Electric Charge

Model Answers

Level	IGCSE(9-1)
Subject	Physics
Exam Board	Edexcel IGCSE
Module	Single Award (Paper 2P)
Topic	Electricity
Sub-Topic	Electric Charge
Booklet	Model Answers

Time Allowed: **62 minutes**

Score: **/51**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'75%	70%	60%	55%	50%	<50%

1 A man pushes a metal trolley along a corridor towards a lift.

The trolley has nylon wheels and the floor of the corridor is covered with plastic.

The man wears shoes with rubber soles.

As he moves the trolley, the man gains an electric charge.

(a) Explain how the man gains an electric charge. **(2)**

(a) As the man walks, the **friction** between his shoes and the floor causes **electrons** to be **transferred** between the two surfaces. **Friction** will also cause the **wheels** of the trolley to **lose or gain electrons**. The man will gain a positive electric charge if electrons are removed from, or a negative charge if electrons are added to the objects he is in contact with.

(b) The man presses a metal button to operate the lift.

There is a spark and the man receives an electric shock.

The spark lasts for 75 ms and 0.0017 C of charge passes.

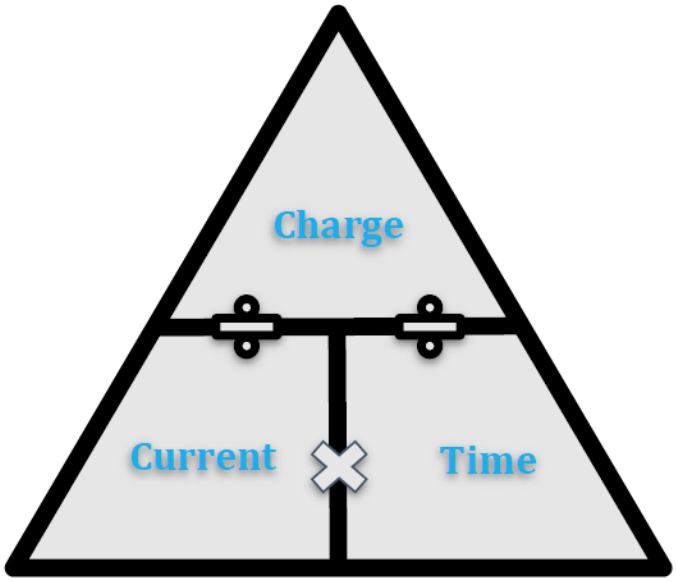
(i) State the equation linking charge, current and time. **(1)**

(b) (i) $Charge = Current \times Time$

(ii) Calculate the average current in the spark.

Give the unit. **(3)**

(ii)



To calculate current, divide both sides of the equation stated in (b)(i) by time to give

$$Current = \frac{Charge}{Time}$$

Substitute in the given values, remembering to convert 75ms to seconds

$$Current = \frac{0.0017}{0.075} = 0.023A$$

The unit for current is the ampere, represented by A.

current = $0.023A$ unit A

(c) Metal appliances, such as the lift button, are earthed for safety.

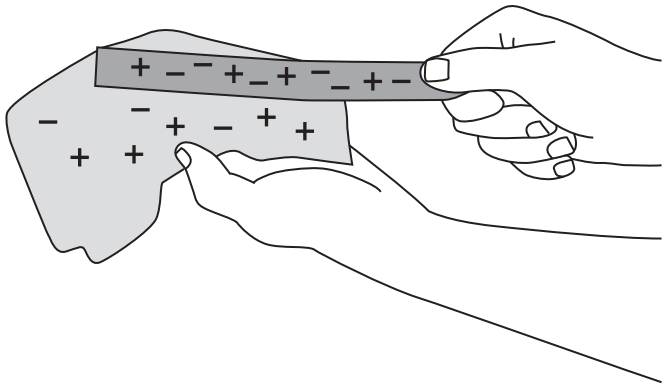
Explain why the man receives a shock even though the button is properly earthed. **(3)**

(c)

- The **metal** button **conducts** electricity to earth.
- The **charge** on the man means that there is a **potential difference** between him and the earth when he touches the button.
- This causes a **transfer of electrons** between the man and the button (the earth), creating a **current** in his body, which causes the shock.

