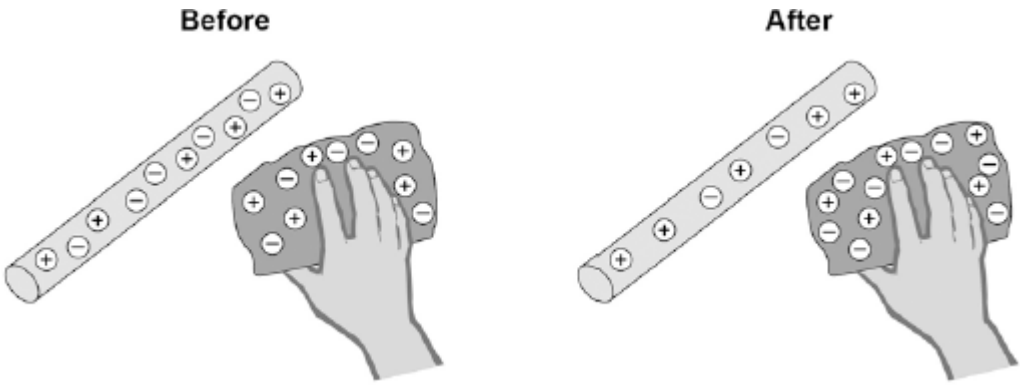
STATIC ELECTRICITY

Q1.

A student rubs an acetate rod with a cloth.

Figure 1 shows the charges on the acetate rod and cloth before and after rubbing.

Figure 1



(a) Explain how rubbing an acetate rod with a cloth causes the rod and cloth to become charged.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) After charging them, the student moves the acetate rod and the cloth closer together.

Which statement is correct?

Tick **one** box.

There is no force between the acetate rod and the cloth. ☐

There is a force of attraction between the acetate rod and the cloth. ☐

There is a force of repulsion between the acetate rod and the cloth. ☐

Give a reason for your answer.

_____

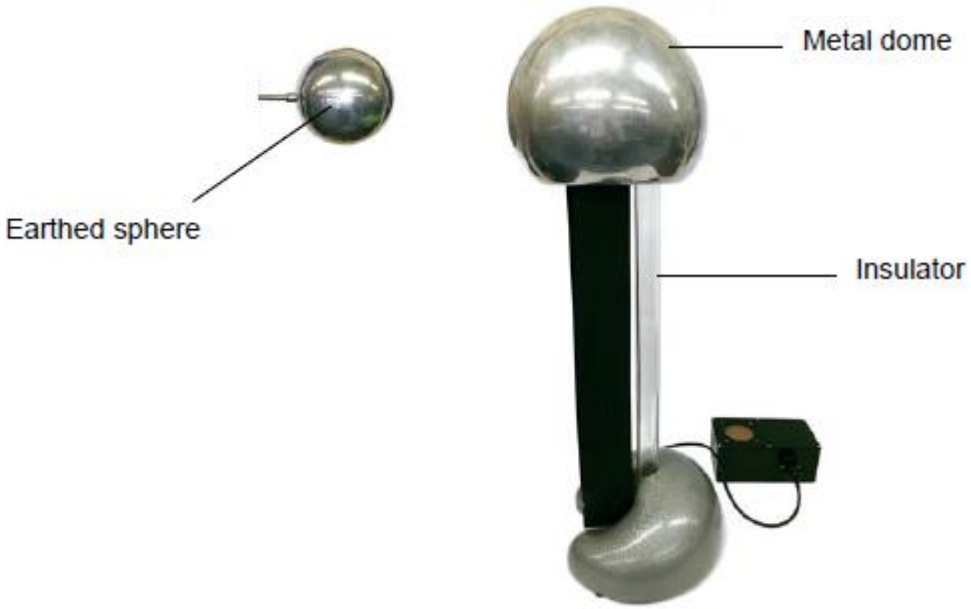
_____

_____

(2)

(c) **Figure 2** shows a Van de Graaff generator, which is used to generate static electricity.

Figure 2



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The longer the Van de Graaff generator is switched on, the more charge is stored on the metal dome.

Use an answer from the box to complete the sentence.

decrease	**increase**	**stay the same**

The amount of charge on the metal dome is increased, which causes the potential difference between the metal dome and the earthed sphere to

_____ .

(1)

(d) When the potential difference between the Van de Graaff generator and the earthed sphere is 60 kV, a spark jumps between the metal dome and the earthed sphere.

The spark transfers 0.000025 coulombs of charge to the earthed sphere.

The equation which links charge, energy and potential difference is:

energy transferred = charge × potential difference

Calculate the energy transferred by the spark.

Energy transferred = _____ J

(2)

(Total 9 marks)

Q2.

Figure 1 shows a Van de Graaff generator that is used to investigate static electricity.

Before it is switched on, the metal dome has no net charge.

After it is switched on, the metal dome becomes positively charged.

