Republic of the Philippines
Department of Education
Region IV (A) – CALABARZON
City Schools Division Office of Antipolo
District I – A

ANTIPOLO CITY SENIOR HIGH SCHOOL
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STUDENT's ACTIVITY SHEET FOR GENERAL PHYSICS 2

SAS #1 MELC 1,5,6 (MODULAR MODALITY)
TITLE/LESSON: ELECTRIC CHARGE, COULOMB'S LAW, AND ELECTRIC FIELDS

I. OBJECTIVES: At the end of the lesson, you are expected to:

a. describe using a diagram charging by rubbing and charging by induction;
b. explain an electric field as a region in which an electric charge experiences a force; and
c. calculate the electric field due to a system of point charges using Coulomb's law and the superposition principle.

A. Content Standard:

The learner demonstrates an understanding of Electric charge. Insulators and conductors, Induced charges. Coulomb's Law, Electric forces and fields, and Electric field calculations.

B. Performance Standard:

The learners shall be able use theoretical and experimental approaches to solve multi concept and rich-context problems involving electricity and magnetism.

C. Most Essential Learning Competency/ies:

1. Describe using a diagram charging by rubbing and charging by induction. (STEM_GP12EM-IIIa-1)
2. Explain an electric field as a region in which an electric charge experiences a force. (STEM_GP12EM-IIIa-7)
3. Calculate the electric field due to a system of point charges using Coulomb's law and the superposition principle. (STEM_GP12EM-IIIa-10)

II. LEARNING RESOURCES

A. Materials/IMs Needed
B. References
C. Additional Materials and Learning Resources

III. TIME FRAME: 50 min or 1 day (30 min will be allotted for the lecture part)

IV. INTRODUCTION/RATIONALE

Electric charge is the physical property of matter that causes it to experience a force when placed in an electromagnetic field. There are two types of electric charge: positive and negative (commonly carried by protons and electrons respectively). Like charges repel each other and unlike charges attract each other. An object with an absence of net charge is referred to as neutral. Early knowledge of how charged substances interact is now called classical

electrodynamics, and is still accurate for problems that do not require consideration of quantum effects.

Electric charges produce electric fields. A moving charge also produces a magnetic field. The interaction of electric charges with an electromagnetic field (combination of electric and magnetic fields) is the source of the electromagnetic (or Lorentz) force, which is one of the four fundamental forces in physics.

What I Need to Know

This activity sheet was designed and written with you in mind. It is here to help you master the Electric Charge, Coulomb's Law, Electric Fields. The scope of this activity sheet permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary of students. The lessons are arranged to follow the standard sequence of the course.

This activity sheet is compromised only of one lesson:

- Electric Charge, Coulomb's Law, and Electric Fields

After going through this activity sheet, you are expected to:

1. Describe using a diagram charging by rubbing and charging by induction;
2. Explain an electric field as a region in which an electric charge experiences a force; and
3. Calculate the electric field due to a system of point charges using Coulomb's law and the superposition principle.

What I Know

Activity 1.1 Express Me! (3 minutes)

Directions: Write the meaning of the following.

a. proton
b. electron
c. electric charges
d. electric field
e. Coulomb's Law

What's In

Activity 1.2 Illustrate Me!

Directions: Draw the water (H_2O) molecule showing it as a polar molecule, that is with positive and negative poles. (**3 minutes)**

Question: How does its polarity arise? Explain this in terms of distribution of electric charges.

What's New

Activity 1.3 Check Your Understanding!

Directions: Analyze the situation below. (3 minutes)

Xerography, used for making xerox copies, applies the properties of static or stationary distributions of electric charges. Briefly explain the important steps in the process.

What is It

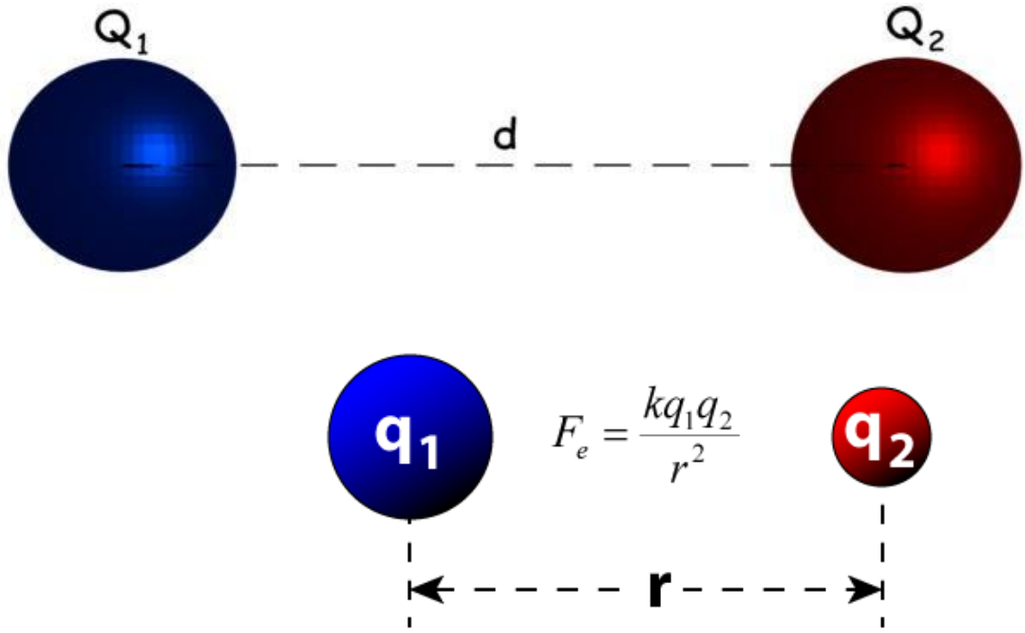
Coulomb's Law Definition

Coulomb's law states that the magnitude of the electrostatic force of attraction or repulsion between two electrically charged bodies is directly proportional to the product of the charge of the charged bodies and inversely proportional to the square of the distance between the center of the charged bodies.

This inverse-square relationship is why the law is also referred to as Coulomb's inverse-square law.

Coulomb's Law Formula

Let us imagine, Q_1 and Q_2 are the electrical charges of two objects.
d is the distance between the center of the objects.



Charles-Augustin de Coulomb, a French physicist in 1784, measured the force between two-point charges and he came up with the theory that the force is inversely proportional to the square of the distance between the charges. He also found that this force is directly proportional to the product of charges (magnitudes only).

We can show it with the following explanation. Let's say that there are two charges q1 and q2. The distance between the charges is 'r', and the force of attraction/repulsion between them is 'F'. Then

F ∝ q1q2

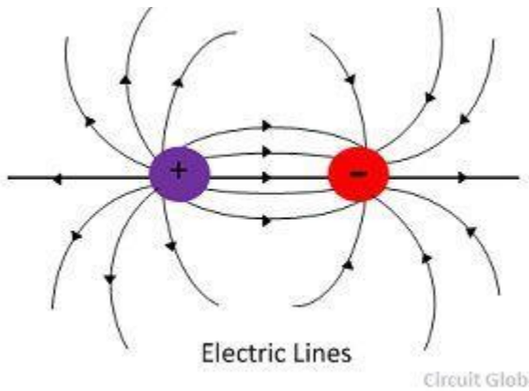
Or, F ∝ 1/r2

F = k q1q2/ r2

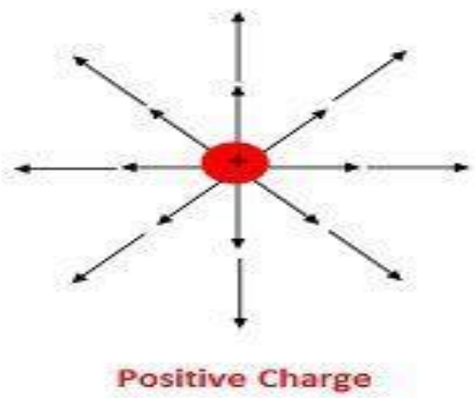
where k is proportionality constant and equals to 1/4 π ε0. Here, ε0 is the epsilon naught and it signifies permittivity of a vacuum. The value of k comes 9 × 109 Nm2/ C2 when we take the S.I unit of value of ε0 is 8.854 × 10-12 C2 N-1 m-2.

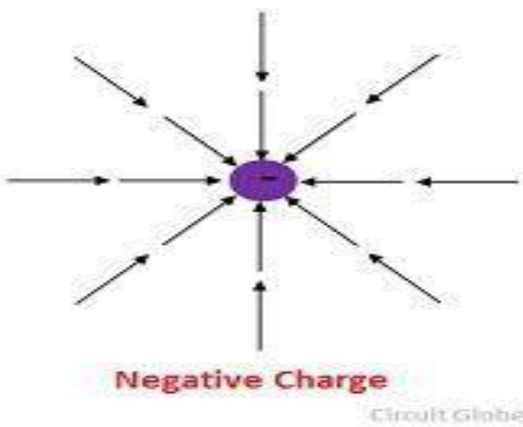
Electric Field

The region around the electric charge in which the stress or electric force act is called an electric field or electrostatic field. If the magnitude of charge is large, then it may create a huge stress around the region. The electric field is represented by the symbol E. The SI unit of the electric field is newton per coulomb which is equal to volts per meter.

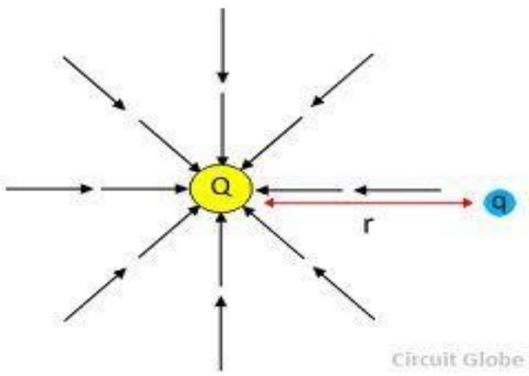


The electric field is represented by the imaginary lines of force. For the positive charge, the line of force come out of the charge and for negative charge the line of force will move towards the charge. The electric field for positive and negative charges are shown below





Consider a unit charge Q placed in a vacuum. If another charge q is placed near the Q then according to Coulomb law, the charge Q apply a force on it. The charge Q produce an electric field around it, and when any other charge is placed near it, then the electric field of Q apply force on it.



The electric field produced by the charge Q at a point r is given by

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

where Q – unit charge
r – distance between the charges

A charge Q applies the force on a charge q is expressed by

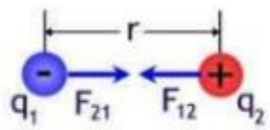
$$F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$$

The charge q also applies an equal and opposite force on the charge Q.

Electric Field - Definition

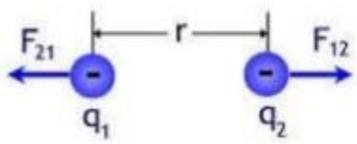
- the electric field vector E at a point in space **is defined as the electric force Fe acting on a positive test charge *q* placed at that point divided by the test charge**:

F = K|q||q|/r² = magnitude of the electric force
k = Coulomb's constant = 8.9875 x 10^9Nm²/c²



$$\mathbf{E} \equiv \frac{\mathbf{F}_e}{q_0}$$

E = K|q| / r²



$$\mathbf{F}_e = q\mathbf{E}$$

Note that since F is a vector and q is a scalar,
E must be a vector.
the units of Electric Field in SI units of newtons per coulomb (N/C)

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What's More

Activity 1.4 Put Your Best!

Directions: Illustrate the following: **(3 minutes)**

Draw the field lines for

a. a single negative point charge;
b. a positive point charge near a negative point charge,
c. two positive charges near each other

What I Have Learned

Activity 1.5 Highlights Zone!

Directions: Answer the following questions:

1. If the charges are not changed, but they are moved farther apart (the distance r becomes bigger), will the electric force become stronger or weaker?
2. Which is stronger, the electric force or the gravitational force?

What I Can Do

Activity 1.6 A Job for Me!

Directions: Refer to the situation below. (3 minutes)

Robert Millikan in his famous oil drop experiment was able to determine the charge of an electron. Draw a force diagram for the oil drop, discuss balance of forces in the experiment, and explain briefly how Millikan was able to achieve his aim in the experiment.

Assessment

Quiz #1

Directions: Solve the following problems: **(5 minutes)**

1. Find the electric field acting on a 2.0 C charge if an electrostatic force of 10500 N acts on the particle.
2. What is the magnitude of a point charge whose E field at a distance of 0.25m is 3.4 N/C?

Additional Activities

Activity 1.7 A Time to Shine!

Directions: Analyze the situation below. (**3 minutes)**

What is the electric force between two protons ½ m apart? (Recall the charge of a proton is +1.6 x 10^{-19} C.) Draw a diagram to show the direction of the force between two protons.

V. REFLECTION: (5 minutes)

Base on the activity/ies conducted, complete the phrases stated below:

- ✓ I understand that

  _____
  _____.

- ✓ I realize that

  _____
  _____.

References:

Coulomb's Law: Definition, Formula, Vector Form, Limitation, Videos, Q&A (toppr.com)

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