

1.4 Electrostatic charging

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Quick review:

Classify the following into superconductors, conductors, semiconductors, insulators:

(Glass, Copper, Germanium, Niobium-titanium alloy).

superconductors	conductors	semiconductors	insulators
Niobium-titanium alloy	Copper	Germanium	Glass

Starter Activity:



Starter Activity: Charging the Balloon



What do you notice happens to the balloon and jumper after you let the balloon go? Give a reason for your answer.

A The balloon is repelled to the jumper because the balloon and jumper are like-charged.

B The balloon is attracted to the jumper because the balloon and jumper are like-charged.

C The balloon is attracted to the jumper because the balloon and jumper are oppositely charged.

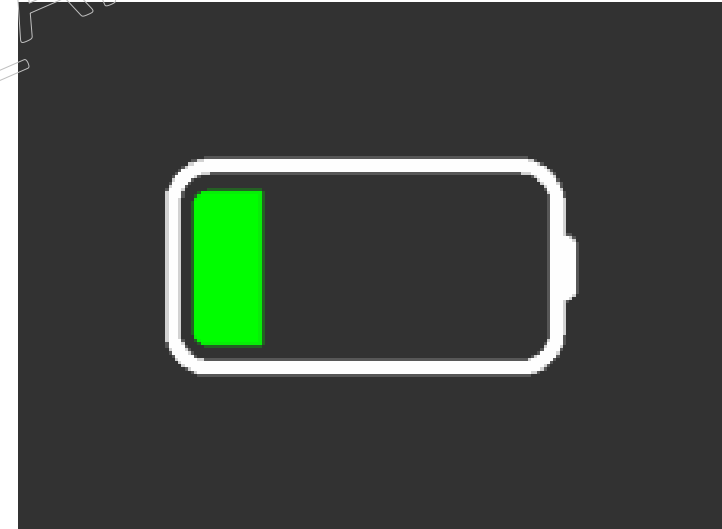
D The balloon is repelled to the jumper because the balloon and jumper are like-charged.

charging

How is lightning created?



How does a battery charge a phone?



Electrostatic charging is the transfer of charges.

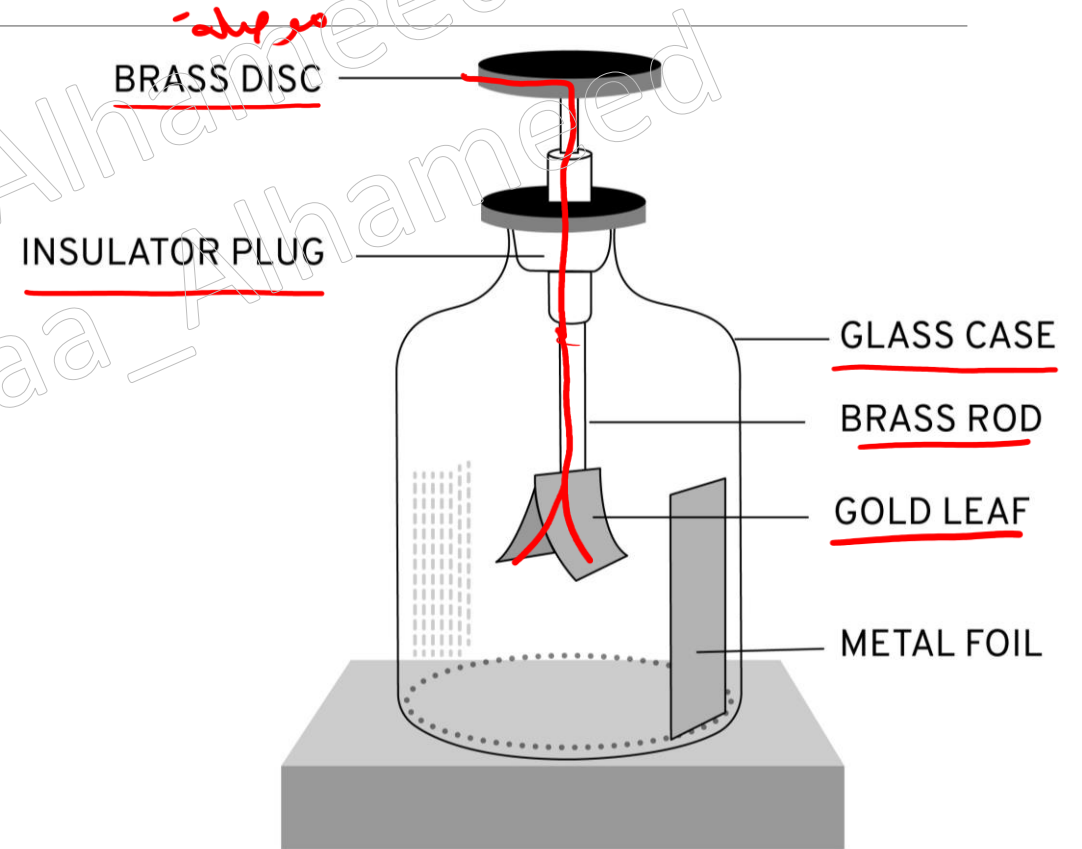
Electroscope

You can use an **electroscope** to detect if an object has an **electrostatic charge**.

