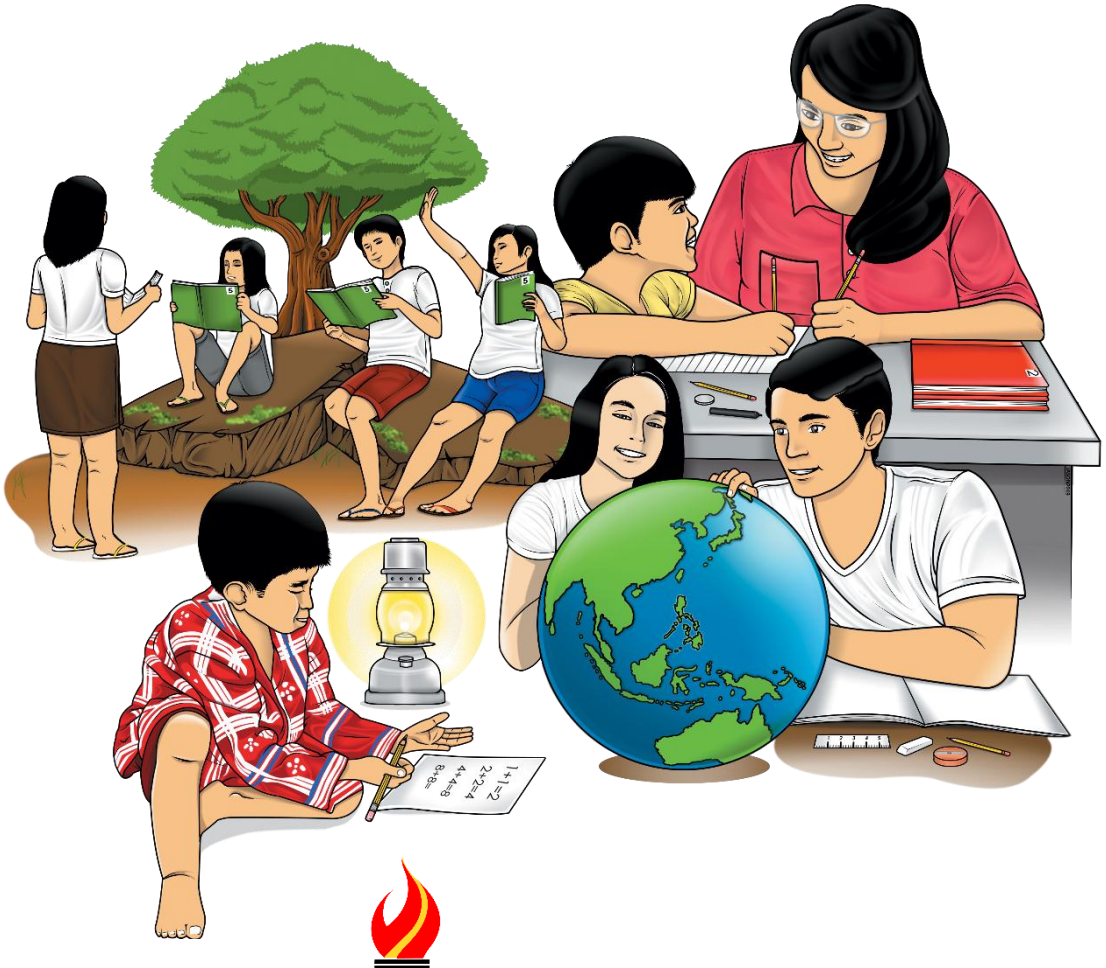
Senior High School

DepED
DEPARTMENT OF EDUCATION

Physical Science

Quarter 1 – Module 4:
Polarity of Molecules and Its Properties



ALTERNATIVE DELIVERY MODE
ADM

Personal Development
Alternative Delivery Mode
Quarter 1 – Module 4: 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

Writers: Bayani T. Vicencio, Valeria Amor C. Rosita, Bayani T. Vicencio

Editors: Priscilla D. Domino, Gertrudes L. Malabanan

Reviewers: Rogelio D. Canuel, Elmer C. Bobis, Gertrudes L. Malabanan, Ronaldo V. Ramilo, Dennis B. Masangcay, Glory R. Perez, Cirilo M. Bathan Jr.

