

Electricity – Notes

Charge of an electron = 1.6×10^{-19}

1C = 6.25×10^{18} electrons

1A = 1C s^{-1} = 6.25×10^{18} electrons per second

Number of electrons = $\frac{\text{Charge}}{\text{Charge of an electron}(1.6 \times 10^{-19})}$

Active wire – Carries the high voltage.

Neutral wire – Completes the circuit.

Earth – A safety wire to stop the appliance from becoming live.

A characteristic of a unit of matter that expresses the extent to which it has **more or fewer electrons than protons**.

Resistance of **2 components in parallel** = **0.5 x the resistance** of one of the **same component in series**. Thus, the **current in the parallel circuit** will be **double** that of the one component in series.

Conventional current flows **from the positive electrode to the negative electrode**.

Electron current flows **from the negative electrode to the positive electrode**.

Note: Not within the cell. From the end around the whole circuit.

It's impossible to say which voltages are dangerous because the **resistance** of each person is different.

A short-circuit is a thermal hazard instead of a shock hazard because in a short-circuit, the **resistance** of the circuit **becomes negligible**. As a result, huge currents are drawn which dissipate lots of **thermal energy**.

AC current's alternating nature has a greater tendency to throw the heart's pacemaker neurons into **fibrillation** whereas DC tends to make the heart **stand still**. Once the current is halted, a **stopped heart** has a **greater chance** of **regaining a normal beat pattern** than a fibrillating heart.

By doubly insulating a device, if there's a fault within the inside of the device allowing the case to have a potential difference, there's nowhere for the circuit to be finished since the **second insulating wire prevents the circuit from being completed**.

Safety features:

- **Earth wire** – Connected to the metallic case of an appliance so that should the appliance become live, the **current will flow harmlessly to earth**.
- **Fuses** – Made from low melting point and low resistance wires which will **melt/blow** if **too large a current goes through a circuit**.
- **Circuit breakers** – Ensure that current flow in a circuit doesn't go over a certain level. An **electromagnetic device breaks the circuit** and **prevents further current flow**.
- **Residual current device (RCD)** – Detects any difference between the currents in the active and neutral wires. If there's an **imbalance, it cuts off the power**.

Electricity has 3 effects on the human body:

- Electrolysis which produces toxins.
- Heating – Body offers high resistance.
- Stimulation of nerves – Nerves use electrical impulses to send signals. Can make muscles contract and 'not let go', stop heartbeat and turn it into a fibrillation.

On dry days there is less water in the air to attract delocalised electrons created through the rubbing of materials. This allows electrons to build up to the point where there is enough charge to create a static discharge.

Q: What effect does rubbing the wool and L-plate have on the charges in the plastic?

The rubbing action removes electrons from the wool, transferring them to the plate. This induces a negative charge on the plate.

Q: Why does the L-plate stay on the window?

The plate will stick to the window as the plate's new charge is more negative than the glass's nucleus. Because of the difference in charges, there is an attractive force between the 2 objects.

Q: Which types of surfaces will the L-plate not stick to?

The L plate won't stick to anything that has a negative charge because the like charges will result in a repulsive force between the 2 surfaces.

Q: Is there an even distribution of the charge on the L-plate?

Assuming the whole plate is attracted to the glass and not just a corner, then the charge is evenly spread on the plate.

Q: Why can't you put polystyrene cups initially stacked in cartons as close together as possible?

As you pull the cups apart, the cups rub against each other, resulting in a build-up of charge. Since each cup is light and placed in close proximity, the electrostatic forces between the cups are strong enough to move the cups.

Q: What happens inside a heating element that causes the resistance to increase as its temperature increases?

As current passes through a heating element/resistor, energy is lost. The lost energy heats up the material, increasing the average kinetic energy of the atoms inside the material. The higher the kinetic energy, the harder it is for electrons to pass through which results in a higher electrical resistance.

Q: How does a brownout affect the resistance and power consumption of the heater?

During a brownout, the supplied voltage drops below a certain voltage value while appliances continue to try and operate on the same amount of power. This leads to an increased current draw to maintain the power being supplied to the appliances. The resistance will change but only temporarily; as more current is drawn, material within the circuit heats up.

Q: Why don't birds get shocked when they perch on high voltage transmission lines?

When a bird perches on a single power line, the wire acts as a short circuit, resulting in only a minute amount of current flow through the bird. This is because the resistance from one bird's foot to the other is very high compared to the low resistance of the power line which is designed to carry current.

Q: Would a lie detector register increased or decreased skin resistance as a subject sweats?

Decreased. This is because sweat is more conductive than the human body due to the ionic salts it's formulated of.

Q: Explain why a fuse in a house circuit doesn't protect against electrocution.

A fuse will only turn off the power once it reaches a certain current draw. Electrocution might happen under the fuse's amperage rating. If the current is too high for the fuse, the fuse takes time to blow.

Q: Why is it that there are only 2 cables coming into the house from the street and yet power points always have 3 connections?

The neutral and earth are common.

Q: Why's the fuse always placed in the active wire at the meter box rather than the neutral one, given that this function could be fulfilled if it was in either?

It's much safer to place the fuse in the active circuit because then it cuts off the supply to the circuit because it then cuts off the supply to the circuit.

Q: What's the function of the "earth stake" that will normally be found near a meter box?

The earth stake ensures that the neutral and earth conductors are at zero potential.

Q: A toaster cable with conductors coloured red, black and green is to be joined to another cable with brown, blue and green/yellow conductors. Peter has joined the red and blue, black and brown and green and green/yellow. Will the toaster work normally when it's plugged in and turned on? Why is the way he has connected the cables dangerous?

The toaster will work normally but the connection is very unsafe because it will remain live even when switched off.

Q: An appliance was mistakenly wired between the active and earth instead of between the active and neutral. Explain why that's a very dangerous thing to do even though the appliance will appear to work normally.

The outer casing of the appliance could become live.

Q: Compare the meaning of the terms "conventional current" and "electron flow".

Conventional current represents the flow of charge around a circuit as if the moving charges were positive, which means the direction is from the positive terminal to the negative terminal. In reality, the moving particles in a metal wire are negatively charged electrons. Electron flow describes the movement of these electrons from the negative terminal to the positive terminal.

Q: Explain how the earth wire improves electrical safety in the home.

The earth wire is usually connected to the metal casing of an electrical appliance. If the insulation around the wire inside the appliance becomes degraded, the casing of the appliance could become live and dangerous to touch. In this situation, the earth wire provides an alternative low-resistance path to earth, protecting users of the appliance from electrocution.

Q: Why's the shock received when a finger touches a live wire likely to be less severe than the shock received by a person who touches a live wire with a pair of uninsulated pliers?

The finger provides less contact with the live wire and hence more resistance.

Q: Explain why a fuse protects property and a safety switch or RCD protects lives.

A fuse will melt when a high current flows in a circuit. Without the fuse the heat generated from a high current could be enough to start a fire and burn the house down. A safety switch switches off a circuit when the current in the active wire and neutral wires aren't equal, hence preventing possible electrocution.