Chemistry

Unit 4: Chemical Reactions

Workbook 3

Name: _____ Period: _____

Guiding Question:

Do Now:

Important Definitions and Equations:

Notes:

The charged wand experiment provides evidence that some molecules are attracted to a charge. The most obvious explanation for this observation is that the molecules that are attached to the charged wand have some sort of charge on them.

- _____ share their electrons unevenly. They contain partial charges and are attracted to the charged wand
- _____ share their electrons evenly. They have no charge and do not respond to the wand

One end of a polar molecule has a partial positive charge and one end has a partial negative charge. It is important to stress that this charge is "partial," as opposed to the type of charge on an ion. In order to differentiate between full charges and partial charges, chemists use the symbols $\delta+$ and $\delta-$ (delta plus and delta minus) to indicate partial charges.

The partial charges on polar molecules also cause individual molecules to be attracted to one another.

- _____ are the forces of attraction that occur between molecules ("inter" means between and "molecular" means molecules)
- These attractive forces are responsible for many observable properties in polar molecules.
  - Polar substances bead up into droplets on wax paper, form meniscuses, and group together in liquids.
  - Nonpolar substances will not dissolve in polar substances. Polar molecules will group together, leaving the nonpolar substance above or below them depending on density.

Response:

12 Attractive Molecules

Attraction Between Molecules

Purpose

To observe the response of certain liquids to an electrical charge and the behavior of the same liquids as droplets

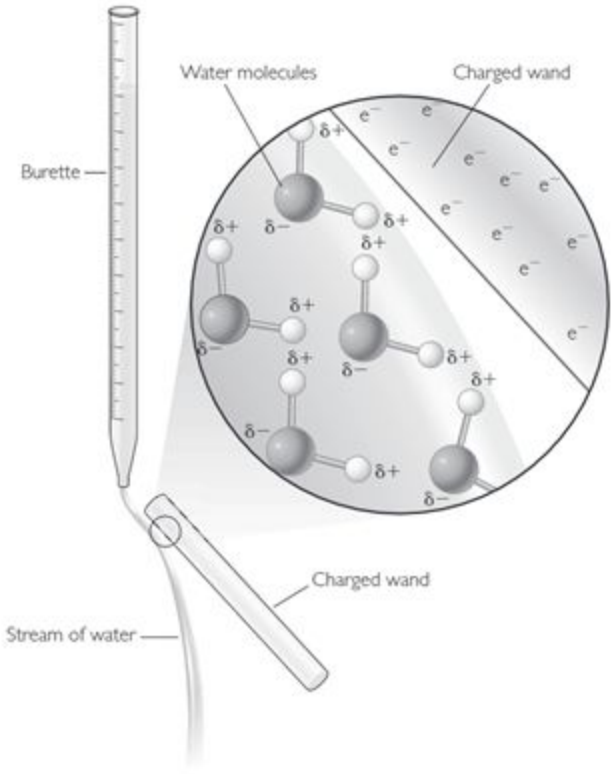
Part 1: Testing the Liquids

With your group, test the liquid at each station with a charged wand. Next place a drop of the liquid on wax paper. Enter the results in the table.

Compound	Effect of charged wand	Behavior on waxed paper
water	attracts	round drop
acetic acid		
isopropanol		
hexane		

Part 2: Analysis

1. Here's an artist's interpretation of what is happening between the water molecules and the charged wand. Write a short paragraph describing in your own words what you think is happening in the picture.

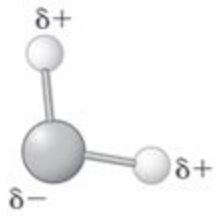


2. What evidence do you have the some of the molecules you tested may have a charge on them?

3. How do you explain any liquids that are not attracted to the charged wand?

4. How is the behavior of the droplets related to the charged wand experiment?

5. **Making Sense** If water molecules are carrying partial charge, as shown, how do you think a group of water molecules would behave toward each other? To illustrate your thinking, draw a picture of several water molecules interacting. Explain your drawing.



