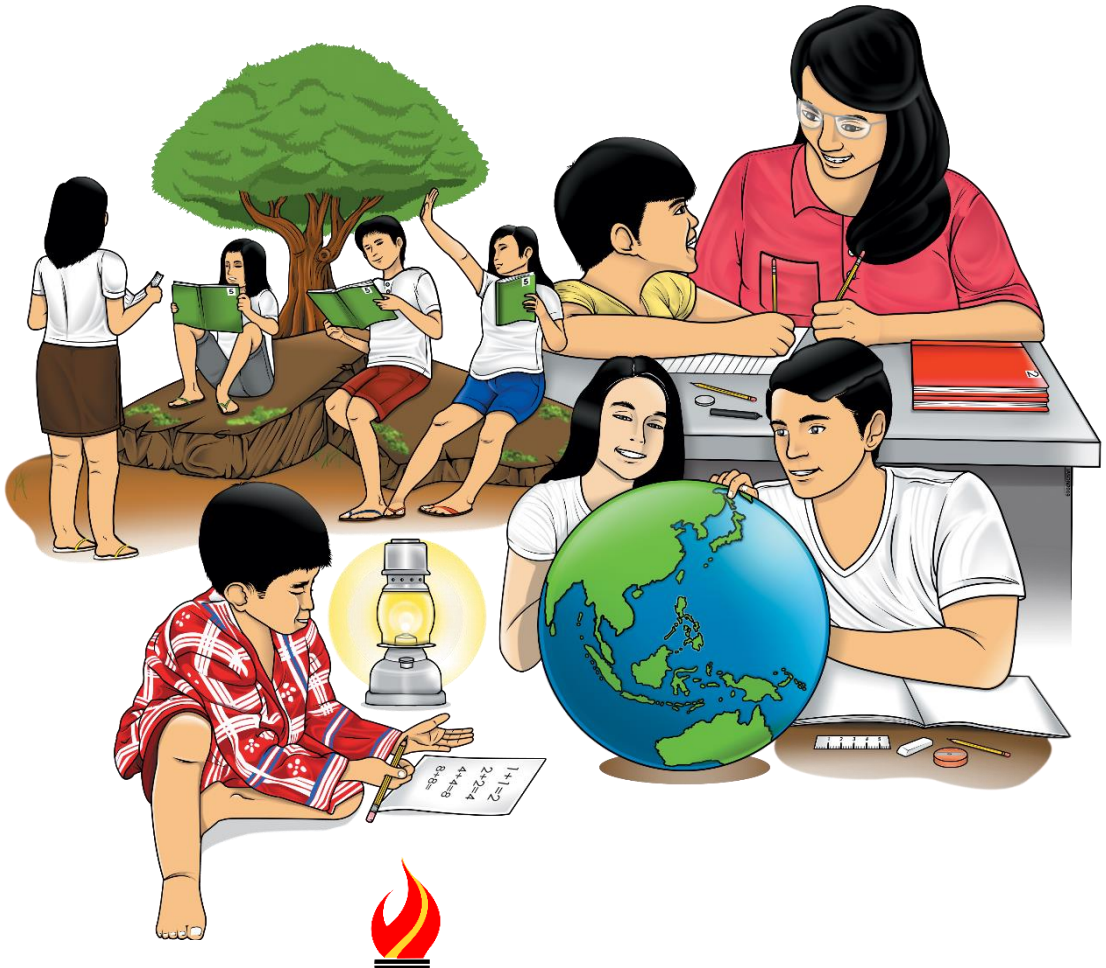
Senior High School

DepED
DEPARTMENT OF EDUCATION

Physical Science

Quarter 1 – Module 2:
Exploring Polarity of Molecules and its Properties



ALTERNATIVE DELIVERY MODE
ADM

Physical Science
Alternative Delivery Mode
Quarter 1 – Module 2: Exploring Polarity of Molecules and its Properties
First Edition, 2020

Published by the Department of Education
Secretary: Leonor Magtolis Briones
Undersecretary: Diosdado M. San Antonio

