Physics 115A   Answers to assigned questions from chapter 19, Giancoli

2. Christmas tree lights in series all go out if one bulb's filament breaks. Parallel Christmas tree bulbs will lose only one light if the filament breaks.

4. Brightness depends on the power transformed into thermal and radiant power in the bulb: $P = I^2R = V^2/R$. If the bulbs are in series, the higher resistance bulb has the greater voltage across it. Thus, if a bulb has a greater resistance, it will be brighter, since $P = IV = I^2R$ and the same current flows through both bulbs. So R_2 is brighter.

If the bulbs are connected in parallel, the voltage across each of the bulbs is the same, so a smaller current will flow through the bulb with greater resistance, since we may also write $P = V^22/R$. R_1 will be brighter, because it will carry a greater current.

5. The emf is the "driving voltage" that sends electrons through wires in a circuit. It results from transformation of some other sort of energy into electrical energy. Such an emf will produce a potential difference in a circuit.

A potential difference is merely a difference in potential between two points that could come from any cause or combinations of causes, such as emfs, resistors, etc.

6. The double outlets are connected in parallel so they can be used independently and each provides the full voltage. If they were in series, both outlets would have to be used to complete the circuit, and the voltage would be divided between the two loads.

For example, if the outlets are in parallel and you connect a 100 W light bulb to the first outlet, you get 100 W of power. If you connect it to the other, you also get 100 W of power. Thus, if you connected 100 W bulbs to each outlet, each bulb would give 100 W. If the outlets were in series, each bulb would be dimmer than the individual bulb, dissipating only 25 W. If you removed one bulb in the series configuration, the other bulb would go out. This is not true for the parallel configuration.

7. Two identical light bulbs are equivalent to two identical resistors. Power is found from $P = IV = V^2/R$. To obtain the largest power, we want the largest possible V together with the smallest possible R. We get the largest V by connecting the batteries in series and the smallest R by connecting the resistors (light bulbs) in parallel. Therefore, we get the largest power out by connecting the batteries in series to the light bulbs connected in parallel to form a closed circuit.

8. The first rule states that the sum of the currents into a junction is equal to the sum of currents out of a junction. Over a time interval Δt, the product of one of the currents into the junction and Δt is the amount of charge that has been carried into the junction by that current. The sum of the currents into a junction times Δt is the amount of charge carried into the junction during that interval. Likewise, the sum of the currents out of the junction times Δt gives the total amount of charge carried out of the junction during the same time interval. Hence, the amount of charge into the junction is equal to the amount of charge out of the junction.

9. Kirchhoff's second rule states that the gains and losses of potential around a closed loop is zero. Since the potential difference between two points is the difference in electric potential energy divided by the charge moving between the points, a test charge moving around the loop will gain and lose energy as the potential rises or drops. Hence, the total energy of the test charge is the same when it ends the traverse as when it started, i.e., it is conserved.

11. a) remains the same (it is just the emf)

b) increases (the circuit current I_1 decreases, so the IR drop across the ammeter and the source of emf decreases)

c) decreases (the circuit current I_1 decreases)

d) increases (the equivalent resistance of the parallel resistors 2 and 3 decreases)

e) increases

f) decreases (since $I_2 R_2 = I_3 R_3$)

g) decreases (the equivalent resistance of the parallel resistors 4, 5, and 6 increases, so I_1, and thus, I_2 and I_3 decrease)

h) decreases

i) remains the same (refer to (b) above)

17. The energy stored in a capacitor of capacitance C connected to a potential difference V is $\frac{1}{2}CV^2$, so in the case that the capacitors are in series, the potential difference for each capacitor will be $\frac{1}{3}$ the emf, for a total energy much smaller than when the capacitors are in parallel, in which case each capacitor has a potential difference of the emf. The factor in energy is $\frac{U_{series}}{U_{parallel}} = \frac{\frac{1}{2}C(\frac{1}{3}V)^2}{\frac{1}{2}CV^2} = \frac{1}{9}$.