Illustrator: Geselle A. Teaňo

Layout Artist: Elsie R. Reyes

Management Team: Francis Cesar B. Bringas
Job S. Zape, Jr.
Ramonito Elumbaring
Reicon C. Condes
Elaine T. Balaogan
Fe M. Ong-ongowan
Rogelio F. Opulencia
Rhina O. Ilagan
Edna U. Mendoza
Ronaldo V. Ramilo

Printed in the Philippines by _____

Department of Education – Region 4A CALABARZON

Office Address: Gate 2 Karangalan Village, Brgy. San Isidro, Cainta, Rizal
Telefax: 02-8682-5773/8684-4914/8647-7487
E-mail Address: lrmd.calabarzon@deped.gov.ph

Senior High School

Physical Science

Quarter 1 – Module 4:
Polarity of Molecules and Its Properties

DepED
DEPARTMENT OF EDUCATION

Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

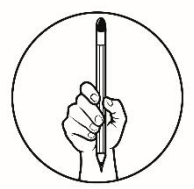
This module was designed and written with you in mind. It is here to help you master the concept of polarity of molecules. The scope of this module permits it to be used in different learning situations. The language used recognizes the varied vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

The module is divided into three lessons, namely:

- Lesson 1 – Properties of Molecules based on its Polarity

After going through this module, you are expected to:

1. define solubility, miscibility and polarity;
2. identify the different types of intermolecular forces of attraction;
3. explain how polarity of molecules related to its properties



What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following is TRUE of polar molecules?

   i. Have high boiling point
   ii. Have high melting point
   iii. low surface tension
   iv. High vapor pressure

   a. I only
   b. I and II only
   c. II and III only
   d. IV only

2. Which of the following intermolecular forces of attraction (IMFA) is arranged from strongest to weakest?
   a. H- bonding – dipole-dipole – London forces
   b. London-forces – dipole-dipole – H-bonding
   c. Dipole-dipole – London forces – H- bonding
   d. H-bonding – London forces – dipole-dipole

For numbers 3-6, consider the choices below:

a. boiling point
b. solubility
c. viscosity
d. vapor pressure

3. Which among the choices refers to the resistance of a liquid to flow?
4. What term refers to the temperature at which the liquid starts to boil?
5. The pressure exerted by a substance when in its gaseous state is known as what?
6. What is the ability of a substance to be dissolved in another substance to form a solution?
7. Viscosity is defined as the resistance of a substance to flow. Which following is NOT an example of a viscous substance?
   a. blood
   b. honey
   c. syrup
   d. vinegar

8. Which of the following is NOT TRUE about water? It _____
    a. becomes denser when freezes
    b. has high surface tension
    c. has high boiling point
    d. has low viscosity
9. Miscibility is the ability of a substance to mix with another substance. Which of the following substances will most likely be miscible in water?
    a. benzene (C_6H_6)
    b. ethyl alcohol (C_2H_6O)
    c. carbon tetrachloride (CCl_4)
    d. toluene ($C_6H_5CH_3$)
10. Which of the following will dissolve in polar solvents?
    a. ionic compounds and polar covalent compounds
    b. nonpolar solvents and covalent compounds
    c. nonpolar solvents and ionic compounds
    d. all of the above

True or False: Write T if the statement is true, otherwise write F.

11. The floating of ice on liquid water is an indication that ice has higher density than liquid water.
12. The volatility of a substance depends on its vapor pressure.
13. Alcohol is less volatile than vinegar.
14. Between water (H_2O) and carbon tetrachloride (CCl_4), water has higher boiling point.
15. Vapor pressure is inversely proportional to the strength of intermolecular forces present.

Lesson 1 Polarity of Molecules Based on Its Polarity

From the previous module, you learned how to determine the polarity of bonds using the concept of electronegativity. Also, you learned that polarity of molecules is affected by both the polarity of bonds and its molecular shape or geometry.

What's In

Let us have some warm up exercise for our nerve cells before we proceed to the presentation of our lesson. You will perform a simple activity that will help you recall some basic concepts related to polarity of molecules. Have some fun!

Notes to the Teacher

There are numerous terms or concepts being studied in science and most of them are either difficult to spell out or pronounce. As teachers, we should think of engaging activities that would motivate our students to learn and at the same time increase their vocabulary skills and spelling ability. Below is an example of an activity you could employ in your class.

WORD CRYPTOGRAM

Directions: Unscramble the letters by placing the correct letter sequence in the shaded boxes to come up with the correct answer for each number. Use the numbered boxes to complete the answer to the riddle below.

1.

L	E	C	M	O	U	L	E
1				5	6		

2.

O	P	A	L	R		O	D	N	B
		3		9					

3.

O	N	L	E		A	P	I	R
	2		14			8		16

4.

N	A	R	O	P	O	L	N		B	D	O	N
					7					12		

5.

A	C	E	G	T	R	O	T	L	I	Y	E	I	T	E	N	V
11							15	4	10							17

RIDDLE: It shows the three-dimensional arrangement of bonding groups of atoms around a central atom.

1	2	3	4	5	6	7	8	9		10	11	12	13	14	15	16	17

Can you define the following words/terms that you have decoded?