Development Team of the Module

Authors: Beverly Joy O. Lorenzo

Editors: Joey H. Villanueva, Arlene C. Malaybalay

Reviewers: Tommy R. Rico, Emiterio D. Macarubbo, Maricris N. Surigao

Illustrator: Daniel A. Lorenzo

Layout Artist: Justine C. Montoya

Management Team: Wilfredo E. Cabral, Director IV
Jennifer Vivas, CLMD Chief
Dennis M. Mendoza, Regional EPS in-charge of LRMS
Micah S. Pacheco, Regional ADM Coordinator
Jocelyn M. Aliñab, CID Chief
Tommy R. Rico, Division in-charge of LRMS
and Division ADM Coordinator

Department of Education – National Capital Region

Office Address: Misamis St., Bago Bantay, Quezon City
Telefax: 02-929-0153
E-mail Address: depedncr@deped.gov.ph

Senior High School

Physical Science

Quarter 1 – Module 2:

Exploring Polarity of Molecules and its Properties

DepED
DEPARTMENT OF EDUCATION

Introductory Message

For the facilitator:

Welcome to Physical Science Grade 11/12 Alternative Delivery Mode (ADM) Module on the Polarity of Molecules and its Properties!

This module was collaboratively designed, developed, and reviewed to assist the teachers/facilitators in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners in guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st - century skills while taking into consideration their needs.

In addition to the material in the main text, you will also see this box in the body of the module:

Notes to the Teacher

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator, you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to Physical Science 11/12 Alternative Delivery Mode (ADM) Module on the Polarity of Molecules and its Properties!

Our hands are the most represented parts of the human body. It is often used to depict skill, action, and purpose. With our hands, we create, accomplish and learn. Hence, you are capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be able to process the contents of the learning resource while being an active learner.

This module has the following parts:

 ***What I Need to Know***	This will give you an idea of the skills or competencies you are expected to learn in the module.
 ***What I Know***	This part includes activity that will check what you already know about the lesson. If you get all the correct answer (100%), you may decide to skip this module.
 ***What's In***	This is a brief drill or review to help you link the current lesson with the previous one.
 ***What's New***	In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity, or a situation.
 ***What is It***	This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.
 ***What's More***	This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.
 ***What I Have Learned***	This includes questions or blank sentences/paragraphs to be filled in to process what you learned from the lesson.
 ***What I Can Do***	This section provides an activity that will help you transfer your new knowledge or skills into real-life situations.

	***Assessment***	This is a task which aims to evaluate your level of mastery in achieving the learning competency.
	***Additional Activities***	In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned.
	***Answer Key***	This contains answers to all activities in the module.

At the end of this module you will also find:

References	This is a list of all sources used in developing this module.

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don't forget to answer *What I Know* before moving on to the other activities in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and in checking your answers.
5. Finish the task at hand before proceeding to the next activity.
6. Return this module to your teacher/facilitator once done.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain a deep understanding of the relevant competencies. You can do it!

What I Need to Know

This module was designed and written with you in mind. It aims to help you master the principles governing polarity of molecules and its properties. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course.

The module consists of only one lesson:

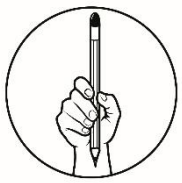
- Lesson 1 – Exploring Polarity of Molecules and its Properties

After going through this module, you are expected to:

1. Compare and contrast polar and non-polar molecule;
2. Identify the polarity of a molecule based on its structure; and
3. Appreciate the importance of different molecules in relation to its polarity by citing examples.

Notes to the Teacher

This module provides learning activities which encourages self-directed learning. Moreover, your role is to facilitate the learning process by providing a clear understanding of how to maximize the use of this module, monitor the development of our learners, scaffold the acquisition of learning to achieve target mastery level, and provide positive feedback regarding their progress.



What I Know

DIRECTIONS: Read each question carefully. Choose the letter of the best answer. Write your answer on a separate sheet of paper.

____1. Which of the following statement is **TRUE** about water?

a. It is a polar molecule
b. It is a non-polar molecule
c. It is both polar & non-polar
d. It has no polarity

____2. Which of the following will be the solvent if a non-polar substance dissolves in an unknown liquid?

a. Non-polar
b. Polar
c. Water
d. All of the above

____3. Which of the following shapes is most likely form of a non-polar molecule?

a. Asymmetric linear
b. Bent
c. Square planar
d. Pyramidal

____4. Which of the following is an example of a non-polar molecule?

a. CO_2
b. H_2O
c. NH_3
d. SO_2

____5. Which of the following is an example of a polar molecule?

a. HCl
b. BF_3
c. CCl_4
d. XeF_4

Lesson 1 Exploring Polarity of Molecules and its Properties

"Three things about water affect almost all of cooking. First are the hydrogen bonds, that is why it has an incredibly high boiling point. Another is that it's a polar molecule, so that it dissolves a lot of things, and there are things that won't mix with it…"

–Nathan Myhrvold

What's In

Directions: Based on your understanding of the formation of heavier elements during stellar nucleosynthesis, complete the table below by writing the reactants and chemical equations of the following elements.

