

## **PHYS 1200 Physics of Everyday Experience**

### **Review questions and exercises for Lecture 24 (E&M-2)**

1. What is the meaning of the statement that there is a fundamental quantity of electric charge?
2. Being inside a car may provide some protection from lightening. What is the physical principle underlying this effect?
3. Under what conditions is water a conductor of electricity?
4. Under what conditions is a gas a conductor of electricity?
5. What are the basic constituents of a battery?
6. How is electric current defined and in what units is it measured?
7. What effect does a battery produce in an electric circuit?
8. Objects A and B initially have no net electric charge. If  $-5\text{ C}$  of charge is transferred from object B to object A, what is the final charge on A and B?
9. Initially object A has a net charge of  $+3\text{ C}$  and object B has a net charge of  $-2\text{ C}$ . If  $-1\text{ C}$  of charge is then transferred from A to B, what is the final charge on A and B?
10. Initially object A has a net charge of  $+3\text{ C}$  and object B has no net charge. If  $-2\text{ C}$  is then transferred from B to A, what is the final charge on A and B?
11. A charge of  $5 \times 10^{-6}\text{ C}$  passes a given point in a wire every 2 seconds. What is the current in the wire?
12. A current of  $5\text{ mA}$  ( $1\text{ mA} = 0.001\text{ A}$ ) flows in a circuit. Over a period of one hour, how much charge passes a given point in the circuit?

Answers and Solutions: (Try to work the problems before reading the solutions.)

1. There is an elementary quantity of electric charge:  $e = \pm 1.60217657 \times 10^{-19} \text{ C}$ . No charge smaller than this exists in nature. Any amount of charge must contain an integral number of elementary charges. We call this phenomenon charge quantization.
2. Electric fields do not penetrate into a conducting enclosure. Any charge placed on a conducting enclosure is on the outside surface. This is called electrostatic shielding. Since a car is mostly metal, it offers some protection in a lightning storm.
3. Pure water is not a conductor of electricity, but water containing is a conductor. The water must contain positive and negative ions to conduct electricity.
4. A neutral gas is not a conductor of electricity. However, if a large voltage is applied across a container of gas, some of the gas molecules will be ionized, i.e., will lose an electron, and thus the gas will become a conductor. A gaseous conductor is called a plasma.
5. A battery contains two different metals and some substance, usually an acid, which allows current to flow through it.
6. Current is the rate of flow of charge:  $I = q/t$ , where  $q$  is the charge. Current is measured in Coulombs (C) per second, and 1 C/s is defined as 1 Ampere (A).
7. A battery is a pump for electric charges in a circuit. The potential difference established across a conductor by a battery produces an electric field within the conductor that pushes the electrons that carry the current.
8. A:  $-5\text{C}$ ; B:  $+5\text{C}$
9. A:  $+4 \text{ C}$ ; B:  $-3\text{C}$
10. A:  $+1\text{C}$ ; B:  $+2\text{C}$
11.  $I = q/t = 5 \times 10^{-6} / 2 \text{ s} = 2.5 \times 10^{-6} \text{ A}$
12.  $q = I t = 0.005 \text{ A} \times (60 \times 60 \text{ s}) = 18 \text{ C}$