What's New

SCI-wonder How, Sci-wonder Why? Isn't it SCImazing?

The picture below illustrates what happens when oil is being added to water. What have you noticed? Does it mix well? Or they form separate layers? Yes, you are right! The mixture forms two distinct layers, the oil on top of the water. But have you ever wondered why these two substances do not mix well despite of stirring and heating?

How does the concept of polarity can be used in explaining the occurrence of this phenomenon? How will you relate the principle of "likes dissolves like" in this situation? Are oil and water miscible or immiscible to each other?

Before you answer the above questions, you may prepare your favorite snack first so that you will have enough energy as we explore more into this topic.

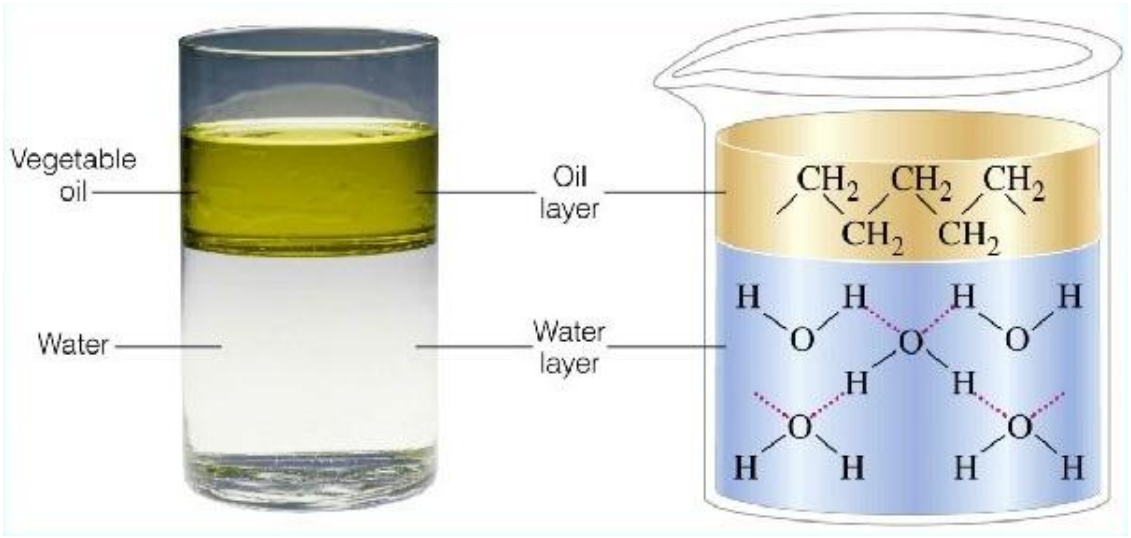
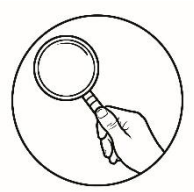


Figure 1. Water and oil mixture forming a bilayer (2 separate layers)



What is It

A. Polarity, Solubility, and Miscibility

One of the practical applications of polarity of molecule in real-life scenario is manifested on the solubility and miscibility of substances to form solution.

Solubility is defined as the ability of a solid substance to be dissolved in a given amount of solvent while ***miscibility*** is the ability of the two liquids to combine or mix in all proportions, creating a homogenous mixture.

The general rule to remember about the solubility and miscibility of molecular compounds can be summarized in a phrase, "*like dissolves like*" or *"like mixes with like"*. This means that polar substances will only be dissolved or mixed with polar substances while nonpolar substances will be soluble or miscible with another nonpolar substance.

Now I want you to try the exercises below in order to assess how much you have understood the solubility (and miscibility) rule of substances in relation to their polarity.

Which of the following substances below will most likely mix with each other?

a. water (H_2O) and chloroform ($CHCl_3$)

b. benzene (C_6H_6) and chloroform ($CHCl_3$)

c. water (H_2O) and vinegar (CH_3COOH)

d. acetone (C_3H_6O) and toluene ($C_6H_5CH_3$)

e. carbon tetrachloride (CCl_4) and water (H_2O)

What chemistry concept did you used in answering the question above? If you answered polarity of molecules, then you are on the right track. Great job! Benzene and chloroform are both nonpolar compounds while water and vinegar are both polar compounds, thus they are miscible to each other. However, the rest is a combination of polar and nonpolar molecules and therefore will not mix and instead will form two layers even if shaken or carefully stirred.

B. Bond Strength and Physical Properties of Covalent Compounds

From the previous module, you learned the *intramolecular forces of attraction*, the attractive force that binds atoms together. In this module, you will learn another type of attractive force, the *intermolecular forces of attraction* (IMFA) which exists between molecules.