A single water molecule

Shaving Cream Science

1. Observations:

2. Draw a model showing the interaction between:
   a. The food coloring and the shaving cream

Does your model include:	
A Key	
Arrows	
Labels	
Written Explanation	

   a. The food coloring and the paper

Does your model include:	
A Key	
Arrows	
Labels	
Written Explanation	

3. Is the food coloring more attracted to the paper or the shaving cream? What is your evidence from the lab? Use you models from question #2 to support your answer.

Guiding Question:

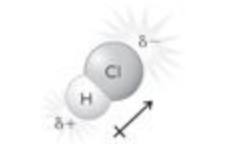
Do Now:

Important Definitions and Equations:

Notes:

_____ is the tendency of an atom to attract a shared pair of electrons.

- When two atoms with different electronegativities bond, they attract the bonding electrons to different degrees.
- The bonding electrons will spend more time around the more electronegative atom, resulting in a partial negative charge on that atom.
- The less electronegative atom will end up with a partial positive charge.



Hydrogen chloride, HCl
Electrons pulled in the direction of the dipole arrow.

We use dipoles to show how electrons are distributed in an atom. A _____ points from the partial positive side of the bond to the partial negative side.

Bonds that involve the sharing or transferring of electrons fall into three categories:

- _____ - electrons are shared equally
- _____ - electrons are more attracted to more electronegative atom
- _____ - the difference in electronegativity is so great that the more electronegative atom just takes the electrons from the less electronegative atom

Response:

13 Polar Bears and Penguins

Electronegativity and Polarity

Purpose

To understand polarity and bonding between atoms.

Instructions

Read the comic strip "The Bare Essentials of Polarity," and use it to answer these questions.

1. How does the comic strip define a polar molecule?

2. Define electronegativity, as you understand it, after reading the first two pages of the comic strip.

3. What is the artist trying to represent by two polar bears arm wrestling and two penguins arm wrestling?

4. What three types of bonds are represented on the third page of the comic strip? What happens to the bonding electrons in each type of bond?

