AP Physics Study Guide Chapter 16 Electric Forces and Fields Name_____

Circle the vector quantities below and underline the scalar quantities below

electrostatic force electric charge electric field

Write the equation that defines each quantity, **INCLUDE UNITS FOR ALL QUANTITIES**
Coulomb's Law electric field

electric field as a function of distance r from charge q

Electric charge and Electric force
Write the value of the elementary charge e

Write the charge of an electron, sign and magnitude

Write the charge of a proton, sign and magnitude

Explain how an object gains an excess negative electric charge

Explain how an object gains an excess positive electric charge

Explain why electrons and not protons are transferred between objects during the charging process

Explain what a conductor is – give an example of a typical conductor

Explain what an insulator is – give two examples of common insulators

Explain what happens when a charged object is grounded

There are three methods whereby an object gains an excess electric charge. Explain each one.
1) Friction

2) Conduction

3) Induction

Briefly describe how an electrically neutral object can be attracted to an electrically charged object (also referred to as "redistribution of charge")

Describe Coulomb's Law in words. Include the value of the electrostatic proportionality constant k

Two charges with like signs will _____ each other and two charges with unlike signs

will _____ each other.

Will the magnitude of the electric force between two electrically charged objects be the same or different if the two objects have different amounts of electric charge?

Electric Field

How is the magnitude and direction of an electric field at a point in space determined?

What must be the sign of the small electric test charge used to determine an electric field, positive or negative?

Is electric field a property of an electrically charged object, the test charge used to determine the field, the force on the test charge or the space around the electrically charged object?

What formula is used to define the magnitude of the electric field strength E at a point in space?

Does the electric field strength E change magnitude if a larger test charge is placed at that point in space? Explain your answer.

Does the electric field change direction if a negative charge is placed at that point in space? Explain your answer and indicate what direction the negative charge will move.

A positive charge moves _____ that the electric field points in and a

negative charge moves _____ to the direction that the electric field points.

What formula can be used to determine the electric force F on an electric charge q when placed at a point where the electric field strength is E?

What does create an electric field at a point in space?

What formula can be used to determine the electric field strength E at a distance r from a point charge q?

Once again, does there need to be a test charge at a point in space for there to be electric field there? Yes or no?

Is the electric field around an electric point charge a uniform or non-uniform field? Explain your answer.

Describe electric field lines.

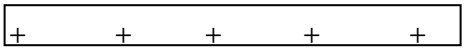
Electric field lines point _____ from positively charged objects and _____ negatively charged objects.

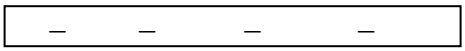
Draw the electric field line pattern created by both the positive and negative charges that are close to each other

Draw the electric field line pattern around the two negative charges that are close to each other

The electric field between two oppositely charge parallel metal plates is uniform or non-uniform?

Draw the electric field line pattern between the two oppositely charged parallel plates below.





When electric charge is placed on a neutral conductor, where does the charge reside?

What is the electric field strength inside the bulk of the conductor?

No process is required for these multiple choice questions. Put answers on lines provided.

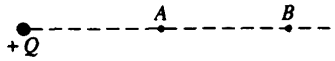
1. The unit $\frac{N}{C}$ is equivalent to which of the following units 1)_____

(A) J (B) V•m (C) F (D) $\frac{V}{m}$ (E) $\frac{J}{s}$

2. A hollow metal sphere of radius R is positively charged. Of the following distances from the center of the sphere, which location will have the greatest electric field strength?
(A) 0 (center of the sphere) (B) 3R/2 (C) 5R/4 (D) 2R 2)_____
(E) None of the above because the field is of constant strength

3. Two isolated charges, + q and - 2q, are 2 centimeters apart. If F is the magnitude of the force acting on charge -2q, what are the magnitude and direction of the force acting on charge + q ?

