Using static electricity

1 (a) Vicky combs her hair with a plastic hair comb.
The comb now has a negative charge.

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

The comb has a negative charge because it has

(1)

☒ **A** gained electrons

☒ **B** lost electrons

☒ **C** gained protons

☒ **D** lost protons

(ii) Vicky's hair has also become charged.

Explain how Vicky's hair has become charged.

(2)

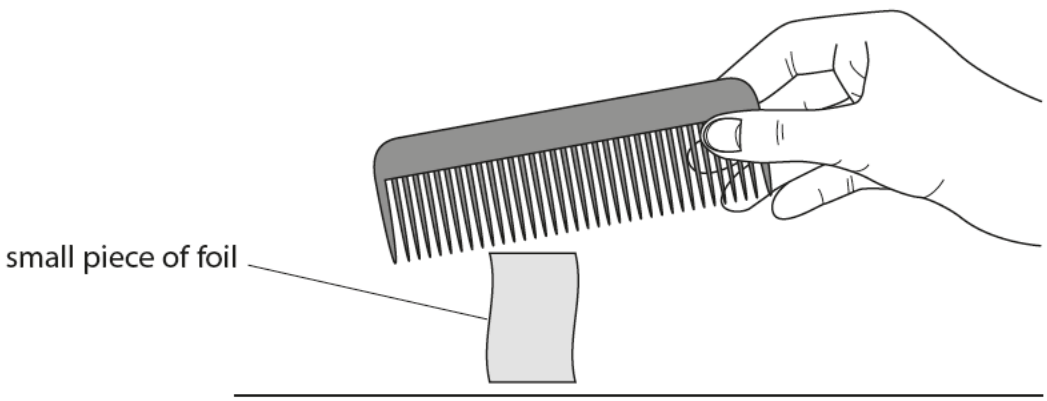
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(iii) Vicky holds the comb over a small piece of metal foil.
The foil jumps up and sticks to the comb.



Show on the diagram where the foil is negatively charged.

(1)

(b) Vicky combs her hair with a metal comb.
Then she tries to pick up some small pieces of metal foil with the comb.
The metal comb does not pick up any pieces of metal foil.

Explain why the metal foil is not picked up by the comb.

(2)

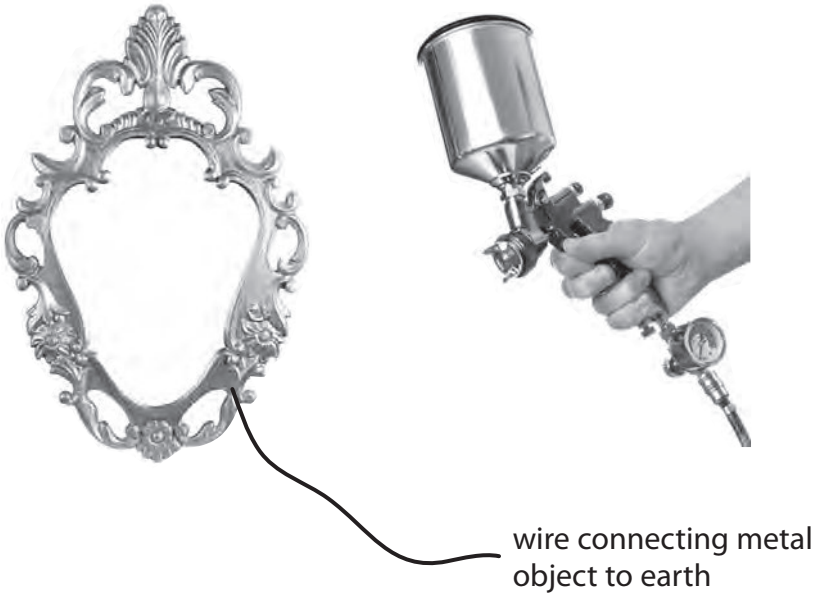
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(c) The picture shows an electrostatic paint sprayer about to be used to paint a metal object.



When the paint particles leave the sprayer, they are negatively charged.

Explain the benefits of using this sprayer compared with one that does not charge the paint.

(6)

(Total for Question 6 = 12 marks)

