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 #3 MELC 16,17,20 (MODULAR MODALITY)
TITLE/LESSON: CAPACITANCE AND DIELECTRICS

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

a. determine the total charge, the charge on, and the potential difference across each capacitor in the network given the capacitors connected in series/parallel;
b. calculate the equivalent capacitance of a network of capacitors connected in series/parallel; and
c. solve problems involving capacitors and dielectrics in contexts such as, but not limited to, charged plates, batteries, and camera flashlamps.

A. Content Standard:

The learner demonstrates an understanding of Capacitance, Capacitors in series and parallel, Energy stored and electric-field energy in capacitors, and dielectrics.

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. Determine the total charge, the charge on, and the potential difference across each capacitor in the network given the capacitors connected in series/parallel. (STEM_GP12EM-IIId-25)
2. Calculate the equivalent capacitance of a network of capacitors connected in series/parallel. (STEM_GP12EM-IIId-24)
3. Solve problems involving capacitors and dielectrics in contexts such as, but not limited to, charged plates, batteries, and camera flashlamps. (STEM_GP12EM-IIId-30)

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

A capacitor is an electrical device which stores electric charge, whereas a dielectric is a material that does not allow current to flow. Dielectrics are often called insulators as they are the opposite of conductors. All the electrons in a dielectric material are bound tightly to their parent nucleus, so no free electrons are available to carry the current. Thus, the electrical conductivity of dielectrics is very low.

What I Need to Know

This activity sheet was designed and written with you in mind. It is here to help you master the Capacitance and Dielectrics. 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:

- Capacitance and Dielectrics

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

1. Determine the total charge, the charge on, and the potential difference across each capacitor in the network given the capacitors connected in series/parallel;
2. Calculate the equivalent capacitance of a network of capacitors connected in series/parallel; and
3. Solve problems involving capacitors and dielectrics in contexts such as, but not limited to, charged plates, batteries, and camera flashlamps.

What I Know

Activity 3.1 Express Me! (3 minutes)

Directions: Write the meaning of the following.

a. conductor
b. insulator
c. capacitor
d. capacitance
e. dielectrics

What's In

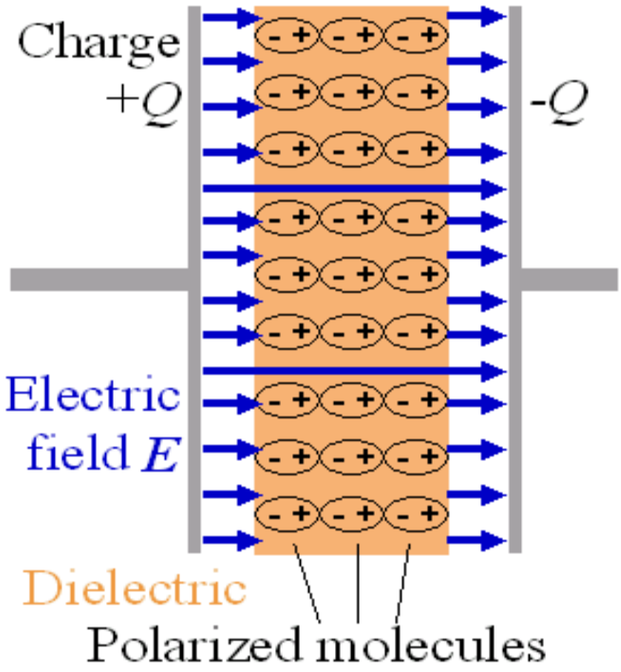
Activity 3.2 Illustrate Me!

Directions: Name the different types of capacitor in the pictures below. (**3 minutes)**

What's New

Activity 3.3 Check Your Understanding!

Directions: Analyze the figure below. (3 minutes)

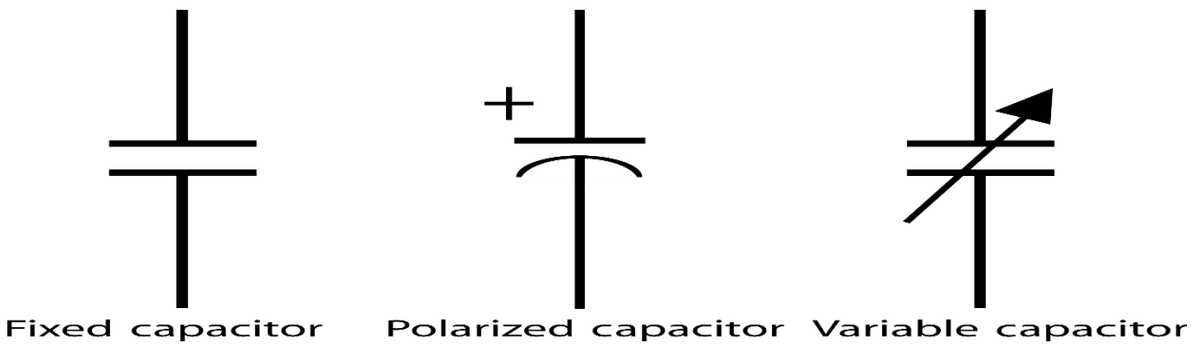


Question: How dielectric and capacitor related to each other and how they differ in function, properties and uses?

