

Name: _____

1. Why would banging on a magnet with a hammer cause it to lose its magnetism?

A substance is magnetic because the magnetic dipoles of the atoms in a substance are aligned in the same direction. When you hit a magnet with a hammer, you cause the dipole moments to become unaligned with each other, and therefore the magnetism goes away.

2. A 34.5 cm wire carrying a current of 12.0 A passes through a magnetic field of 2.35×10^2 T. (a) What is the maximum force exerted on the wire? (b) If the wire makes an angle of 35.0° to the field, what is the force exerted on it?

a. $F_b = I\ell B \sin\theta = 12.0 \text{ A} \cdot 0.345 \text{ m} \cdot 2.35 \times 10^2 \text{ T} \cdot \sin(90.0^\circ) = 972.9 \text{ N} = \boxed{973 \text{ N}}$

b. $F_b = I\ell B \sin\theta = 12.0 \text{ A} \cdot 0.345 \text{ m} \cdot 2.35 \times 10^2 \text{ T} \cdot \sin(35.0^\circ) = 558.0325149 \text{ N} = \boxed{558 \text{ N}}$

3. A conductor has 2.35×10^{20} electrons passing through a 76.0Ω resistor in 1.13 s. Find (a) the current through the resistor and (b) what is the potential difference across the resistor?

a. $I = Q/t = (2.35 \times 10^{20} e^- \cdot 1.6 \times 10^{-19} \text{ C}/e^-) / 1.13 \text{ s} = 33.27433628 \text{ A} = \boxed{33.3 \text{ A}}$

b. $V = RI = 76.0 \Omega \cdot 33.27433628 \text{ A} = 2528.849558 \text{ V} = \boxed{2530 \text{ V or } 2.53 \text{ kV}}$

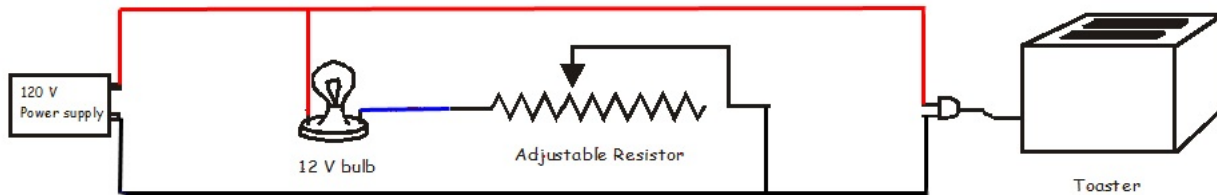
4. A certain light bulb is designed to dissipate 6.00 W when it is connected to a 12.0 V source.
- Calculate the resistance of the light bulb.
 - If the light bulb functions as designed and is lit continuously for 30 days, how much energy is used?

a. $R = V^2/P = 144 \text{ V}^2/6.00 \text{ W} = \boxed{24.0 \ \Omega}$

b. $E = P \cdot t = 6.00 \text{ W} \cdot (30 \text{ d} \cdot 24 \text{ h/d}) = \boxed{4320 \text{ Wh or } 4.32 \text{ kWh}}$

The 6.00 W, 12.0 V bulb is connected in a circuit with a 1500 watt, 120 V toaster; an adjustable resistor; and a 120 V power supply. The circuit is designed so that the bulb and the toaster operate at the given values and, if the light bulb fails, the toaster will continue to function at these values.

- On the drawing below draw in wires connecting the components shown to make a complete circuit that will function as described above.



