

Questions on Electricity and Magnetism*

Ohm's Law ($V = IR$)

1. Suppose you have a wire in a circuit that has 10 A flowing in it and it branches into two other wires. If there is 7 A in one of the wires, how much must be flowing in the other?
2. Which is more like an electrical circuit, the cooling system of your car or the plumbing in your house? Explain.
3. Why is it incorrect to say that voltage flows around a circuit? (Hint: start with definitions of current and voltage.)
4. A person standing on an insulated stool touches a charged insulated conductor. What happens?
5. Birds sit on high-tension wires and do not get electrocuted, even when the wire is bare, yet a squirrel which steps from a bare wire to a pole or to another wire dies instantly. Why?
6. What happens to the brightness of a light bulb if more current flows through it?
7. What is the difference between current (in Amperes) and voltage (in Volts)?
8. If you want make a brighter light bulb, do you want to increase the resistance or decrease the resistance of the filament? (Hint: The brightness increases if more current flows.)
9. What is the difference between AC and DC?
10. What do batteries supply to an electric circuit?
11. When a battery dies, is it out of electrons or out of energy? Explain.
12. If the same amount of current (electrons per second) flows into a light bulb flow out of it, what is being 'used up' in the circuit?
13. If the same current flows into your house as flows out of it, why do you have to pay for electricity?
14. Is it current or voltage that cause electric shock?
15. Wet feet reduce the resistance between you and the ground. From this fact explain why the same 120V outlet is much more dangerous if you have wet feet than if you have dry feet.
16. Why do warnings on power relay stations say 'Warning, High Voltage' when it is the current that is dangerous?

Magnetic Fields

1. Electric fields come from charges. Where do magnetic fields come from (your answer should include more than just saying "magnets")?
2. In what sense can we say that the ultimate source of all magnetic fields (even permanent magnets) is moving charge?
3. What is an electromagnet?
4. Suppose you float a magnet in a bowl by attaching it to a piece of Styrofoam. Will it drift towards the north side of the bowl due to the attraction of the north pole of the magnet? Why or why not?
5. Opposite magnetic poles repel each other. So why does the north end of a compass point north?
6. If a compass needle could point in any direction (north, south, up, down, etc.) which way would it point if it were located at the earth's geographical north pole?
7. Does a compass still point north if it is in the southern hemisphere, or does it reverse?
8. Do electrical charges always feel a force due to a magnetic field? Explain.
9. If a charged particle moves in a straight line through a region of space at constant speed, can you say that the magnetic field in that region is zero? Explain.
10. What is the origin of the Aurora Borealis (the Northern Lights)? Why are they not usually seen near the equator?
11. Residents of Alaska get hit by more cosmic rays (charged particles from space) than residents of Panama. Why is that?
12. Explain how an electric motor works.

Faraday's law

1. Why is a generator coil harder to turn when it is generating electricity than when it does not?

2. A magnet falling through a narrow copper tube will slow down, even though copper is not magnetic (your instructor may have demonstrated this in class). Explain why this happens.
3. Does your car burn more gas when you run the head lights than if the lights are off?
4. When you swipe a credit card the reader gets information from a strip on the back of the card. Explain how that works.
5. Most traffic lights are connected by a small computer chip to a wire embedded in the road which detects the presence of a car. How does this work?
6. The metal detectors at airport security can detect non-magnetic metals such as aluminum. Explain how that works.
7. Information is contained on your computer hard drive as a series of small magnetic fields (hard drives have iron particles embedded in them so that different regions can be magnetized). The read head consists of a small coil of wire that is located very close to the disk and can be moved around to reach different parts of the disk. Explain how the read head detects the information. Would this work if the disk were not spinning?
8. Explain how a generator works.
9. What is the difference between an electric motor and an electric generator?
10. Why don't transformers work with direct current (DC)?
11. Why is power transmitted at high voltages (and low current) over long distances?
12. What is Faraday's law?
13. A transformer with 10 turns in the primary and 100 turns in the secondary will convert an AC voltage of 5 V to 50 V. Explain why this doesn't contradict conservation of energy.
14. A pickup for an electric guitar consists of a small metal coil of wire wrapped around a magnet. Due to Faraday's law current is induced in the coil if the magnetic field near the pickup changes. Will this type of pickup work with nylon or other, non-metal strings? Explain.
15. Suppose a metal string is vibrating at 100 Hz in front of the pickup described in the previous question. What frequency will the induced current in the coil have as a result of Faraday's law?

* Many of these ideas came from *Conceptual Physics* 11th Ed. by Paul Hewitt (Addison Wesley, 2011).