DO ALL EIGHT PROBLEMS. THE WORTH OF EACH PROBLEM IS MARKED NEXT TO THE PROBLEM. SHOW YOUR WORK FOR PARTIAL CREDIT.

1) Consider two charged particles ($q_1 = -12 \mu C$, $m_1 = 14$ grams; $q_2 = +3 \mu C$, $m_2 = 8$ grams). The first particle is 27 cm to the West of the second one.

a) What is the magnitude and direction of the electric FORCE on the 1\textsuperscript{st} particle due to the presence of the 2\textsuperscript{nd} particle? [when answering this direction question, answer with North, East, South, West, Up or Down.] magnitude: \[4.44 \text{ Nt}\] direction: East

b) Is the magnitude of the force on the 2\textsuperscript{nd} particle due to the 1\textsuperscript{st} particle [bigger than, the same as, or smaller than] the force on the 1\textsuperscript{st} particle due to the 2\textsuperscript{nd} particle? \[\text{same}\]

c) Is the direction of the force on the 1\textsuperscript{st} particle due to the 2\textsuperscript{nd} particle [the same as or opposite to] that of the force on the 2\textsuperscript{nd} particle due to the 1\textsuperscript{st} particle? \[\text{opposite}\]

d) Is the magnitude of the acceleration of the 2\textsuperscript{nd} particle due to the presence of the 1\textsuperscript{st} particle [bigger than, the same as, or smaller than] the acceleration of the 1\textsuperscript{st} particle due to the 2\textsuperscript{nd} particle? (Assume there are no other forces acting on the two particles). \[\text{bigger}\]

2) Consider the same two point charges as in problem #1.

a) What is the electric field (magnitude, direction) due to 1\textsuperscript{st} charge at the location of the 2\textsuperscript{nd} charge? magnitude: \[1.48 \times 10^6 \text{ Nt/C}\] direction: West

b) What is the voltage due to the 1\textsuperscript{st} charge at the location of the 2\textsuperscript{nd} charge? \[-4.0 \times 10^5 \text{ V}\]
3) a) What is the magnitude of the gravitational force between a proton and an electron when they are separated by 0.3 nm? 
[6] \(1.13 \times 10^{-48}\) Nt 

b) What is the magnitude of the electrical force between a proton and an electron when they are separated by 0.3 nm? 
[6] \(2.56 \times 10^{-9}\) Nt

4) An electron is to be accelerated from rest by using an accelerating voltage of 20 volts.

a) How fast will the electron be going after the acceleration through 20 volts? 
[8] \(2.65 \times 10^6\) m/s .

b) Should the electron start out at a higher or lower voltage? 
[2] lower

c) If the electron is to be accelerated with twice the voltage (40 volts), will the final velocity of the electron be [twice as large, less than twice as large, or greater than twice as large] as in part a? 
[2] less than twice

5) A 3 microFarad capacitor has a voltage of 20 volts applied across it. a) How much charge is stored on the capacitor? 

[5] \(6.0 \times 10^{-5}\) C 

b) How much energy is stored on the capacitor? 
[4] \(6.0 \times 10^{-4}\) J 

c) If the capacitor is a parallel plate type of capacitor, and the area of its plates is doubled (with the distance between the plates and the voltage remaining the same), which of the following quantities will change (relative to the original 5 microF capacitor with 40 volts applied): (1) capacitance, (2) energy stored, (3) charge stored? [if none change, then answer none; if one changes, simply indicate which changes, if two change, then indicate both of those that change, if all three change then answer all] 
[3] all


6) A particular light bulb is rated at 12 Watts when a voltage of 6 volts is placed across it.
   a) What is the electric current through the light bulb in this circumstance? 
      [5] ___2 A___
   b) What is the resistance of the light bulb?
      [5] ___3 Ω___
   c) In designing a new wattage light bulb, should the resistance of the light bulb be [lowered or raised] from that in part b above if the power of the light bulb is to be decreased when used with the same 6 volts power supply?
      [2] ___increased___

7) Consider three capacitors:   C₁ = 5 nF,  C₂ = 9 nF,  C₃ = 15 nF .
   a) Connect the three capacitors in a circuit (make a circuit drawing) such that the effective capacitance is the largest it can be: [5]

   b) Are the three capacitors above connected in series, parallel, or some other combination?
      [2] ___parallel___
   c) What is the effective capacitance of this circuit that has the largest effective capacitance using these three capacitors?
      [5] ___29 nF___
8) Consider three resistors: \( R_1 = 5 \, \Omega \), \( R_2 = 9 \, \Omega \), \( R_3 = 15 \, \Omega \).

a) Connect the three resistors in a circuit (make a circuit drawing) such that the effective resistance is the largest it can be: [5]

b) Are the three resistors above connected in series, parallel, or some other combination? [2] series _________.

c) What is the effective resistance of this circuit that has the largest effective resistance using these three resistors? [5] _____ 29 \, \Omega _________.

d) Connect all three resistors in a circuit (make a circuit drawing) such that the effective resistance is between 9 \, \Omega and 15 \, \Omega. If no combination will work, then write NONE. [4]