Reactant 1	Reactant 2	Atomic #	Mass #	Chemical Equation	Product
Helium					Ti
Helium					Ar
Helium					Si
Helium					Cr
Helium					Mg

What's New

Activity Objective

Investigate the solubility and miscibility of several substances using water as the solvent. Describe what happens at the molecular level for each setup. Lastly, identify the polarity of the substances based on the result of each setup.

Materials: 5 plastic cups half-filled with water, 5 ml of denatured alcohol, 5 ml of cooking oil, 5 ml of soy sauce, 5 ml of ethyl alcohol, and 5 ml of shampoo.

Safety Guidelines:

1. Perform this activity on a clean table and with complete materials.

2. Follow the given procedures and do not deviate from the instructions.

3. Clean and dispose of the materials properly after the activity.

Instructions:

Fill each cup halfway with water, then add 5 ml of each substance to each cup. Observe and record your findings.

PREDICTION	OBSERVATION	EXPLANATION

Guide Questions:

1. Which of the following substances are miscible with water? Explain.
2. Explain why some substances do mix while others don't.

What is It

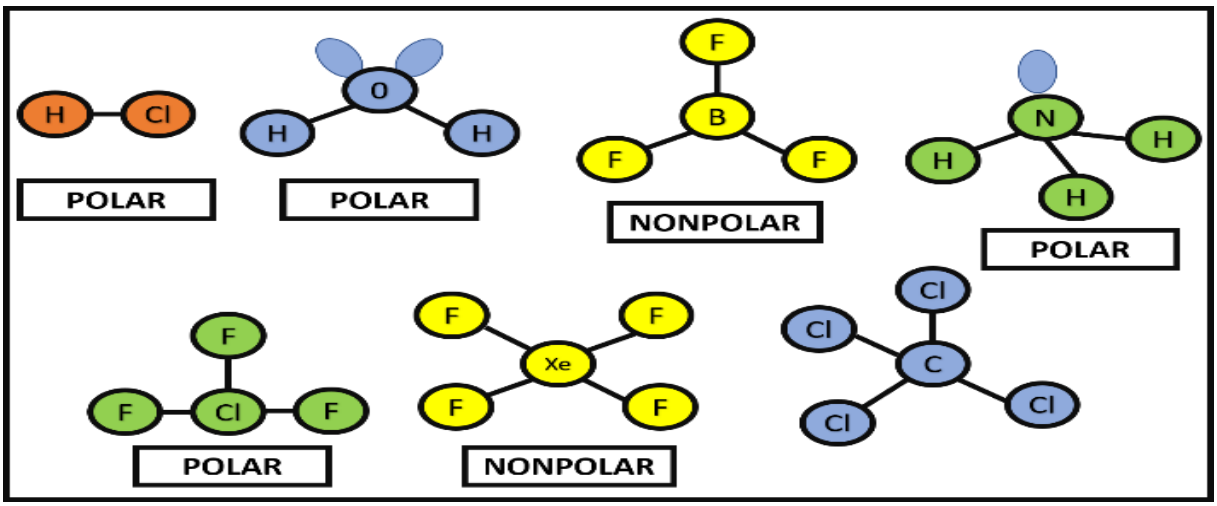
Polarity of Molecules

Polarity refers to having a dipole, that is, a positive and a negative end. Polarity is dictated by the distribution of electrons in the molecule; either the electrons are equally distributed or unevenly scattered throughout the molecule. Molecules can be classified as polar or nonpolar. Polarity is a physical aspect of a molecule that affects and influences the behavior of a molecule. Generally, the polarity of a molecule can be predicted from its shape (refer to the image next page).

