DEPARTMENT OF EDUCATION
SCHOOLS DIVISION OF NEGROS ORIENTAL
REGION VII
Kagawasan Ave., Daro, Dumaguete City, Negros Oriental

CAPACITORS AND DIELECTRICS WITH CALCULATIONS

for GENERAL PHYSICS 2/ Grade 12/ Quarter 3/ Week 3

SELF-LEARNING KIT

NegOr_Q3_GenPhysics2_SLKWeek3_v2

FOREWORD

Learning Physics concepts could be interesting because of its problems that require basic mathematical knowledge like Algebra. Thus, you, the learners, need to be motivated with working on physics modules. This self-learning kit will teach you about Capacitors and Dielectrics that have calculations.

In this self-learning kit, you will gain knowledge in determining the potential energy stored inside the capacitor and deducing the effects of simple capacitors on the capacitance, charge, and potential difference when the size, potential difference or charge is changed. It will also help you calculate the equivalent capacitance of a network of capacitors connected in series/parallel and solve problems involving capacitors and dielectrics in contexts such as, charged plates, batteries, and camera flash lamps. Lastly, this will help you describe the effects of inserting dielectric materials on the capacitance, charge, and electric field of a capacitor and determine the total charge, the charge on, and the potential difference across each capacitor in the network given the capacitors connected in series/parallel.

OBJECTIVES

At the end of this Self–Learning Kit, you should be able to:

K: discuss about capacitors and its types, the total charge, the charge on, and the potential difference across each capacitor in the network given the capacitors connected in series/parallel;

: define potential energy and determine the potential energy stored inside and across a capacitor;

S: calculate the equivalent capacitance of a network of capacitors connected in series/parallel;

: solve problems involving capacitors and dielectrics; and

A: recognize the significant effects of the different physical characteristics of capacitors on determining its capacitance, charge and potential difference.

LEARNING COMPETENCIES

Deduce the effects of simple capacitors (e.g., parallel-plate, spherical, cylindrical) on the capacitance, charge, and potential difference when the size, potential difference, or charge is changed **(STEM_GP12EMIIId-23).**

Calculate the equivalent capacitance of a network of capacitors connected in series/parallel **(STEM_GP12EMIIId-24).**

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_GP12EMIIId-25).**

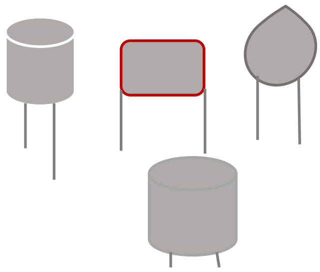
Determine the potential energy stored inside the capacitor given the geometry and the potential difference across the capacitor **(STEM_GP12EMIIId-26).**

Describe the effects of inserting dielectric materials on the capacitance, charge, and electric field of a capacitor **(STEM_GP12EMIIId-29)**

Solve problems involving capacitors and dielectrics in contexts such as, but not limited to, charged plates, batteries, and camera flash lamps **(STEM_GP12EMIIId-30).**

I. WHAT HAPPENED

Hi! It's me again Rose. We will be dealing with capacitors and dielectrics this time.



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Do grab your pen and notebooks with you because those are very essential for this journey of ours.

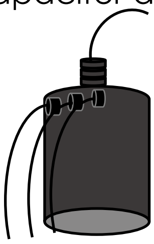
PRE-TEST:

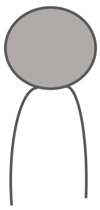
⏰ Let's look back and check your memory.

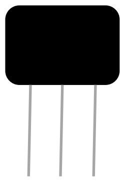
PRE-ACTIVITY 1: Guess What?

Directions: Observe the illustrations below. Read and answer each question very carefully. Write your answers on your notebook/Answer Sheet.

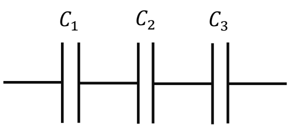
1. Everyone in the STEM class knows how to operate appliances but some only knew what a capacitor looks like. To make her project, Anna needs to know what a capacitor looks like. Let us help her recognize a capacitor and draw it for her on her notebook.