(Total for Question 1 = 9 marks)

2 When a plastic rod is rubbed with a cloth, the rod gains charge.



(a) How could you show that the plastic rod gains charge? **(1)**

(a)
- A **charged rod** may **attract** hair, scraps of paper, **deflect** a steam of water or a gold leaf electroscope.
- Alternatively, a **coulombmeter** could simply be used to measure the charge on the rod.

(b) Explain how the plastic rod gains charge when it is rubbed. **(2)**

(b) When the rod is rubbed, **electrons** are either **transferredto** its surface, giving it a **negative charge**, or **transferredfrom** its surface, leaving it with a **positive charge**.

(c) There are two types of charge.

Describe how you could demonstrate this using different insulating rods and a cloth.

In your answer, you should name any other equipment you would use. **(3)**

(c)
- Rub the rods with the cloth to **charge** them.
- **Suspend** the rods, allowing them to **swing freely** in close proximity to each other.
- The observation of **attraction** and **repulsion** of the rods shows that there are two types of charge.

(Total for Question 2 = 6 marks)

3 The photograph shows an investigation of static electricity.

A teacher rubs a balloon with a cloth so that the balloon gains a positive charge.

She then holds the balloon close to her head, and her hair rises.

(a) Explain, in terms of moving charges, how the balloon becomes positively charged. **(2)**

Electrons move from the balloon to the cloth

(b) Explain why the teacher's hair rises. **(2)**

The movement is due to the **attraction of the negative charges** in the hair and the **positive charge** of the balloon. Along with the negatively charged hair r**epelling** other strands of hair.

(c) Suggest why the charge remains on the balloon even when it is being held.

(1)

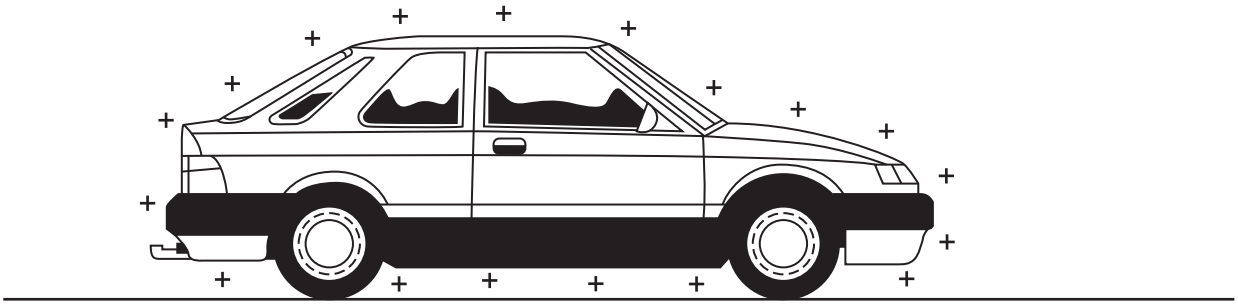
The balloon is an **insulator** and so is a **poor conductor of charge**

(d) Suggest why the experiment does not work so well when the air is humid (damp). **(1)**

When the hair is damp, **electrons** will move **from the hair into the water** and into the air as water is a **good conductor of electrical charge**.

(Total for Question 3 = 6 marks)

4 A car becomes electrically charged as it travels along a road.



(a) (i) Explain how a moving car becomes electrically charged. **(2)**

(a) (i)

- The **friction** between the **wheels** and the **road** causes **electrons** to be **transferred** between them.
- **Electrons** from the car are **transferred** to the road, giving the car a **net positive charge**.

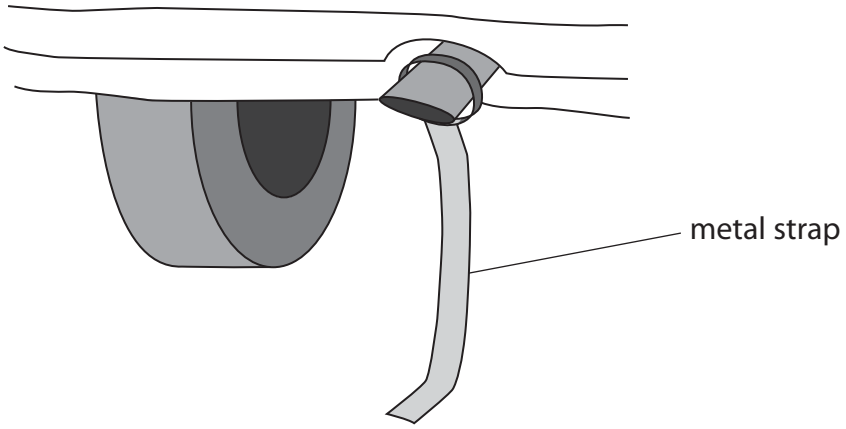
(ii) Why does this charge remain on the car after it has stopped moving? **(1)**

(ii) The **rubber** on the wheels of the car is an **insulator**, so the **charge** cannot move from the **car** to the **ground**.