In this lesson, we will not discuss IMFA in so much detail because it will be tackled to you in the next module. We will just focus on the following salient points of IMFA and its effect on the physical properties of covalent compounds:

1. There are several types of IMFA and below they are arranged from STRONGEST to WEAKEST.
   Ion-dipole → H-bonding→ dipole-dipole→dipole-induced dipole→ London forces of attraction
2. The strength of IMFA greatly affects the physical properties of substances such as boiling point, melting point, vapor pressure, surface tension, etc.

Before we move further, try to perform the exercise below to test your ability to analyze concepts and principles that you have learned from the discussion.

Put a check (/) to those properties applicable for polar molecule.

____1. High boiling point
____2. Low boiling point
____3. High melting point
____4. Low melting point
____5. High volatility
____6. Low volatility
____7. High vapor pressure
____8. Low vapor pressure
____9. High surface tension
____10. Low surface tension
____11. H-bonding & dipole-dipole present
____12. London dispersion is present

How well did you perform in this exercise? Continue reading for you to find out the correct answers for this activity.

From the above discussion you learned that there are several types of IMFA and their relative strength as compared to other types. Strong intermolecular forces tend to yield solids and liquids while weak intermolecular forces favor formation of gases.

Table 1 shows the comparison of the various types of IMFA while table 2 shows the physical properties of polar and nonpolar molecules as affected by the type of IMFA present.

Table 1. Summary of Types of Intermolecular Forces of Attraction (IMFA)

Type of IMFA	*Interacting Substances*	*Examples*
Ion-dipole	Ion (cation or anion) and a polar molecule	Sodium chloride (NaCl) dissolved in water (H_2O); Calcium ion (Ca^{2+}) and Phosphorus trichloride (PCl_3)
Hydrogen bonding	Polar molecules containing H chemically bonded to a small and highly electronegative nonmetal atom such as N, O, and F	Water (H_2O), ammonia (NH_3), methanol (CH_3OH)
Dipole –dipole	Polar molecules	Fluoromethane (CH_3F) and Dihydrogen sulfide (H_2S); Hydrochloric acid (HCl);
Dipole-induced dipole	Polar and nonpolar molecules	Hydrogen iodide (HI) and methane (CH_4)
London forces	All substances and solely for nonpolar molecules and noble gases	diatomic oxygen (O_2), diatomic nitrogen (N_2), Helium (He) gas, diatomic bromine (Br_2)

Table 2. General Properties of polar and nonpolar molecules

Polar molecules	**Nonpolar molecules**
• IMFA type: H-bonding and dipole-dipole	• IMFA type: London dispersion
• exist as solids or liquids at room temperature	• exist as gases at room temperature
• High boiling point	• Low boiling point
• High melting point	• Low melting point
• High surface tension	• Low surface tension
• Low vapor pressure	• High vapor pressure
• Low volatility	• High volatility
• Soluble in water	• Insoluble in water

Let us define the physical properties of substances:

A. *Boiling point:* temperature at which the vapor pressure and atmospheric pressure of a liquid substance are equal. IMFAs can be used to predict relative boiling point of a substance. The stronger the IMFA, the higher the boiling point. For example, methyl alcohol (CH_3OH; BP= 64.7^0C) has higher boiling point than methane (CH_4, BP = -161.6^0C) since the IMFA present in methyl alcohol is H-bonding which is stronger than London dispersion present in methane.

B. *Melting point:* temperature at which solid becomes liquid. At this point, the solid and liquid phases exist in equilibrium. Similar to boiling point, melting point of a substance increases as the intermolecular force of attraction becomes stronger. Thus, methy alcohol (MP=-97.6^0C) with H-bonding has higher melting point than methane (MP= -182^0C) which has a weaker London dispersion

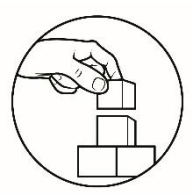
C. *Surface tension:* is measured as the energy required increasing the surface area of a liquid by a unit of area. Surface tension allows the small insects like water strider to walk on water and dried fallen leaf floating on top of the water.

D. *Viscosity:* the resistance of the liquid to flow. Honey, syrup and oil are examples of viscous substances since they do not freely flow compared to water.

E. *Vapor pressure:* pressure exerted by a substance in its gaseous state. A liquid with weak intermolecular forces evaporates more easily and has a high vapor pressure. This explains why acetone (C_3H_6O) evaporates easily than water since acetone has a dipole-dipole force which is weaker than H-bonding present in water.

F. *Volatility:* measures the rate at which a substance vaporizes (changes from liquid to gas). Substances like acetone, ethyl alcohol, ethyl alcohol are more volatile than water since they have weaker intermolecular forces of attraction.