Figure 1

(a) Explain how an uncharged object may become positively charged.

(3)

(b) **Figure 2** shows a plan view of the positively charged metal dome of a Van de Graaff generator.

Draw the electric field pattern around the metal dome when it is isolated from its surroundings.

Use arrows to show the direction of the electric field.

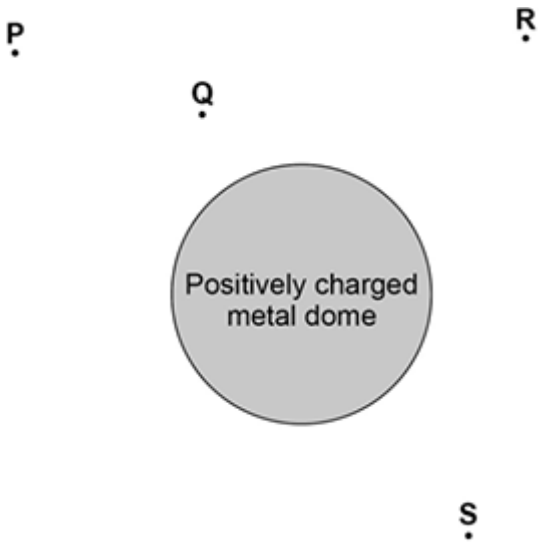
Figure 2

(2)

(c) Another positively charged object is placed in the electric field.

Look at **Figure 3**.

Figure 3



In which position would the object experience the greatest force?

Tick **one** box.

P ☐

Q ☐

R ☐

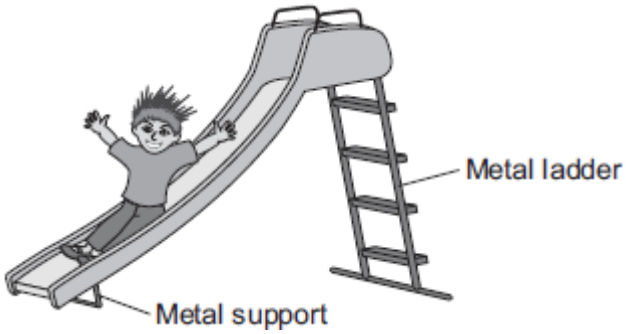
S ☐

(1)

(Total 6 marks)

Q3.

The figure below shows a slide in a children's playground.



(a) A child of mass 18 kilograms goes down the slide.

The vertical distance from the top to the bottom of the slide is 2.5 metres.

Calculate the decrease in gravitational potential energy of the child sliding from the top to the bottom of the slide.

Gravitational field strength = 10 N / kg

_____

_____

_____

Decrease in gravitational potential energy = _____ J

(2)

(b) The slide is made of plastic.

(i) The child becomes electrically charged when he goes down the slide.

Explain why.

_____

_____

_____

_____

(2)

(ii) Going down the slide causes the child's hair to stand on end.

What conclusion about the electrical charge on the child's hair can be made from this observation?

_____

_____

Give a reason for your answer.

_____

_____

(2)

(iii) Why would the child **not** become electrically charged if the slide was made from metal?

_____

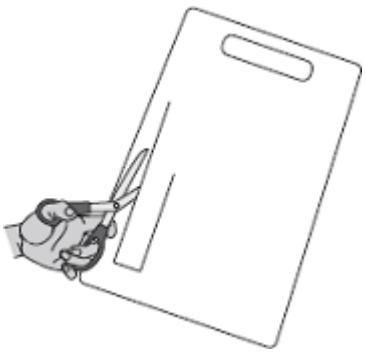
_____

(1)

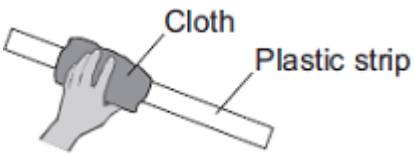
(Total 7 marks)

Q4.

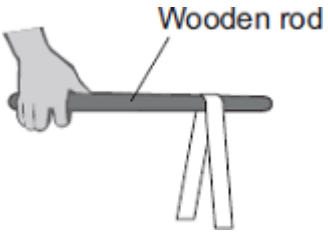
(a) A student uses some everyday items to investigate static electricity.



1 A strip of plastic is cut from a plastic carrier bag



2 The plastic strip is rubbed with a cloth



3 The plastic strip is hung over a wooden rod

(i) Draw a ring around the correct answer in the box to complete each sentence.

Rubbing the plastic strip with a cloth causes the strip to become negatively charged.

This happens because

electrons
neutrons
protons

move from the cloth onto the plastic strip.

The cloth is left with

a negative
a positive
zero

charge.

(2)

(ii) When the plastic strip is hung over the wooden rod, the two halves of the strip move equally away from each other.

What **two** conclusions should the student make about the forces acting on the two halves of the plastic strip?

1. _____

_____

2. _____

(2)

(b) Electrical charges move more easily through some materials than through other materials.

Through which **one** of the following materials would an electrical charge move most easily?

Draw a ring around your answer.

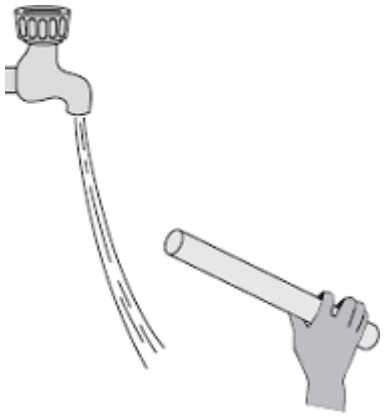
aluminium **glass** **rubber**

(1)

(Total 5 marks)

Q5.

(a) The diagram shows a negatively charged plastic rod held near to a thin stream of water. The water is attracted towards the rod.



Which **one** of the following statements explains what is happening to the charge in the water?

Tick (✓) **one** box.

The positive and the negative charges in the water are attracted to the rod. ☐

The positive and the negative charges in the water are repelled by the rod. ☐

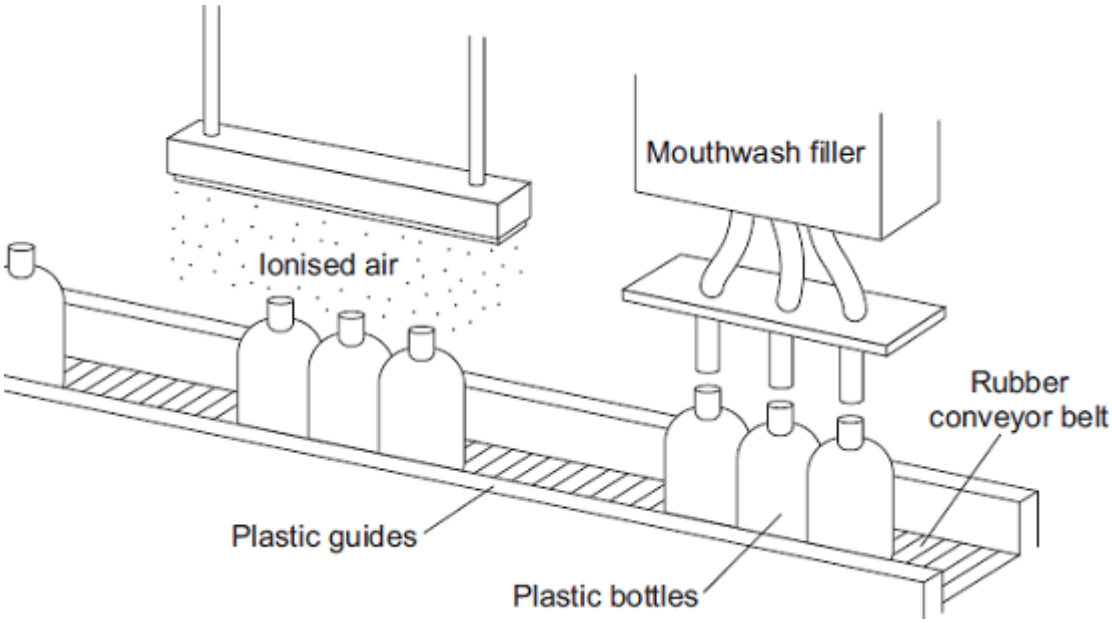
The negative charge in the water is repelled by the rod and the positive charge is attracted to the rod. ☐

The negative charge in the water is attracted to the rod and the positive charge is repelled by the rod. ☐

(1)

(b) A company that produces bottles of mouthwash found a problem with the automatic filling system.

As the bottles go towards the filler, the bottles move around on the conveyor belt and become electrostatically charged. This causes the stream of mouthwash to move sideways, missing the open top of the bottle.



The company came up with an answer to the problem. Before the bottles reach the dfiller, the bottles pass through a stream of ionised air. The ions in the air neutralise the charge on the bottles.

(i) Explain why the plastic bottles became charged.

_____

_____

_____

_____

(2)

(ii) What happens to the structure of an atom to change the atom into an ion?

_____

_____

(1)

(iii) Earthing the conveyor belt with a conducting wire would not have solved this problem.
Give a reason why.

_____

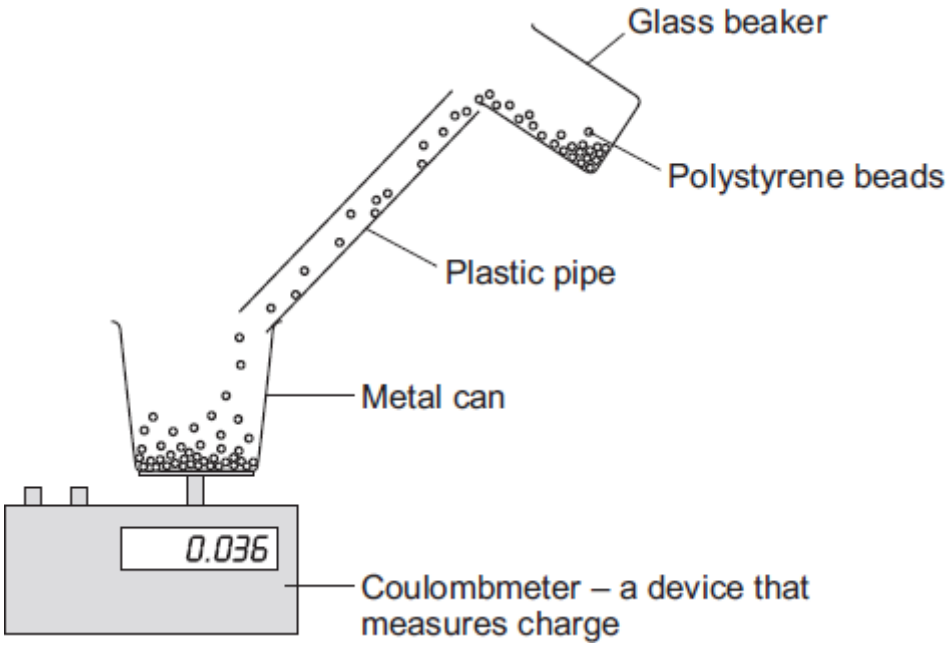
_____

(1)

(Total 5 marks)

Q6.

(a) Fine powders poured through a pipe can become charged. The diagram shows the apparatus used by a student to investigate this effect.



The student poured 75 cm^3 of polystyrene beads down the pipe. The beads fell into a metal can and the charge on them was measured directly using a coulombmeter.

The student repeated this twice more, but each time used 75 cm^3 of beads of a different size.

(i) When they fell through the pipe, the polystyrene beads became negatively charged.

Explain how this happened.

(3)

(ii) Give **one** control variable in the student's investigation.

(1)

(b) The results obtained by the student are shown in the table.

Diameter of polystyrene beads in mm	Charge in microcoulombs
1.0	0.080
2.0	0.044

3.0	0.012

(1 000 000 microcoulombs = 1 coulomb)

(i) Describe the connection between the size of the polystyrene beads and the total charge on the beads.

_____

_____

(1)

(ii) Explain how these results might be different if the student had used a shorter pipe.

_____

_____

_____

_____

(2)

(c) In industry, powders are often pumped through pipes. If the static charge caused a spark, the powder could ignite and cause an explosion.

(i) Is an explosion more likely to happen when pumping very fine powders or when pumping powders that consist of much larger particles?

_____

Give a reason for your answer.

_____

_____

(1)

(ii) Suggest **one** way that the risk of an explosion could be reduced.

_____

_____

(1)

(d) The table gives the minimum ignition energy (MIE) value for a number of fine powders.
The MIE is the minimum amount of energy required to cause a fine powder to ignite.

Type of powder	**MIE in millijoules**
Coal dust	60.00
Aluminium powder	10.00

Cornstarch dust	0.30
Iron powder	0.12

The MIE values for different substances are all measured in the same way and under the same conditions of pressure and temperature.

Why is this important?

_____

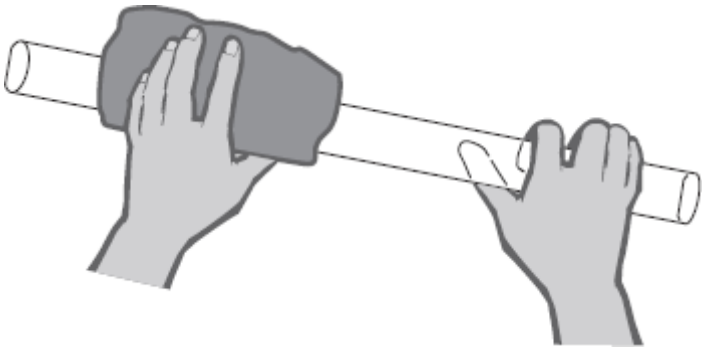
_____

(1)

(Total 10 marks)

Q7.

(a) The diagram shows a polythene rod being rubbed with a woollen cloth.



The polythene rod becomes negatively charged.

Explain how this happens.