5. Explain why there are four scoops of ice cream in the illustration of O_2 on the third page.

6. What do the six scoops of ice cream represent in the illustration of N_2 on the fourth page?

7. Describe what you think is happening to the penguin in the CO_2 molecule in the picture on the fourth page.

8. Name three things that the picture of CO_2 on the fourth page illustrates about the molecule.

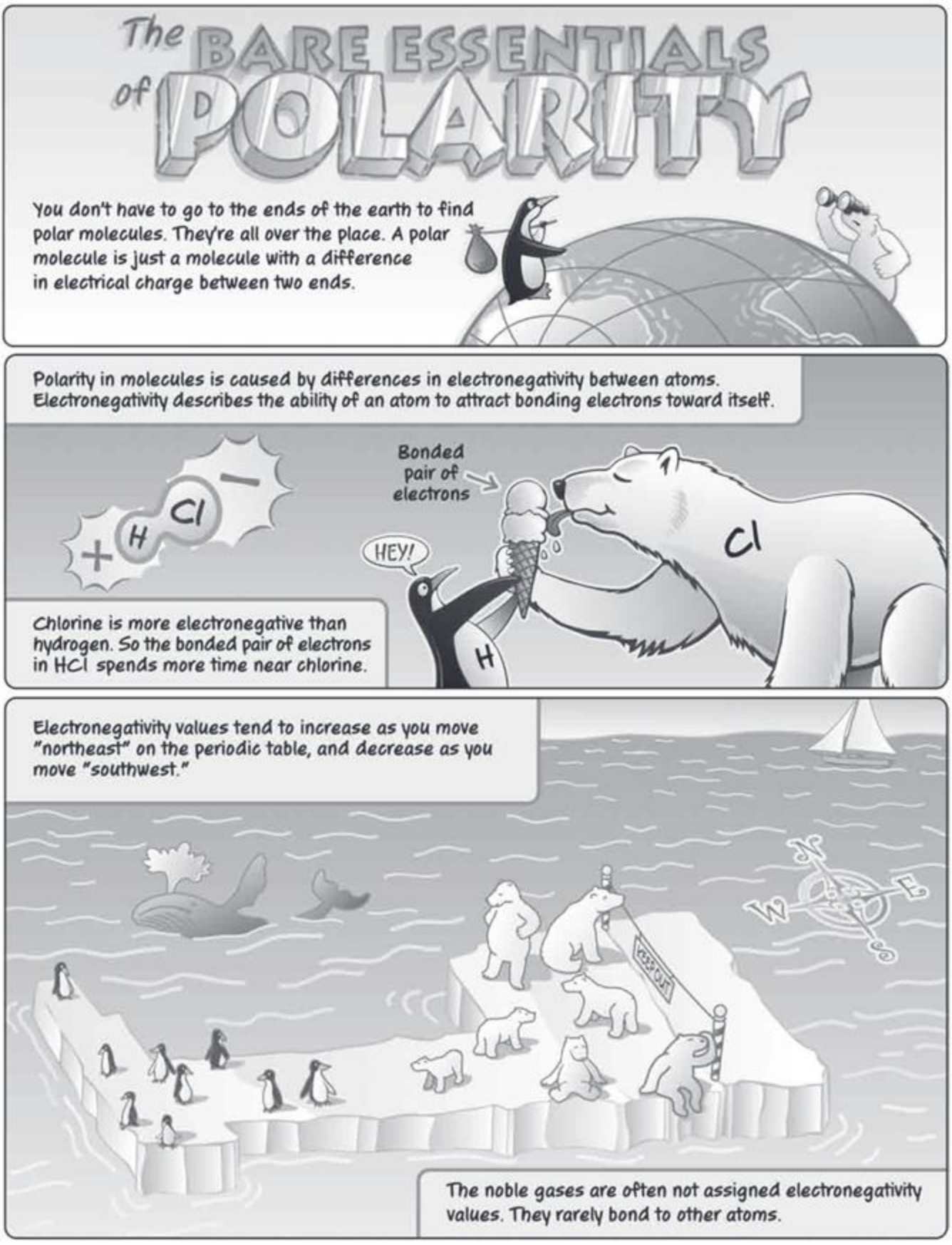
9. Describe what you think is happening to the penguins in the illustration of H_2O on the fourth page.

