Static electricity ws MS

Question 1a

a)

i) One way that the student could give the balloon an overall electrostatic charge is to:

- Rub the balloon; [1 mark]
- With a piece of cloth / hair / fur; [1 mark]

ii) The sentence which explains why the overall charge on the balloon is negative is:

- B / Negative charge has been added to the balloon; [1 mark]

iii) The student can show that the two balloons have the same type of charge by:

- Hanging balloons up by their string; [1 mark]
- Bringing the balloons near to each other; [1 mark]
- Observing that the balloons repel each other; [1 mark]

[Total: 6 marks]

- For part iii), any method of handling the balloons without discharging them would gain the first marking point.

Question 1b

b)

i) The diagram which shows how the charge is distributed on the metal disc is:

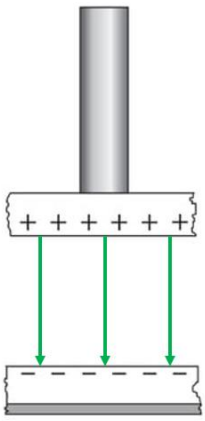
- **B**; [1 mark]

ii) The disc now has an overall positive charge because:

- Electrons / negative charges move; [1 mark]
- From the metal disc to the student / earth / ground; [1 mark]

iii) On Figure 10, draw lines to show the shape and direction of the electric field between the metal disc and the plastic block.

A diagram which would score two marks is:



- At least three straight lines joining the disc and the plastic; [1 mark]
- Arrow(s) from the disc towards the plastic; [1 mark]

[Total: 5 marks]

- For part i)
  - **A** and **D** are incorrect because a negative charge cannot induce a negative charge
  - **C** is incorrect because the disc is insulated so negative charge cannot be removed
- For part ii) saying 'flow' or 'transfer' instead of 'move' would also gain the marks - any word which implies movement is fine
  - Remember that it must be negative charges that move.

Question 2a

a)

i) The student can give the plastic strip an overall electric charge by:

- Using friction (rubbing the plastic rod); [1 mark]

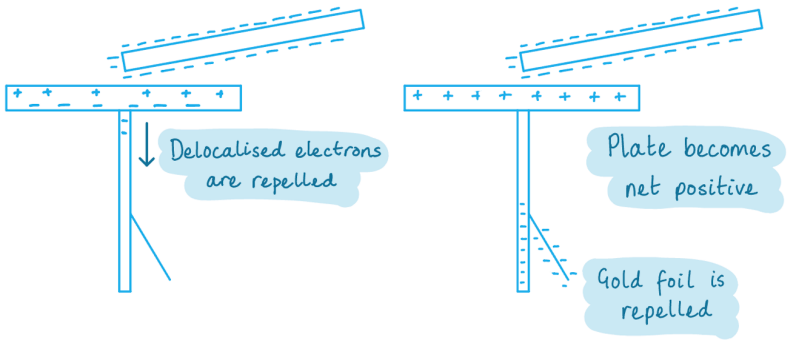
ii) The diagram that correctly shows the charge distribution is:

- C; [1 mark]

[Total: 2 marks]

- For part ii) the negatively charged rod is brought close to the metal plate. The delocalised electrons in the metal plate are repelled by the negatively charged rod, and move to the metal rod and gold leaf (foil). The lack of electrons in the metal plate cause it to have a positive charge, whilst the metal rod and gold foil become negatively charged, and the gold leaf is repelled by the metal rod

- The diagram used in the question is not an accurate representation, it is a model (a simplified version)
- A more accurate depiction would look like this:



Question 2b

b) Explain why earthing the charged electroscope causes the gold leaf to move:

- Electrons move (to the earth); [1 mark]

Any **one** from:

- Discharging the gold leaf and / or rod; [1 mark]
- And the gold leaf is no longer repelled; [1 mark]

[Total: 2 marks]

Question 2c

c)

i) **Two** differences between the charge on P and the charge on Q are:

- The charge on Q is greater than the charge on P; [1 mark]
- P has an (overall) negative charge and Q has an (overall) positive charge; [1 mark]

ii) State the effect that the electric field of object Q has on object P:

- There is a force of attraction on object P from object Q; [1 mark]

[Total: 3 marks]

- You can tell that the charge is greater on Q is greater because there are more field lines
- Field lines always go from positive to negative (the direction that a positive charge would travel if placed in the field)
    - Therefore, we can tell that object P is negatively charged because the field lines point toward it
    - And we can tell that object Q is positively charged because the field lines point away from it

Question 3a

a)

i) Sphere M is negatively charged because it has:

- **A** / gained electrons; [1 mark]

ii) Describe what happens in the wire connecting sphere N to earth when the spark jumps between M and N:

- Electrons / negative charges move; [1 mark]

- Down the wire / to earth; [1 mark]

iii) State a use of earthing in everyday life use and describe why earthing is needed:

EITHER

- Earthing is needed at the fuel pump when fuelling cars / planes; [1 mark]
- Because charge can build up on the metal of the vehicle and cause a spark; [1 mark]

OR

- Earthing is used with paint / insecticide spraying machines; [1 mark]
- Because the earthed object gains a charge which attracts the paint / insecticide; [1 mark]

OR

- Earthing is used for electrical devices such as a kettle; [1 mark]
- Because earthing protects the user by preventing electric shocks; [1 mark]

[Total: 5 marks]

Question 3b

b) Draw on Figure 15 the shape and direction of the electric field **between** the plates:

A diagram scoring two marks:

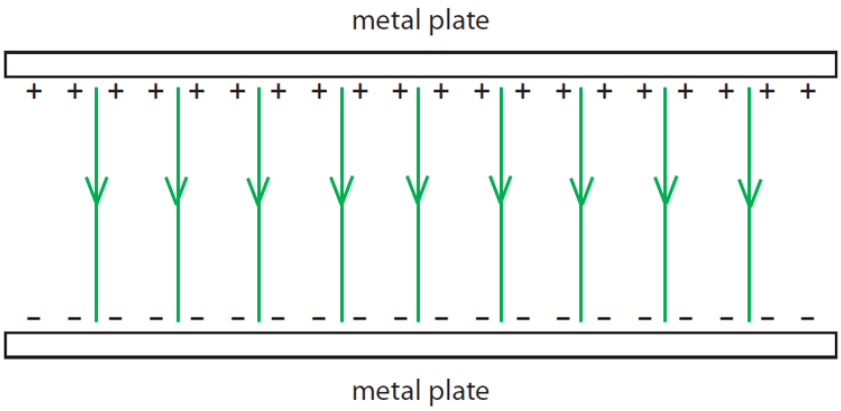


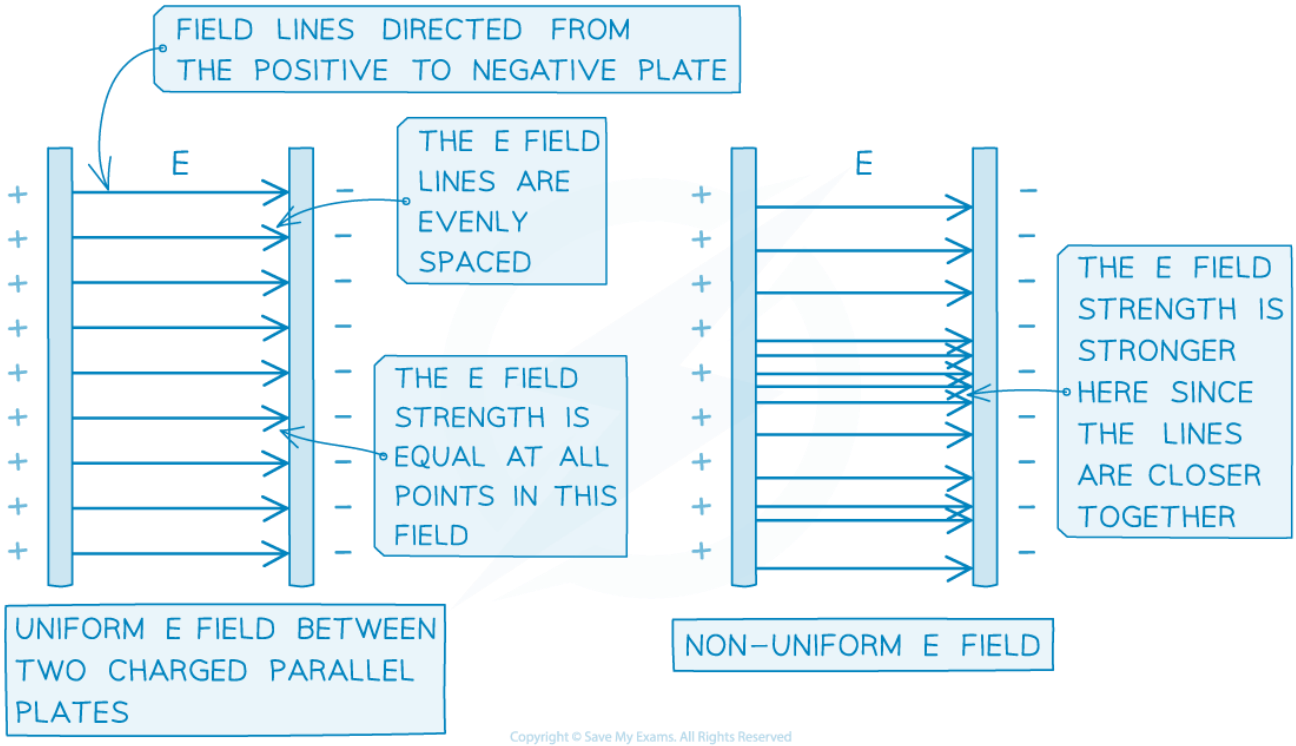
Figure 15

Any **two** from:

- Any vertical line drawn between the plates; [1 mark]
- Two or more parallel lines; [1 mark]
- At least one arrow drawn pointing downwards; [1 mark]

[Total: 2 marks]

- Remember that the electric field between parallel plates is uniform therefore the field lines are:
    - Straight lines
    - Parallel
    - Directed from positive to negative



Question 3c

c) Explain how you would use the apparatus in Figure 16 to show that like charges repel and unlike charges attract:

The following are the key physics points that will help you with your answer. You do not need to include them all, but will need to use them to write an answer as explained below:

- Rub the acetate strip with a cloth
- Test to see if the charge of the strip is positive or negative by rubbing it against a coulomb meter
- Place the acetate strip in the holder
- Charge a polythene strip by friction / rubbing with the cloth
- Test the charge of the polythene strip with the coulomb meter
- Bring the second strip close to the one in holder to see if it is attracted or repelled
- Repeat all the previous steps with another charged polythene strip (to confirm the results)
- Then charge an acetate strip and test its charge with a coulomb meter
- Bring the second charged acetate strip to the acetate strip in the holder, and see if it is attracted or repelled

An example answer scoring six marks:

Rub the acetate strip with a cloth to give it a charge and place it in the holder. Test the charge on the strip using the coulombmeter, to confirm that the acetate strip is positively charged. Rub the polythene strip with a cloth to give it a charge and use the coulombmeter to prove that it is negatively charged. Bring the negative polythene strip close to the positive acetate and see if it is repelled or attracted. Repeat the process with another charged acetate strip to see if it is repelled or attracted.

Level 1 (1 - 2 marks)

- At least two steps are listed, but the method given would not prove the hypothesis.
    - Eg: *rub one of the strips with a cloth and place it in the holder*

Level 2 (3 - 4 marks)

- At least three steps are described, with reasons given.
    - Eg: *rub one of the strips with a cloth to give it a charge and place it in the holder, give another strip a charge and see if it is repelled or attracted by the first strip*

Level 3 (5 - 6 marks)

- A detailed explanation of the procedure is given, with scientific understanding of the steps clearly shown.
    - *Example answer shown above.*

Question 4a

a)

i) The paint drops have a positive charge because the sprayer:

- **A** / removes electrons from the paint drops; [1 mark]

ii) The pattern of sprayer Y is different because:

- The charged drops with like charge repel each other; [1 mark]
- So the spray is wider / more spread out / covers a larger area / is more dispersed; [1 mark]

iii) A metal wire connects the object to earth because:

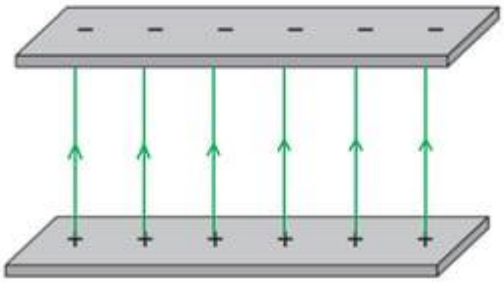
- Metal conducts electrons / charge; [1 mark]
- Which prevents (positive) charge accumulating on object; [1 mark]

[Total: 5 marks]

Question 4b

b)

A correct diagram of the field lines looks like:



- At least three vertical straight lines (equally spaced, by eye); [1 mark]
- At least one arrow from positive to negative; [1 mark]

[Total: 2 marks]

- You don't need to connect the arrows to the charges. We did this to be sure that our arrows were evenly spaced out, which *is* important.

Question 5a

a)

i) The rod becomes positively charged because:

- The student rubs the rod with the cloth; [1 mark]
- This transfers / moves; [1 mark]
- Electrons (from rod to cloth); [1 mark]

ii) The ball which is repelled by the positively charged rod is:

- **B** / ball R is repelled; [1 mark]

[Total: 4 marks]

You should recall that **like charges repel**, which is why positively charged ball **R** is repelled by the positively charged rod.

Question 5b

b)

Lightning is produced by:

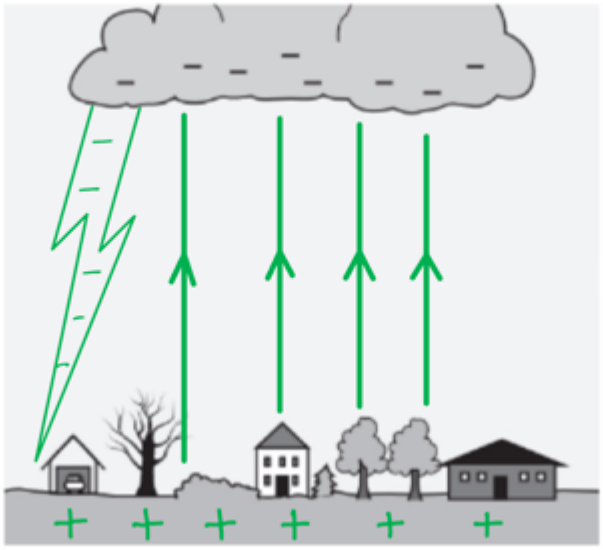
Any **three** from:

- The ground is charged (by induction); [1 mark]
- The charge on ground is positive; [1 mark]
- An electric field builds up (between cloud and ground); [1 mark]
- The air is ionised; [1 mark]
- Electrons travel to the ground **OR** positive ions travel to the cloud; [1 mark]

An example of an answer which would score 3 marks is:

- The negatively charged cloud induces [1 mark] a positive charge in the ground. [1 mark]
- The different charges cause an electric field to between the clouds and the ground. [1 mark]
- The field makes electrons travel from the cloud to the ground. [1 mark]

An example of an diagram which would score 3 marks is:



- Ground shown with positive charges; [1 mark]
- Electric field shown; [1 mark]
- Electrons moving to ground (lighting bolt **OR** arrows); [1 mark]

[Total: 3 marks]

The question states that; '*Your answer should refer to induced charges*'. This is the examiner giving you a clue as to where to start with your answer. Follow their advice!

Notice that the direction of the field and the direction of the electrons are opposite. An electric field arrow shows the direction a positive charge would move in.

Question 5c

c)

The hazards and precautions when transferring fuel are:

Each point from the list can score **one mark** up to a **maximum of six marks** (*but read the guidance below in blue*):

Dangers

- There is friction (as fuel flows through pipe)
- This causes a build-up of (electrostatic) charge
- The charges create a potential difference between nozzle and plane
- p.d. causes spark
- Leads to an explosion / fire

Use of metal wire

- So that the potential is the same on both objects;
- There is no electric field
- Excess charge goes to earth
- Charge is constantly / safely discharged
- There is no imbalance of electrons

An example of an answer that scores 6 marks is:

- When fuel flows through the pipes there is friction [1 mark] which leads to a build up of electrostatic charge. [1 mark]
- With a p.d. between the nozzle and the plane, [1 mark] sparks may be generated, [1 mark] leading to an explosion or fire. [1 mark]
- By putting a wire connecting them the potential is the same on the nozzle and the plane, [1 mark] and any excess charge can go to earth. [1 mark]
- This means the charge is safely discharged, [1 mark] so there is no fire.

[Total: 6 marks]

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