Name: Key

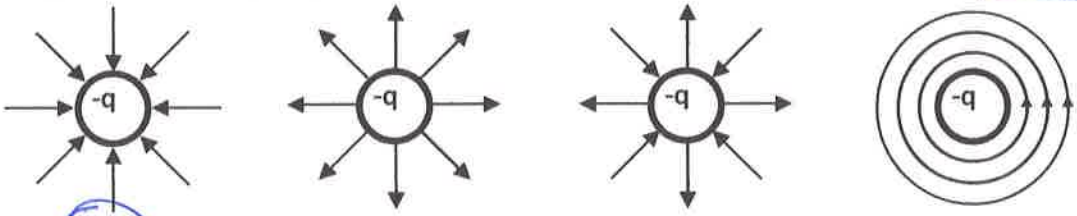
Chapter 18 Test 2015-2016

I. Multiple Choice

1. Which is a true statement?
   A. Electric field lines are parallel to the surface of a conductor.
   B. Electric field lines are perpendicular to the surface of a conductor.
   C. Electric field lines are at an angle of 45 degrees to the surface of a conductor.
   D. The angle electric field lines make with the surface of a conductor can vary.

2. When placed in an electric field,
   A. both a proton and an electron will be accelerated in the same direction as the electric field.
   B. both a proton and an electron will be accelerated in the opposite direction of the electric field.
   C. the proton will be accelerated in the same direction as the electric field and the electron will be accelerated in the opposite direction.
   D. the electron will be accelerated in the same direction as the electric field and the proton will be accelerated in the opposite direction.

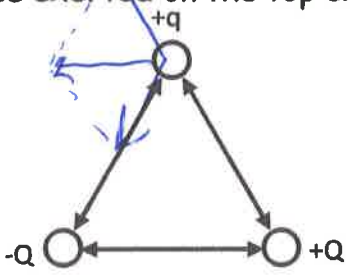
3. Which diagram correctly depicts the direction of the electric field from charge -q?



A. B. C. D.

4. In electrostatic equilibrium, the electric field inside a conductor is equal to
   A. $\frac{kQ}{r^2}$ B. F/q C. zero D. $\frac{kQ_1Q_2}{r^2}$

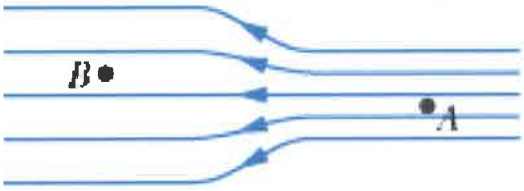
5. Charges -Q, +Q, and +q are placed at the vertices of an equilateral triangle as shown. +Q and -Q have equal magnitudes. The direction of the net force exerted on the top charge +q is
   A. directly up.
   B. directly down.
   C. up and to the right.
   D. directly left.
   E. directly right.



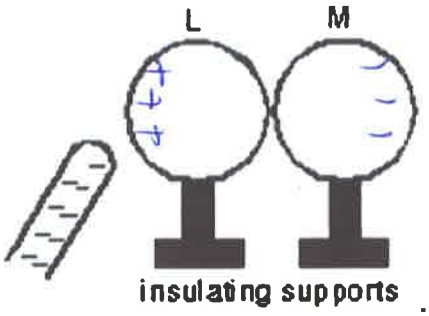
6. Given two protons separated by a given distance, which of these statements is true.
   A. The gravitational force between them is much stronger than the electric force.
   B. The electric force between them is much stronger than the gravitational force.
   C. The electric force and gravitational force are approximately the same strength.

7. Charge moves much more freely and easily in a
   A. conductor.
   B. insulator.
   C. semiconductor
   D. Charge moves just as freely and easily in all of the above.

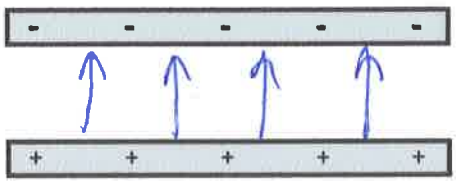
8. At which point is the electric field greater?
   A. A
   B. B
   C. The electric field strength is the same at A and B.