	Magnitude	Direction	
(A)	(1/2) F	Toward charge - 2q	3)_____
(B)	2 F	Away from charge -2q	
(C)	F	Toward charge - 2q	
(D)	F	Away from charge - 2q	
(E)	2F	Toward charge - 2q	



4. The diagram above shows an isolated, positive charge Q. Point (B) is twice as far away from Q as point A. The ratio of the electric field strength at point A to the electric field strength at point B is
(A) 8 to 1 (B) 4 to 1 (C) 2 to 1 (D) 1 to 1 (E) 1 to 2 4)_____

5)_____ 6)_____

Questions 5-6

An isolated, hollow aluminum sphere is positively charged. A cross section through the center of the sphere is shown above.

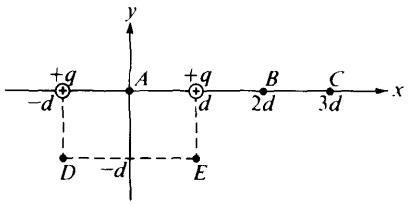
5. The magnitude of the electric field is greatest at point

(A) *A*
(B) *B*
(C) *C*
(D) *D*
(E) *E*

6. The direction of the electric field is correctly indicated in which of the following?

I. To the left at point *A*
II. To the right at point *D*
III. To the right at point *E*

(A) I only
(B) II only
(C) III only
(D) I and III
(E) II and III



Two positive charges of magnitude q are each a distance d from the origin A of a coordinate system as shown above.

7. At which of the following points is the electric field least in magnitude? 7)_____

(A) A (B) B (C) C (D) D (E) E

8) A point P is 0.50 meter from a point charge of 5.0 X 10^{-8} coulomb. The intensity of the electric field at point P is most nearly

(A) 2.5 x 10^{-8} N/C (B) 2.5 x 10^{1} N/C (C) 9.0 x 10^{2} N/ C (D) 1.8 x 10^{3} N/C (E) 7.5 x 10^{8} N/C

8)_____

Questions 9 – 10

An electron is accelerated from rest for a time of 10^{-9} second by a uniform electric field that exerts a force of 8.0×10^{-15} newton on the electron.

9. What is the magnitude of the electric field? 9)_____

(A) 8.0×10^{-24} N/C (B) 9.1×10^{-22} N/C (C) 8.0×10^{-6} N/C
(D) 2.0×10^{-5} N/C (E) 5.0×10^{4} N/C

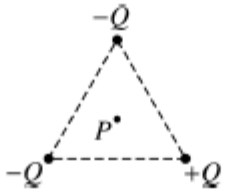
10. The speed of the electron after it has accelerated for the 10^{-9} second is most nearly 10)_____

(A) 10^{1} m/s (B) 10^{3} m/s (C) 10^{5} m/s (D) 10^{7} m/s (E) 10^{9} m/s

11. Which of the following is true about the net force on an uncharged conducting sphere in a uniform electric field?

A) It is zero.
B) It is in the direction of the field. 11)_____
C) It is in the direction opposite to the field.
D) It produces a torque on the sphere about the direction of the field.
E) It causes the sphere to oscillate about an equilibrium position.

12) 12)_____



Three particles having charges of equal magnitude Q are fixed at the corners of an equilateral triangle as shown above. Two of the charges are negative; the other is positive. Which of the following vectors best represents the direction of the resultant electric field at point P, the center of the triangle?

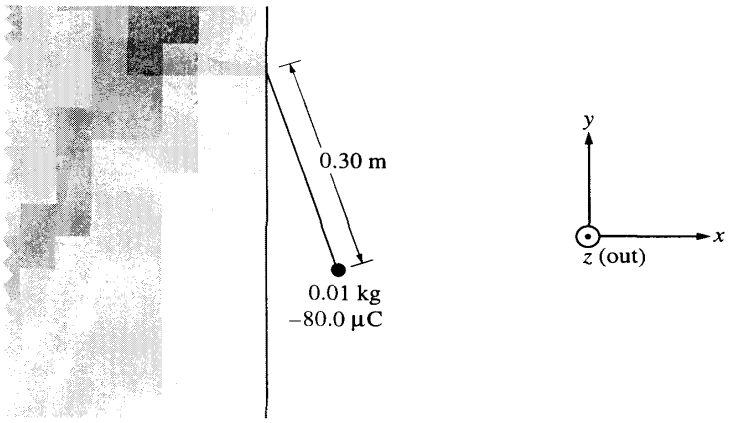
(A) 