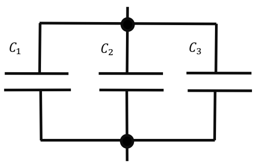
A. 

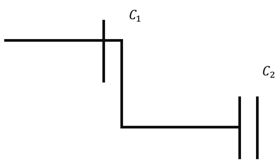
B. 

C. 

2. Anna is trying to put the capacitor for her series circuit project. Which of the following she should follow? Why?

A. 

B. 

C. 

3. What is the use of putting capacitor on our appliances?
4. How is a charge stored inside a capacitor?

5. Is there a means of deducing a capacitor on the capacitance, charge, and potential difference when the size, potential difference, or charge is changed?

PRE-ACTIVITY 2: Loosen up!

Directions: Read and answer the questions very carefully. Write your answers on your notebook/Activity Sheet.

1. Electric potential has the unit of volts. This unit is named after the person who devised on of the first electric cells.
   a. Michael Volta
   b. Alessandro Volta
   c. Alexander Volta
   d. Rene Descartes
2. The capacitors capability of storing electric charges is called capacitance. How are you going express capacitance in an equation?
   a. Q= CV
   b. C= QV
   c. C= $\frac{Q}{V}$
   d. C= $\frac{V}{Q}$
3. Inserting dielectric is important in a capacitor. Which of the following does not show the importance of dielectric?
   a. To keep the conducting plates from coming in contact, allowing for smaller plate separations and therefore higher capacitances.
   b. To make the voltage of the capacitor contained.
   c. To increase the effective capacitance by reducing the electric field strength, which means you get the same charge at a lower voltage.
   d. To reduce the possibility of shorting out by sparking during operation at high voltage.
4. Which of the following statement is true?
   a. The capacitance tells us how much charge the device stores for a given voltage.
   b. Dielectric between the conductors increases the capacitance of a capacitor.
   c. The energy stored in a capacitor is the work required to charge the capacitor, beginning with no charge on its plates
   d. All of the above.
5. Why is an electric field pointing from right to left when placing a dielectric layer between two parallel charged metal plates?
   a. Because the positive nuclei of the dielectric will move with the field to the right and negative electrons will move against the field to the left.
   b. Because of how you are placing it.
   c. Because it is a vector quantity resulting it to point that way and when two vectors meet it will make a charge.
   d. For it to repel.

II. WHAT I NEED TO KNOW
DISCUSSION:

CAPACITORS

Capacitors are used commonly and are useful as electronic component in the modern circuits and devices. This has long history usage of more than 250 years and was being studied, designed and developed up to the present.

*A **capacitor** is a passive device for storing electric charges.* The simplest type of capacitor consists of two parallel conducting plates separated from each other by a thin sheet of insulating material or ***dielectric***. Capacitors can be classified in terms of their construction-parallel-plate, spherical, and cylindrical. Each of these has advantages and disadvantages based on a capacitance, charge, and potential difference.

Parallel- plate capacitors this type of capacitor has two parallel charging plates are separated by a dielectric that contains charges. The capacitance that can be offered by a parallel-plate capacitor is directly proportional to the area of the plates as well as to the distance between these plates. The voltage across this type of capacitor is also directly proportional to the distance between the plates.

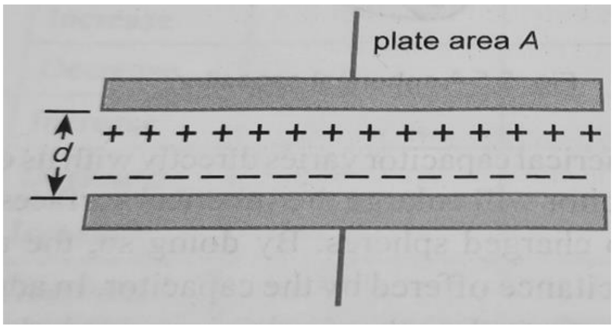


Figure 1. A parallel-plate capacitor
Source: Oliver M. David. GENERAL PHYSICS 2. DIWA LEARNING SYSTEMS INC

Cylindrical capacitors have different construction as seen in figure 2, inner and outer cylindrical structures. The dielectric is placed between these two charged cylinders. The capacitance of a cylindrical capacitor varies directly with its length. Longer capacitor provides higher capacitance, whereas a shorter provides a lower value. Increasing the amount of dielectric in this capacitor also increases the capacitance that it offers. Also, a fat or large cylindrical capacitor offers higher capacitance than a thin one. Such variation means that an increase in the distance between the two charged cylinders will increase the amount of work to be done to move a charge from one cylinder to the other, therefore increasing the voltage across the capacitor.