(b) Some people prefer to prevent their car from becoming charged.

They do this by fixing a metal strap underneath the car.

The metal strap rubs on the ground as the car moves.



(i) Suggest why it is safer to have no electrical charge on a car. **(1)**

(b) (i) There is **no risk** of **shock** or a **spark** from a **neutral** object.

(ii) Explain how the metal strap prevents a car from becoming charged. **(2)**

(ii)

- The **metal** strap is a **conductor**.
- When the car is stationary, it can **discharge** through the metal strap.
- There is **no insulator** between the **strap** and the **ground**, so **electrons** can flow through it between the **car** and the **ground**.

(Total for Question 4 = 6 marks)

5 The photograph shows a fuel delivery at a petrol station.

Source: Jeeferson Siegel, New York Daily News

(a) Explain how a fuel tanker can become electrically charged while it is moving. **(2)**

(a)The **friction** between the tanker and the road could cause **electrons** from the road to be **transferred** to the tanker, or **electrons** from the tanker to be **transferred** to the road, giving the tanker a **net negative or positive charge** respectively.

(b) Pumping fuel from an electrically-charged tanker can be dangerous.

(i) Describe a possible danger of pumping fuel from an electrically-charged tanker. **(1)**

(b) (i) The **electrostatic charge** could cause a **spark**, which creates the **risk of fire**.

(ii) The driver connects an earth wire to the fuel tanker before pumping fuel.

Explain how connecting the earth wire reduces the possible dangers. **(2)**

(ii)

- **Charge** flows down through the **earth wire** to **ground**.
- This **discharges** the tanker, so there is **no** longer a **potential difference**.
- Since the **potential difference** causes the **spark**, this **risk** is **reduced** when there is **no potential difference**.

(Total for Question 5 = 5 marks)

6 This question is about electrostatic charges.

(a) Complete the sentences using words from the box.

Each word may be used once, more than once or not at all. **(2)**

electrons	**negative**	**neutral**	**neutrons**	**positive**	**protons**

When a plastic rod is rubbed with a cloth, the plastic rod gains **electrons** .....

After the plastic rod has been rubbed with the cloth, the plastic rod has a

negative ..... charge.

- Rubbing two surfaces against each other transfers **electrons**. Protons or neutrons could not be transferred as they are bound together in the nucleus.

- Since electrons have a **negative charge**, negative charges are transferred when two surfaces rub together.
- The surface that **gains electrons** will **gain** a **negative charge**.

(b) Electrostatic charges can be useful during paint spraying.

(i) The droplets of paint are given the same charge as they leave the sprayer.

Explain why this is an advantage.

(2)

(b) (i)

- **Like charges repel**.
- The **repulsion** between the **droplets** causes them to **spread out** in a finer spray.

(ii) The droplets of paint are positively charged.

The object being painted is given a negative charge.

Explain why this is an advantage.

(2)

(ii)

- **Opposite charges attract.**
- The **positively charged droplets** will be **attracted** to the **negatively charged object**.
- This means that the paint will stick to the object and it will be easier to get **good coverage** on **obscured areas** of the object.
- It also means that **less paint** is **wasted**.

(c) Give **one** hazard caused by electrostatic charges and state how the risk from this hazard can be reduced.

(2)

(c)

- **Electrostatic charges** create the risk of a **spark**, which can cause **damage**.
- **Earthing** objects which can become charged reduces this risk.
- **Electrostatic charges** can also cause **shocks**.
- The risk of a **shock** can be reduced by, for example, using **rubber gloves** or standing on a **rubber mat** when coming into contact with **charged objects**, as **rubber** is an **insulator**.