_____

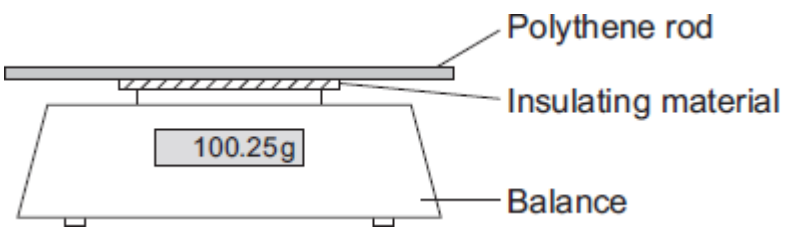
_____

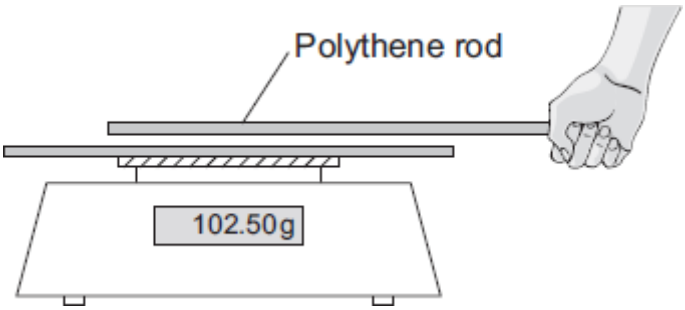
_____

_____

(2)

(b) A student put the charged polythene rod on to a balance. The rod was separated from the metal pan of the balance by a thin block of insulating material.
The student then held a second charged polythene rod above, but **not** touching, the first rod. The reading on the balance increased.





(i) Explain why the reading on the balance increases.

_____

_____

_____

_____

(2)

(ii) The student observed that the nearer the two rods are to each other, the bigger the increase in the balance reading.

What should the student conclude from this observation?

_____

_____

_____

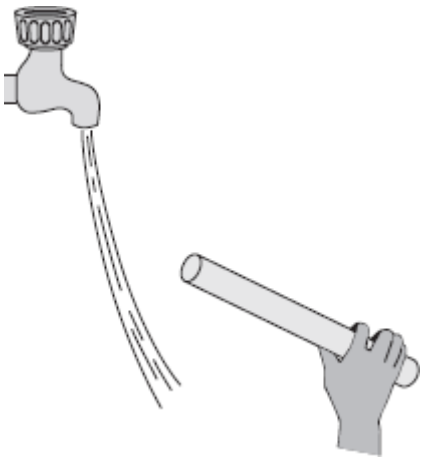
_____

(2)

(Total 6 marks)

Q8.

(a) The diagram shows a negatively charged plastic rod held close to a thin stream of water. The water is attracted towards the rod.



Which **one** of the following statements explains what is happening to the charge in the water?

Tick (✓) **one** box.

The positive and the negative charges in the water are attracted to the rod. ☐

The positive and the negative charges in the water are repelled by the rod. ☐

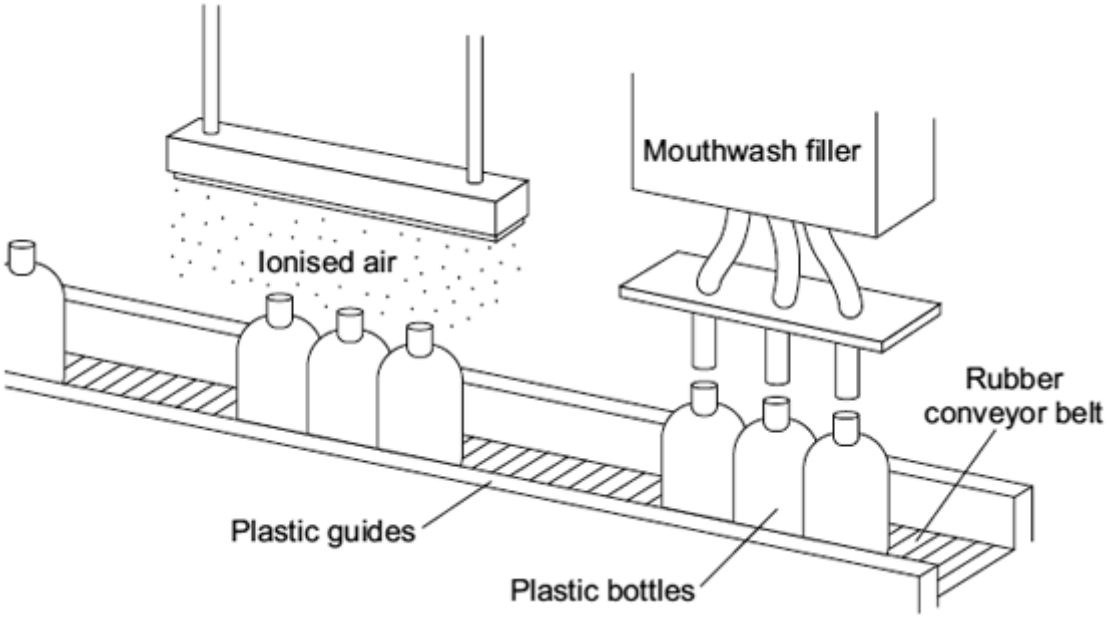
The negative charge in the water is repelled by the rod and the positive charge is attracted. ☐

The negative charge in the water is attracted by the rod and the positive charge is repelled. ☐

(1)

(b) A company that produces bottles of mouthwash found a problem with the automatic filling system.

As the bottles go towards the filler, they move around on the conveyer belt and become electrostatically charged. This causes the stream of mouthwash to move sideways, missing the open top of the bottle.



The company came up with a solution to the problem. Before the bottles reach the filler, they pass through a stream of ionised air. The ions in the air neutralise the charge on the bottles.

(i) Explain why the plastic bottles become charged.

_____

_____

_____

_____

(2)

(ii) What is an ion?

_____

_____

(1)

(iii) Earthing the conveyor belt with a conducting wire would not have solved this problem.

Give a reason why.

_____

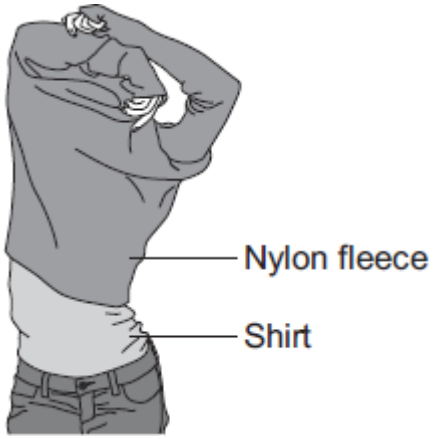
_____

(1)

(Total 5 marks)

Q9.

(a) A student takes off his nylon fleece and feels a small electric shock.
He realises that this happens because his fleece becomes charged.



Explain why the fleece becomes charged.

_____

_____

_____

_____

_____

(2)

(b) Only **two** of the following statements are correct.

Put a tick (✓) in the boxes next to the **two** correct statements.

Positively charged objects repel negatively charged objects. ☐

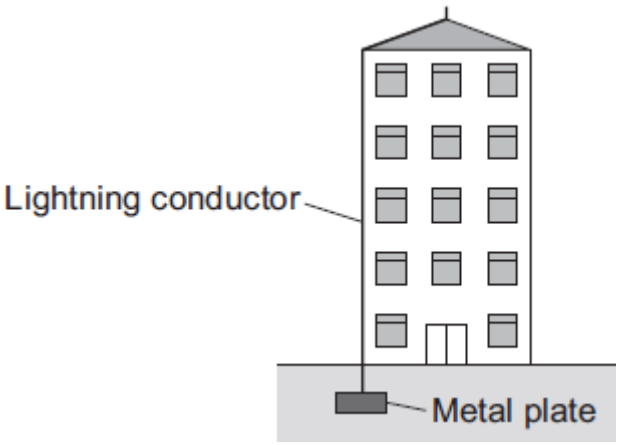
Electrical charges move easily through metals. ☐

Static electricity is safe; it never causes any danger. ☐

An electric current is a flow of electrical charge. ☐

(2)

(c) The diagram shows a lightning conductor attached to the side of a tall building.



If the building is struck by lightning, charge flows to earth through the lightning conductor.

(i) Which of the materials in the list is used to make the lightning conductor?

Draw a ring around your answer.

copper **glass** **plastic**

Give a reason for your answer.

_____

_____

_____

(2)

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

The resistance of the lightning conductor is

higher than
the same as
lower than

the resistance of the building.

(1)

(iii) It is almost impossible to test different designs of lightning conductor in controlled experiments during a lightning storm.

Suggest a reason why.

_____

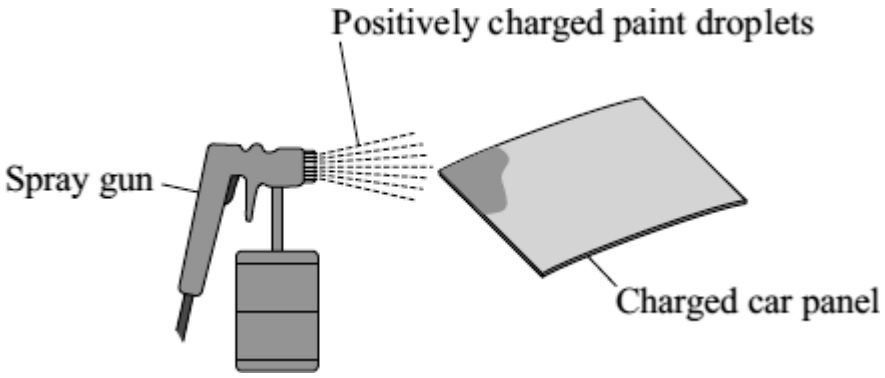
_____

(1)

(Total 8 marks)

Q10.

(a) The diagram shows how static electricity is used to paint a metal car panel.



Use words from the box to complete the following sentences.

attract	**opposite**	**repel**	**same**

All the paint droplets have the same type of charge. This makes the paint droplets

_____ each other and spread out.

The car panel and the paint droplets have the _____ type of

charge. This causes the car panel to _____ the paint droplets.

The car panel is covered by an even layer of paint.

(3)

(b) In which **one** of the following situations is static electricity dangerous and not useful?

Put a tick (✓) in the box next to your answer.

using a photocopier ☐

refuelling an aircraft ☐

a smoke precipitator ☐

Give a reason for your answer.

_____

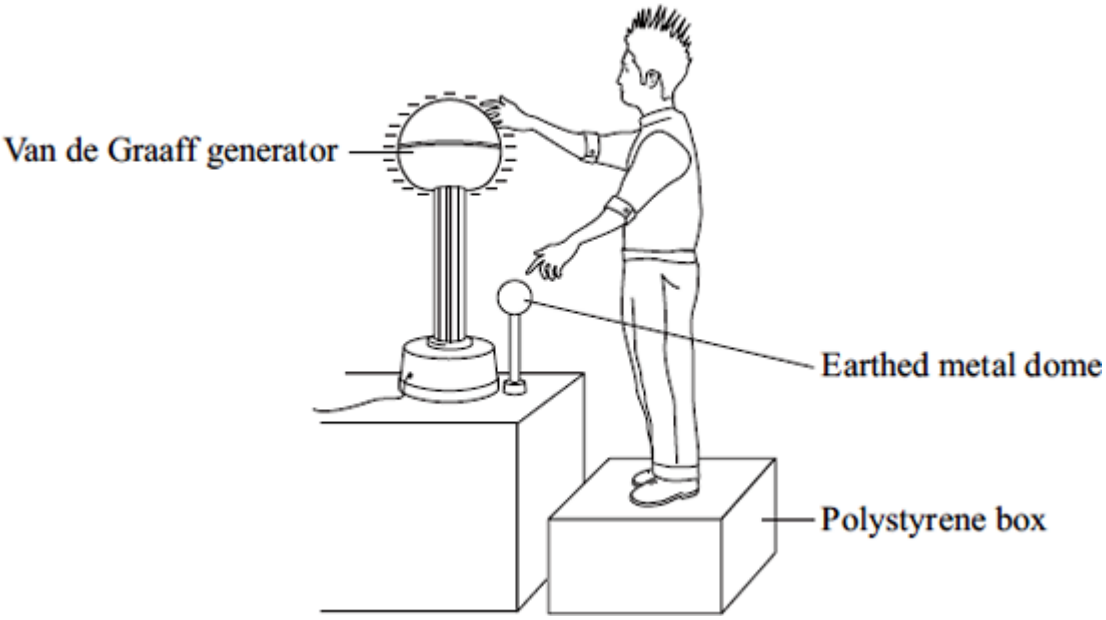
_____

(2)

(Total 5 marks)

Q11.

(a) The diagram shows a student touching the metal dome of a Van de Graaff generator.
When the generator is switched on, the metal dome becomes negatively charged.



Explain why the student's hair stands on end when the generator is switched on.

_____

_____

_____

(2)

(b) When the potential difference between the student and a nearby earthed metal dome reached 15 kV, a spark jumped between the student and the earthed dome. The spark transformed 30 mJ of energy into heat, light and sound. (1 mJ = 0.001 J)

Calculate the charge carried by the spark.

_____

_____

Charge transferred = _____ coulombs

(2)

(c) What name is given to the rate of flow of charge?

_____

(1)

(Total 5 marks)

Q12.

During car journeys, the driver will often become electrostatically charged.

This is more noticeable on dry days than on damp, humid days.

(a) Explain what happens to cause the driver to become charged.

_____

_____

_____

_____

(2)

(b) Scientists were asked to find out whether the build-up of charge on the driver depends on the type of material used to make the driver's clothes. The results of the investigation are given in the table.

Material	Humidity	Temperature in °C	Charge on the driver in millicoulombs
Nylon	48%	18	3.0 to 3.2
Wool	48%	18	2.4 to 2.5
Cotton	48%	18	1.4 to 1.7

Humidity is a measure of how much water vapour the air can hold.

(i) Why was it important that the scientists controlled the humidity?

_____

_____

(1)

(ii) Does the data in the table show that the charge on the driver would always be less if they were to wear cotton clothing?

Give a reason for your answer.

_____

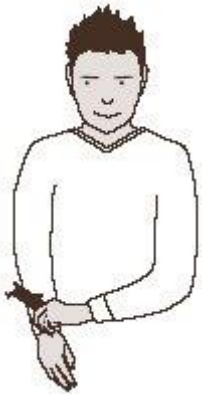
_____

(1)

(Total 4 marks)

Q13.

(a) A student rubs a nylon comb on the sleeve of his jumper.



(i) Use words from the box to complete the following sentence.

electrons	**hand**	**jumper**	**protons**

The comb becomes negatively charged because _____ move

from the student's _____ to the comb.

(2)

(ii) What type of charge is left on the jumper?

_____

(1)

(iii) The negatively charged comb is placed close to a charged plastic ruler. The comb and the ruler attract each other.

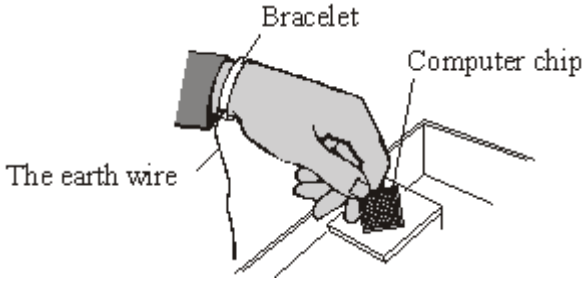
Complete the following sentence by drawing a ring around the correct line in the box.

The ruler is

negatively charged
positively charged
uncharged

(1)

(b) Electrostatic charge can damage computer chips. People working with computer chips may wear a special bracelet, with a wire joining the bracelet to earth (the earth wire). Any negative charge on the person will flow through the wire to earth.



(i) Which **one** of the following materials should the bracelet be made from?

Draw a ring around your answer.

copper **plastic** **rubber**

Give a reason for your answer.

_____

_____

(2)

(ii) Which **one** of the following words is used to describe the rate of flow of charge through a wire?

Draw a ring around your answer.

current **resistance** **voltage**

(1)

(Total 7 marks)

Q14.

You wash and dry your hair, then comb it with a plastic comb. As you move the comb away from your head some hairs are attracted to the comb.

(a) What has happened to the comb to make it attract the hairs?

_____

_____

(1)

(b) If the comb is now held above some small pieces of dry tissue paper what is likely to happen?

_____

_____

(1)

(c) If you rub your hands all over the comb it will no longer attract your hair. Explain why.

_____

_____

(2)
(Total 4 marks)

Q15.

A pupil did an experiment following the instructions below.

1. Take a polythene rod (AB), hold it at its centre and rub both ends with a cloth.

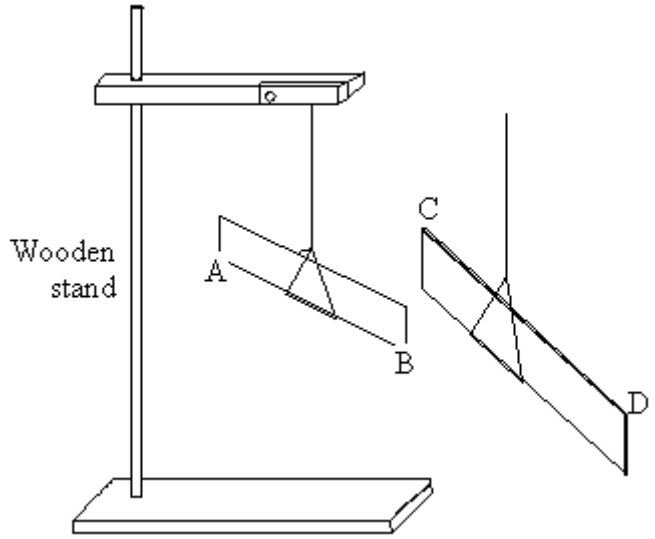
2. Suspend the rod, without touching the ends, from a stand using a stirrup and nylon thread.

3. Take a perspex rod (CD) and rub it with another cloth.

4. Without touching the ends of the perspex rod bring each end of the perspex rod up to, but without touching, each end of the polythene rod.

5. Make notes on what is observed.

The diagram below shows how the apparatus is to be set up.



(a) When end C was brought near to end B they attracted each other.

(i) Explain why they attracted each other.

_____

_____

(ii) What would happen if end C were brought near end A?

_____

(3)

(b) The experiment was repeated with two polythene rods.

(i) Describe what you would expect the pupil to observe as the end of one rod was brought near to the end of the other.

_____

_____

(ii) Explain your answer.

_____

_____

(2)

(c) Explain, in terms of electron movement, what happened as the rods were rubbed with the cloths.

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q16.

A student did an experiment with two strips of polythene. She held the strips together at one end. She rubbed down one strip with a dry cloth. Then she rubbed down the other strip with the dry cloth. Still holding the top ends together, she held up the strips.

(a) (i) What movement would you expect to see?

_____

_____

(1)

(ii) Why do the strips move in this way?

_____

(2)

(b) Complete the **four** spaces in the passage.

Each strip has a negative charge. The cloth is left with a_____

charge. This is because particles called _____ have been transferred

from the _____ to the _____ .

(4)

(c) The student tried the experiment using two strips of aluminium. The strips did not move.

Complete **each** of the sentences.

(i) Materials, such as aluminium, which electricity will pass through easily, are

called _____ .

(1)

(ii) Materials, such as polythene which electricity will **not** pass through easily, are

called _____ .

(1)

(Total 9 marks)