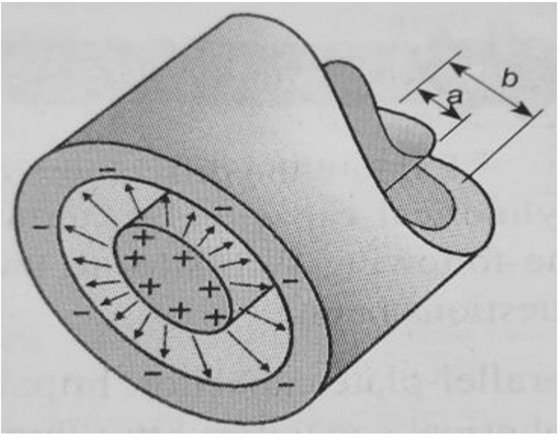


Figure 2. A Cylindrical capacitor
Source: Oliver M. David. GENERAL PHYSICS 2. DIWA LEARNING SYSTEMS INC

Spherical Capacitors have a construction similar to that of cylindrical capacitor. As seen in figure 2, an internal spherical structure is one of the charged bodies of the capacitor. The other charged body is the outer spherical structure that covers the internal sphere. The dielectric is placed between these two charged spheres. The capacitance of this capacitor varies directly with its overall radius. Increasing the radius of this type of capacitor will enlarge the spherical surface, consequently widening the distance between the two charged spheres with that the amount of dielectric also surges, thus boosting the capacitance offered by the capacitor. In addition, the work necessary to move a charge from one sphere to another is also increased, thus intensifying the voltage across the capacitor.

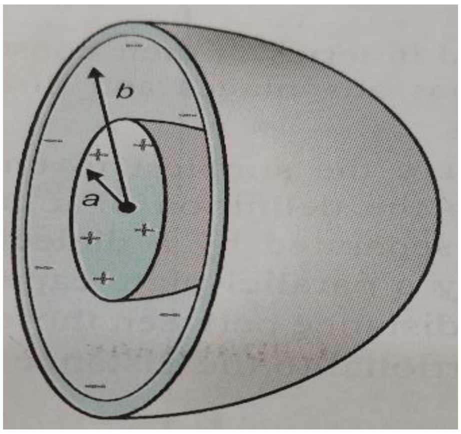


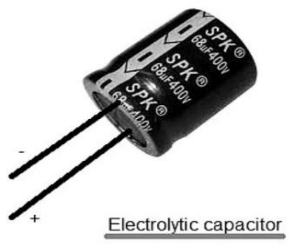
Figure 3. A Spherical Capacitors
Source: Oliver M. David. GENERAL PHYSICS 2. DIWA LEARNING SYSTEMS INC

DIFFERENT TYPES OF CAPACITORS

The different types of capacitors are the following:

1. Electrolytic Capacitor
2. Mica Capacitor
3. Paper Capacitor
4. Film Capacitor
5. Non-Polarized Capacitor
6. Ceramic Capacitor

Electrolytic Capacitor



Source: https://bit.ly/3t6uWSd

This is used when the large capacitor values are required. The thin metal layer is used for one electrode and for the second electrode (cathode) a semi-liquid electrolyte solution which is in jelly or paste is used. The dielectric plate is a thin layer of oxide, it is developed electrochemically in production with thickness of the film. It is possible to make capacitors with a large value of capacitance for a physical size, which is in small and the distance between the two plates is very small. Majority of electrolytic capacitors are polarized.

The uses of this capacitor are generally in the DC power supply circuit because they are in large capacitance and small in reducing ripple voltage. The applications of this electrolytic capacitors are coupling and decoupling. The disadvantage of this is their relatively low voltage rating because of the polarization of electrolytic capacitor.

