Curie, Marie
Set 2, Due Sat, Sep 3, 2011 at 08:00

You have 6 tries on any given problem - there is no penalty for wrong answers, but if you use up all 6, you'll be "locked out" of that particular question. (Wrong units don't count as a wrong answer, CAPA just says "u" instead of "N" and doesn't even look at your number yet!)

1.[2pt]
Two point-like particles are placed 44.0 cm apart and are given equal and opposite charge. The first particle, of mass 33.7 g, has an initial acceleration of 7.30 m/s^2 towards the second particle. What is the mass of the second particle if its initial acceleration towards the first is 1.75 m/s^2?

Answer: Submit All Answers

2.[2pt]
What is the magnitude of the charge on each particle?

Answer: Submit All Answers

3. [2pt]
A fancy lecture demo is shown in the figure above: an electrically charged ball of mass 0.540 grams, is suspended on a string of negligible mass in a uniform electric field of magnitude 4.49×10^1 N/C. We observe that the ball hangs (stationary) at an angle of \( \theta = 15.0 ^\circ \) from the vertical. How much charge do you need on the ball to keep it hanging like this?

Answer: Submit All Answers

4. [2pt]
Inside most old fashioned ("tube") TV sets you will find two parallel charged plates designed to accelerate electrons. Let's assume an electron (mass \( m = 9.11 \times 10^{-31} \) kg) is accelerated in the uniform field \( E \) (E = 1.45×10^3 N/C) between the plates shown in the figure. (The thickness of the plates themselves is negligible, despite how fat they might look in this picture) The electron starts from rest near the negative plate and passes through a tiny hole in the positive plate, as seen in the figure below. It exits with a kinetic energy of 2.58×10^{-18} J (which, as we will see later in this course, is enough to generate light when it finally hits the phosphors on the front screen!)
In designing this system, how far apart do you need to space the two plates?

Answer: 

5. [2pt]
The diagram below shows a dipole centered at the origin and along the x-axis. Point A is located at \((r = 3.4L,0)\). (not drawn to scale!)

![Diagram of a dipole centered at the origin and along the x-axis. Point A is located at \((r = 3.4L,0)\).]

Given the above, for each statement below, if the statement is true, answer `T", if it is false, answer `F", and if the answer cannot be determined from the information provided, answer `C". For example if `A" and `E" are true and there is not enough information to answer `C" and the rest are false, then answer `TFCFTF". Note: the symbols N, S, E, and W refer to compass directions. E, for example would be to the right on your page

A) The direction of the net electric field at A is E
B) The direction of the net electric field at a point on the negative y-axis is SE
C) The direction of the net electric field at the point \((-r,0)\) is W
D) The direction of the net electric field at a point on the positive y-axis is N
E) The direction of the net electric field at the origin is E
F) The magnitude of the net electric field at point A is less than the magnitude of the net electric field at the origin.

Answer:  

6. [2pt]
Many molecular systems can be modeled as (approximate) electrical dipoles (like the one in the previous problem, or as shown in the figure below), this is one of the most common charge configurations in nature. Suppose two charges, \(+q\) and \(-q\), are located in
the x-y plane at points (0,+d/2) and (0,-d/2), respectively. Calculate the magnitude of the electric field at point P. (figure is not to scale)

Data: \( q = 1.28 \times 10^{-20} \text{ Coulombs} \),
\( d = 0.90 \text{ nanometers} \)
and P is at \( x = 1.125 \text{ nanometers} \).

Answer:

7. [2pt]

A charge \( Q = 3.55 \times 10^{-04} \text{ C} \) is distributed uniformly along a rod of length \( 2L \), extending from \( y = -14.6 \text{ cm} \) to \( y = +14.6 \text{ cm} \), as shown in the diagram above. A charge \( q = 5.75 \times 10^{-06} \text{ C} \), and the same sign as \( Q \), is placed at \( (D,0) \), where \( D = 31.5 \text{ cm} \).

Consider the situation as described above and the following statements.
If the statement is true, answer `T`, if it is false, answer `F`, and if the answer cannot be determined from the information provided, answer `C`. For example if `B` and `C` are true and there is not enough information to answer `D` and the rest are false, then answer `FTTCF`.

A) The total force on \( q \) is in the east direction.
B) The magnitude of the force on charge \( q \) due to the small segment \( dy \) is \( \text{d}F = \left( \frac{kqQ}{16L^2r^2} \right) \text{dy} \)
C) The net force on \( q \) in the y-direction does not equal zero.
D) The charge on a segment of the rod of infinitesimal length \( dy \) is given by \( \text{d}Q = \frac{Q}{2L} \text{dy} \)
E) The net force on q in the x-direction equals zero.

Answer: 

8. [2pt]
As part of the optics in a prototype scanning electron microscope, you have a uniform circular ring of charge \( Q = 6.10 \) microCoulombs and radius \( R = 1.10 \) cm located in the x-y plane, centered on the origin as shown in the figure.

What is the magnitude of the electric field, \( E \) at point P located at \( z = 2.40 \) cm?

Answer: 

9. [2pt]
Consider other locations along the positive z-axis. At what value of \( z \) does \( E \) have its maximum value?

Answer: 

10. [2pt]
If \( z \) is much smaller than \( R \) then \( E \) is proportional to \( z \). (You should verify this by taking the limit of your expression for \( E \) for \( z \) much smaller than \( R \).) If you place an electron on the z-axis near the origin it experiences a force \( F_z = -cz \), where \( c \) is a constant. Obtain a numerical value for \( c \). (To think about: what kind of motion would that electron undergo if you let it go?)

Answer: 

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