9. Two uncharged metal spheres, L and M, are in contact. A negatively charged rod is brought close to L, but not touching it, as shown. The two spheres are slightly separated and the rod is then withdrawn. As a result:
   A. both spheres are neutral
   B. both spheres are positive
   C. both spheres are negative
   D. L is negative and M is positive
   E. L is positive and M is negative



10. Two parallel plates are shown to the right. The top plate is negatively charged and the bottom plate is positively charged. In which direction does the electric field between the plates point?
   A. Left
   B. Right
   C. Out of the page towards you
   D. Down
   E. Up



11. What is the unit of acceleration?
   A. N B. N/C C. C D. m/s^2 E. kg

12. What is the unit of electric field?
A. N B. N/C C. C D. m/s^2 E. kg

13. What is the unit of electric charge?
A. N B. N/C C. C D. m/s^2 E. kg

14. What is the unit of electric force?
A. N B. N/C C. C D. m/s^2 E. kg

15. What is the unit of mass?
A. N B. N/C C. C D. m/s^2 E. kg

16. If the distance between two charges increases by a factor of 3X, what happens to the size of the electric force F on each charge?
A. 1/16 F B. 1/9 F C. 1/3 F D. 9 F E. 16 F

17. If the charge on two particles is each increased by a factor of 3X, what happens to the size of the electric force F on each charge?
A. 1/16 F B. 1/9 F C. 1/3 F D. 9 F E. 16 F

18. If a negatively-charged rod is brought close to a small neutral conducting sphere,
A. the electrons on the sphere move toward the rod and the sphere will then be repelled by the rod.
B. electrons on the sphere move away from the rod and the sphere will then be attracted to the rod.
C. protons on the sphere move toward the rod and the sphere will then be attracted to the rod.
D. protons on the sphere move away from the rod and the sphere will then be repelled by the rod.

19. Like charges (such as two positive charges or two negative charges) will
A. attract each other.
B. repel each other.
C. both attract and repel each other.
D. annihilate each other in a burst of energy.

20. In response to bringing a charged particle close to a metal conductor,
A. only the negatively-charged electrons move.
B. only the positively-charged protons move.
C. both the electrons and protons flow in the same direction.
D. the electrons flow in one direction and the protons flow in the other.

21. A particle with charge q is placed into an electric field. The acceleration that the particle undergoes is equal to

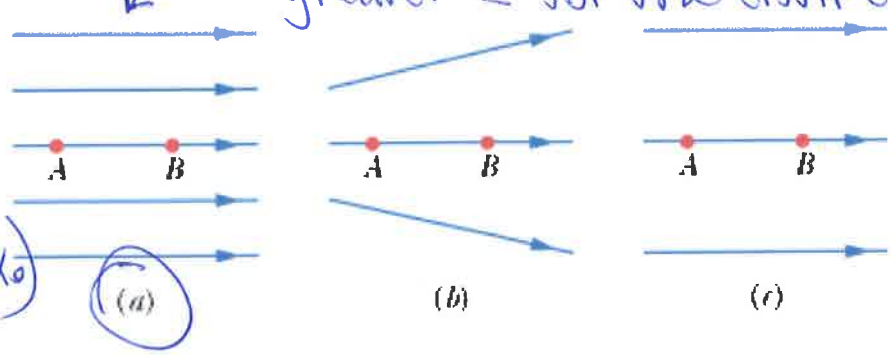
A. $\frac{qE}{m}$ B. $\frac{q}{Em}$ C. $\frac{E}{qm}$ D. mqE E. $\frac{m}{qE}$

22. Three arrangements of electric field lines are shown below. In each arrangement, a proton is released from rest at point A and is then accelerated through point B by the electric field. Points A and B have equal separations in the three arrangements. In which arrangement is the linear momentum of the proton at point B the greatest?

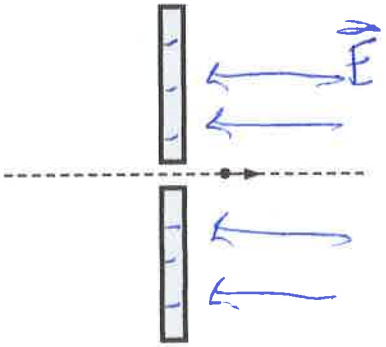
$a = \frac{qE}{m}$ greater E for the entire path (closer spaced lines)

$p = mv$

$v^2 = v_0^2 + 2a(x - x_0)$



23. An electron travels from left to right through a small hole in a uniformly-charged plate. Once through the hole the electron accelerates to the right. What is the sign of the charge on the plate and what is the direction of the electric field on the right hand side of the plate.



	A	B	C	D	E
Charge on Plate	Positive	Negative	Positive	Negative	Positive
Direction of E Field	Right	Right	Left	Left	Down

II. Problems: On a separate sheet of paper, show your starting equation(s), show your work and box your answer. 5 points each.

Starting equation:	**1 point**
Work and correct answer:	**3.5 points**
Boxed answer:	**0.5 points**

1. What is the electric force between two 40.0 μC charges that are 22.0 cm apart?

2. How far apart must two point 25.0 mC charges be to exert an electric force of 1.00 N on each other?

3. What is the magnitude and direction of the electric force exerted on a -3.30 μC charge by a 480 N/C electric field that points in the positive x-direction?

4. What magnitude point charge creates a 5.50×10^4 N/C electric field at a distance of 0.400 m?

5. A proton has an initial velocity of 2.00×10^6 m/s in a uniform electric field whose magnitude is 5.00×10^4 N/C. The field accelerates the proton in the direction opposite to its initial velocity. How long does it take the proton to come to rest?

6. Earth has a net charge that produces an electric field of approximately 150 N/C straight downward at its surface. What mass object with an excess of 3.60×10^4 electrons on its surface will have its weight supported by this field?

7. Derive an expression for the velocity v of an electron with mass m_e in a circular "orbit" of radius r around a proton with mass m_p. Your answer should be an equation starting with "v =" and be in terms of mass, radius, charge and any appropriate constants.

8. What is the momentum (p = mv) of a charge particle of mass m and charge q after a time t when it starts from rest in a uniform electric field E? Your answer should be an equation starting with "p = " followed by an expression using the variables given here.

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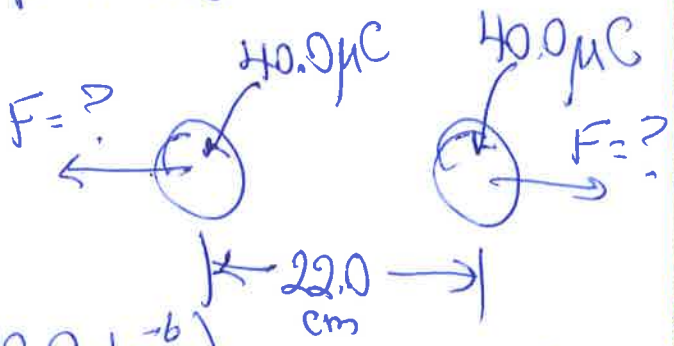
(1) $F = \frac{kQ_1Q_2}{r^2}$

$= \frac{\left(8.99\times10^{9}\ \frac{Nm^2}{C^2}\right)\left(40.0\times10^{-6}\ C\right)\left(40.0\times10^{-6}\ C\right)}{\left(22.0\times10^{-2}\ m\right)^2}$

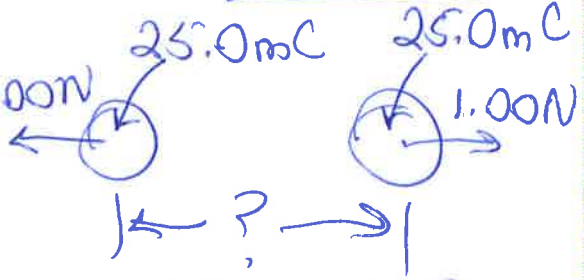
$= \boxed{297\ N}$



(2) $F = \frac{kQ_1Q_2}{r^2}$

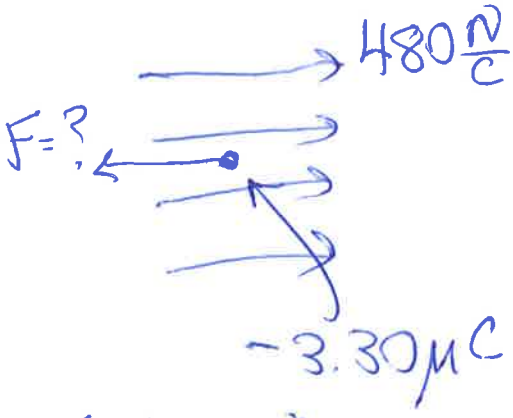
$\Rightarrow r = \sqrt{\frac{kQ_1Q_2}{F}} = \sqrt{\frac{\left(8.99\times10^{9}\ \frac{Nm^2}{C^2}\right)\left(25.0\times10^{-3}\ C\right)\left(25.0\times10^{-3}\ C\right)}{1.00\ N}}$

$= \boxed{2.37\times10^{3}\ m}$



(3) $\vec{F} = q\vec{E} = \left(3.30\times10^{-6}\ C\right)\left(480\ \frac{N}{C}\right)$

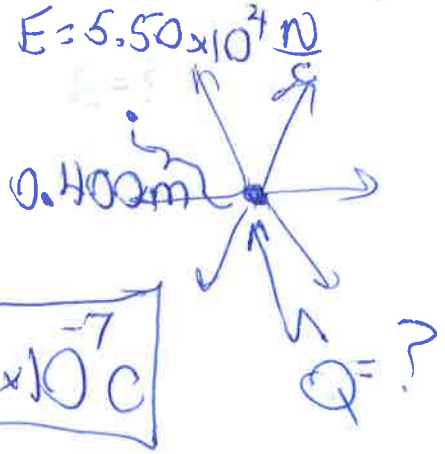
$= \boxed{1.58\times10^{-3}\ N \text{ in negative-x direction}}$



(4) $E = \frac{kQ}{r^2} \Rightarrow Q = \frac{Er^2}{k}$

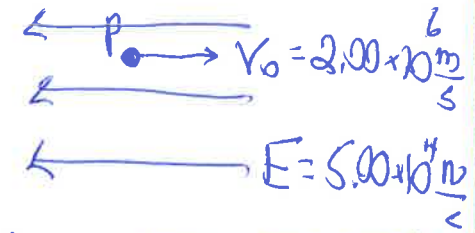
$Q = \frac{\left(5.50\times10^{4}\ \frac{N}{C}\right)\left(0.400\ m\right)^2}{8.99\times10^{9}\ \frac{Nm^2}{C^2}} = \boxed{9.79\times10^{-7}\ C}$

$= 0.979\ \mu C$



(5) $a = \frac{qE}{m} = \frac{(1.60\times10^{-19}\,C)(5.00\times10^{4}\,\frac{N}{C})}{1.67\times10^{-27}\,kg}$

$= 4.79\times10^{12}\,\frac{m}{s^2}$

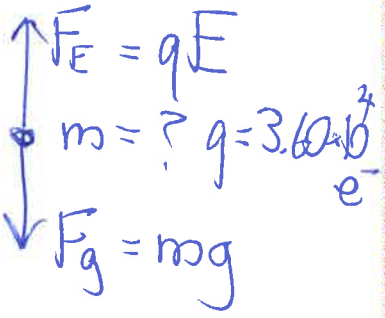


$v = v_0 + at \Rightarrow t = \frac{-v_0}{a} = \frac{-2.00\times10^{6}\,\frac{m}{s}}{-4.79\times10^{12}\,\frac{m}{s^2}} = \boxed{4.18\times10^{-7}\,s}$

(6) $F_e = F_g \Rightarrow qE = mg$

$\Rightarrow m = \frac{qE}{g} = \frac{(3.60\times10^{4}\,e^-)(1.60\times10^{-19}\,\frac{C}{e^-})(150\,\frac{N}{C})}{9.80\,\frac{m}{s^2}}$

$= \boxed{8.82\times10^{-14}\,kg}$



(7) $\frac{mv^2}{r} = \frac{kq_eq_p}{r^2} \Rightarrow \boxed{v = \sqrt{\frac{kq_eq_p}{mr}}}$

(8) $p = mv = m(v_0 + at) = mat$

$F_e = ma = qE \Rightarrow a = \frac{qE}{m}$

$p = m\left(\frac{qE}{m}\right)t \Rightarrow \boxed{p = qEt}$