Mica Capacitor


Mica Capacitor
Source: https://bit.ly/3t6uWSd

This capacitor is a group of natural minerals. These are the two types of mica capacitors namely ***clamped capacitors*** & ***silver mica capacitor***. *Clamped mica capacitor* is considered obsolete because of their inferior characteristic. *Silver mica capacitor* is prepared by sandwiching mica sheet coated with metal on both sides and this assembly is then encased in epoxy to protect the environment.

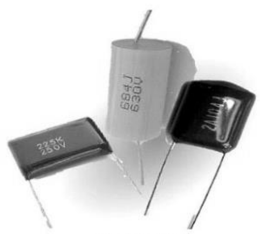
These capacitors are low loss capacitors, used at high frequencies and is very stable chemically, electrically, and mechanically due to its specific crystalline structure binding and typical layered structure.

Paper Capacitor

Paper Capacitor
Source: https://bit.ly/3t6uWSd

The construction of this capacitor is between the two tin foil sheets and they are separated from the paper or oiled paper and thin waxed. The sandwiched foils and papers are rolled in a cylindrical shape then it is enclosed in a plastic capsule. The two foils of this paper capacitor attach to the external load. The capacitance range of this capacitor is from 0.001 to 2.000micro farad and the voltage is very high which is up to 2000V.

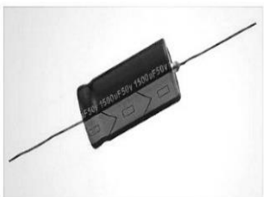
Film Capacitor


Film Capacitor
Source: https://bit.ly/3t6uWSd

This capacitor used a thin plastic as a dielectric. The film capacitor is prepared extremely thin using the sophisticated film drawing process. There are different types of film capacitors available like polyester film, metalized film, polypropylene film, PTE film and polystyrene film. The main difference between these film capacitors is the material used as a dielectric and is chosen properly according to their properties.

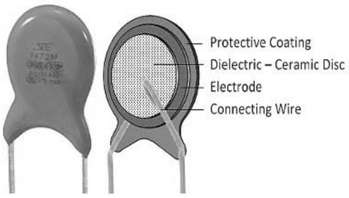
The applications of the film capacitors are stability, low inductance, and low cost. The PTE film capacitance is a heat resistance and is used in the aerospace and military technology.

Non-Polarized Capacitor


Non-Polarized Capacitor
Source: https://bit.ly/3t6uWSd

The non-polarized capacitors are classified in to two, the plastic foil capacitor and the electrolytic non-polarized capacitor. The non-polarized capacitor requires the Ac applications in a series or parallel with a signal or power supply. The examples are the speaker crossover filters and power factor correction network. In these two applications, a large AC voltage signal is applied across the capacitor.

Ceramic Capacitor



Ceramic Capacitor
Source: https://bit.ly/3t6uWSd

This capacitor uses ceramic material as dielectric. The ceramics are one of the first materials used in the production of capacitors as an insulator. The two common types of ceramic capacitors are multilayer ceramic capacitor (MLCC) and ceramic disc capacitor. The *multilayer ceramic capacitors* are prepared by using the surface mounted (SMD)technology and they are smaller in size, therefore, it used widely. While the *ceramic disc capacitor* is manufactured by coating a ceramic disc with silver contacts on both sides and to achieve larger capacitance, these devices are made from multiple layers.

CAPACITANCE

The effect or the ability of a capacitor to store charges is called ***capacitance***. This capacitance is made up of two close conductors and separated by the dielectric material. If the plates are connected to the power, then the plates accumulate the electric charge. One plate accumulates the positive charge while the other got the opposite. The capacitance (**C**) of a capacitor is mathematically defined as the ratio of the amount of charge (**Q**) in one plate to the potential difference (**V**) between the plates.

In symbols,

$$C = \frac{Q}{V}$$

The SI unit of capacitance is the ***farad,*** symbolized by letter **F** and was named after *Michael Faraday*. It follows that one farad equals 1 coulomb per volt.