What is It

What is Dielectric?

A dielectric is an insulating material with a poor conductor of electric current but an efficient supporter of electrostatic fields. It is a medium or substance that has the ability to withstand high electric stress without appreciable conduction. When stress is applied, energy in the form of an electric charge is held by the dielectric. Most of this energy is retained when the stress is removed. A dielectric material is more or less insulating material which becomes polarized when it comes in contact with an electrical field. Like any material, a dielectric is an assembly of ions with positive and negative charges which balance to ensure electrical neutrality. Because of dielectric polarization, positive charges are displaced in the direction of the electric field, and the negative charges shift in the opposite direction of the field.



What is Capacitor?

A capacitor is a two-way electrical component consisting of a pair of conductors separated by a dielectric insulator. It is one of the most fundamental passive components with the ability to store electrical energy in an electric field. It's their capacity to store electric energy that makes them so special. A capacitor is one of the three fundamental components of a circuit, along with resistors and inductors. It holds the electric charge when voltage is applied across it and releases the charge as and when required.

Capacitors are ubiquitous on high-speed circuit boards, but engineers often do not fully understand their electrical characteristics. Although, capacitors vary in size and shape, the basic configuration remains the same, i.e. two conductors carry equal but opposite charges. Capacitors are basically characterized by the material used for their dielectric as: variable air, paper, mica, ceramic, plastic, titanium oxide, and electrolytic.

The following formulas and equations can be used to calculate the capacitance and related quantities of different shapes of capacitors as follow.

Charge Stored in a Capacitor:
If capacitance C and voltage V is known then the charge Q can be calculated by:

$$Q = C\,V$$

Voltage of the Capacitor:
And you can calculate the voltage of the capacitor if the other two quantities (Q & C) are known:

$$V = Q/C$$

where

Q is the charge stored between the plates in Coulombs
C is the capacitance in farads
V is the potential difference between the plates in Volts

Energy Stored in a Capacitor:
The Energy E stored in a capacitor is given by:

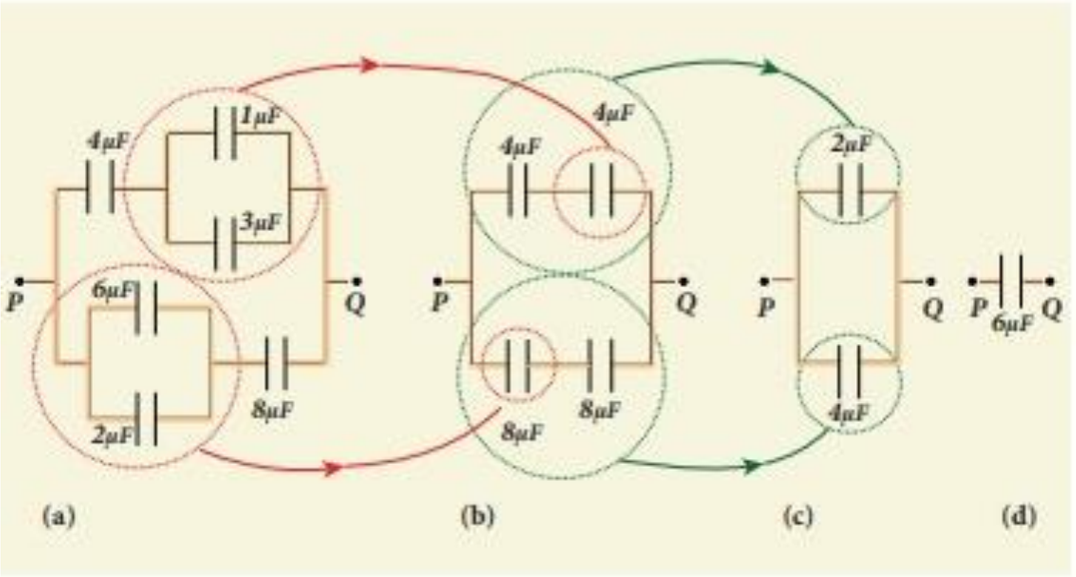
$$E = \tfrac{1}{2}\,CV^2$$

where

E is the energy in joules
C is the capacitance in farads
V is the voltage in volts

Capacitor in Series and Parallel

Find the equivalent capacitance between P and Q for the configuration shown below in the figure (a)



Solution

The capacitors 1 μF and 3μF are connected in parallel and 6μF and 2 μF are also separately connected in parallel. So these parallel combinations reduced to equivalent single capacitances in their respective positions, as shown in the figure (b).

Ceq = 1μF + 3μF = 4μF

Ceq = 6μF + 2μF = 8μF

From the figure (b), we infer that the two 4 μF capacitors are connected in series and the two 8 μF capacitors are connected in series. By using formula for the series, we can reduce to their equivalent capacitances as shown in figure (c).

$$\frac{1}{C_{eq}} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2} \qquad \Rightarrow C_{eq} = 2\,\mu F$$

and

$$\frac{1}{C_{eq}} = \frac{1}{8} + \frac{1}{8} = \frac{1}{4} \qquad \Rightarrow C_{eq} = 4\,\mu F$$

From the figure (c), we infer that 2μF and 4μF are connected in parallel. So the equivalent capacitance is given in the figure (d).

Ceq = 2μF + 4μF = 6μF

Thus the combination of capacitances in figure (a) can be replaced by a single capacitance 6 μF.

What's More

Activity 3.4 Put Your Best!

Directions: Make a comparison chart of dielectric and capacitor: **(3 minutes)**

What I Have Learned

Activity 3.5 Highlights Zone!

Directions: Answer the following questions:

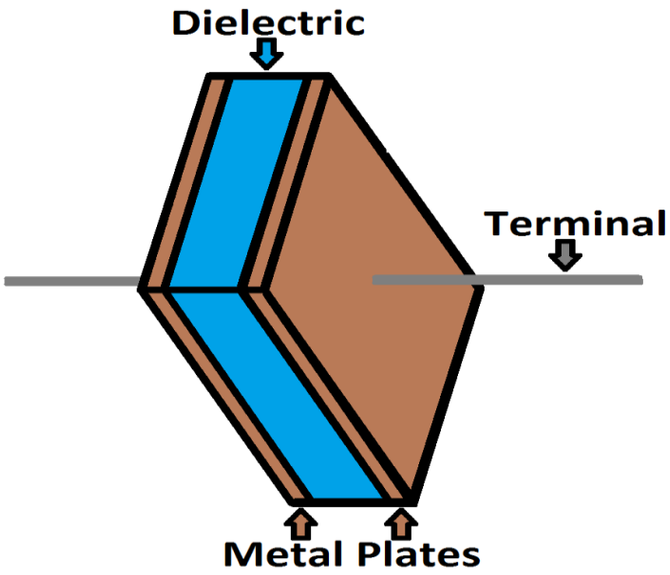
1. How does charging and discharging happen in a capacitor?
2. What happens to electrical potential energy whenever positive and negative electric charges move apart?
3. What is the property of a capacitor to store charge?

What I Can Do

Activity 3.6 A Job for Me!

Directions: Use the diagram to answer the question below. (3 minutes)

The schematic symbol for a capacitor actually closely resembles how it's made. A capacitor is created out of two metal plates and an insulating material called a dielectric. The metal plates are placed very close to each other, in parallel, but the dielectric sits between them to make sure they don't touch.



Your standard capacitor sandwich: two metal plates separated by an insulating dielectric.

The dielectric can be made out of all sorts of insulating materials: paper, glass, rubber, ceramic, plastic, or anything that will impede the flow of current.

The plates are made of a conductive material: aluminum, tantalum, silver, or other metals. They're each connected to a terminal wire, which is what eventually connects to the rest of the circuit.

Questions:

1. How a capacitor is made?
2. Suppose you are to construct a capacitor, what insulating materials will you use as dielectric?

Assessment

Quiz #3

Directions: Solve the problem below: **(5 minutes)**

Calculate the net capacitance of three capacitors of capacitances 2.0 μF, 4.0 μF, and 6.0 μF when connected in

a) series
b) parallel

Additional Activities

Activity 3.7 A Time to Shine!

Directions: Answer the following questions: (**3 minutes)**

1. What are the different types of capacitor? Describe each.
2. Give the electrical and electronic applications of capacitor.

V. REFLECTION: (5 minutes)

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

✓ I understand that

_____
_____.

✓ I realize that

_____
_____.

References:
http://www.differencebetween.net/science/physics-science/difference-between-dielectric-and-capacitor/

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