Name: _____ ID: _____ Lab (day/time): _____

Physics 203
Midterm Exam 2
5/16/2018

Collaboration is not allowed. Allowed on your desk are: up to ten 8.5 x 11 inch doubled sided sheets of notes that are bound together, non-communicating scientific calculator, 1 page of scratch paper, writing utensils, and the exam. You will have 80 minutes to complete this exam.

Constants:

$$\mathbf{e = 1.602 \times 10^{-19} C}, \quad \mathbf{m_e = 9.109 \times 10^{-31} kg}, \quad \mathbf{m_p = 1.67 \times 10^{-27} kg}$$

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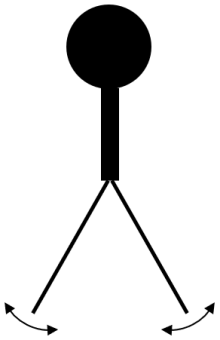
1. (6 points) One charge of 2 μC is placed at (x,y) = (1 cm, 0 cm), another charge of 1 μC is placed at (x,y) = (0 cm, 1 cm).

a) What is the electric field at (x,y) = (1 cm, 1 cm)?

b) What is the magnitude of the electric field?

For questions 2 through 5 **fill in the square** next to all correct answers, a given problem may have more or less than one correct answer. Each correctly chosen answer will receive two points. There are 7 correct answers in this section and only the first 7 filled in answers will be graded. There is no partial credit.

2. A metal rod with an excess of positive charge touches a previously neutral electroscope and the leaves spread apart. The metal rod is then removed. Which of the following options will cause the leaves to move closer together?



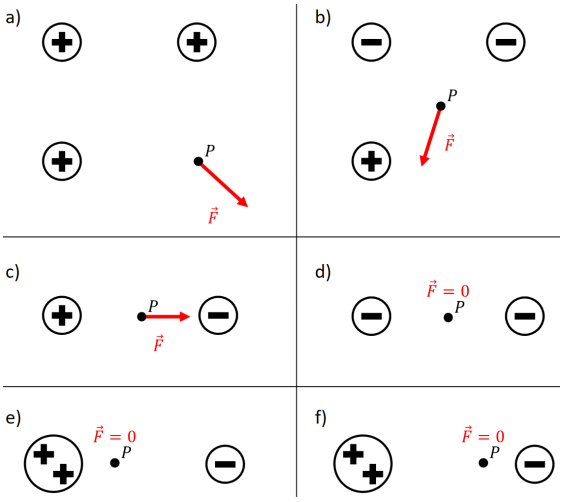
☐ a) Bringing a negatively charged metal rod close to the top of the electroscope
☐ b) Bringing a positively charged metal rod close to the top of the electroscope
☐ c) Bringing a negatively charged insulating rod close to the top of the electroscope
☐ d) Bringing a positively charged insulating rod close to the top of the electroscope

3. A +1 C charge is placed at the origin. A -2 C charge is placed on the x-axis, 30 cm to the right of the origin. Which of the following statements are true?

☐ a) Other than $x = \pm\infty$, there are no locations on the x axis where the electric field magnitude is zero.
☐ b) Other than $x = \pm\infty$, there is only one location on the x axis where the electric field magnitude is zero.
☐ c) In addition to $x = \pm\infty$, there is more than one location on the x axis where the electric field magnitude is zero.
☐ d) The electric field is zero at a point between the two charges.
☐ e) Other than $x = -\infty$, the electric field is zero at one point to the left of both charges.
☐ f) Other than $x = \infty$, the electric field is zero at one point to the right of both charges.
☐ g) The electric potential energy of the -2 C charge is greater than the electric potential energy of the +1 C charge.