The capacitance of a parallel plate capacitor is affected by the following factors:

a. *Area of plates*. The bigger the area of the plates, the greater is the capacitance.
b. *Distance between the plates.* The closer the plates to one another, the greater the capacitance.
c. *Insulating material or dielectric* between them.

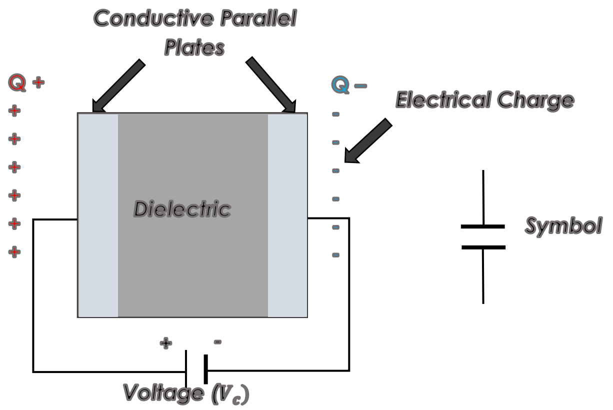


Figure 4. Basic parts of a capacitor

Table 1. Factors Affecting Capacitance of a Capacitor

Variable		Effect on Capacitance
Area of the conducting plate	Increase	Increase
	Decrease	Decrease
Distance between the conducting plates	Increase	Increase
	Decrease	Decrease
Type of dielectric	More conducting	Decrease
	Less conducting	Increase

This means increasing the area of the capacitor plates will also increase the capacitance of a capacitor and vice versa.

The dependence of the capacitance of a parallel plate capacitor on the factors cited above is mathematically expressed as

$$\mathbf{C} = \varepsilon \frac{A}{d}$$

where, *A* is the area of one plate in square meters, *d* is the distance between plates in meters, and ε is the permittivity of the insulating material or dielectric.

Table 2. Permittivity of Some Materials	
Materials	$\boldsymbol{\varepsilon (x\ 10^{-11} C^2/Nm^2)}$
Air or vacuum	0.885
Glass (ordinary)	7
Glass (pyrex)	4.7
Mica	4.8
Mylar	2.7
Paraffin	2
Polyethylene	1.99
Porcelain	6.2
Teflon	1.9
Water at 20 ˚C	70.8

DIELECTRICS

Dielectrics are insulators that serve three purposes:

1. To keep the conducting plates from coming in contact, allowing for smaller plate separations and therefore higher capacitances;
2. To increase the effective capacitance by reducing the electric field strength, which means you get the same charge at a lower voltage; and
3. To reduce the possibility of shorting out by sparking (dielectric breakdown) during operation at high voltage

The role of a dielectric inserted between the capacitor plates is to impede or block the charges passing through the material. This means that a dielectric has to be made of insulating or less conducting materials to provide greater capacitance. Greater insulation allows more charges to be stored.

Introducing a dielectric into a capacitor decreases the electric field, which decreases the voltage, which increases the capacitance. A capacitor with a dielectric store the same charge as one without a dielectric, but a lower voltage. Therefore, a capacitor with a dielectric in it is more effective.

POTENTIAL DIFFERENCE

Potential difference is the work done in moving a unit positive charge from point A to point B in an electric field. Potential difference is designated as V_{AB} and is found by subtracting the potential at point A from the potential at point B.

If point A refers to the ground or infinity, the work done in bringing a unit positive charge from ground or infinity to another point B is called the *electric potential* at point B. Electric potential is designated by letter V.

$$\mathrm{V} = \frac{W}{Q}$$

Electric potential has the unit of volts. This unit is named after Alessandro Volta who devised one of the first electric cells. It can be shown that 1 volt= 1 joule/ coulomb (J/C).

On the other hand, if point A is not the ground nor the infinity, then the work done in moving a unit positive test charge from point A to point B is called *the potential difference* between points A and B.

$$V_{AB} = V_B - V_A$$

$$V_{AB} = \frac{W_{AB}}{Q}$$

Sample Problem 1:

A charge of $6\text{x}\ 10^{-7}$C is transferred from infinity to point A. If the work done to do this is 1.2 x 10^{-5}J, what is the potential at point A?