When electrons in a polar covalent bond are unequally shared between two bonded atoms, it causes partial positive and negative charges. One example of this is hydrochloric acid, where electrons are more concentrated on the chlorine atom, being more electronegative than hydrogen. This separation of the charges is responsible for its polarity.

Dipole moment is a quantity that describes the polarity of a bond in a molecule. In more complex molecular shapes, if the dipole moments do not add up to zero or do not cancel out, a net dipole moment is present, making the molecule polar. A polar molecule results when a molecule contains polar bonds in an asymmetrical arrangement. Example here are bent (H2O), trigonal pyramidal (NH_3), T-shape (ClF_3).

If the dipole moments do cancel out, the molecule is non-polar. Carbon tetrachloride, CCl4 is one examples. Even if the C-Cl bonds are polar, their tetrahedral arrangement allows the bond dipoles to cancel each other. Other shapes under this category can be symmetrical linear (CO_2), trigonal planar (BF_3), square planar (XeF_4).



Polarity of Molecules and Its Properties

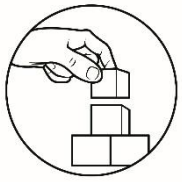
Properties of different molecules can be attributed to their polarity. One of the most common manifestations of these molecular properties is solubility and miscibility. Solubility refers to the ability of a substance (solute) to dissolve in another substance (solvent). On the other hand, miscibility refers to the ability of two substances, usually liquids, to mix in all proportions. [Note: In advanced chemistry courses, the term *miscibility* may also be used for solids and gases.]

Polarity has a direct effect on solubility and miscibility. Liquids tend to be miscible with liquids of a similar polarity. That is, polar is miscible with polar, nonpolar with nonpolar liquids. This is due to the attractive and repulsive forces between molecules in the mix. Remember, concerning polarity, structure, and properties of different molecules, the general rule “like dissolves like” and “like mixes well with like”. The practical application of this principle is when different substances mix well due to their similar polarity. One notable example is that vinegar mixes well with water since both water and vinegar are polar substances.

Boiling point is the temperature at which a liquid turns into a gas. There are several factors that influence the boiling point of a substance, but here, we focus on the polarity of its molecules. Substances have varied boiling points due to the differences in their respective molecular polarity.

How does polarity of molecules affect the boiling point of a substance? The greater the polarity of the molecules in the substance, the greater their forces of attraction between molecules, the greater the energy needed to separate them into a gaseous form, and, therefore, the higher its boiling point. The molecules in water, for example, are held together by strong H-bonds (hydrogen bonds), which results in its

very high boiling point (100°C). In contrast, non-polar substances usually have relatively lower boiling points because of weaker forces of attraction among the molecules.



What's More

Activity 1

Properties of Polarities

Directions: Explain the different molecular properties below regarding your understanding of molecular polarity.

Property	Explanation
Solubility	
Boiling Point	
Miscibility	

Activity 2

Molecular Doodle

Directions: Illustrate the Lewis dot structures, name the shape of the molecule, and identify whether the following molecules are polar or nonpolar based on structure.

Molecule/Compound	Lewis Dot Structure	Shape	Polarity
$AlCl_3$			
H_2O			
N_2O			
HF			
PCl_3			
CO_2			
HCN			
CH_4			
SO_2			

What I Have Learned

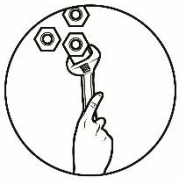
efers to having a dipole, that is, a positive and a negative end. The term may be applied to a bond between atoms in a molecule, or to a whole molecule. In a polar bond, the electron pair is unevenly pulled between the atoms. In a non-polar bond, the electron pair is more or less evenly distributed. Simple molecules with non-polar bonds are non-polar molecules. Those with polar bonds are polar molecules.

2. In more complex molecules, their polarity depends on the general distribution and type of bonds (whether polar or non-polar) present. Polarity can be visualized through molecular shapes or quantified by using dipole moments.

3. Molecules are either symmetrical or asymmetrical. Asymmetry refers to molecule having no axis of symmetry and that the original state and rotated state is distinguishable from one another.

4. Symmetry refers to a property of molecule whose structure does not change if you turn its axis of symmetry in its original state, and the rotated state is indistinguishable from one another.

5. Miscibility refers to the capacity of a liquid to be mixed with other liquids to form a homogenous substance. Miscibility is influenced by the polarity of the substances attempted to be mixed. *[Miscibility may also be used in relation to solids and gases, but this use is beyond the scope of this lesson]*.



