Physics 10

Electric Current

⇒ It is a useful analogy to think of the flow of electric charge as similar to the flow of water.

⇒ Water will only flow if there is a difference in water pressure.
⇒ Once the water pressure equalizes, the flow of water will stop.

⇒ To have a continuous flow of water, we need to maintain a difference in water pressure by using a pump.

⇒ Similarly, to maintain a continuous flow of electric charge, there must be an “electrical pump” or voltage source to maintain a difference in “electric pressure”.
A Simple Circuit

A simple circuit consists of a voltage source that supplies electrical energy, conducting wires, and some sort of electrical appliance.

Exercise 9

Sometimes you hear someone say that a particular appliance “uses up” electricity. What is it that the appliance actually uses up and what becomes of it?

⇒ An electric device does not “use up” electricity, but rather energy. And strictly speaking, it doesn’t “use up” energy, but transforms it from one form to another.

Electric Shock

What causes electric shock in the human body – current or voltage?

⇒ The damaging effects of electric shock are caused by the current passing through the body.

⇒ A person can be killed by 120 V if their resistance is low enough. A person could touch a 1000 V potential difference and be alright if their resistance is high enough.

Electric Shock

⇒ The resistance of the human body varies from about 100 ohms if soaked with salt water to about 500,000 ohms if the skin is very dry.

Effects of current on the human body:

0.001 A ⇒ can be felt
0.005 A ⇒ is painful
0.010 A ⇒ causes involuntary muscle spasms
0.015 A ⇒ causes loss of muscle control
0.070 A ⇒ if through the heart, serious disruption; probably fatal if current lasts for more than 1 s
**Direct Current and Alternating Current**

⇒ There are two types of current: direct current (DC) and alternating current (AC)

**Direct Current** (DC) ⇒ charge flows in only one direction

element: batteries

⇒ electrons in a battery always move from the negative terminal towards the positive terminal

**Alternating Current** (AC) ⇒ electrons in the circuit are first moved in one direction and then in the opposite direction, constantly alternating back and forth about relatively fixed position

⇒ in most of the electrical outlets in North America, the electrons move back and forth 60 times every second (60 hertz)

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**Exercise 33**

Why is the wingspan of birds a consideration in determining the spacing between parallel wires in a power line?

⇒ If the parallel wires are closer than the wing span of birds, a bird could short circuit the wires by contact with its wings, be killed in the process, and possibly interrupt the delivery of power.

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**Electrons in a Circuit**

⇒ When we turn on a light switch, the light bulb appears to glow immediately.

⇒ This happens because the electric signal (electric field) travels at nearly the speed of light, **not the electrons**.

⇒ Electrons in a conducting wire move randomly with an average speed of about a million miles an hour.
**Electrons in a Circuit**

⇒ However, if the wire is not connected to a voltage source, there is no current because the electrons move randomly.

⇒ When an electric field exists within the wire (because it is connected to a voltage source), the electrons continue their random motion, but they are simultaneously nudged forward by the electric field.

When you turn on a flashlight, when then does the light bulb appear to glow immediately?

⇒ Electrons throughout the entire conducting wire all react simultaneously to the electric field and drift forward (while continuing their random motion).

**Electrons in a Circuit**

⇒ The electrons only drift forward through the wire at a speed of about 0.01 cm/s. It would take about 3 hours for an electron to travel through about 1 m of wire.

⇒ In an alternating current (AC), the electrons do not progress along the wire at all. The oscillate back and forth about relatively fixed position.

**Note:** the source of electrons in a circuit are the electrons already present in the conducting material.

⇒ When you plug a lamp into an outlet, energy flows from the outlet into the lamp, not electrons!

**Series Circuit**

⇒ In a series circuit, there is only one path for electrons to flow. If the path is broken anywhere, then all of the lamps will go out because electrons will stop flowing.
In a series circuit, there is only one path for electrons to flow.

In a parallel circuit, there are multiple paths for electrons to flow. If one of the paths is broken, electrons will still flow through the other paths.

In a parallel circuit, there are multiple paths for electrons to flow.