pair
Share

What happens when two electrically charged objects are brought close together?

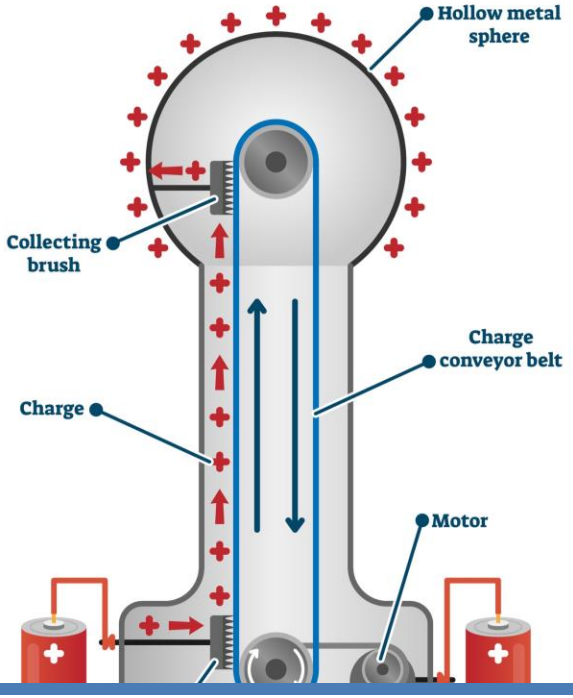


CS/F CS/H SS/F SS/H

2.5.2 Electric Fields

Think
Pair
Share

What is an electric field?



A charged object creates an electric field around itself.

The electric field is strongest close to the charged object.

The further away from the charged object, the weaker the field.

Key Term	Definition
Electric Field	

CS/F CS/H SS/F SS/H

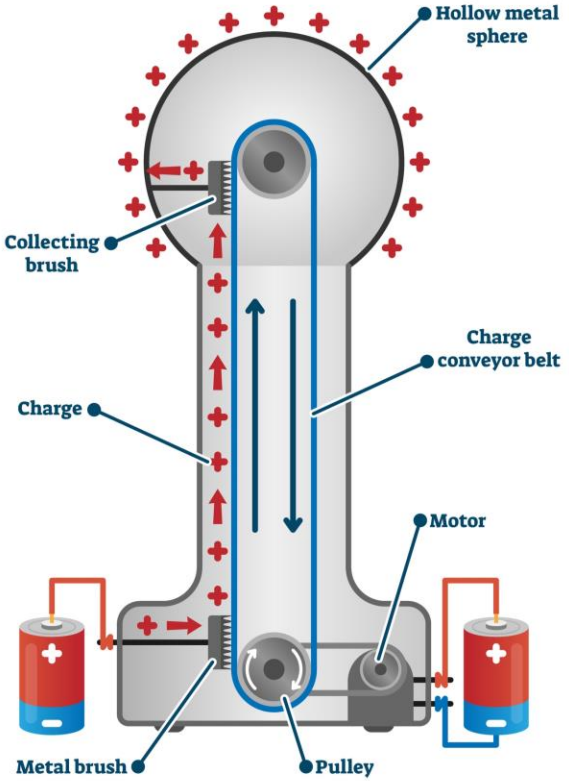
2.5.2 Electric Fields

Think
Pair
Share

What is an electric field?

A second charged object placed in the field experiences a force.

The force gets stronger as the distance between the objects decreases.



Key Term	Definition
Electric Field	An area surrounding an electric charge that may influence other charged particles.

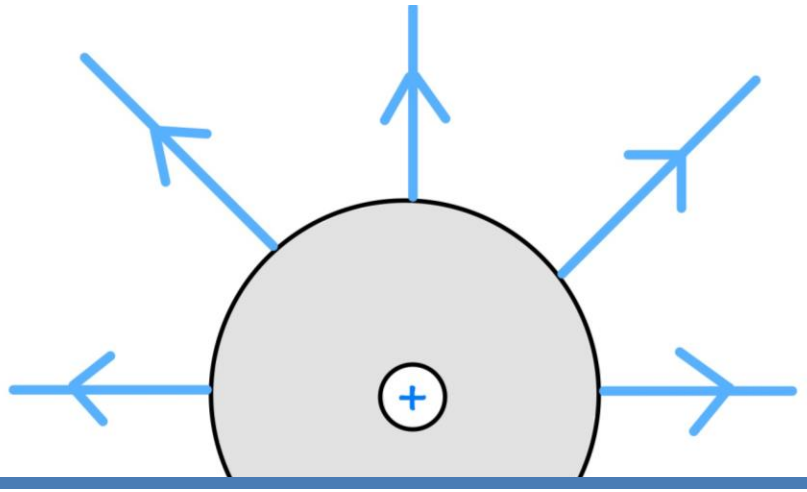
CS/F CS/H SS/F SS/H

2.5.2 Electric Fields

Think
Pair
Share

What is the electric field pattern for an isolated sphere?

Be prepared to draw this in your exam!



This is an isolated sphere with a positive charge. If it had a negative charge the arrows would be in the opposite direction.

CS/F CS/H SS/F SS/H

2.5.2 Electric Fields

Think
Pair
Share

How does sparking occur?

Lightening is an example of sparking.

If the field is strong enough, charges can be forced though insulators such as air and a spark will occur.

It can also happen if a charged person touches a conductor. This is when we experience static shocks.

CS/F CS/H SS/F SS/H