Demonstrate understanding of aspects of electricity and magnetism

Electrostatics

2020:1

(a) When a glass rod is rubbed with silk, the glass will become positively charged. What is the name of this process?

(b) A spark can be generated between two surfaces if there is a sufficient buildup of charge on one surface. Calculate the power of the spark if the energy transferred was 12.5 millijoules (12.5×10^{-3} J) and the spark lasted for 1.5 milliseconds (1.5×10^{-3} s).
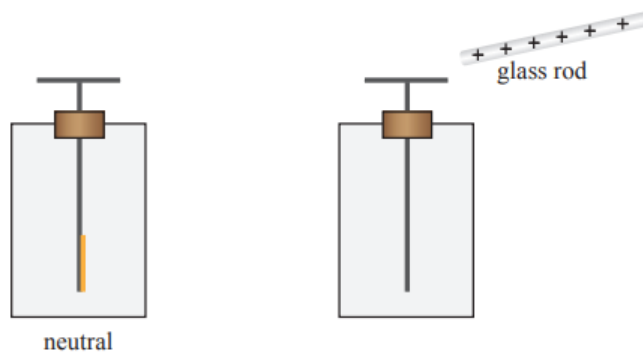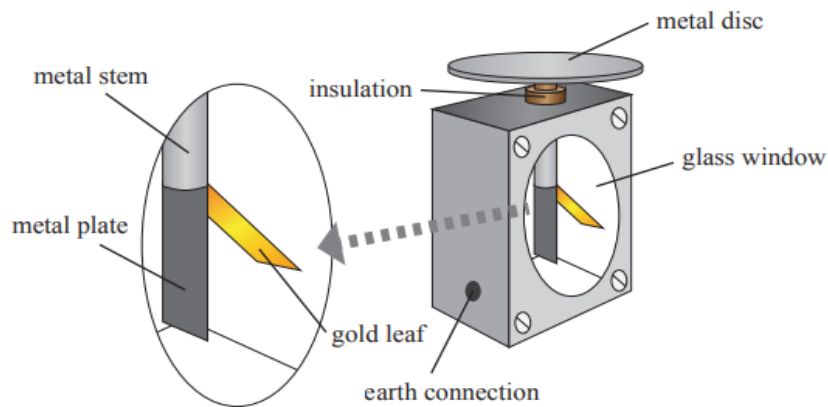

* Options for leaf position:

(d)   A negatively charged electroscope can be grounded. This can occur when a person touches the metal disk, causing the leaf to fall against the stem. Using the diagrams below, explain why the leaf falls against the stem. In your answer:
   •   draw the charge distribution on each electroscope diagram below
   •   draw the relative position of the leaf in each diagram to show the movement of charge

Negatively charged
electroscope

grounding / earthing

* Options for leaf position:
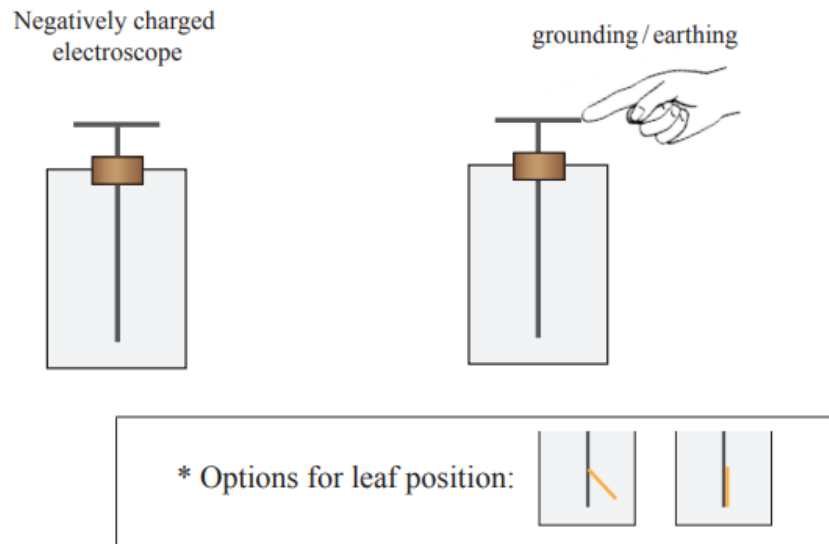
2019:1

(a)   What is meant by the term "static electricity"?

(b)   Ewan enjoys jumping on trampolines. He notices that sometimes he can build up a static charge when jumping on a trampoline. The trampoline mat is made of polypropylene.
   (i)   Explain how Ewan can become negatively charged while jumping on a trampoline.
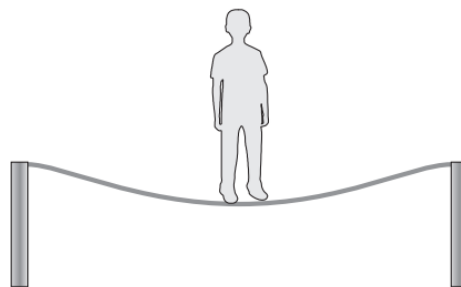
(c)   When Ewan touched the metal frame of the trampoline, he felt an electric shock, even though he did not feel a shock when he was touching only the polypropylene trampoline mat.
   (i)   Explain why Ewan did not get a shock when he was only touching the polypropylene mat, but did when he touched the metal frame.
   (ii)   Ewan decides that one way to prevent getting a shock when he touched the metal frame would be to make the trampoline mat from a material that conducts electricity. Explain why this change would prevent Ewan from experiencing a shock when he touches the metal frame.

(d)   When Ewan touched the metal frame of the trampoline, there was a small spark. The spark lasted for 2.5×10^{-4} s, had a voltage of 3500 V, and released a total energy of 1.25×10^{-5} J. Calculate the average current that flowed during the spark.

2018:1

(a) Below are two positively charged metal objects. The round object has charge evenly distributed over the surface, as shown. Draw the charge distribution to show how the positive charges are distributed along the surface of the non-round metal object.
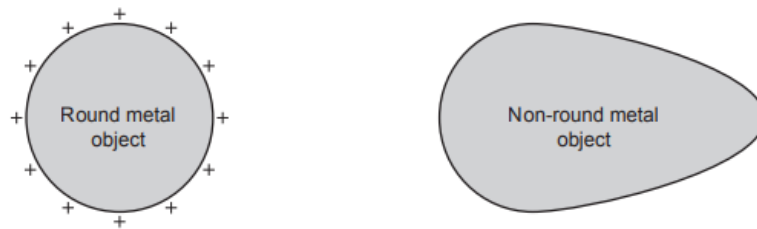
(b) Explain why copper is a good conductor of electricity, whereas glass is a poor conductor of electricity.

A Van de Graaff generator is an electrostatic generator that uses a moving belt to accumulate electric charge on a hollow metal globe, which sits on the top of an insulated column. The largest air-insulated Van de Graaff generator in the world was built in the 1930s. It is now on display at Boston's Museum of Science. The Van de Graff generator can generate 2.0 MV (2.0×10^6 V). During a demonstration, a spark was measured to last for 0.001 s. The spark carried 100 kJ (1.0×10^5 J) of energy.


(c) (i) Calculate the amount of current that flows during the spark.

(ii) Electrical currents above 100 mA are extremely hazardous for humans. Explain whether or not the current created by this demonstration is safe.

(d) A smaller Van de Graaff generator is used for a class activity. The teacher places a container of conductive balls onto the top of the Van de Graaff generator, as shown in the picture. The top and bottom of the container contain metal discs. They then touch the ground sphere against the top of the container. The conductive balls start to bounce back and forth between the top and bottom metal discs. This is called a Volta Hailstorm.
Explain why the balls bounce back and forth between the discs.
As part of your answer you should:
   •   explain why the balls initially move towards the top disc
   •   explain why the balls then fall back down.
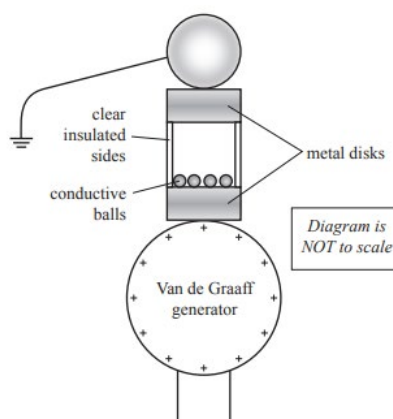
2017:1

A paint gun sprays tiny droplets of paint at a metal surface. Paint droplets are initially neutral, but become negatively charged as they leave the metal spray gun nozzle. motion of droplets metal surface being painted spray gun
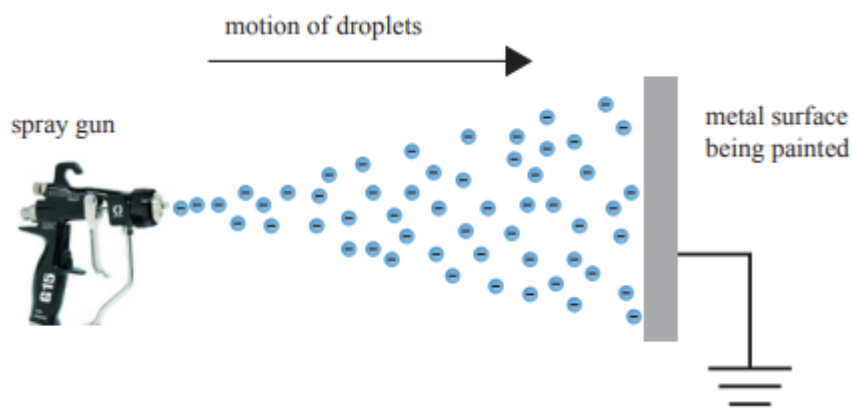
(a)   Describe the key property of metal that makes it suitable for painting with this technique.

(b)   One reason for charging the droplets is to ensure the paint is spread evenly across a wider area of the surface being painted.
   (i)   When two negatively charged droplets are near each other, they exert electric forces on each other. On the diagram below, draw arrows to show the electric force acting on each droplet.

   (ii)   Explain how negatively charging the droplets helps the paint spread evenly across a wider area.

(c)   When spray painting metal objects, a power supply can be connected, which allows the back of the object to be painted.
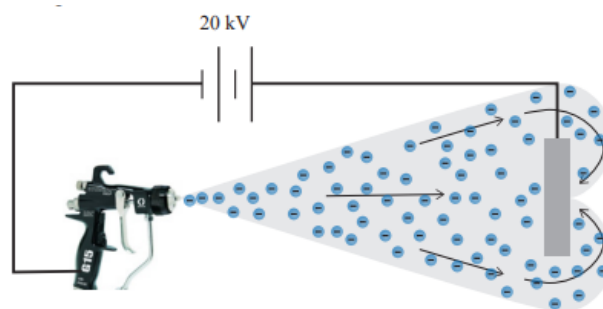
Explain how connecting a power supply to the metal sheet in this way allows the back of the metal sheet to be painted.

(d)   The maximum safe current that can flow from the spray gun nozzle is 1.0×10^{-4} A. When the spray gun is operated for 2.0 s, it draws 3.8 J of energy from the 20 kV power supply.
Determine whether the spray gun is operating within safe limits. Begin by calculating the power drawn by the spray gun.