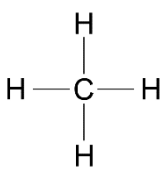
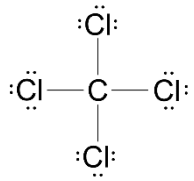
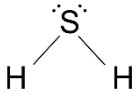
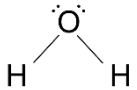
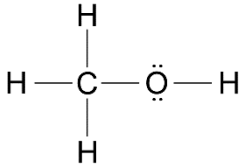
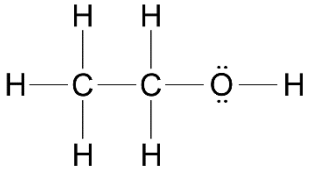
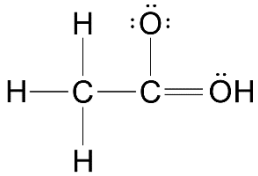
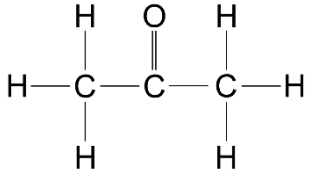
In the simplest sense, boiling point, melting point, viscosity and surface tension increase as the strength of intermolecular forces increases. On the other hand, vapor pressure and volatility decrease with increasing strength of IMFA. London dispersion forces increase as the molecular mass of a substance increases. Unlike in H-bonding, as the molar mass increases, the boiling point, melting point, viscosity and surface tension decrease.



What's More

Activity 1. Strength of IMFA and Physical Properties of Covalent Compounds

For each pair of molecules, identify the one with the higher boiling point (BP), melting point (MP), viscosity (V), surface tension (ST) and vapor pressure (VP). Briefly explain your choice.

	BP	MP	V	ST	VP
 Methane, CH_4  carbon tetrachloride, CCl_4					
 Dihydrogen sulfide, H_2S  water, H_2O					
 Methanol, CH_3OH  ethanol, CH_3CH_2OH					
 Acetic acid, CH_3COOH  acetone, CH_3OCH_3					

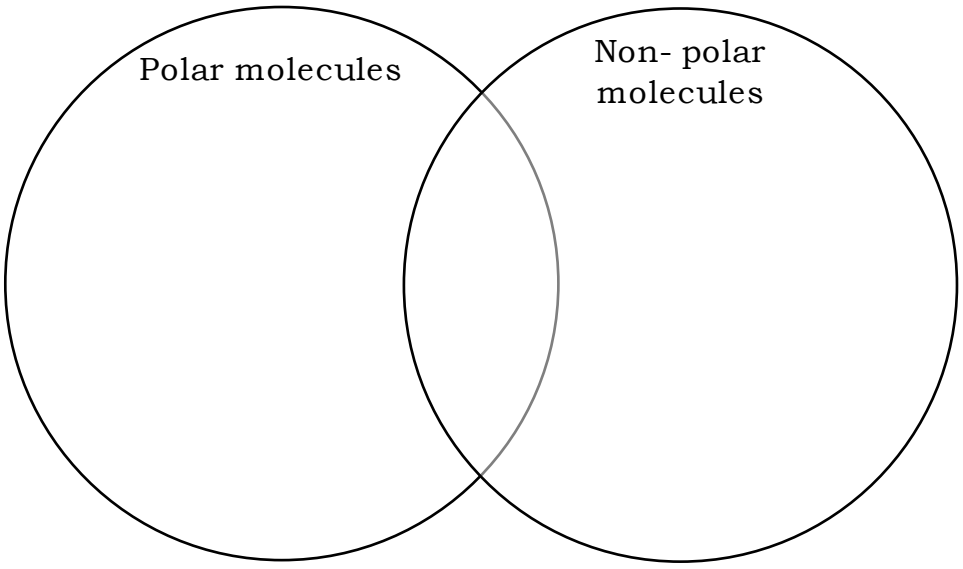
Adapted from Punzalan and Monserat (2016)

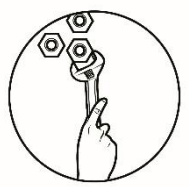
What I Have Learned

1. Determine if each statement relates to intramolecular or intermolecular forces of attraction. You may put your answers to the table below.
    a. exist within each molecules
    b. exist between molecules
    c. strong force
    d. weak force
    e. London forces, dipole-dipole forces, and hydrogen bonding
    f. covalent and ionic bonds
    g. responsible for physical properties of a substance
    h. responsible for chemical properties of a substance
    i. chemical bonds
    j. attractive force

INTRAmolecular forces of attraction	INTERmolecular forces of attraction

2. Using the Venn diagram below, compare and contrast polar and non-polar molecules based on its physical properties.





What I Can Do

A. Go to your kitchen and obtain the following materials: 2 clear containers (glass or disposable cups), water, vinegar and oil. Fill one glass with half full of water. Then slowly add ¼ cup of vinegar. Record you observation. In another glass, fill it with half-full of vinegar then gently add ¼ cup of oil. Using the concept of bond polarity and solubility, explain why water (H_2O) and vinegar are miscible, but vinegar and oil are immiscible.

B. Remove the solidified butter from the refrigerator. Obtain ¼ slice of butter and place it in a plate. Set aside at room temperature until the butter becomes melted. Now, place the melted butter inside the refrigerator and wait until it resolidifies. Using the concept of intermolecular forces of attraction, explain why butter melts at room temperature but solidifies when refrigerated.

C. While arranging the vegetables and fruits bought by your mom in the grocery store, you remembered that your Biology teacher taught you that most organisms like onions, tomatoes, apples, and oranges in your kitchen are made up of cells, and each cell is bounded by a plasma membrane. Below is the Fluid Mosaic Model which describes cell membrane as a fluid combination of phospholipids, cholesterol, proteins and carbohydrates. Based on what you have learned from this module, explain the importance of polarity of molecules on the structure and biological role of cell membrane.

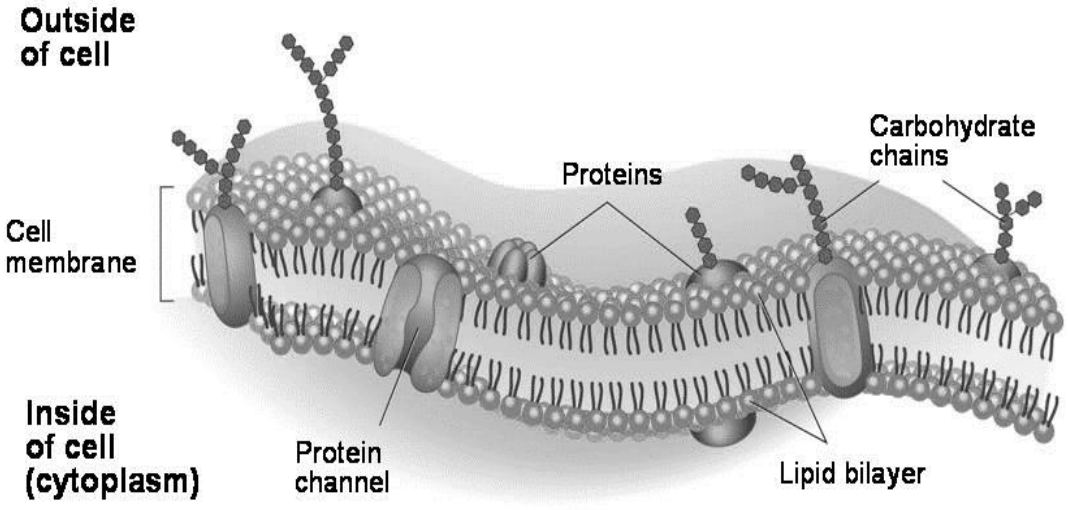


Figure 2. Structure of Cell Membrane

Assessment

Multiple Choice: Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following (intermolecular forces of attraction) IMFAs is considered as the weakest?
    a. Ion-dipole
    b. H-bonding
    c. Dipole-dipole
    d. London forces

2. The boiling point of water is greater than dihydrogen sulfide (H_2S). This is because of the presence of what type of intermolecular forces of attraction?
    a. Ion-dipole
    b. H-bonding
    c. London dispersion
    d. Dipole-dipole bond

3. Which of the following substances will dissolve most likely in water?

    I. Oil
    II. Hexane (C_6H_{14})
    III. Vinegar (CH_3COOH)
    IV. Carbon tetrachloride (CCl_4)

    a. I only
    b. I and II only
    c. III only
    d. III and IV only

4. By principle, polar molecules have a relatively high melting point than non-polar molecules because they have a stronger intermolecular force. Which of the following molecules has high melting point?
    a. BCl_3
    b. CCl_4
    c. $BeCl_2$
    d. $CHCl_3$

5. It is the energy required to increase the surface area of a substance by a unit amount.
    a. Density
    b. Viscosity
    c. Vapor pressure
    d. Surface tension

6. Which of the following statements is TRUE about nonpolar molecules?
    a. Have high boiling point
    b. Have high melting point
    c. Have low surface tension
    d. Have low vapor pressure

7. Which of the following substances is miscible in hexane (C_6H_{14})?
    a. Acetone (C_3H_6O)
    b. Methanol (CH_3OH)
    c. Chloroform ($CHCl_3$)
    d. Vinegar (CH_3COOH)