What I Can Do

Directions: Based on your understanding of the topics presented in this module, briefly answer the following questions regarding the structure and properties of polar molecules.

1. Which substances available in your home are miscible in water? Explain.
2. Classify ten substances/compounds present in your surrounding as to their polarity?
3. Relate the polarity of the listed substances and compounds to their properties?
4. How did your understanding of polarity and its property change your perception of different substances and compounds available around you?

Assessment

DIRECTIONS: Read each question carefully. Choose the letter of the best answer. Write your answer on a separate sheet of paper.

____1. Which of the following will be the solvent if a nonpolar substance dissolves in an unknown liquid?

a. Ionic
b. Non-polar
c. Polar
d. Water

____2. Which of the following is an example of non-polar molecule?

a. O_3
b. N_2
c. $ClBr_3$
d. SO_2

____3. Which of the following is a common structure of a non-polar molecule?

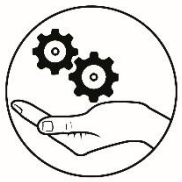
a. Bent
b. Trigonal pyramidal
c. Linear
d. Trigonal planar

____4. Which of the following is TRUE about boiling point of polar molecules?

a. Generally high boiling point
b. Generally low boiling point
c. Boiling point cannot be determined
d. Similar non-polar molecules

____5. Which of the following is TRUE about H_2O?

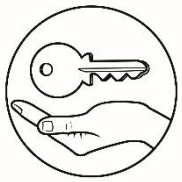
a. Non-Polar
b. Polar
c. Low boiling point
d. Linear Structure



Additional Activities

Directions: Complete the table below, based on your understanding of the polarity of molecules, their structure, and their properties.

Molecule	Molecular Shape	Polarity	Water Soluble?	Miscible on Water?	High Boiling Point?
CH_4					
SO_2					
N_2					
O_2					
O_3					
PCl_3					
H_2O					
HF					



Answer Key

What I Know

1. A
2. A
3. C
4. A
5. A

Assessment

1. B
2. B
3. D
4. A
5. B

What's More

Activity 2

Molecule/Compound	Lewis Dot Structure	Shape	Polarity
$AlCl_3$		Trigonal Planar	Nonpolar
H_2O		Bent	Polar
N_2O		Linear	Polar
HF		Linear	Polar
PCl_3		Trigonal Pyramidal	Polar
CO_2		Linear	Nonpolar
HCN		Linear	Polar
CH_4		Tetrahedral	Nonpolar
SO_2		Bent	Polar

Additional Activity

Molecule	Molecular Shape	Polarity	Water Soluble?	Miscible on Water?	High Boiling Point?
CH_4	TETRAHEDRAL	NONPOLAR	NO	NO	LOW
SO_2	BENT	POLAR	YES	YES	HIGH
N_2	LINEAR	NONPOLAR	NO	NO	LOW
O_2	LINEAR	NONPOLAR	NO	NO	LOW
O_3	BENT	POLAR	YES	YES	HIGH
PCl_3	TRIGONAL PYRAMIDAL	POLAR	YES	YES	HIGH
H_2O	BENT	POLAR	YES	YES	HIGH
HF	LINEAR	POLAR	YES	YES	HIGH

References

Bayo-ang, Roly., Coronacion, Maria Lourdes., Jorda, Annamae., & Restubog, Anna Jamille. *Physical Science for Senior High School* (1st edition). Quezon City: Educational Resources Corporation, 2017.

DepEd. *K to 12 Senior High School Core Curriculum – Physical Science Curriculum Guide*. Learning Resource Portal, 2020. https://lrmds.deped.gov.ph/detail/14519

DepEd. *Most Essential Learning Competencies (MELC)*. Teach Pinas, 2020. https://www.teachpinas.com/k-12-most-essential-learning-competencies-melc/

Malenab, Ryan., Catchiller, Gerry., Vibal, Pablito., & Martinez, Felipe. *Essentials of Physical Science*. Quezon City: Rex Bookstore, 2016.

Punzalan, Jervy., & Monserrat, Richard. *Science in Today's World for Senior High School: Physical Science*. Quezon City: Sibs Publishing House, 2016.

For inquiries or feedback, please write or call:

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph