Quantity	Symbol	Unit	Vector or Scalar	Math Relationship	Qualitative Description
Electric Charge					
Electric Force					
Electric Field					
Electric potential energy					
Electric potential difference					
Fundamental Charge					
Coulomb's Constant					

1) Electrostatics-

2) Electrical forces-

3) Charges-

4) Coulomb's law-

5) k –

6) conductors-

7) Insulators-

8) Semiconductors-

9) Superconductors-

10) Induction-

11) Grounding-

12) Electrically polarized-

13) Bohr model-

14) Electric field-

15) Lightning-

16) Electric potential difference-

17) Capacitor-

18) Electroscope-

19) Van de Graaf generator-

20) Lightning rod-

21) Point Charge-

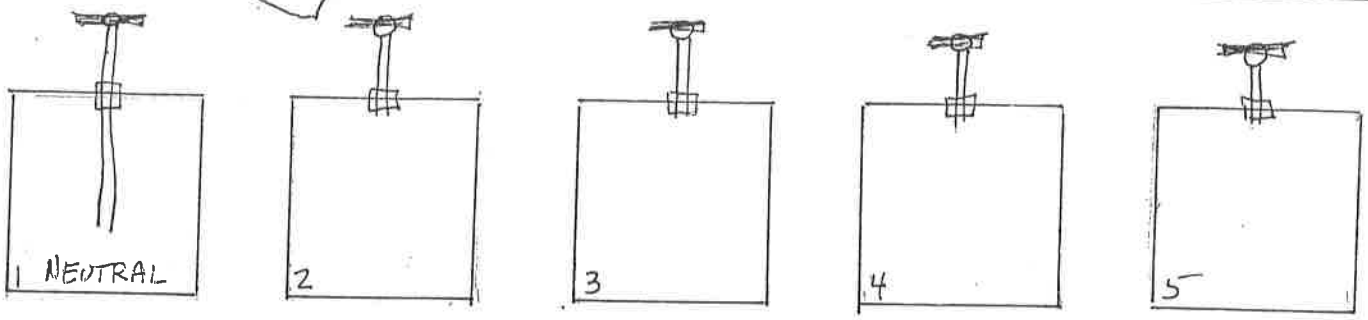
22) Source Charge-

23) Test Charge-

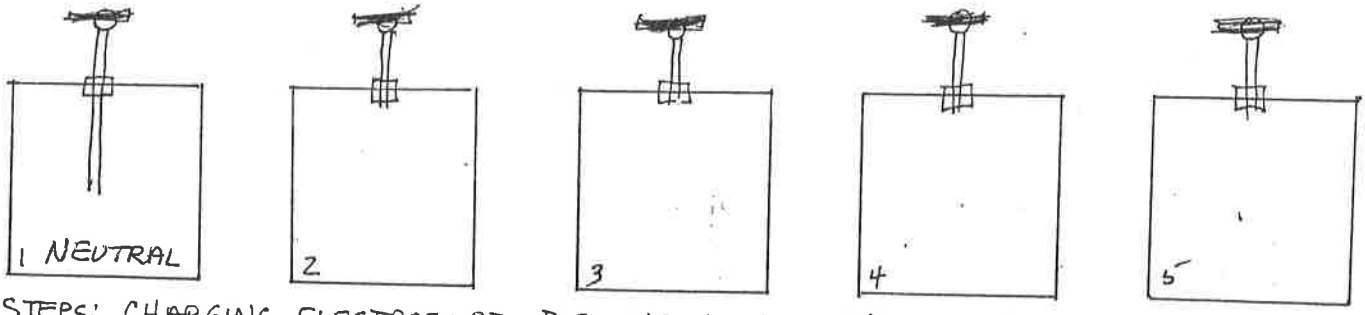
NAME _____

PERIOD _____

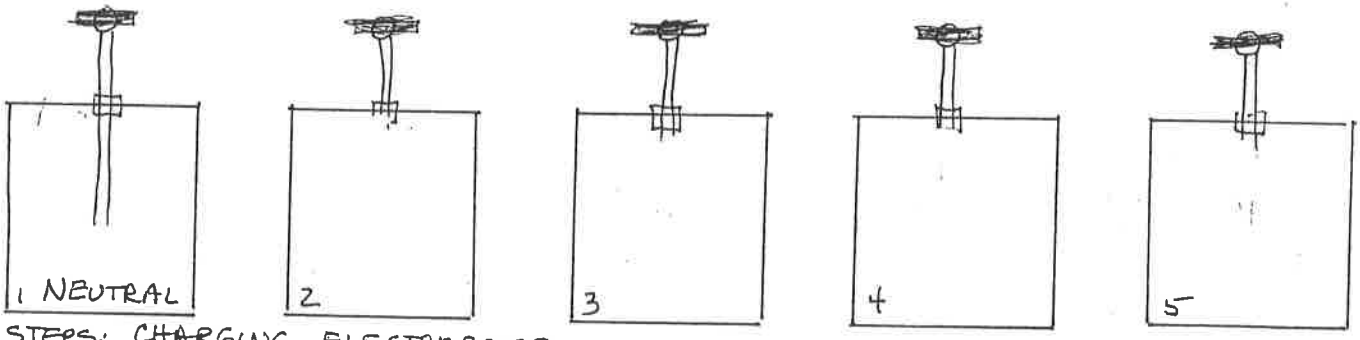
GROUP MEMBERS _____



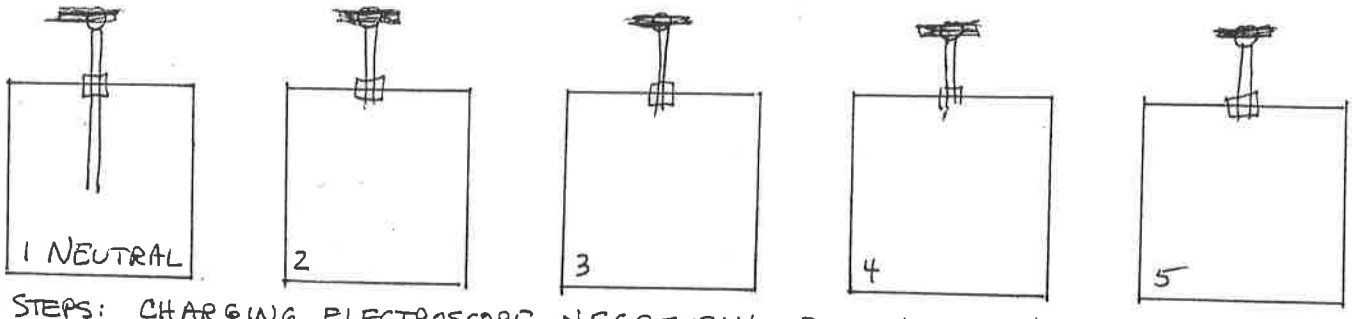
STEPS: CHARGING ELECTROSCOPE POSITIVELY BY CONTACT.



STEPS: CHARGING ELECTROSCOPE POSITIVELY BY INDUCTION.



STEPS: CHARGING ELECTROSCOPE NEGATIVELY BY CONTACT.



STEPS: CHARGING ELECTROSCOPE NEGATIVELY BY INDUCTION

Electric Force Problem Set

1) Find the magnitude of the electric force between two protons separated by one femtometer (10^{-15}). (Ans: 230 N)

2) The electron and proton of a hydrogen atom are separated by an average distance of about 5.3×10^{-11}m. Find the magnitudes of the electric force and the gravitational force that each particle exerts on the other, and the ratio of the electric force (F_e) to the gravitational force (F_g). (Ans: $F_g = 3.6 \times 10^{-47}$N, $F_e = 8.2 \times 10^{-8}$N, ratio = 2.27×10^{39})

3) Three point charges lie along the y-axis. A charge of $q_1 = -9$C is at y = 6m, and a charge of $q_2 = -8$C is at y = -4m. If a third charge of +6C is located at y = 2m, what is the force on that third charge?

4) Three charges lie along the x-axis. The positive charge is 15 microcoulombs at x = 2.0m and the other positive charge of 6 microcoulombs is at the origin. Where must a negative charge be placed so that the electric force is zero (this is called the equilibrium position)? (Ans: 0.7m on x-axis)

Electric Field Line Diagrams

An <u>electric field</u> exists when there is a region in space where a charge would feel a force.

Electric field lines are drawn to demonstrate the strength of the electric field.

Rules:

1) Draw the field lines by imagining there is a positive test charge in the area and the line points in the direction that the test charge would move.
2) The more electric field lines present show a greater electric field.
3) Electric field lines cannot cross.
4) Electric field lines congregate at sharp areas as opposed to rounded ones.

Draw electric field lines around the following situations.

1) +2C

2) +1C +1C

3) -1C

4) -4C

5) -1C +1C

Electric Field Line Diagrams

General Rules:

1) Electric field lines are drawn pointing in the way that a **positive** point charge (a very small charge compared to the much larger charged object generating the field) would move when placed by the charged object.
2) Field lines can never cross.
3) Electric fields exist even in the absence of a point charge.
4) The direction of the electric field is in the same direction as the electric force on the point charge.
5) The relative strength of the electric field is proportional to the number of field lines in a given location.
6) Electric field lines accumulate as sharp points more than rounded objects.

Draw electric field line diagrams around the following:

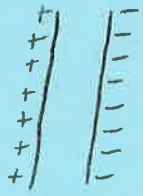
1) Positively Charged Object

2) Negatively Charged Object

3) Dipole

4) Two Like Charges

5)Parallel Capacitor Plates



Capacitance

1. A parallel-plate capacitor has a charge of 6.0 μC when charged by a potential difference of 1.25 V.
   a. Find its capacitance.
   b. How much electrical potential energy is stored when this capacitor is connected to a 1.50 V battery?
2. You are asked to design a parallel-plate capacitor having a capacitance of 1.00 F and a plate separation of 1.00 mm. Calculate the required surface area of each plate. Is this a realistic size for a capacitor?
3. A 4.00 μF capacitor is connected to a 12.0 V battery.
   a. What is the charge on each plate of the capacitor?
   b. If this same capacitor is connected to a 1.50 V battery, how much electrical potential energy is stored?
4. A capacitor has a capacitance of 2.00 pF.
   a. What potential difference would be required to store 18.0 pC?
   b. How much charge is stored when the potential difference is 2.5 V?

Section Review

1. Explain why two metal plates near each other will not become charged unless they are connected to a source of potential difference.
2. A parallel-plate capacitor has an area of 2.0 cm^2, and the plates are separated by 2.0 mm.
   a. What is the capacitance?
   b. How much charge does this capacitor store when connected to a 6.0 V battery?
3. A parallel-plate capacitor has a capacitance of 1.35 pF. If a 12.0 V battery is connected to this capacitor, how much electrical potential energy would it store?
4. **Physics in Action** Assume Earth and a cloud layer 800.0 m above the Earth can be treated as plates of a parallel-plate capacitor.
   a. If the cloud layer has an area of 1.00×10^6 m^2, what is the capacitance?
   b. If an electric field strength of 2.0×10^6 N/C causes the air to conduct charge (lightning), what charge can the cloud hold?

[redacted]: Electrostatics

Name _____
Periods _____

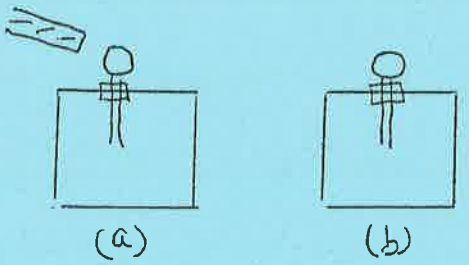
$k_e = 9 \times 10^9 \frac{N \cdot m^2}{C^2}$

Part I. Modified True/False. If the statement is true, write the word "true" in the space. If it is false, make it true by changing the underlined word. Print the corrected word in the space given.

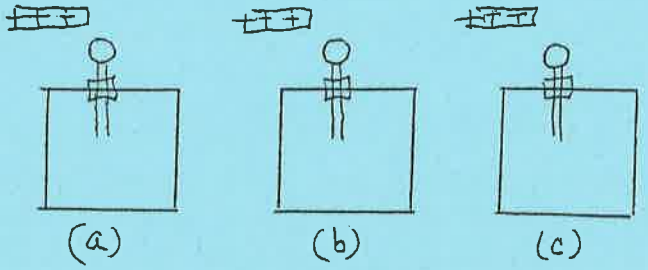
1. When a positively charged glass rod is brought near to a neutral electroscope, the leaves on the electroscope remain in the neutral position. _____
2. When a glass rod is rubbed with silk and becomes positively charged, electrons are moved to the ground. _____
3. The fact that no object can have an electric charge equal to 2.5 time the charge on an electron means that charge is conserved. _____
4. A proton has a mass 2000 times that of an electron. A proton as an electric charge 2000 times that of an electron. _____
5. It is possible for a positively charged object to attract a neutral object. _____

Part II. Problem- Solving and Drawing. Remember to show all work when solving a problem mathematically.

1. A charged rod is held near the top of an electroscope as shown. Then it is removed. Show the leaves on the electroscope and the movement of charge in each diagram.

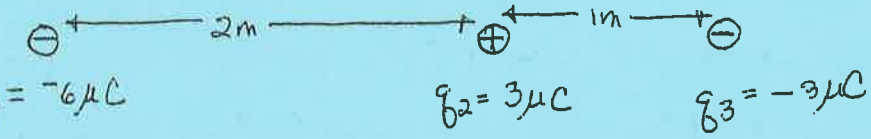


2. A charged rod is held near the top of an electroscope as shown. Then it is grounded. Show the grounding in figure (b) and then the final charge on the electroscope in figure (c).

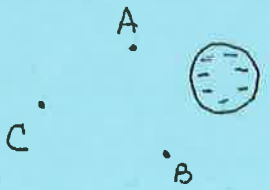


3. Carefully draw field lines around the two charges shown below. The charge on q_2 is twice the charge on q_1.

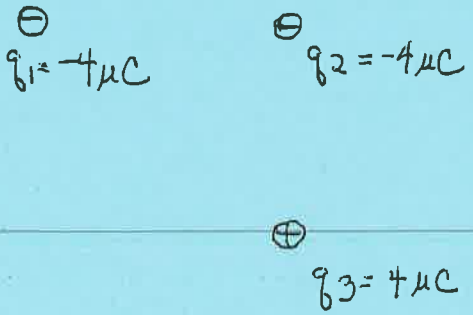
4. Three charges are lined up as shown. They are charged as shown in the diagram. Find the net force on q_2. Be sure to show the forces as vectors in the diagram as well as all steps in the mathematical solution.



5. A charged conductor is shown below. A test charge, q_o, is placed in several positions around the sphere. Use a carefully drawn vector to show the magnitude and direction of the electric force acting on the test charge in each of the specified positions.



6. Three charges of equal magnitude ($4\,\mu C$) are positioned at the vertices of a triangle as shown below. Mathematically calculate the force of each charge on q_2 and show these as vectors on the diagram. Use your diagram to show qualitatively the resultant or net force acting on this charge.



Electrostatics – Sample Essay Questions

1) Use diagrams to predict the charge on the charging rod which will charge the leaves of an electroscope in the following ways?
    a. **Negatively** by induction.

    b. **Positively** by conduction.

2) Use sample information to prove of the two field forces which is stronger and by how much when two protons are close to each other, electric force or gravitational force.

3) Two positively, q_1 and q_2, repel each other with a greater strength than two other positive charges, q_3 and q_4, that have triple the amount of positive charge. How is this possible? Prove your answer.

4) Draw electric field lines around the following set of two charges.

VOCABULARY- ELECTROSTATICS

1) Electrostatics- electricity at rest; involves electric charges, forces between them and their behavior in materials.
2) Electrical forces- forces that arise due to protons and electrons in atoms.
3) Charges- develop due to an imbalance in the atomic structure in atoms, like electrons and protons attract, protons and protons repel, and electrons and electrons repel.
4) Coulomb's law- states that for charged particles or objects that are small, compared with the distance between them, the force between the charges varies directly as the product of the charges and inversely as the square of the distance between them.
5) k – proportionality constant used in Coulomb's law(9.0×10^9 Nx m^2 / C^2
6) conductors- materials that allow electrons to move from atom to atom freely.
7) Insulators- materials that have electrons tightly bound not allowing them to move easily.
8) Semiconductors- materials that can be made to behave as insulators in some cases and conductors in others.
9) Superconductors- at temperatures near absolute zero, certain metals acquire infinite conductivity.
10) Induction- if a charged object comes near a conducting surface it will cause electrons to move within the conducting material even without touching.
11) Grounding- allowing a charge to move off of it or on to an object into the ground.
12) Electrically polarized- one side of the atom is induced to a slightly more positive or negative than the opposite.
13) Bohr model- model of the atom that indicates that the electrons are found in specific orbits or paths surrounding the nucleus.
14) Electric field- a field force that surrounds every electric charge.
15) Lightning- an electric discharge between the clouds and the oppositely charge ground
16) Electric potential difference- it allows charges to flow, the difference in potential(voltage) between the ends of a conductor.
17) Capacitor- a device that stores electric energy
18) Electroscope- an instrument used to indicate the attraction or repulsion of charges.
19) Van de Graaf generator- a common laboratory instrument used to build up high voltage and distribute charge.
20) Lightning rod- a device attached to buildings to direct the electric discharge from lightning directly to the ground.

Important Diagram Elements and Diagrams for Understanding Electrostatics

(Copy down any parts of a diagram you find in the book, so you remember. Label everything.)