

13.1 and 13.2 + CHEM 1311 Review

I. CHEM 1311 Review

1. A weather forecaster predicts the temperature will reach 31°C . What is this temperature (a) in K, (b) in $^{\circ}\text{F}$?

a.) $T_K = T_C + 273.15$

$$T_K = (31^{\circ}\text{C}) + 273.15$$

$$T_K = 304.15 \text{ K} \rightarrow 3.0 \times 10^2 \text{ K}$$

b.) $T_F = \frac{9}{5} T_C + 32$

$$T_F = \frac{9}{5} (31^{\circ}\text{C}) + 32$$

$$T_F = 87.8^{\circ}\text{F} \rightarrow 88^{\circ}\text{F}$$

2. How many significant figures are in each of the following numbers (assume that each number is a measured quantity)? (a) 4.003, (b) 6.023×10^{23} , (c) 5000.

a.) 4 sig-figs

c.) 1 sig-fig

does not include the period at the end.

b.) 4 sig-figs

3. How many significant figures does each of the following numbers have? (a) 0.02670, (b) 328.0, (c) 7000.0, and (d) 0.00200.

a.) 4 sig-figs

c.) 5 sig-figs

b.) 4 sig-figs

d.) 3 sig-figs

4. Give the answer to the following problem to the maximum number of significant figures: $50.00 \times 27.8 \times 0.1167$.

4SF 3SF 4SF

$$= 162.213 \rightarrow 162$$

5. Give the answer to the following problem to the maximum number of significant figures:

$$(2.776 \times 0.0050) - (6.7 \times 10^{-3}) + (0.036 \times 0.0271)$$

$$0.014 - 0.0067 + 9.756 \times 10^{-4}$$

$$0.014 - 0.0067 + 0.0009756$$

$$= 0.0082756 \rightarrow 0.008$$

There are 2 different types of operations! Steps must be treated separately

6. If a woman has a mass of 115 lb, what is her mass in grams? Note: 1 lb = 453.6 g.

$$\frac{115 \text{ lb}}{1 \text{ lb}} \times \frac{453.6 \text{ g}}{1 \text{ lb}} = 52164 \text{ g} \rightarrow 52200 \text{ g} \text{ or even better: } 5.22 \times 10^4 \text{ g}$$

Talk about $5.22 \times 10^4 \text{ g}$

7. The average speed of a nitrogen molecule in air at ^{idc}25°C is 515 m/s. Convert this speed to miles per hour. Note: 1 mile = 1.6093 km.

$$\frac{515 \text{ m}}{1 \text{ s}} \times \frac{10^{-3} \text{ km}}{1 \text{ m}} \times \frac{1 \text{ mile}}{1.6093 \text{ km}} \times \frac{3600 \text{ s}}{1 \text{ hr}} = 1152.053688 \text{ mi/hr} \rightarrow 1150 \text{ mi/hr}$$

$$1 \text{ cm}^3 = 1 \text{ mL}$$

Kilo - 10^3
X
X
X
Centi - 10^{-2}

8. Earth's oceans contain approximately $1.36 \times 10^9 \text{ km}^3$ of water. Calculate the volume in liters.

$$\frac{1.36 \times 10^9 \text{ km}^3}{1 \text{ km}^3} \times \frac{10^{15} \text{ cm}^3}{1 \text{ km}^3} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} = 1.36 \times 10^{21} \text{ L}$$

5, but b/c it's cubic, it'll be 15.

never report answers as with E.

$$\text{g/mL} = \text{g/cm}^3$$

Density as a conversion factor.

9. What is the mass in grams of 1.00 gal of water? The density of water is 1.00 g/mL. Note: 1.057 qt = 1 L.

$$\frac{1.00 \text{ gal}}{1 \text{ gal}} \times \frac{4 \text{ qt}}{1 \text{ gal}} \times \frac{1 \text{ L}}{1.057 \text{ qt}} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times \frac{1 \text{ g}}{1 \text{ mL}} = 3784.295175 \text{ g} \rightarrow 3.78 \times 10^3 \text{ g}$$

Mass #
Atomic #
Oxidation Charge

10. How many protons, neutrons, and electrons are in an atom of (a) ^{197}Au , (b) Strontium-90?

a.) $^{197}_{79}\text{Au}$ p⁺ - 79 protons
n - 118 neutrons
e⁻ - 79 electrons b/c it's neutral.
n = 197 - 79 = 118

b.) Strontium-90 p⁺ - 38 protons
 $^{90}_{38}\text{Sr}$ n - 52 neutrons
e⁻ - 38 electrons b/c neutral

11. Magnesium has three isotopes with mass numbers 24, 25, and 26. (a) Write the complete chemical symbol (superscript and subscript) for each. (b) How many neutrons are in an atom of each isotope?

$^{24}_{12}\text{Mg}$, $^{25}_{12}\text{Mg}$, $^{26}_{12}\text{Mg}$

n - 12, n - 13, n - 14

#10 and #11 require a periodic table.

12. Which of these compounds would you expect to be ionic: N_2O , Na_2O , CaCl_2 , SF_4 ? N_2O - No, covalent. CaCl_2 - Yes, ionic.

Na_2O - Yes ionic. SF_4 - No, covalent.

13. Select the most electronegative element from the list below.

A) B
B) C
C) O
D) H
E) N

For a compound to be ionic, it is the electronegativity between the atoms in a very polar bond that determines the ionic strength. NOT WHETHER IT'S METAL + NONMETAL!

14. The greatest degree of ionic character is anticipated for the bond between which of the following?

- ☐ A) H and C. = 0.4
☒ B) H and Cl. > 0.4
☐ C) Br and Cl.
☐ D) C and Cl.
☐ E) H and Br.

HCl is "covalent", but
HCl (aq) is ionic.

15. Which of these substances contain both covalent and ionic bonds?

- ☐ A) HCN
☐ B) CH₄
☒ C) NH₄Cl
☐ D) H₂O₂
☐ E) H₂S

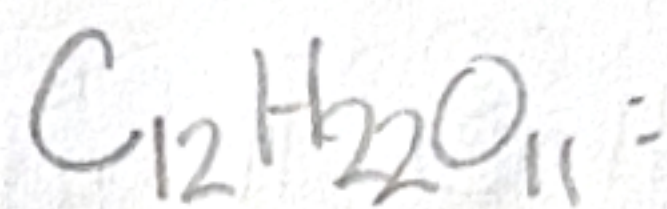
Ionic Compound = Metal + Nonmetal
 will NOT help/suffice.

NO!

16. Calculate the formula weight of (a) sucrose, C₁₂H₂₂O₁₁ (table sugar); and (b) calcium nitrate, Ca(NO₃)₂.

a.)

$$\left. \begin{array}{l} \text{C} - 12.011 \times 12 \\ \text{H} - 1.0078 \times 22 \\ \text{O} - 15.999 \times 11 \end{array} \right\}$$



342.29 amu

b.) Ca - 40.078 × 1

N - 14.007 × 2

O - 15.999 × 6

164.08 g



164.09 g

17. Without using a calculator, arrange these samples in order of increasing numbers of carbon atoms: 12 g ¹²C, 1 mol C₂H₂, 9 × 10²³ molecules of CO₂.

12g of ¹²C is 1 mol ¹²C

1 mol of C₂H₂ is 2 mol ¹²C

9 E 23 molecules of CO₂ is 0.022 E 23 molecules mol ¹²C

→ so, it's **a, c, b**

18. Calculate the number of H atoms in 0.350 mol of C₆H₁₂O₆.

0.350 mol Glucose	12 mol H	0.022 E 23 atoms	1.49 mol
1 mol Glucose	1 mol H		

= 2.53 E 24 atoms H

19. What is the molar mass of glucose? C₆H₁₂O₆?

C - 12.00 amu × 6 = 72.00 amu	}	72.00 g
H - 1.008 amu × 12 = 12.096 amu		+ 12.096 g
O - 16.00 amu × 6 = 96.00 amu		96.00 g

180.096 g

180.10 g

Exact vs.
Inexact

20. Calculate the number of moles of glucose ($C_6H_{12}O_6$) in a 5.380 g sample.

$$\frac{5.380 \text{ g } \cancel{C_6H_{12}O_6}}{180.10 \text{ g } \cancel{C_6H_{12}O_6}} \times \frac{1 \text{ mol } C_6H_{12}O_6}{1} = 0.298722932 \text{ mol}$$

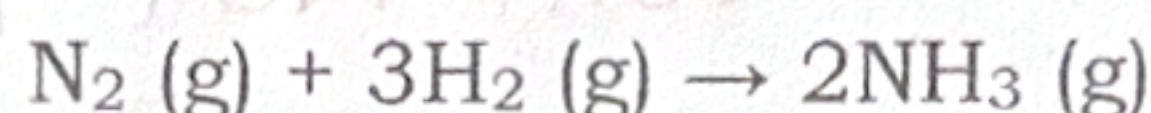
$$= \boxed{0.2987 \text{ mol}}$$

21. Calculate the mass, in grams, of 0.433 mol of calcium nitrate.

$$\frac{0.433 \text{ mol } \cancel{Ca(NO_3)_2}}{1 \text{ mol } \cancel{Ca(NO_3)_2}} \times \frac{164.09 \text{ g } Ca(NO_3)_2}{1} = 71.05097 \text{ g}$$

$$= \boxed{71.1 \text{ g}}$$

22. The most important commercial process for converting N_2 from the air into nitrogen-containing compounds is based on the reaction of N_2 and H_2 to form ammonia (NH_3).