4. Which of the following situations correctly depict the force on a negative charge placed at the black dot? (+ and - charges have equal magnitudes, ++ implies twice the charge)

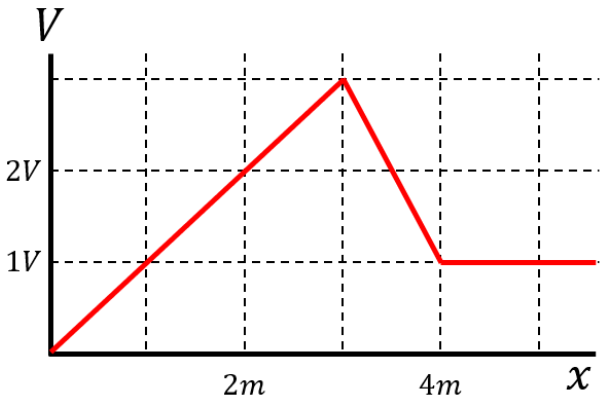
☐ a)
☐ b)
☐ c)
☐ d)
☐ e)
☐ f)

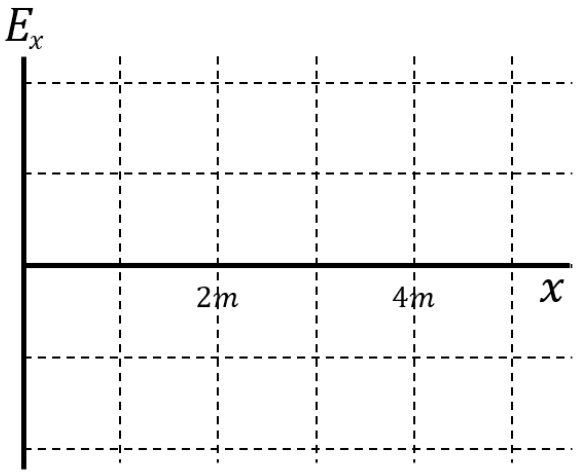


5. For the electric force to do no work on a charge moving through an electric field, the charge must be:

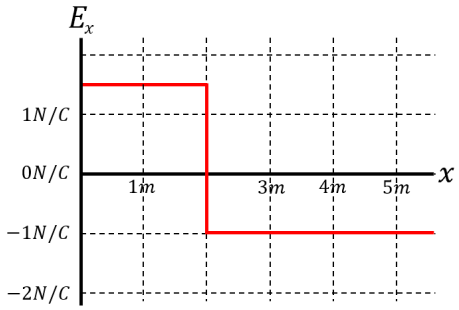
☐ a) Moving along an electric field line, in the direction of the electric field
☐ b) Moving along an electric field line, opposite the direction of the electric field
☐ c) Moving along an equipotential line
☐ d) Moving along an electric potential vector line
☐ e) Moving along an electric potential energy vector line

6. (5 points) The electric potential along the x-axis is given by the following plot. Create a graph of the x component of the electric field along the same x-axis. (Make sure to add a scale to the electric field axis!)





7. (10 points) An electric field points only in the x direction (no y or z components). The x component is shown in the following graph. The potential energy of a **2 C** charge is **U = 10 J** at x = 0 m.



a) (8 points) If the charge starts from rest at the origin and experiences no outside forces, what will it's kinetic energy be at x = 4 meters?

b) (2 points) What is the potential energy of the charge at x = 2 meters? (hint: this is the easy way to solve part a!)

8. (8 points) Q1 is placed on the x axis at **x = -1.0 cm**. Q2 is placed on the x axis at **x = +1.0 cm**. For the following questions let the electric potential equal zero at $x = \pm\infty$.

a) Give a value for Q1 and a value for Q2 that will give $V = 0$ at the origin, but $E \neq 0$.

Q1:_____

Q2:_____

b) Find the electric field vector at the origin for the charges you chose in part a.

c) Give a value for Q1 and a value for Q2 that will give $E = 0$ at the origin, but $V \neq 0$.

Q1:_____

Q2:_____

d) Find the electric potential at the origin for the charges you chose in part c.

9. (12 points) A ball with charge $\mathbf{q = -2.3\ C}$ and mass $\mathbf{m = 0.85\ kg}$ is falling due to gravity. A uniform vertical electric field of strength $\mathbf{E = 5.3\ N/C}$ exists between the ground and **D** meters above the ground. The ball enters the electric field from the top with a downward velocity $\vec{\mathbf{v}}_i = \mathbf{5.0\ m/s}$ and hits the ground with a downward velocity $\vec{\mathbf{v}}_f = \mathbf{4.0\ m/s}$.

a) (2 point) What direction does the electric field point?

b) (8 pts) What is the distance **D**?

b) (2 pts) The same situation occurs, except the uniform electric field of strength **E** now points horizontally to the right. Sketch the path of the ball as it falls through the electric field.