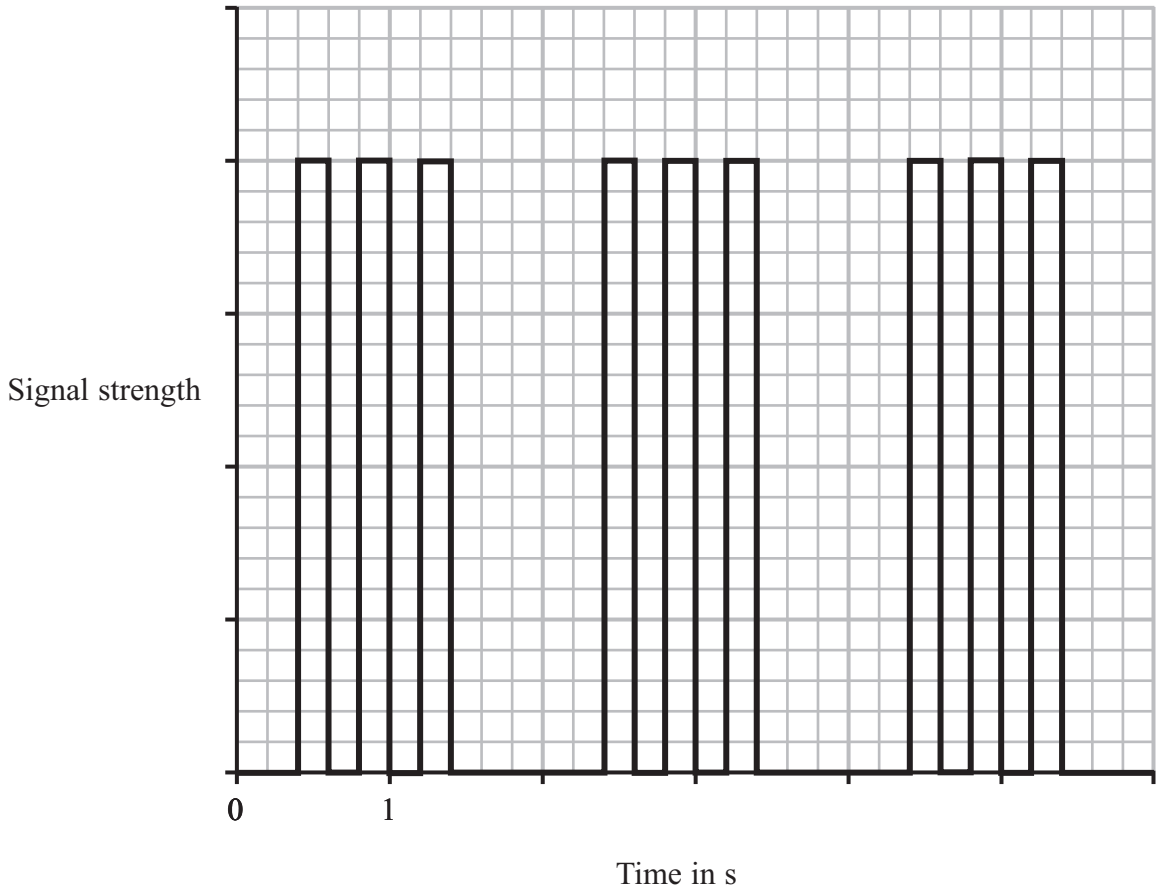
(Total for Question 6 = 8 marks)

7 In 1901, Marconi received the first radio signal across the Atlantic Ocean.

The signal was the letter S in Morse code (three 'dots') sent over and over again.

Each letter S was produced by quickly turning an electric spark on and off three times.

The graph shows how the strength of the signal changed with time.



(a) (i) The graph shows a digital signal.

Explain what is meant by a digital signal. **(2)**

a)i)A digital signal is a signal that is only **two values** either a high or a low (1 or a 0)

(ii) Suggest **two** ways that this signal could be made to carry more information. **(2)**

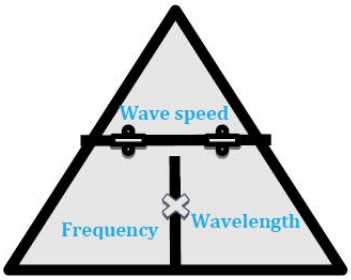
Ii) – The **signal frequency should be increased** to transfer more information per second.

- The **bandwidth of the signal should be increased**, allowing the use of more channels to transfer the data increasing the rate of data transfer

(b) The frequency of Marconi's radio wave was 820 kHz and the wavelength was 366 m.

(i) State the equation linking wave speed, frequency and wavelength for radio waves. **(1)**

b)i) $\boldsymbol{Wave\ speed = Frequency \times Wavelength}$



(ii) Calculate the speed of the radio waves Marconi received. **(2)**

ii) $Wave\ speed = 820 \times 10^3 \times 366 = \mathbf{3 \times 10\text{^}8 ms^{-1}}$

Speed of radio waves = **3 × 10^8** m/s

(c) Some people do not believe that Marconi received 820 kHz radio waves.

They think that the frequency was really twice as much: 1640 kHz.

If these people are correct, what wavelength radio waves did Marconi receive? **(1)**

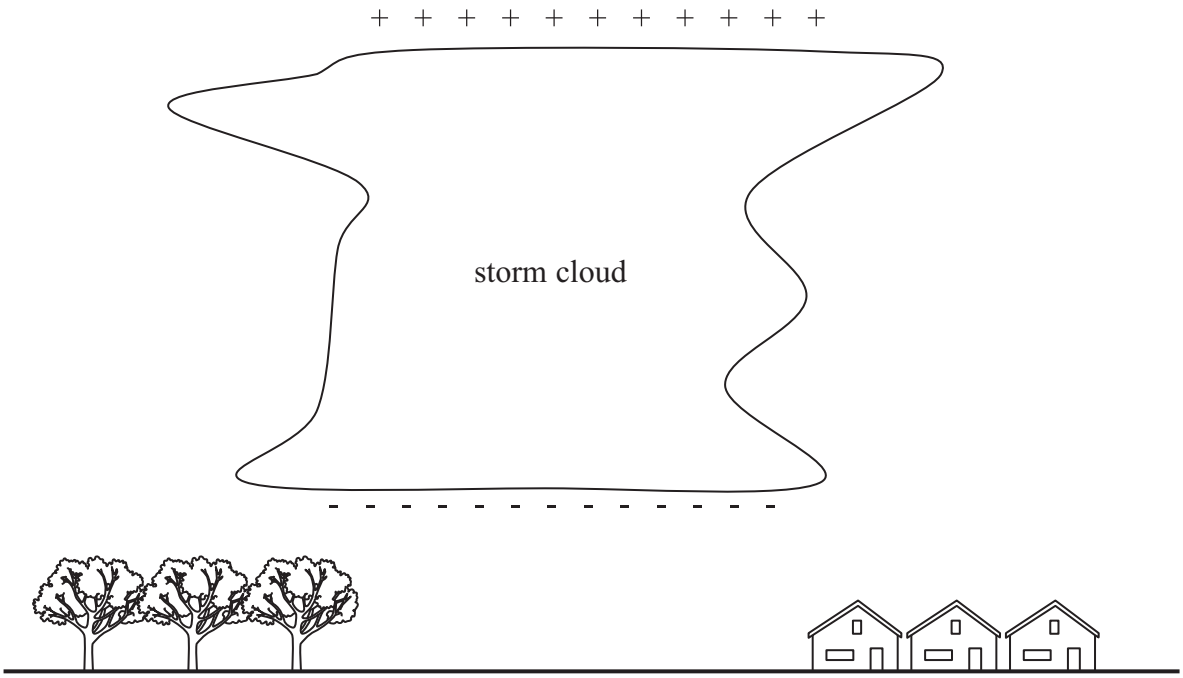
c) $Wavelength = \frac{Wave\ speed}{Frequency}$

$Wavelength = \frac{3 \times 10^8}{1640} \times 10^3 = \mathbf{183 m}$

Wavelength = **183** m

(d) Other people do not think Marconi received a radio signal across the Atlantic Ocean at all.

They think the radio waves he received were really caused by electrostatic discharges from storm clouds.



Explain what happens when a storm cloud discharges. **(3)**

d)When a storm cloud discharges the potential difference between

the charged clouds and the earth becomes high enough for **air to become a conductor**. Charge tries to find the **path to ground (Earth)** and since **air is a conductor (temporarily)** the **charge travels through the air** and **to the ground in a lightning strike.**

(Total for Question 7 = 11 marks)