★ What is an electroscope?

It is a device that gives an observable response when it is charged.

You can build a relatively simple electroscope by using two strips of very thin metal foil that are attached at one end and are allowed to hang straight down adjacent to each other from an isolating frame.

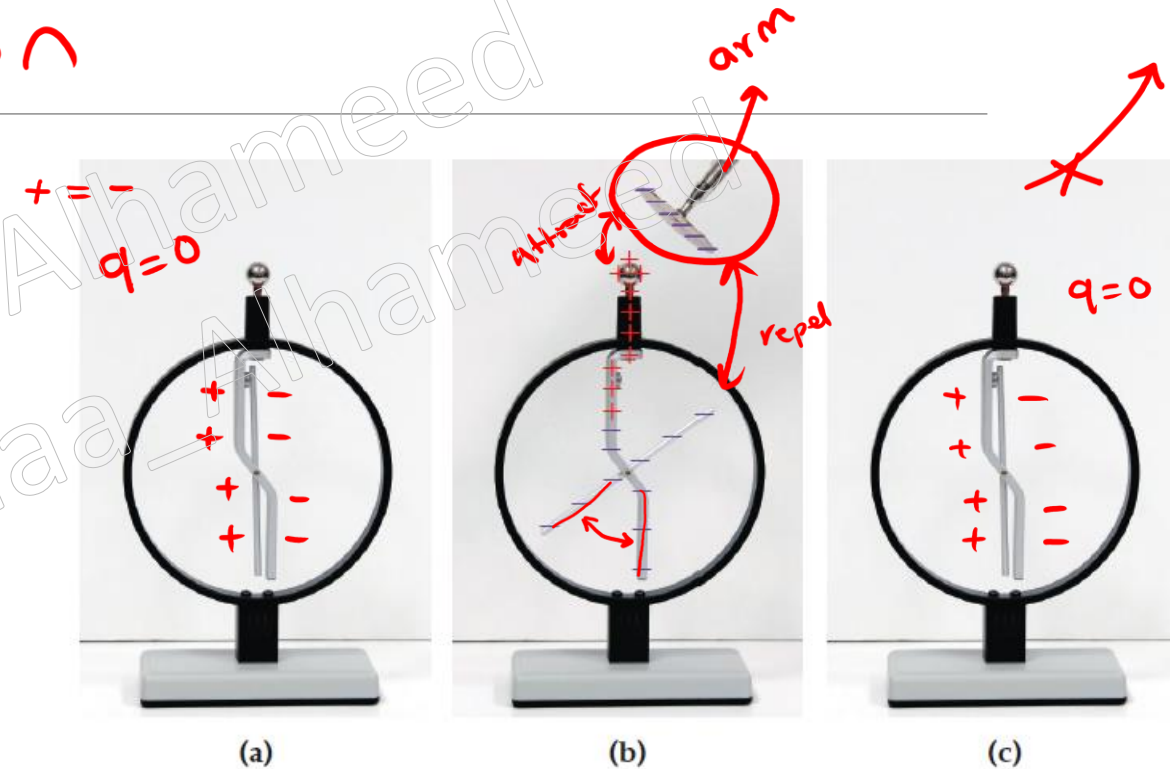


Gold leaf electroscope

Electroscope: induction

- An uncharged (neutral) electroscope is shown in Figure (a). The two arms are closed.
- If you bring a negatively charged paddle near the metal ball, it will attract the positive charges. A negative net charge will be created on the arms, and they will repel each other and move away as in Figure (b).
- If you remove the negatively charged paddle away from the metallic ball, the two arms will go back to the original position as in Figure (c).

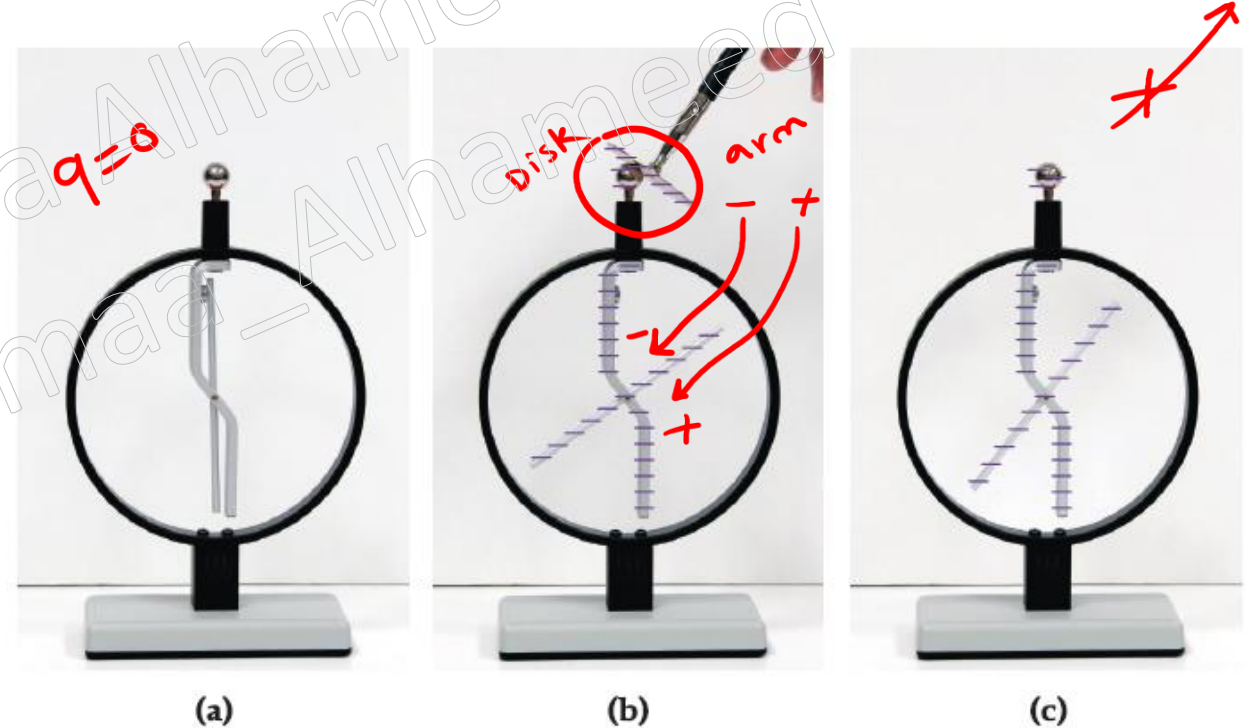
We say the charge on the arms were **induced**, because the negatively charged paddle didn't touch the metallic ball.



Note that the **net charge** of the **electroscope** is **zero** in both cases and that the motion of the conductor indicates only that the paddle is charged.

Electroscope: conduction ^{بالتمسك}

- If a negatively charged paddle touches the ball of the electroscope, Figure (b), electrons will flow from the paddle to the conductor, producing a net negative charge.
- If you remove the negatively charged object away from the metallic ball, the electroscope will carry a negative net charge, and will be called negatively charged.
- This method is known as charging by contact.



Electroscope: induction

The electroscope can be given a charge without touching it with the charged paddle. This method requires the electroscope be connected to a **ground**. Then, while the charged paddle is still close to but not touching the ball of the electroscope, the ground connection is removed.

This process is called **charging by induction** and yields an electroscope charge that has the **opposite sign** from the charge on the **paddle**.

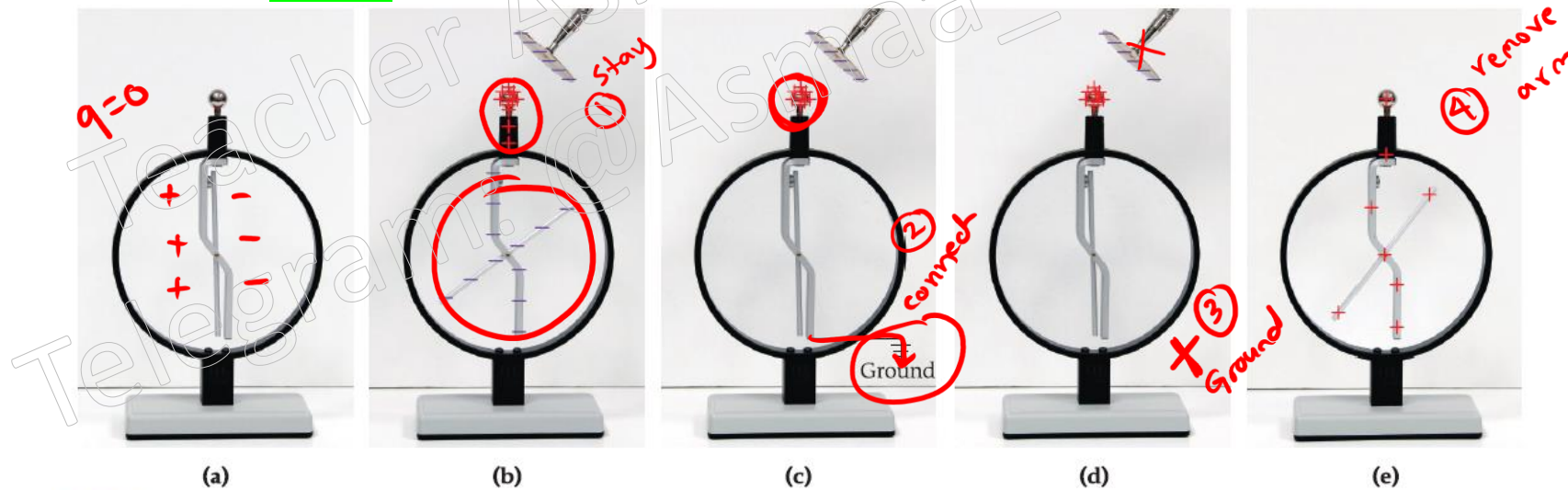
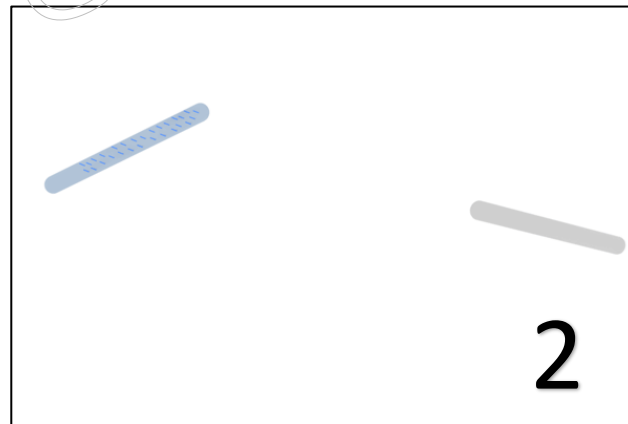
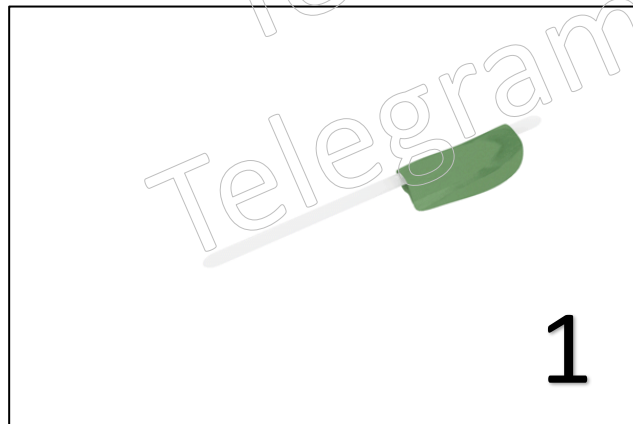


FIGURE 1.11 Charging by induction: (a) An uncharged electroscope. (b) A negatively charged paddle is brought close to the electroscope. (c) A ground is connected to the electroscope. (d) The connection to the ground is removed. (e) The negatively charged paddle is taken away, leaving the electroscope positively charged.

Electrostatic Charging

There are three ways an object can become electrostatically charged:

- 1) **Friction**: Rubbing two insulating objects together will transfer negative charges from one object to the other.
- 2) **Conduction**: Charges will flow between two objects with a different net charge connected by a conductive path.
- 3) **Induction**: A charged object will attract opposite charges in nearby objects, causing these nearby objects to become charged.



Activity: (Page: 8)

Concept Check 1.2

The hinged conductor moves away from the fixed conductor if a charge is applied to the electroscope, because

- a) like charges repel each other.
- b) like charges attract each other. ✗
- c) unlike charges attract each other. ✗
- d) unlike charges repel each other. ✗

1.2 مراجعة المفاهيم

يتحرك الموصل المتصل بمفصلة بعيداً عن الموصل الثابت عند شحن الكشاف الكهربائي لأن:

- (a) الشحنات المتماثلة تتنافر.
- (b) الشحنات المتماثلة تتجاذب.
- (c) الشحنات المختلفة تتجاذب.
- (d) الشحنات المختلفة تتنافر.



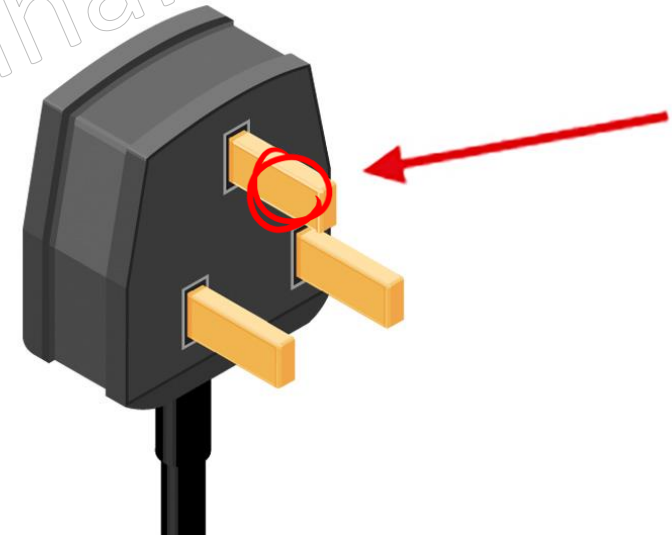
Grounding:

A quick and large **transfer of charge** can be dangerous and harmful. The sudden transfer of energy can cause burns or start fires.

To reduce the risk of a sudden charge transfer, the net charge of an object must be reduced.

Objects are connected to **ground** using a conductive wire. Any build up of charge in the object can be safely taken away through this conductive wire.

- What is the third pin used for?

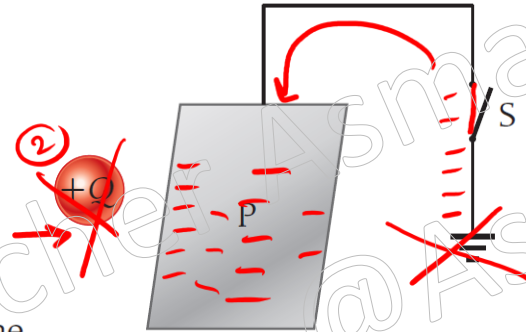


The top pin in the plug is the ground connection. This top pin is always longer than the other pins to ensure your device is always grounded before it is connected to the live wires.

Practice:

1.9 A metal plate is connected by a conductor to a ground through a switch. The switch is initially closed. A charge $+Q$ is brought close to the plate without touching it, and then the switch is opened. After the switch is opened, the charge $+Q$ is removed. What is the charge on the plate then?

- a) The plate is uncharged.
- b) The plate is positively charged.
- c) The plate is negatively charged.**
- d) The plate could be either positively or negatively charged, depending on the charge it had before $+Q$ was brought near.



1.9 وُصِّلَ لوح فلزي بالأرض عن طريق موصل يعمل بمفتاح وكان مغلقاً في البداية. وفُزِّبَت شحنة $+Q$ إلى اللوح من دون ملامسته. ثم فتح المفتاح. ثم تم إبعاد الشحنة $+Q$. ما شحنة اللوح عندئذٍ؟

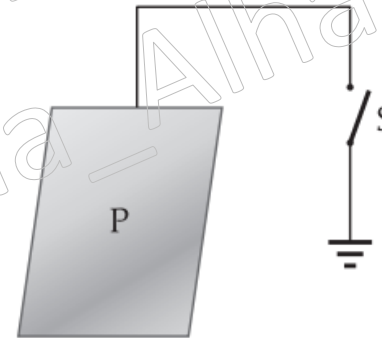
(a) اللوح غير مشحون.

(b) شحنة اللوح موجبة.

(c) شحنة اللوح سالبة.

(d) يمكن أن تكون شحنة اللوح موجبة أو سالبة.

حيث يعتمد ذلك على شحنته قبل تقريب الشحنة $+Q$ إليه.



Practice:

1.10 إذا قُرِّبَت قضيبًا بلاستيكيًا ذا شحنة سالبة إلى موصل مؤرَّض من دون ملامسته، ثم قُمْتَ بفصل التأريض، فما إشارة شحنة الموصل بعد إبعاد القضيب المشحون؟
(a) سالبة
(b) موجبة
(c) بدون شحنة
(d) لا يمكن تحديدها من المعلومات المعطاة

1.10 You bring a negatively charged rubber rod close to a grounded conductor without touching it. Then you disconnect the ground. What is the sign of the charge on the conductor after you remove the charged rod?

- a) negative
- b) positive**
- c) no charge
- d) cannot be determined from the information given

Thank you

Link for slides in the description

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