Solution:

Given: W= 1.2 x 10^{-5}J
Q= $6\text{x}\ 10^{-7}$C

Using the formula: $\mathrm{V} = \frac{W}{Q}$

$$\mathrm{V} = \frac{1.2 \text{ x } 10^{-5}\mathrm{J}}{6\text{x } 10^{-7}\mathrm{C}}$$

$$= \mathbf{20V}$$

Sample Problem 2:

Base on sample problem 1, what is the potential difference of point A to B if point B is 37 V?

Solution:

Given: V_A=20V and V_B= 37V

Using the formula: $V_{AB}= V_B - V_A$

V_{AB}= 37 V – 20 V

= 17 V

Potential difference is an actual consideration of the potentials in the circuit. The existence of PD also identifies the flow of charges through the circuit. Without this difference, there will be no electric potential, thus making the flow of charges through the conductor impossible.

THE AMOUNT OF CHARGE (Q) A CAPACITOR CAN STORE

The amount of charge (Q) a capacitor can store depends on two major factors- *the voltage applied and the capacitor's physical characteristics, such as its size*. It is easy to see the relationship between the voltage and the stored charge for a parallel plate capacitor, as shown in Figure 4. Each electric field line starts on an individual positive charge and ends on negative one, so that there will be more field lines if there is more charge.

The electric field strength (E) is directly proportional to the charge (Q).

$$\boldsymbol{E \propto Q}$$

where, α means "proportional to". We know that the voltage applied across parallel plate is *V= Ed* where, *V* α *E* and *V* α Q and so is Q α *V*.
This is true in general that the greater the voltage applied to any capacitor, the greater the charge stored in it.

Different capacitors will store different amounts of charge for the same applied voltage, depending on their physical characteristics. We define their capacitance (C) to be such that the charge (Q) stored in capacitor is proportional to (C). The charge stored in capacitor is given by *Q= CV.* And this equation expresses the two major factors affecting the amount of charge stored. I we will rearrange it we will come up with C= $\frac{Q}{V}$.

COMBINATION OF CAPACITORS

Capacitors may be connected in series or in parallel as shown in Figure 5. (a)&(b).

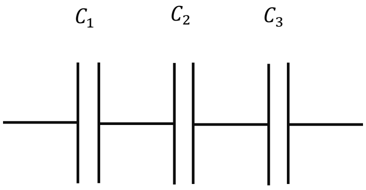


Figure 5. *(a) Capacitors in series*

There are three important rules for capacitors in series. These are:

1) The reciprocal of the total capacitance is equal to the sum of the reciprocals of the individual capacitance. It should be noted that adding a capacitor in series decreases the total capacitance of the combination.

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots$$

2) The total potential difference or total voltage is the sum of the potential differences across each capacitor.

$$V_T = V_1 + V_2 + V_3 + \cdots$$

3) The total charge is equal to the individual charge stored in each capacitor.

$$Q_T = Q_1 = Q_2 = Q_3 = \cdots$$

For parallel capacitors, the following rules apply:

1. The total capacitance is the sum of the individual capacitances.

$$C_T = C_1 + C_2 + C_3 + \cdots$$

2. The voltage across all capacitors is equal to the voltage across each capacitor.

$$V_T = V_1 = V_2 = V_3 = \cdots$$

3. The total charge is equal to the sum of the individual charges.

$$Q_T = Q_1 + Q_2 + Q_3 = \cdots$$

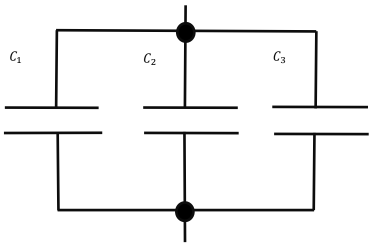


Figure 5. (b) Capacitors in parallel

Formulas to ponder!

Capacitors may be connected in series or in parallel.