(B) 

(C) 

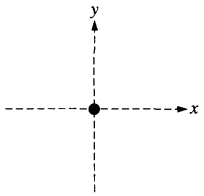
(D) 

(E)



1) A wall has a negative charge distribution producing a uniform horizontal electric field. A small plastic ball of mass 0.01 kg, carrying a charge of −80.0 μC is suspended by an uncharged, nonconducting thread 0.30 m long.
The thread is attached to the wall and the ball hangs in equilibrium, as shown above, in the electric and gravitational fields. The electric force on the ball has a magnitude of 0.032 N.

a. On the diagram below, draw and label the forces acting on the ball.



b. Calculate the magnitude of the electric field at the ball's location due to the charged wall, and state its direction relative to the coordinate axes shown.

b)_____

_____

c. Determine the perpendicular distance from the wall to the center of the ball.

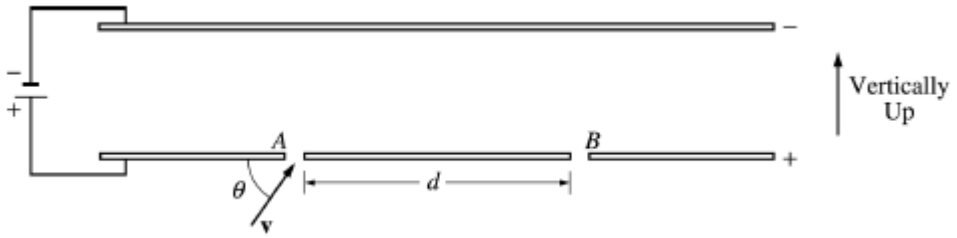
c)_____

d. The string is now cut.

i. Calculate the magnitude of the resulting acceleration of the ball, and state its direction relative to the coordinate axes shown.

i)_____

ii. Describe the resulting path of the ball.



2) An electric field E exists in the region between the two electrically charged parallel plates shown above. A beam of electrons of mass m, charge q and velocity v enters the region through a small hole at position A. The electrons exit the region between the plates through a small hole at position B. Express your answers to the following questions in terms of the quantities m, q, E, θ, and v. Ignore the effects of gravity.
Put your solutions on this sheet.

a) i. On the diagram of the parallel plates above, draw and label a vector to show the direction of the electric field E between the plates.

ii. On the following diagram, show the direction of the force(s) acting on an electron after it enters the region between the plates.

iii. On the diagram of the parallel plates above, show the trajectory of an electron that will exit through the small hole at position B.

b) Determine the magnitude of the acceleration of an electron after it has entered the region between the parallel plates.

b)_____

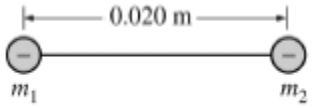
c) determine the total time that it takes the electrons to go from position A to position B.

c)_____

d) determine the distance d between positions A and B

d)_____

e) Now assume that the effects of gravity cannot be ignored in this problem. How would the distance d change for an electron entering the region at A and leaving at B? Explain your reasoning.



3. (15 points)

Two small objects, each with a charge of –4.0 nC, are held together by a 0.020 m length of insulating string as shown in the diagram above. The objects are initially at rest on a horizontal, nonconducting frictionless surface. The effect of gravity on each object due to the other is negligible.

(a) Calculate the tension in the string.

a)_____

b) Illustrate the electric field by drawing electric field lines for the two objects on the diagram below.

The masses of the objects are m_1 = 0.030 kg and m_2 = 0.060 kg. The string is now cut.

c) calculate the magnitude of the initial acceleration of each object.

c)_____

(d) On the axes below, qualitatively sketch a graph of the acceleration a of the object of mass m_2 versus the distance d between the objects after the string has been cut.

(e) Describe qualitatively what happens to the speeds of the objects as time increases, assuming that the objects remain on the horizontal, nonconducting frictionless surface.