- Determine the value of the adjustable resistor that must be used in order for the circuit to work as designed.
- If the resistance of the adjustable resistor is increased, what will happen to the following?
 - The brightness of the bulb – explain your response.
 - The power dissipated by the toaster. Explain your reasoning.

d. $I_{\text{bulb}} = P_{\text{bulb}}/V_{\text{bulb}} = 6.00 \text{ W}/12.0 \text{ V} = 0.500 \text{ A}$
 $R_{\text{bulb} + \text{variable}} = V_{\text{bulb} + \text{variable}}/I_{\text{bulb}} = 120 \text{ V}/0.500 \text{ A} = 240 \ \Omega$
 $R_{\text{variable}} = R_{\text{bulb} + \text{variable}} - R_{\text{bulb}} = 240 \ \Omega - 24 \ \Omega = \boxed{216 \ \Omega}$

- If the variable resistor's resistance is increased the bulb will be dimmer. The power source is a constant 120 V. If the branch with the resistor and bulb has a higher resistance, then less current will flow making the bulb dimmer.
 - If the variable resistor's resistance is increased, the power dissipated by the toaster will not change. The toaster is hooked up in parallel with the variable resistor and bulb, so the amount of current flowing through the bulb's branch doesn't affect the toaster. The toaster has a constant 120 V supply and will pull the same current as long as its own resistance doesn't change.

5. A circuit is set up as shown. (a) What is the total current? (b) What is the total resistance? (c) What is the power dissipated by the 10.0Ω resistor?

$$b. R_T = 18.0 \Omega + (15.0^{-1} + 75.0^{-1})^{-1} \Omega + 12.0 \Omega = \boxed{42.5 \Omega}$$

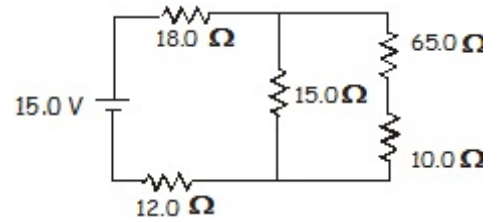
$$a. I = V/R = 15.0 \text{ V}/42.5 \Omega = 0.3529411765 \text{ A}$$

$$= \boxed{0.353 \text{ A or } 353 \text{ mA}}$$

$$c. I_{10\Omega} = I_T - I_{15\Omega} = I_T - V_{15\Omega}/15 \Omega = I_T - (I_T \cdot 12.5 \Omega)/15 \Omega$$

$$= 0.0588235294 \text{ A}$$

$$P = I^2 R = 0.0346020761 \text{ W} = \boxed{0.0346 \text{ W or } 24.6 \text{ mW}}$$



6. An electron is accelerated through 2400 V from rest and then enters a region in which there is a uniform 1.70 T magnetic field. What are (a) the maximum and (b) the minimum magnitudes for the magnetic force this charge can experience?

$$KE = U_E$$

$$\frac{1}{2} mv^2 = qV$$

$$v = (2qV/m)^{\frac{1}{2}} = (2 \cdot 1.60 \times 10^{-19} \text{ C} \cdot 2400 \text{ V}/9.11 \times 10^{-31} \text{ kg})^{\frac{1}{2}}$$

$$= 29034972.67 \text{ m/s} = 29\,000\,000 \text{ m/s}$$

- a. The maximum magnetic force would be if the electron is traveling at a right angle or perpendicular to the magnetic field:

$$F_B = qvB \sin \theta = 1.6 \times 10^{-19} \text{ C} \cdot 29034972.67 \text{ m/s} \cdot 1.70 \text{ T} \cdot \sin(90^\circ)$$

$$= 7.89751257 \times 10^{-12} \text{ N} = \boxed{7.90 \times 10^{-12} \text{ N or } 7.90 \text{ pN}}$$

- b. The minimum force would be if the electron is traveling in the same direction as the magnetic field. Then the force would be 0 N as the $\sin(0^\circ)$ is 0.

7. A duck flying horizontally due north at 15 m/s passes over Atlanta, where the magnetic field of the earth is $5.0 \times 10^{-5} \text{ T}$ in a direction 60.0° below a horizontal line running north and south. The duck has a positive charge of $4.0 \times 10^{-8} \text{ C}$. What is the magnetic force acting on the duck?

$$F_B = qvB \sin \theta = 4.0 \times 10^{-8} \text{ C} \cdot 15 \text{ m/s} \cdot 5.0 \times 10^{-5} \text{ T} \cdot \sin(60^\circ)$$

$$= 2.59807621 \times 10^{-11} \text{ N} = \boxed{2.6 \times 10^{-11} \text{ N or } 26 \text{ pN}}$$