# SOLUTIONS TO THE MODULE #12 STUDY GUIDE

1 a. Photon – A small "package" of light that acts like a particle

b. Charging by conduction – Charging an object by allowing it to come into contact with an object that already has an electrical charge

c. Charging by induction – Charging an object without direct contact between the object and a charge

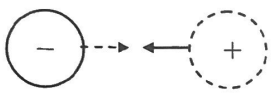
d. Electrical current – The amount of charge that travels past a fixed point in an electric circuit each second

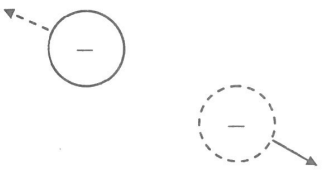
e. Conventional current – Current that flows from the positive side of the battery to the negative side. This is the way current is drawn in circuit diagrams, even though it is wrong.

f. Resistance – The ability of a material to impede the flow of charge

g. Open circuit – A circuit that does not have a complete connection between the two sides of the power source. As a result, current does not flow.

2. Like charges repel one another and will thus exert forces pushing the other directly away. Opposite charges attract and will therefore exert forces pulling the other directly in.

a. 


b. 


3. The electromagnetic force is inversely proportional to the square of the distance between the objects. Thus, if the distance is multiplied by 3, the force is divided by 9. Since the poles are opposite, it is an attractive force.

4. The electromagnetic force is directly proportional to the charge. When the first charge is doubled, the force is doubled. Since the second charge is left the same, there is no change with respect to that charge. The force varies inversely with the square of the distance between objects. Thus, if the distance is divided by 2, the force is multiplied by 4. The total change, then, is 2 x 4 = 8. The new force is 8 times stronger than the old one.

5. The exchange of photons causes the electromagnetic force.

6. Charged particles do not glow because the photons they emit are not visible to you and me. Under the right conditions, however, charged particles can emit visible light. At those times, you could say that the charged particles do "glow."

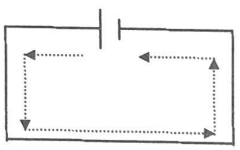
7. Charging by induction results in a charge opposite of the rod. Thus, the object will be negatively charged.

8. Charging by conduction results in the same charge as the rod. Thus, the object will be positively charged.

9. Voltage tells us how hard the electricity source pushes on the electrons. This means the larger the voltage, the higher the energy of each electron. Thus, each electron has high energy. Current refers to how many electrons flow through the circuit. Thus, few electrons flow through the circuit. Even though there are few electrons, they each have high energy. Thus, the circuit could be dangerous.

10. A circuit is reasonably safe when both the voltage and the current are low. Please realize that "low" is a relative term. A low voltage is 9 volts or less. A low current is 0.001 Amps or less.

11. Conventional current flows from the positive side of a battery to the negative side.



12. Conventional current assumes that electricity is the flow of positive charges. We know, however, that electricity is the flow of electrons, which are negative.

13. The longer the wire, the more chances the electrons have for colliding with atoms within the wire. Thus, the longer wire has more resistance.

14. The wider, or thicker, the wire, the more the electrons can spread out. This means there is less likelihood of electrons colliding with atoms in the wire. Thus, the thicker wire will have less resistance. For the same amount of current, less resistance means less heat. Thus, the thin wire will get hotter. This is one of the causes of house fires. A person uses too thin an extension cord and tries to allow it to run too many devices. This draws too much current for the thin wire, heating it up to the point that it causes a fire.

15. In circuit (a), the open switch makes it impossible for any current to flow. Thus, the light bulb won't glow. In circuit (b), the light bulb glows because the open switch is parallel to the light bulb. Thus, current can still flow through the bulb.

16. The bulbs are wired in a series circuit, because a burnt-out bulb acts like an open switch. If the open switch turns off the bulbs, it is wired in series with the other bulbs.

17. In a permanent magnet, the flow of charged particles is the motion of the electrons in its atoms.

18. As far as we know, this is not possible. Magnets must always have both a north and south pole.

19. Yes, it is possible. If the material responds strongly enough to a magnet, you can align its atoms and make it a magnet.

20. If a material is not magnetic, its atoms cannot be aligned. As a result, the flow of electrons is random, and the material cannot respond to a magnet.