Name: _____

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page.

Multiple choice

1. (1 point) The electric force is the following type of force:

   ◯ a contact force ◯ a field force ◯ a normal force

2. (1 point) A conductor is an object that:

   ◯ that has free electrons and can transmit charges
   ◯ that doesn't have free electrons and can't transmit charges
   ◯ that can transmit charges between objects of only one charge
   ◯ do not experience electric forces

3. (1 point) Who named the two types of charges "positive" and "negative"?

   ◯ Abraham Lincoln
   ◯ Fidel Castro
   ◯ Thomas Jefferson
   ◯ Chiang Kai-shek
   ◯ Benjamin Franklin

4. (1 point) The Millikan Oil-Drop Experiment proved that:

   ◯ Showed that charges are continuous.
   ◯ Showed that electrons are massless.
   ◯ Showed that the electric field only interacts with electrons.
   ◯ Showed that charges come in integer multiples of the elementary charge e.

5. (1 point) Gauss's law tells us that the net flux of the electric field passing through the surface of an imaginary 3D shape is proportional to:

   ◯ The charge on the surface.
   ◯ The charge enclosed.
   ◯ The charge outside of the surface.

6. (1 point) The electric potential energy is a [ ] and the electric force is a [ ].

   ◯ scalar/vector ◯ vector/scalar ◯ scalar/scalar ◯ vector/vector

Problems

7. (6 points) Charge A is a 5.0μC point charge is placed at position $(x, y) = (0.0, 0.0)$ m, and charge B is a point charge $q_2 = -2.0$ μC is located at $(x, y) = (3.0, 0.0)$m.

   (a) If the electric potential is taken to be zero at infinity, find the total electric potential due to these charges at a point located at a point C at $(x, y) = (0.0, 4.0)$ m?

   (b) How much work is required to bring a third point charge of 4.0 μC from infinity to the point P? Assume the mass is 1.0kg.

   (c) If you found the net potential to be positive, and if the third particle is postive, it will not want to go to that point and work needs to be done to put it there. In general, if the net potential and the third charge have the same sign, that third charge will want to go away from that point rather than toward it.

   On the other hand, if the net potential and the charge have opposite signs, then it would want to go towards that point.

   If they have the same signs and the particle starts from infinity, then to bring that particle to point C, the electric force be doing negative work, i.e. work against that motion.

   If they have opposite signs, then the electric force itself is doing positive work and the charge will accelerate naturally to that point.

   Look at your numbers and figure out which case you have. If you have the first case, where the sign of the particle is the same as the sign of the net potential, assume that the third particle starts out at infinity with a velocity v pointing towards the point C. It so happens that this velocity is large enough that there is enough kinetic energy for the third particle to arrive at point C from infinity, slowing along the way, and coming to a complete stop at point C before it starts going backwards. Find v.

   If you have the case where the third charge and the net potential have opposite signs, then assume the point particle starts out at infinty with zero velocity. How fast will it be going by the time it makes it to point C?

8. (3 points) Draw three charged particles in the space below. Place them randomly. Assign positive/negative charges to each, making sure that at least one is positive and at least one is negative. For simplicity, let the charges have equal magnitude. Draw the electric field lines.

9. (9 points) A proton is released from rest in a uniform electric field of magnitude 8×10^4V/m directed along the positive x axis. The proton undergoes a displacement of 0.50 m.

   (a) In which direction will the proton go when released?

   (b) Find the change in electric potential of the proton as a result of this displacement. *Hint: The electric field is uniform, and your textbook will be very helpful here.*

   (c) Find the change in electrical potential energy of the proton for this displacement and explain the physical meaning of the sign of the change. *Hint: Think of how the gravitational potential energy changes for an object sliding down a hill.*

   (d) Find the speed of the proton after it has moved 0.50 m starting from rest?