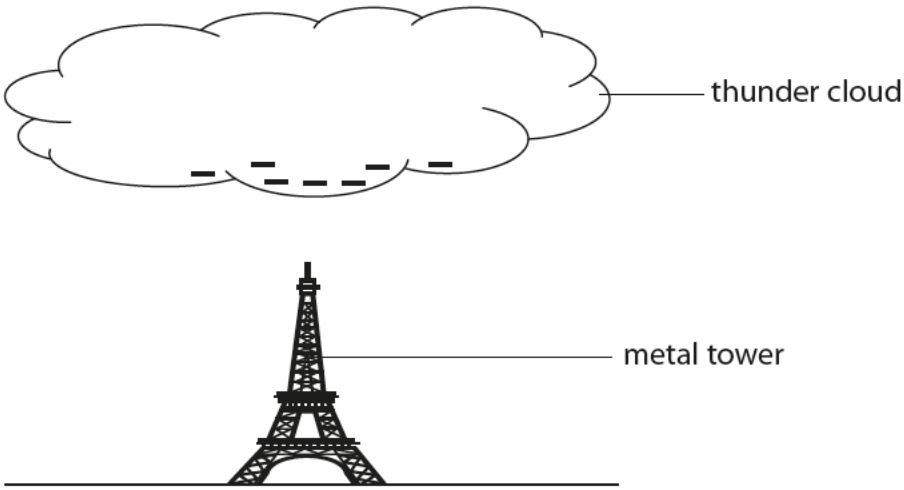
2 (a) A lightning strike on a metal tower can be described as follows.

In the cloud.

A thunder cloud contains moving ice particles.

Some of these ice particles are negatively charged and some are positively charged.

The negatively charged particles move to the bottom of the cloud.



Not to scale

When the charged cloud is over the metal tower.

A charge builds up on the top of the metal tower as the cloud passes over.

During the lightning flash.

Eventually a flash of lightning travels between the cloud and the tower.

(i) Which row of this table is correct when the cloud is over the top of the tower before the lightning flash?

Put a cross (☒) in the box next to your answer.

(1)

	charge on top of the cloud is	**charge on top of the tower is**
☒ **A**	negative	negative
☒ **B**	negative	positi e
☒ **C**	positive	positive
☒ **D**	positive	negative

(ii) Here are **four** statements.
Three of these are a reason for what happens at each stage.

1: opposite charges attract each other
2: like charges repel each other
3: ice particles gain electrons
4: ice particles lose protons

Choose the best reason for each of the stages listed below by writing its number in the box next to the description of what happens.
One has been done for you.
A reason can only be used **once**.

(2)

in the cloud	reason
the bottom of the cloud becomes negatively charged	

when the charged cloud is over the metal tower	reason
the top of the tower becomes charged	

during the lightning flash	reason
electrons move through the air	1

(iii) Explain what happens to the charge on the metal tower as a result of the lightning flash.

(2)

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(b) During the lightning flash a total charge of 52 C flows.
The average current is 2600 A.

Calculate the duration of the flash in seconds.

(3)

duration of flash = ... s

(c) When fuel tanks on an aircraft are being filled, the aircraft, fuel pipes and tanker are connected by a metal wire to the ground.

Explain why this greatly reduces the chance of a spark.

(2)

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(Total for Question 4 = 10 marks)

3 (a) Balloon **P** hangs from an insulating thread.

A teacher gives the balloon a positive electric charge, as shown in Figure 15.

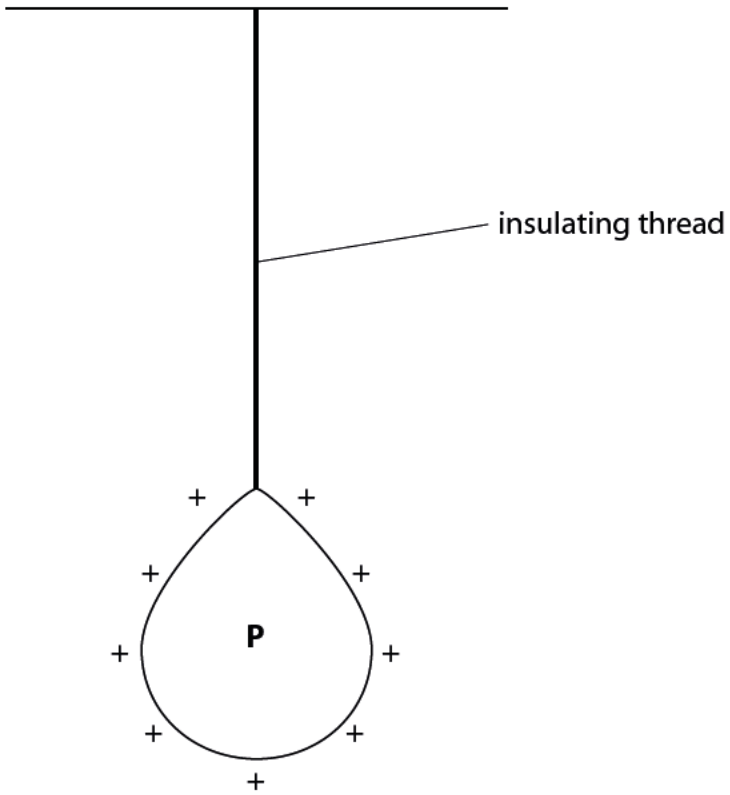


Figure 15

(i) When the balloon is charged like this, it has

(1)

- ☒ **A** gained electrons
- ☒ **B** lost electrons
- ☒ **C** gained protons
- ☒ **D** lost protons

(ii) Two more balloons, **Q** and **R**, are charged and placed either side of balloon **P**.