10. What does the crossed arrow represent in the comic strip?

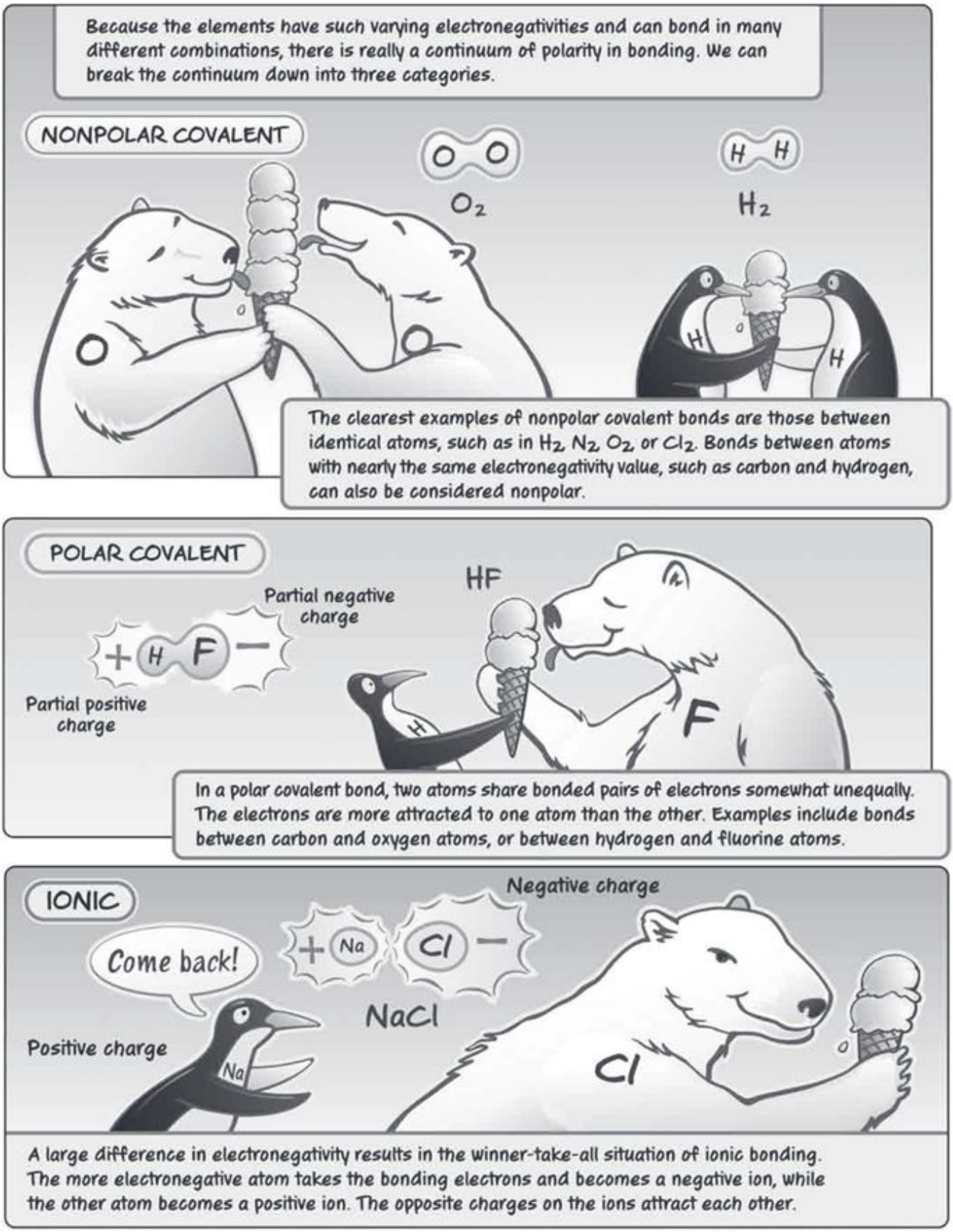
11. What are the two definitions of dipole given in the comic strip?

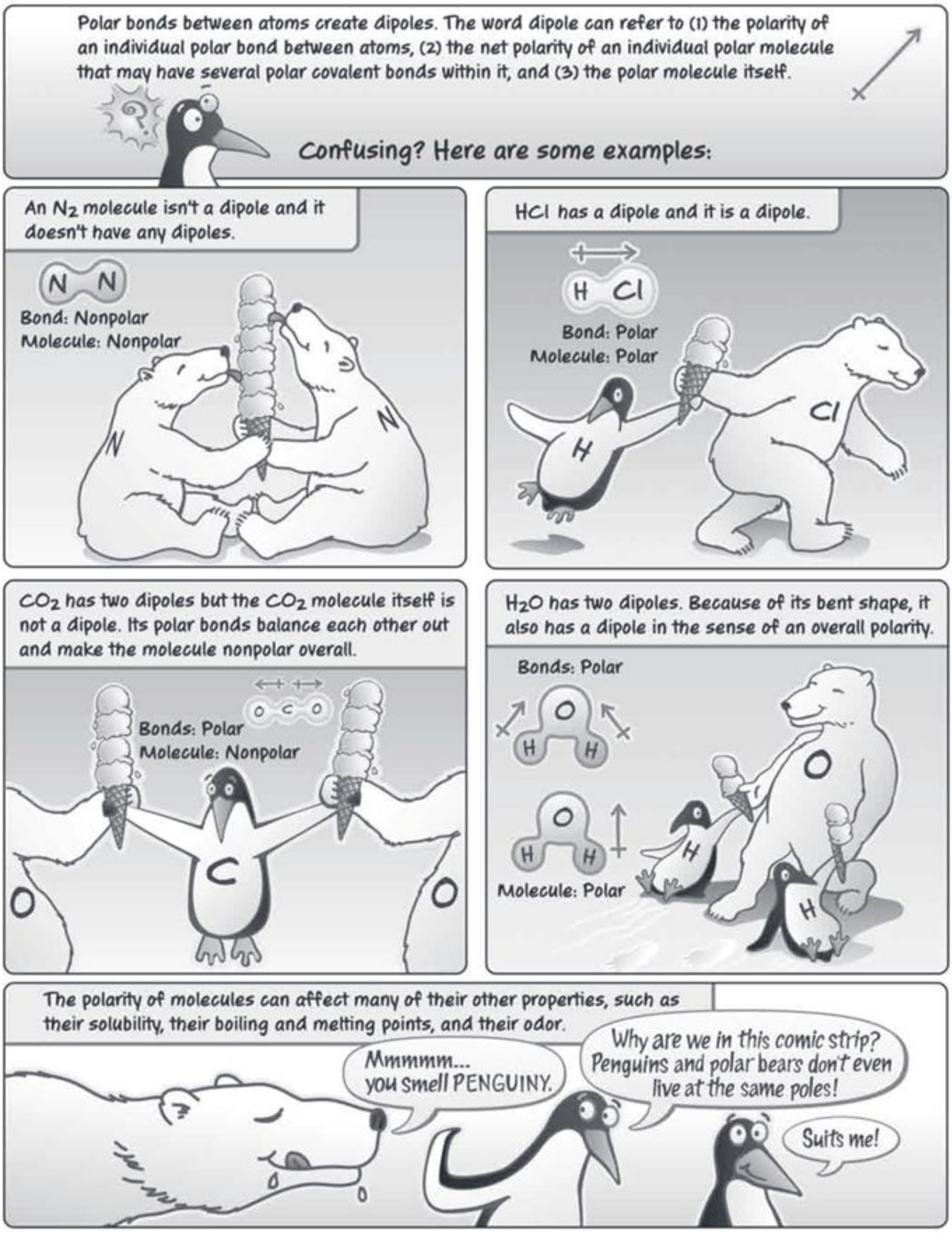
12. **Making Sense** What does electronegativity have to do with polarity?

13. **Going Beyond** Make a drawing of polar bears and penguins that would represent a dihydrogen sulfide molecule, H_2S. [Hint: You may want to start with a Lewis structure].


The BARE ESSENTIALS of POLARITY
You don't have to go to the ends of the earth to find polar molecules. They're all over the place. A polar molecule is just a molecule with a difference in electrical charge between two ends.
Polarity in molecules is caused by differences in electronegativity between atoms. Electronegativity describes the ability of an atom to attract bonding electrons toward itself.
+
H
Cl
−
Bonded pair of electrons
HEY!
Cl
H
Chlorine is more electronegative than hydrogen. So the bonded pair of electrons in HCl spends more time near chlorine.
Electronegativity values tend to increase as you move "northeast" on the periodic table, and decrease as you move "southwest."
KEEP OUT
N
W
E
S
The noble gases are often not assigned electronegativity values. They rarely bond to other atoms.


When two atoms with different electronegativity values bond, the bonding electrons spend more time around the more electronegative atom, creating a PARTIAL NEGATIVE CHARGE on that atom. The other atom then has a PARTIAL POSITIVE CHARGE, and the bond is polar.
Polarity is UNFAIR.
Oh, try to be more POSITIVE.
H
Cl
+
−
When atoms with equal electronegativity values bond, they form nonpolar bonds. The electron-attracting strength of each atom is the same.
Cl_2
Cl
Cl
H_2
H
H
However, if the electronegativities of two bonded atoms are different, then their bond will be polarized—maybe a little...
HCl
Cl
H
Eeep!
−
+
...maybe a lot.


Because the elements have such varying electronegativities and can bond in many different combinations, there is really a continuum of polarity in bonding. We can break the continuum down into three categories.
NONPOLAR COVALENT
O O
O_2
H H
H_2
The clearest examples of nonpolar covalent bonds are those between identical atoms, such as in H_2, N_2, O_2, or Cl_2. Bonds between atoms with nearly the same electronegativity value, such as carbon and hydrogen, can also be considered nonpolar.
POLAR COVALENT
Partial negative charge
+ H F −
Partial positive charge
HF
In a polar covalent bond, two atoms share bonded pairs of electrons somewhat unequally. The electrons are more attracted to one atom than the other. Examples include bonds between carbon and oxygen atoms, or between hydrogen and fluorine atoms.
IONIC
Negative charge
Come back!
+ Na Cl −
NaCl
Positive charge
Na
Cl
A large difference in electronegativity results in the winner-take-all situation of ionic bonding. The more electronegative atom takes the bonding electrons and becomes a negative ion, while the other atom becomes a positive ion. The opposite charges on the ions attract each other.


Polar bonds between atoms create dipoles. The word dipole can refer to (1) the polarity of an individual polar bond between atoms, (2) the net polarity of an individual polar molecule that may have several polar covalent bonds within it, and (3) the polar molecule itself.
Confusing? Here are some examples:
An N_2 molecule isn't a dipole and it doesn't have any dipoles.
N N
Bond: Nonpolar
Molecule: Nonpolar
HCl has a dipole and it is a dipole.
H Cl
Bond: Polar
Molecule: Polar
CO_2 has two dipoles but the CO_2 molecule itself is not a dipole. Its polar bonds balance each other out and make the molecule nonpolar overall.
O C O
Bonds: Polar
Molecule: Nonpolar
H_2O has two dipoles. Because of its bent shape, it also has a dipole in the sense of an overall polarity.
Bonds: Polar
Molecule: Polar
The polarity of molecules can affect many of their other properties, such as their solubility, their boiling and melting points, and their odor.
Mmmmm... you smell PENGUINY.
Why are we in this comic strip? Penguins and polar bears don't even live at the same poles!
Suits me!

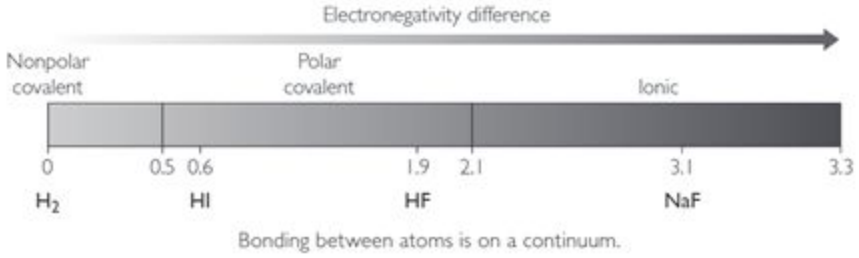
Guiding Question:

Do Now:

Important Definitions and Equations:

Notes:

Numerical differences in electronegativity can help us predict the type of bond that will form between two atoms.



Bonding between atoms is on a continuum.

Check-In:

- Is the bond between potassium chloride, KCl, nonpolar, polar, or ionic? Explain.

- What happens to the valence electrons in KCl?

Response:

14 Think (Electro)negatively

Electronegativity Scale

Purpose

To explore numerical values for electronegativity and to learn how to use them to compare atoms and bonds.

Questions

Use the electronegativity scale on page 16 to answer the following questions

1. What happens to the electronegativity values across each period from left to right?

2. What happens to the electronegativity values of each group from bottom to top?

3. If you have a bond between a metal atom and a nonmetal atom, which one of them is more electronegative? Explain your thinking.

4. Where are the atoms with the greatest electronegativity values located? Are they metals, metalloids, or nonmetals?

5. Where are the atoms with the lowest electronegativity values located? Are they metals, metalloids, or nonmetals?

6. Metals are often referred to as electropositive. Explain why.

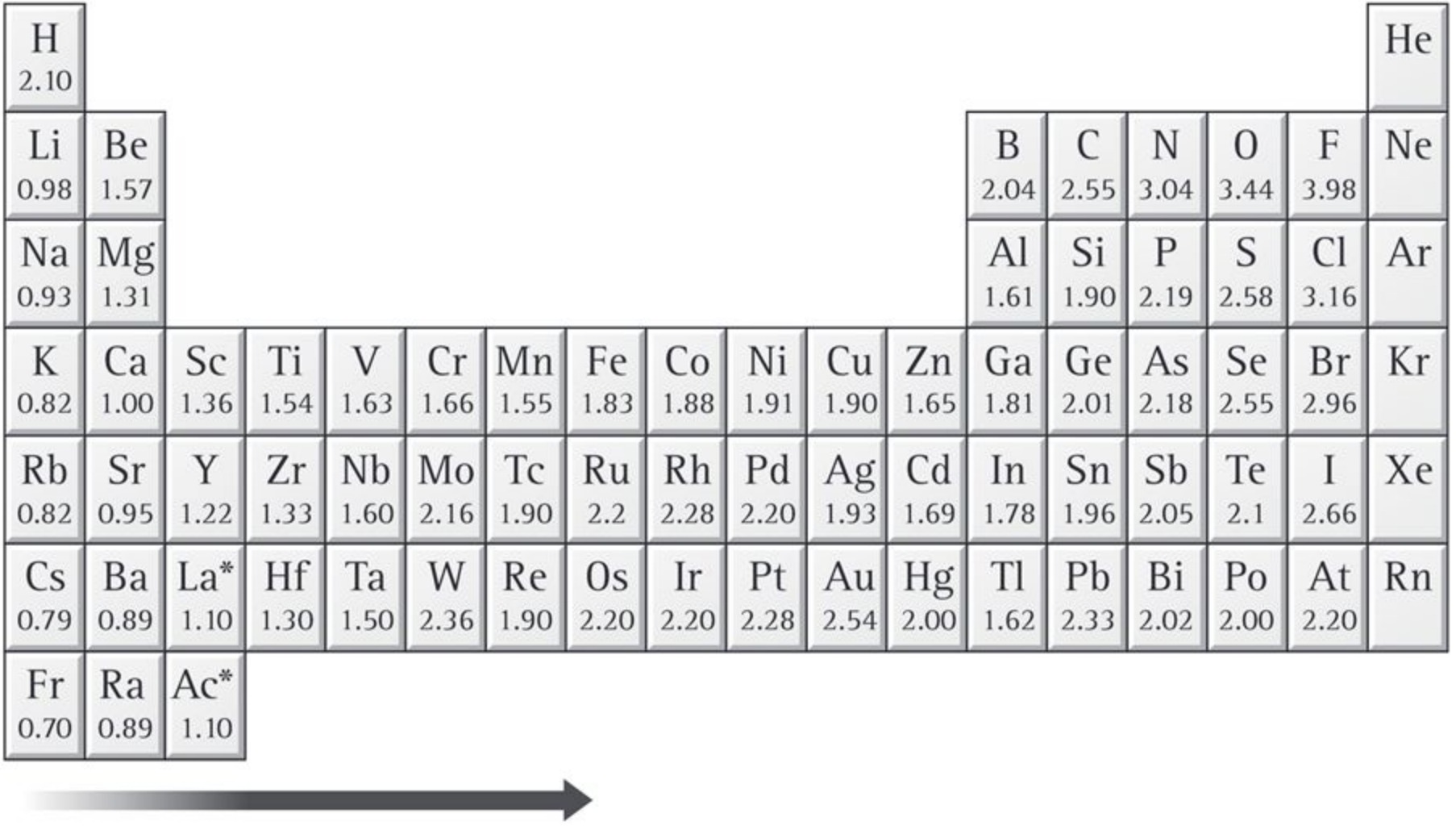
7. Why do you think the noble gases do not have electronegativity values?

8. Circle the atom in each pair below that will attract shared electrons more strongly.

C—H **O—N** **P—F** **C—O**

9. Which two atoms in the periodic table form the most polar bond?

Electronegativity Scale



* Electronegativity values for the lanthanides and actinides range from about 1.10 to 1.50.

Date: