PHYSICS 12

NAME: Key

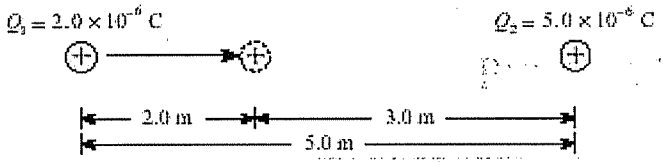
Electrostatics Review

1. An electron orbits a nucleus which carries a charge of +9.6 x10^{-19} C. If the electron's orbital radius is 2.0 x10^{-10} m, what is its electric potential energy?

A. -6.9 x10^{-18} J
B. -3. 5 x10^{-8} J
C. 43 J
D. 2.2 x10^{11} J

$E_p = \frac{KQ_1Q_2}{r} = \frac{(9\times10^9 \frac{Nm^2}{C^2})(9.6\times10^{-19}C)(-1.6\times10^{-19}C)}{2\times10^{-10}m}$

2. Charge Q_1 is located 5. 0 m from charge Q_2 as shown.



How much work must be done to move charge Q_1 2.0 m closer to charge Q_2?

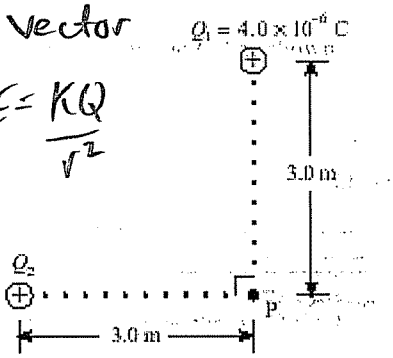
A. 7. 2 x 10^{-3} J
B. 1.1 x 10^{-2} J
C. 1. 2 x 10^{-2} J
D. 2.0 x 10^{-2} J

$W = \Delta E = E_f - E_0$

$= \frac{KQ_1Q_2}{r_f} - \frac{KQ_1Q_2}{r_0}$

$= \frac{K(2\mu C)(5\mu C)}{3} - \frac{K(2\mu C)(5\mu C)}{5}$

3. The magnitude of the net electric field at P in the diagram below is 5.0 x10^3 N/C.



Vector

$E = \frac{KQ}{r^2}$

$E_1 = 4\times10^3$ N/C

5×10^3 N/C

$E_2 = 3\times10^3$ N/C

$(b^2 = c^2 - a^2)$

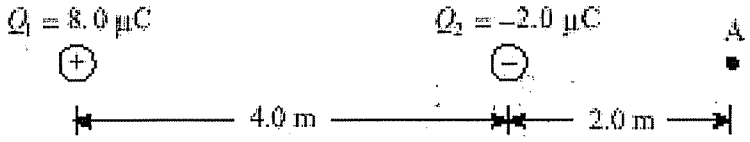
Find the magnitude of charge Q_2.

A. 1. 0 x10^{-6} C
B. 3. 0 x10^{-6} C
C. 6. 4 x 10^{-6} C
D. 1. 0 x10^{-5} C

So $E_2 = \frac{KQ_2}{3^2} = 3\times10^3$ N/C

$Q_2 =$

4. Two charges are positioned as shown in the diagram below.



E_2 E_1

$E_{Net} = 2500$ N/C (left)

a) Find the magnitude and direction of the electric field at A. (Note: 1. 0 μC = 1. 0 x10^{-6} C) **(4 marks)**

$E_1 = \frac{K(8\mu C)}{6^2} = 2000$ N/C (right), $E_2 = \frac{K(2\mu C)}{2^2} = 4500$ N/C (left)

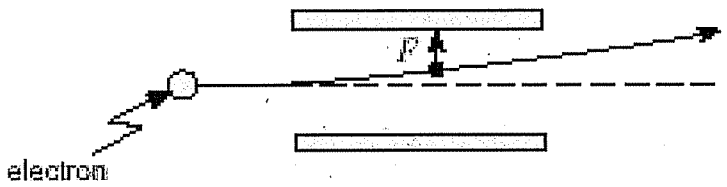
b) A charge placed at A experiences a force of 4.0 x10^{-3} N towards the right. What are the magnitude and polarity of this charge? **(3 marks)**

$F = E \cdot Q$

Since E is to the left, the charge must be negative

$Q = \frac{F}{E} = \frac{4\times10^{-3}\ N}{2500\ N/C} = 1.6\times10^{-6}\ C$

5. An electron passing between parallel plates 0. 025 m apart experiences an upward electrostatic force of 5.1 x10^{-16} N.



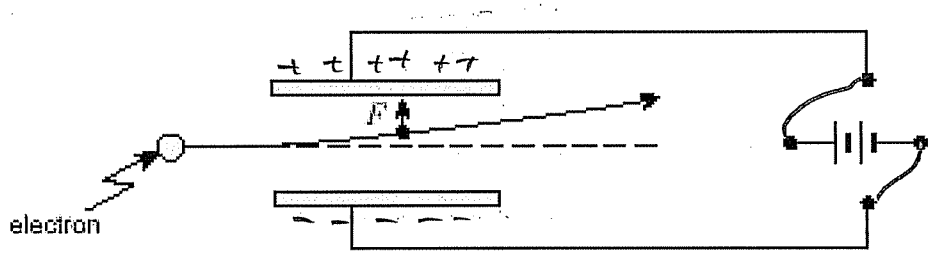
a) What is the magnitude of the electric field between the plates? **(3 marks)**

$E = \frac{F}{Q} = \frac{5.1\times10^{-16}\ N}{1.6\times10^{-19}\ C} = 3.2\times10^{3}\ N/C$

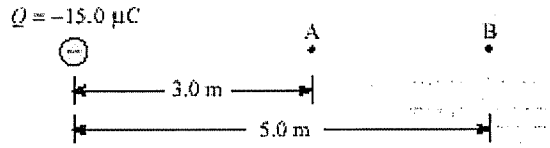
b) What is the potential difference between the plates? **(2 marks)**

$E = \frac{\Delta V}{d}$, $\Delta V = E \cdot d = (3.2\times10^{3}\ N/C)(.025\ m) = 80\ V$

c) On the diagram below draw in the connections to the power supply necessary for the electron to experience this upward force. **(2 marks)**



6. a) Find the electric potential at point A and at point B. **(3 marks)**



$V = \frac{kQ}{r}$

$V_A = \frac{k(-15\mu C)}{3} = -45000\ V$

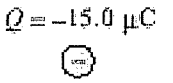
$V_B = \frac{k(-15\mu C)}{5} = -27000\ V$

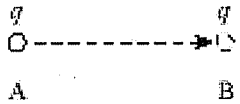
b) What is the potential difference between A and B? **(1 mark)**

$\Delta V = V_f - V_o = V_A - V_B = -27000 - (-45000) = +18000\ V$

or $V_B - V_a = -18000\ V$

c) 0. 036 J of work must be done to move a charge q from A to B. Find the magnitude and polarity of this charge. **(3 marks)**





must be positive to do work

$W = \Delta E = \Delta E_p = E_f - E_o$

$.036J = E_B - E_a$

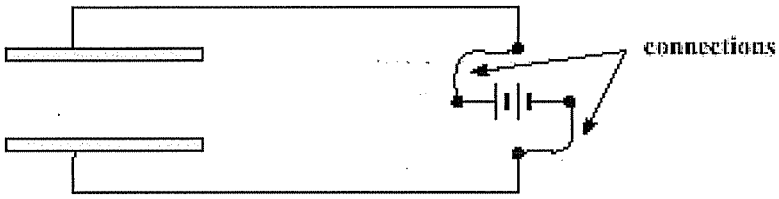
$.036J = \Delta V \cdot Q$

$= (-45000 - -27000)\,Q$

$Q = 2 \times 10^{-6}\ C$

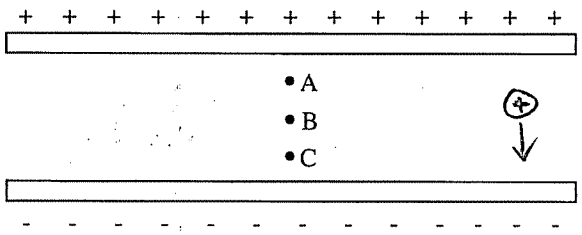
Answers To Electrostatics Review

1. A
2. C
3. B
4. a) 2.5 x 10^3 N/C to the left
   b) -1.6 x 10^{-6} C
5. a) 3.2 x 10^3 N/C
   b) 80V
   c)



6. a) -27000 V
   b) +/- 18000 V
   c) + 2.0 x 10^{-6} C

Assignment: Multiple Choice



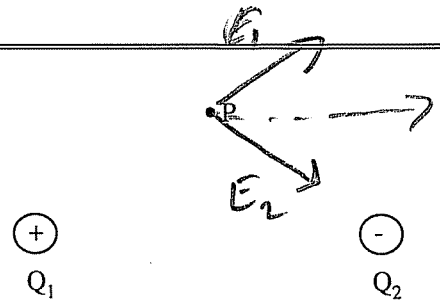
1. What is the *direction* of the electric field at **B**, which is located between a pair of oppositely charged plates?
   A. ↑ B. → C. ← D. ↓

2. The electric field strength between the plates is
   A. strongest at A, weakest at B.
   B. strongest at B.
   C. strongest at C, weakest at A.
   D. strongest at A and C, weakest at B.
   E. the same at A, B and C.

E is uniform in parallel plates.

3. What is the direction of the electric field at **P** due to point charges Q_1 and Q_2?

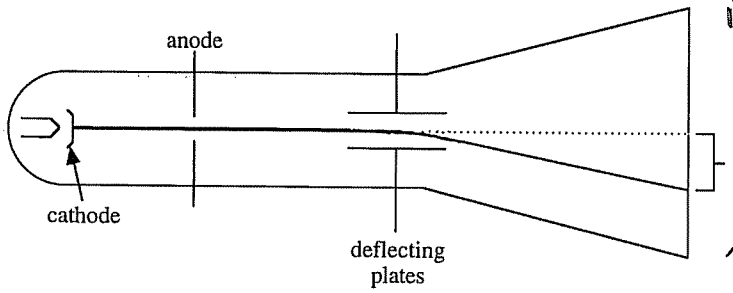
A. ↑ B. → C. ← D. ↓



4. Electric field strength can be measured in
   A. N/A.
   B. J/C.
   C. N/A·m.
   D. N/kg.
   E. V/m. $E = \frac{V}{d}$

5. The electric field strength at a distance of 1.0 m from a point charge is 4.0×10^4 N/C. What will the electric field strength be at a distance of 2.0 m from the same point charge?
   A. 1.0×10^4 N/C
   B. 2.0×10^4 N/C
   C. 4.0×10^4 N/C
   D. 8.0×10^4 N/C
   E. 16×10^4 N/C

$E = \frac{kQ}{r^2}$ $E_1 = \frac{kQ}{1^2}$ $E_2 = \frac{kQ}{2^2} = \frac{kQ}{4} = \frac{E_1}{4} = 1 \times 10^4$ N/C



is t is $\frac{1}{2}$, but deflection $= \frac{1}{2}at^2$

so d is $\frac{1}{4}$

6. A beam of electrons in a cathode ray tube is accelerated toward the anode by an accelerating voltage of 100 V. After passing through the anode, the electrons are deflected as they pass through two oppositely charged parallel deflecting plates. On the screen, the observed deflection is δ. If the accelerating voltage is increased to 400 V, what deflection will be observed on the screen? $E_p = V \cdot Q$, if V is 4x, then E_k is 4x so v is 2x

A. δ B. ¼ δ C. ½ δ D. 2 δ E. 4 δ

7. An atom carrying an excess charge of 1.60×10^{-19} C is accelerated from rest by a potential difference of 750 V. It reaches a peak speed of 8.50×10^4 m/s. What is the mass of the atom?
   A. 1.67×10^{-27} kg
   B. 3.32×10^{-26} kg
   C. 4.84×10^{-20} kg
   D. 9.11×10^{-31} kg

$E_p = V \cdot Q = E_k = \frac{1}{2}mv^2$

$(750)(1.6 \times 10^{-19}) = \frac{1}{2}m(8.5 \times 10^4)^2$

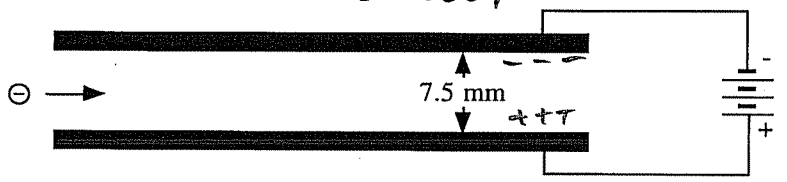
8. What increase in electrical potential energy occurs when an alpha particle with a charge of 3.2×10^{-19} C is brought from infinity to a distance of 5.0×10^{-10} m of a stationary charge of 7.5×10^{-18} C?
   A. 4.3×10^{-17} J
   B. 8.6×10^{-8} J
   C. 5.8 J
   D. 1.4×10^2 J

$\Delta E_p = E_{p_f} - E_{p_0}$

$= \frac{kQq}{r} - 0 = \frac{(9 \times 10^9)(3.2 \times 10^{-19})(7.5 \times 10^{-18})}{5 \times 10^{-10}}$

Open-Ended Questions $F = \frac{kQ_1Q_2}{r^2}$

9. Calculate the electrostatic force of attraction between a positive charge of 8.0×10^{-6} C and a negative charge of 5.0×10^{-6} C, when they are 0.30 m apart.
10. When a charged object is accelerated through a potential difference of 500 V, its kinetic energy increases from 2.0×10^{-5} J to 6.0×10^{-5} J. What is the magnitude of the charge on the object? $\Delta E = V \cdot Q$, $(4 \times 10^{-5}) = 500 \cdot Q$
11. How fast will an electron be moving if it is accelerated from rest, in a vacuum, through a potential difference of 200 V? $\Delta E = V \cdot Q = E_K = \frac{1}{2}mv^2$, $(200)(1.6 \times 10^{-19}\text{C}) = \frac{1}{2}(9.1 \times 10^{-31}\text{kg})v^2$
12. Two parallel plates are 4.0 mm apart. If the potential difference between them is 200 V, what is the magnitude of the electric field strength between the plates? $E = \frac{V}{d} = \frac{200}{.004}$

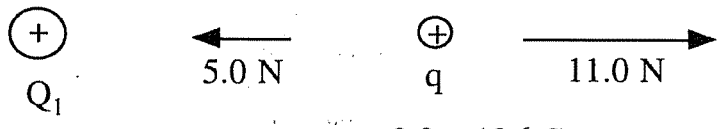


$F_e = E \cdot Q = \frac{V}{d}(Q)$

$\frac{150}{.0075}(1.6 \times 10^{-19}\text{C})$

↑ down

13. An electron enters the space between two oppositely charged, parallel plates. What is the magnitude and direction of the electric force that acts on the electron when it is between the two plates?



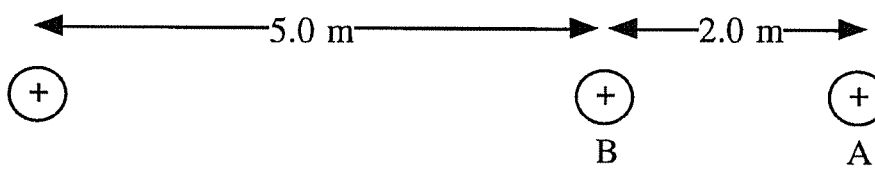
$q = 3.0 \times 10^{-6}$ C

$F_{net} = 6$ N right

$F = Eq$

Q_2 $6 = E(3\mu C)$ right

14. The 3.0×10^{-6} C charge, q, experiences opposing forces exerted by Q_1 and Q_2 of 5.0 N and 11.0 N respectively. What is the magnitude and direction of the electric field strength at the location of q?



$Q_1 = 8.0 \times 10^{-6}$ C

$Q_2 = 2.0 \times 10^{-6}$ C

$W = \Delta E = E_B - E_A$

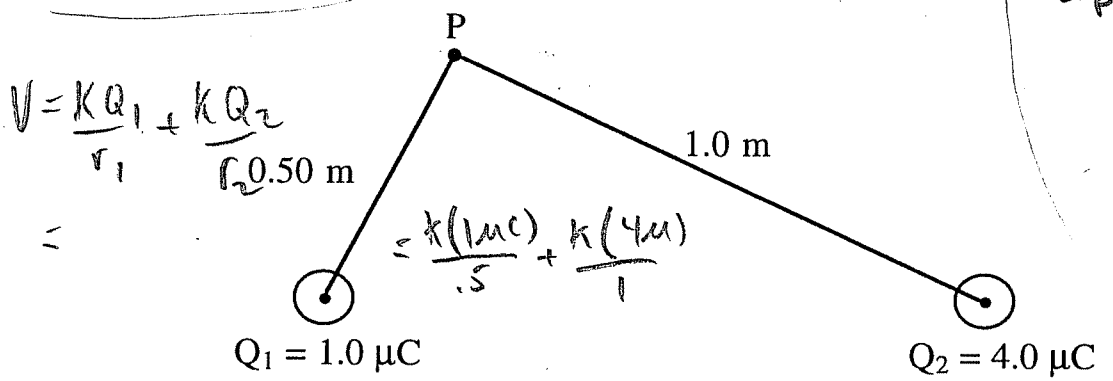
$= \frac{kQ_1Q_2}{5} - \frac{kQ_1Q_2}{7}$

15. How much work must be done to move charge $Q_2 = 2.0 \times 10^{-6}$ C from A to B? The other charged object has a charge $Q_1 = 8.0 \times 10^{-6}$ C.

16. What is the electric potential energy, relative to infinity, of an electron located 5.3×10^{-11} m from the proton in a hydrogen atom?

$E_P = \frac{kQ_1Q_2}{r}$

$= \frac{k(1.6 \times 10^{-19})(-1.6 \times 10^{-19})}{5.3 \times 10^{-11}}$



$V = \frac{kQ_1}{r_1} + \frac{kQ_2}{r_2}$

$= \frac{k(1\mu C)}{.5} + \frac{k(4\mu)}{1}$

17. What is the electric potential at **P** due to charges Q_1 and Q_2?

Assignment Asnwers

1. D 2. E 3. B 4. E 5. A 6. B 7. B 8. A
9. 4.0 N
10. 8.0×10^{-8} C
11. 8.4×10^{6} m/s
12. 5.0×10^{4} V/m, or 5.0×10^{4} N/C
13. 3.2×10^{-15} N (down)
14. 2.0×10^{6} N (to the right)
15. 8.2×10^{-3} J
16. -4.3×10^{-18} J
17. 5.4×10^{4} V (total)