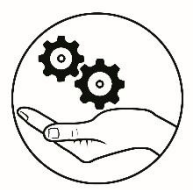
8. From the choices below, which is NOT an example of intermolecular forces of attraction?
    a. H-bond
    b. Dipole-dipole
    c. Covalent bond
    d. London forces

9. Which of the following properties has indirect relationship with the strength of IMFA?
    a. Boiling point
    b. Melting point
    c. Vapor pressure
    d. Surface tension

10. In which of the following solvents would molecular iodine (I_2) be most soluble?
    a. Water (H_2O)
    b. Vinegar (CH_3COOH)
    c. Ethyl alcohol (C_2H_5OH)
    d. Carbon tetrachloride (CCl_4)

True or False: Write T if the statement is true, otherwise write F.

11. H-bonds are broken when ice melts.
12. Molecules with H-bonds have higher boiling point than molecules with dipole-dipole bond.
13. In covalent molecules, vapor pressure decreases with decreasing strength of intermolecular forces.
14. When the attractive forces holding particles together are greater, you have to get to a higher temperature to break those forces, so the melting point is higher.
15. The strength of dispersion (London) forces tends to increase with increased molecular weight.



Additional Activities

1. Water is a colorless, transparent, odorless liquid that constitutes around 71 percent of the Earth's surface and about 60 percent of the organism's body. It plays a significant role in the survival of most organisms and in various biogeochemical process on Earth. Briefly explain why water is considered as the universal solvent.

2. Using the concept of intramolecular forces of attraction (IMFA), explain difference in boiling point and melting point of each of the following molecular substances:

Substance	**Boiling point (^{0}C)**	**Melting point (^{0}C)**
Helium gas, He	-269	-272
Methane, CH_4	-162	-184
H_2O	100	0
Ethanol, C_2H_5OH	78	-117

Answer Key

What I Know

1. C
2. A
3. C
4. A
5. D
6. B
7. D
8. A
9. B
10. A
11. F
12. T
13. F
14. T
15. F

What's More

WORD

CRYPTOGRAM

Assessment

1. D
2. B
3. C
4. D
5. D
6. C
7. C
8. C
9. C
10.
11.
12. D
13. F
14. T
15. F
16. T

What's More

1.

M	O	L	E	C	U	L	E
1				5	6		

2.

P	O	L	A	R		B	O	N	D
		3		9					

3.

L	O	N	E		P	A	I	R
	2		14			8		16

4.

N	O	N	P	O	L	A	R		B	O	N	D
					7					12		

5.

E	L	E	C	T	R	O	N	E	G	A	T	I	V	I	T	Y
11							15	4	10							17

6.

A	T	O	M
			13

RIDDLE

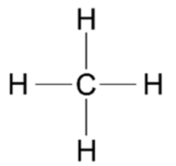
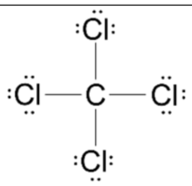
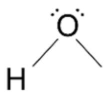
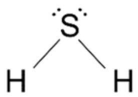
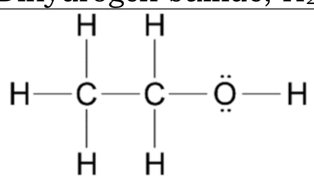
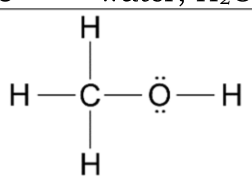
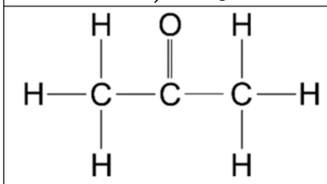
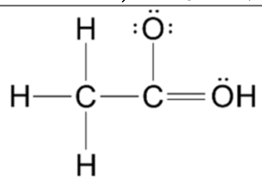
M	O	L	E	C	U	L	A	R		G	E	O	M	E	T	R	Y
1	2	3	4	5	6	7	8	9		10	11	12	13	14	15	16	17

What I have Learned

1. Distinguish intramolecular forces of attraction and intermolecular forces of attraction.
   Answer: Intramolecular forces of attraction exist within a molecule. Ionic, covalent and metallic bonds constitute the intramolecular forces of attraction. On the other hand, intermolecular forces of attraction are forces of attraction between molecules. Ion-dipole, H-bond, dipole-dipole and London forces are examples of intermolecular forces of attraction.

2. In your own words, explain the Solubility Rule.
   Answer: Solubility rule states that "like dissolves like." This means that polar solutes are soluble (miscible) only to polar solvents while nonpolar solutes are only soluble (miscible) to nonpolar solvents. Intramolecular forces exist *between* atoms *within* a molecule. Ionic, covalent and metallic bonds constitute the intramolecular forces

What's More

	BP	MP	V	ST	VP
  Methane, CH_4carbon tetrachloride, CCl_4	CCl_4 Because it is polar molecule and IMFA type is dipole - dipole which is stronger than London forces				CH_4
  Dihydrogen sulfide, H_2S water, H_2O	H_2O Because it is polar molecule and IMFA type is H-binding which is stronger than dipole-dipole				H_2S
  Methanol, CH_3OH ethanol, CH_3CH_2OH	CH_3OH Both have H-bonding but methanol has lower molar mass than ethanol				CH_3CH_2OH
  Acetic acid, CH_3COOH acetone, CH_3OCH_3	CH_3OCH_3 Both have H-bonding however acetone has lower molar mass than acetic acid				CH_3COOH

What I have Learned

3. Compare and contrast polar and non-polar molecules based on its physical properties.
Answer:

Polar molecules	Nonpolar molecules
• IMFA type: H-bonding and dipole-dipole	• IMFA type: London dispersion
• exist as solids or liquids at room temperature	• exist as gases at room temperature
• High boiling point	• Low boiling point
• High melting point	• Low melting point
• High surface tension	• Low surface tension
• Low vapor pressure	• High vapor pressure
• Low volatility	• High volatility
• Soluble in water	• Insoluble in water

4. What relationship can you derive between the strength of IMFA and the physical properties of covalent molecules?
Answer: Boiling point, melting point, viscosity and surface tension increase with increasing strength of IMFA. Vapor pressure increases with decreasing strength of IMFA. Therefore, BP, MP, V and ST are directly proportional to the strength of IMFA while VP is inversely proportional to the strength of IMFA.

What I Can Do

C. Explain the importance polarity of molecules to biological processes such as in the structure of proteins and phospholipids.
Possible answer: Proteins are macromolecules having polar and nonpolar ends which are essential for life processes to occur. It can form a long chain and it also has the ability to bend to form various shapes. The shape of proteins is affected by attraction and repulsion among its polar and nonpolar groups. Once its shape has been altered or modified, it can no longer perform its basic function. Phospholipids, on the other hand, are present in the cell membrane. It has a hydrophilic (water-loving) end and hydrophobic (water-fearing) end. When placed in water, it forms a micelle wherein its hydrophilic part has a close contact with water while its hydrophobic part is oriented inward. In this way, the cell membrane can perform its function of being selectively permeable membrane effectively.

What I Can Do

A. Using the concept of bond polarity and solubility, explain why water (H_2O) and vinegar are miscible, but vinegar and oil are immiscible.
Possible answer: Water and vinegar are both polar substances therefore they are miscible to each other. On the other hand, vinegar is polar while oil is a nonpolar substance, therefore they will not mix.

B. Using the concept of intermolecular forces of attraction, explain why butter melts at room temperature but solidifies when refrigerated.
Possible answer: Butter is composed of complex mixture of fatty acids held together by a weak attractive van der Waals interaction called London forces. The physical change of melting requires heat that disrupts the London forces of attraction between fatty acids. As the amount of heat increases, more London forces are disrupted and fats begin to vibrate, rotate and move freely. On the other hand, when you placed the butter inside the freezer, the temperature decreases and more London forces gets assembled between fatty acids thus butter becomes solid.

References

Department of Education- Bureau of Secondary Education (2003). *Lesson Plans in Science III(Chemistry)*.

CHED-PNU. (2006). Teaching Guide in Senior High School-Physical Science. Commission on Higher Education. C.P. Garcia Ave., Diliman, Quezon City. Retrieved from https://lrmds.deped.gov.og/detail/14519 last May 19, 2020

Punzalan, J.M. &Monserat, R.C. (2016). *Science in Today's World for Senior High School- Physical Science*. Sibs Publishing House, Inc. Quezon City, Philippines.

Padua, A.L., Padolina, M.C.D., Crisostomo, R.M., &Alumaga, M.J.B. (2016). *Physical Science*. Vibal Group Inc. G. Araneta Avenue, Quezon City

Santiago, K. S., & Silverio, A.A. (2016). *Exploring Life Through Science-Physical Science*. Pheonix Publishing House, Inc. Quezon Avenue, Quezon City.

Religioso, T.F., & Cordero-Navaza, D. (2017). *You and the Natural World- Physical Science*. Phoenix Publishing House, Inc. Quezon Avenue, Quezon City.
http://www.songlyrics.com/sharon-cuneta/langis-at-tubig-lyrics/Retrieved last May 25, 2020.

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