Series Capacitors	***Parallel Capacitors***
$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots$	$C_T = C_1 + C_2 + C_3 + \cdots$
$V_T = V_1 + V_2 + V_3 + \cdots$	$V_T = V_1 = V_2 = V_3 = \cdots$
$Q_T = Q_1 = Q_2 = Q_3 = \cdots$	$Q_T = Q_1 + Q_2 + Q_3 = \cdots$

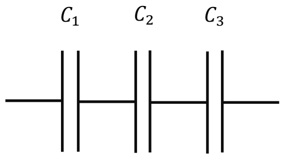
Source: https://bit.ly/3mBqPtf

Figure 6. Formulas in calculating series or parallel capacitors

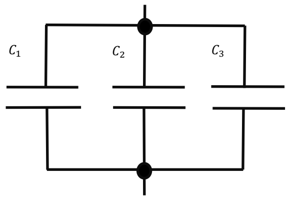
Sample Problem 3:

Find the total capacitance for each connection shown. C_1= 10.0F, C_2= 5.0F, and C_3= 4.0F.

a)



b)



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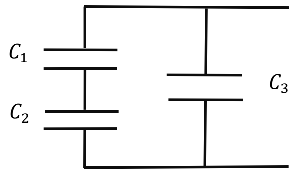

Solution:

Given: C_1= 10.0F, C_2= 5.0F, and C_3= 4.0F

a) $C_1, C_2, and\ C_3$ are in series

$$\frac{1}{C_T} = \frac{1}{10.0F} + \frac{1}{5.0F} + \frac{1}{4.0F}$$

= $\frac{2+4+5}{20} = \frac{11}{20}$ (where 20 is the least common denominator of the 3 capacitors)

C_T= 1.8 F (the reciprocal of $\frac{11}{20}$)

b) $C_1, C_2, and\ C_3$ are in parallel

C_T=10.0F + 5.0 F +4.0 F

= 19 F

c) Combination of series-parallel. First get the total capacitance of $C_1, and\ C_2$ in series.

$$\frac{1}{C_T} = \frac{1}{10.0F} + \frac{1}{5.0F} = \frac{1+2}{10} + \frac{3}{10}$$

C= 3.3 F (the reciprocal of $\frac{3}{10}$)

This series combination of C_1 and C_2 is parallel to C_3. Therefore, the total capacitance is

C_T= C + C_3= 3.3 F + 4.0 F

= 7.3 F

Performance Task:

Directions: Read the situation below and do what is asked. Take a video of yourself doing the lecture–discussion and submit it to your teacher.

A ***battery*** is known as a convenient source of electric energy, whereas an ***electroscope*** is an effective storage of electrical energy. Both devices are relevant to capacitors because they allow electric charges to be stored in them.

The next topic for your lecture is on the storage of charges by batteries and electroscopes. As one of the best Physics instructors in a University, you are expected by the Physics Department Chairperson to deliver a lecture on this topic in a very engaging manner. As part of the evaluation of your lecture, you are expected to thoroughly and accurately discuss the relevant concepts of capacitance in relation to the mechanism of how batteries and electroscopes work, to incorporate appropriate teaching methodologies, and to effectively use technology to make the lecture–discussion interesting.

III. WHAT I HAVE LEARNED EVALUATION/POST –TEST

A. MULTIPLE CHOICE:

Directions: Choose the correct letter and word of the correct answer. Write it on your notebook.

1) What are the three factors affecting the capacitance of a parallel plate capacitor?
   a. Dielectric, farad & voltage
   b. Area of plates, dielectric & distance between the plates
   c. Voltage, capacitance & dielectric
   d. None of the above

2) Isn't it true that capacitor stores electric charges?
   a. Yes b. No c. Maybe d. I don't know

3) The SI unit of capacitance is farad symbolized by letter F and was named after who?
   a. Michaele Farad c. Michael Faraday
   b. Michael Farad d. Michael Faraed

4) What are the two major factors affecting the amount of charge a capacitor can store?
    a. Voltage applied & capacitor's physical characteristics
    b. Dielectric & voltage applied
    c. Capacitance & dielectric
    d. Charge and voltage applied

5) Why is inserting dielectrics in a capacitor important?
    a. To impede or block the charges passing through the material.
    b. To keep the conducting plates from coming in contact
    c. To reduce the possibility of shorting out by sparking
    d. All of the above mentioned.

B. COMPLETING THE TABLE

Directions: Copy the table on your notebook and answer the missing data.