The balloons move to the positions shown in Figure 16.

Add the charges on balloons **Q** and **R** in Figure 16.

(2)

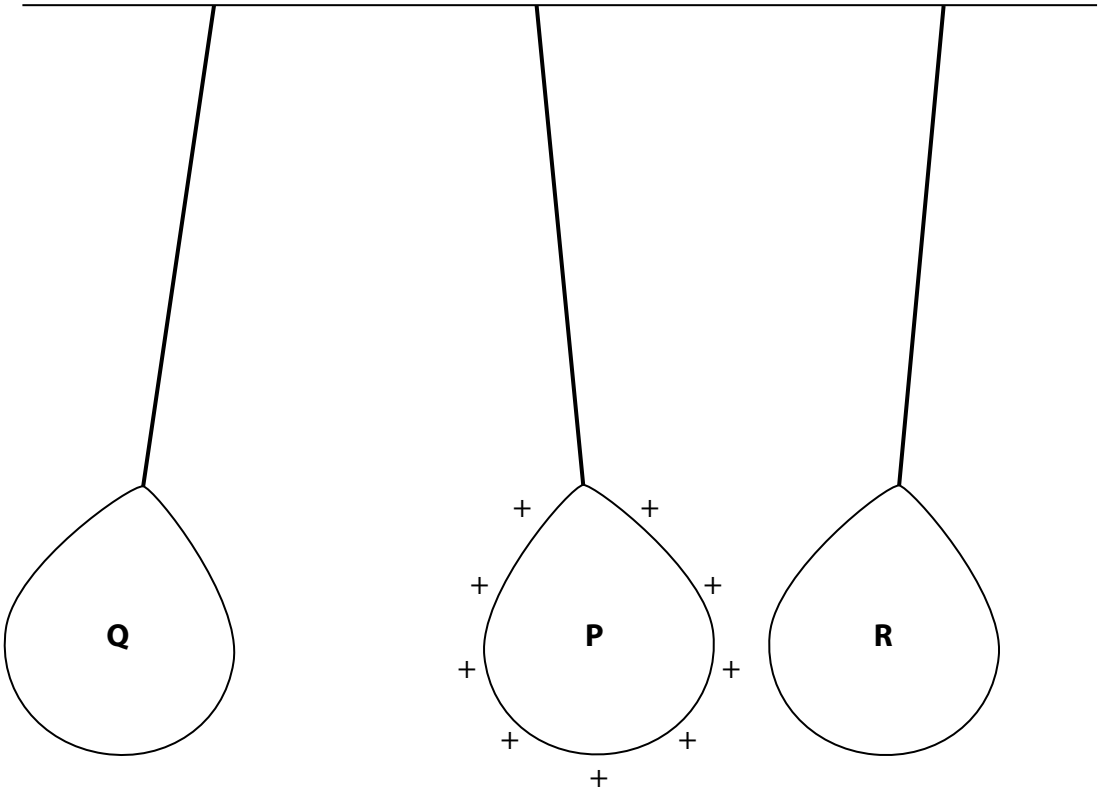


Figure 16

(b) Figure 17 shows an airport worker refuelling an aircraft.



(Source: © Stanisław Tokarski/123RF)

Figure 17

(i) As fuel moves through the pipe, it becomes positively charged.

Explain how the worker can prevent a build-up of charge when pumping fuel into the aircraft.

(3)

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(ii) Explain how an aircraft can become electrically charged as it flies through the air.

(2)

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(c) Fuel weighing 230 000 N is pumped into the aircraft.

This fuel moves upwards through a vertical height of 4.7 m.

The power developed by the pump is 1600 W.

Calculate the time needed to refuel the aircraft.

(3)

time = ... s

(Total for Question 7 = 11 marks)

4 (a) Figure 8 shows an airport worker refuelling an aircraft.



(Source: © Stanisław Tokarski/123RF)

Figure 8

(i) Pumping fuel into an aircraft can be dangerous.

The worker connects an earth wire to the aircraft before pumping fuel.

Give **one** reason why earthing reduces the risk of fire.

(1)

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(ii) Explain how an aircraft can become electrically charged as it flies through the air.

(2)

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(b) Fuel weighing 230 000 N is pumped into the aircraft.

This fuel moves upwards through a vertical height of 4.7 m.

The power developed by the pump is 1600 W.

Calculate the time needed to refuel the aircraft.

(3)

time = ... s

(c) Figure 9 shows an electrostatic method for spray-painting a car door.

The car door has a negative charge.

The droplets of paint receive a positive charge as they leave the spray gun.



(Source: © Jens Brüggemann/123RF)

Figure 9

Explain how charging the door helps the paint to form an even coating on both sides of the door.

You should use ideas of forces and fields in your answer.

(2)

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(Total for Question 4 = 8 marks)