Question: *Infer what will happen to the capacitance, charge, and potential difference in the respective capacitors when their size, potential difference,*

		Capacitance	**Potential Difference**	**Charge**
Size	Increase			
	Decrease			
Potential Difference	Increase			
	Decrease			
Charge	Increase			
	Decrease			

C. PROBLEM SOLVING

Directions: Read each problem very carefully. Solve the problems and show your solutions on your notebook.

1) A 2.0 F and a 3.0 F are connected in series and subjected to a total potential difference of 100 V. Find (a) their equivalent capacitance, (b)charge stored in each capacitor, and (c) potential difference across each capacitor.

2) The capacitors in problem 1 are connected in parallel instead of being in series. The combination is connected to 100 V line. Find (a) total capacitance, (b) potential difference across each capacitor, and (c) charge stored in each capacitor.

3) Suppose you have five 10.0 F capacitors. Show all possible connections of all five capacitors to produce an equivalent capacitance of (a) 50.0 F, (b) 2.0 F, and (c) 35.0 F.

4) Solve the potential difference of point A and point B. If point A is 46 V and point B is 100 V.

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SYNOPSIS

This self-learning kit contains interactive approach in describing Capacitors and in deducing the effects of different physical characteristics of capacitors on determining its capacitance, charge and potential difference. It also contains problem solving that shows how to calculate the equivalent capacitance and dielectrics of a network of capacitors connected in series/parallel. The module is made simple, fun, easy and interactive to help facilitate independent learning while learners are at home.

ANSWER KEY

✓ **Pre-activity: Guess what?**

1. B. (draw) **2.** A. **3.** Answer may vary. **4.** Yes **5.** Yes

✓ **Assessment 1**

1. b. Area of plates, dielectric & distance between the plates **2.** b. No
3. c. Michael Faraday **4.** a. Voltage applied & capacitor's physical characteristics
5. d. All of the above mentioned.

		Capacitance	Potential Difference	Charge
Size	Increase	Increase	Increase	Increase
	Decrease	Decrease	Decrease	Decrease
Potential Difference	Increase	Decrease	Increase	Increase
	Decrease	Increase	Decrease	Decrease
Charge	Increase	Increase	Increase	Increase
	Decrease	Decrease	Decrease	Decrease

✓ **Assessment 2**

1. (a) $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{2.0\,F} + \frac{1}{3.0\,F}$

$= \frac{3+2}{6} = \frac{15}{6} = \frac{6}{15} = 1.2\ F$

(b) Q= CV

=1.2 F x 100 V= 120 C

(c) C= $\frac{120C}{100V}$= 1.2 V

2. (a) $C_T = C_1 + C_2$=2.0 F+ 3.0 F= 5

(b) $C = \frac{500C}{100V} = 5V$

(c) Q=CV

= 5.0F x 100 V

4. $V_{AB} = V_B - V_A$

= 100 V – 46 V

= 54 V

3. (a) parallel

$C_T = C_1 + C_2 + C_3 + C_4 + C_5$

=10.0F+10.0F+10.0F+10.0F+10.0F

= 50.0F

(b) series

$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} + \frac{1}{C_5}$

$= \frac{1}{10.0F} + \frac{1}{10.0F} + \frac{1}{10.0F} + \frac{1}{10.0F} + \frac{1}{10.0F}$

$= \frac{1+1+1+1+1}{10.0F} = \frac{5}{10F} = \frac{10F}{5} = 2.0F$

(c) parallel to series

$C_T = C_1 + C_2 + C_3$= 10.0F+10.0F+10.0F

= 30.0F

$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} = \frac{1}{10.0F} + \frac{1}{10.0F}$

$= \frac{1+1}{10.0F} = \frac{2}{10.0F} = \frac{10.0F}{2} = 5.0F$

Combine: $C_T = C_1 + C_2$

= 30.0 F + 5.0 F

= 35.0 F

ABOUT THE AUTHOR

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She was studying her Master's Degree in Education major in General Science at Central Philippines State University at Kabankalan, Negros Occidental. Currently, she is a Teacher 1 at Jimalalud National High School of Jimalalud District in the Division of Negros Oriental.