How many moles of NH_3 can be formed from 3.0 mol of N_2 and 6.0 mol of H_2 ?

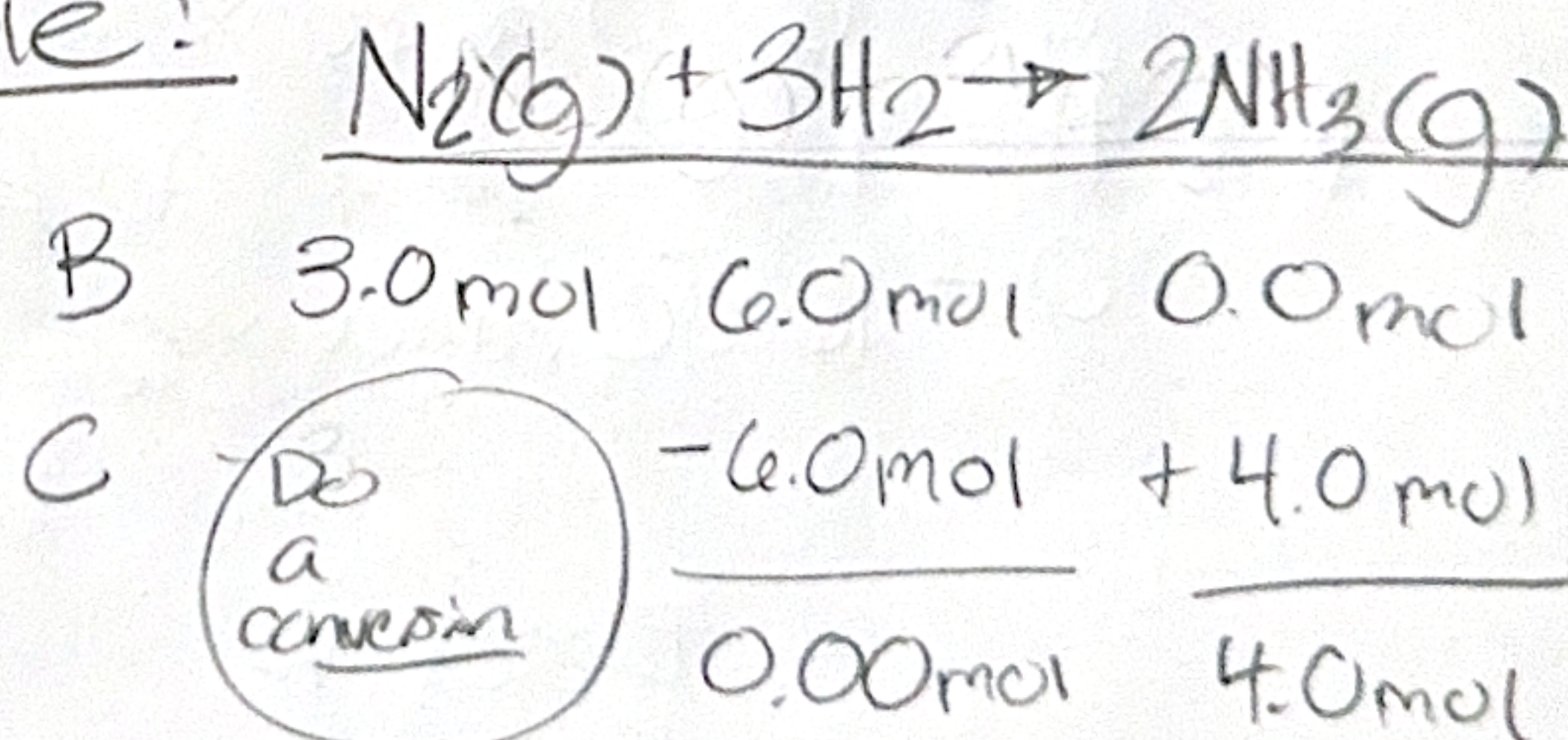
① Which one is the limiting reactant?

$$\frac{3.0 \text{ mol } \cancel{N_2}}{1 \text{ mol } \cancel{N_2}} \times \frac{2 \text{ mol } NH_3}{1} = 6 \text{ mol } NH_3; \text{ assume excess } H_2$$

$$\frac{6.0 \text{ mol } \cancel{H_2}}{3 \text{ mol } \cancel{H_2}} \times \frac{2 \text{ mol } NH_3}{1} = 4 \text{ mol } NH_3; \text{ assume excess } N_2$$

Therefore, 6.0 mol H_2 is the limiting reagent. Only 4.0 mol NH_3 can be made.

② Make a BCA Table!



→ NOT pure!

● Solution = Homogeneous Mixture

Solution Components:

Solvent - Major Component

Solute - Minor Component

★ The phase of the solvent will be the phase of the solution!

But how does a solution form?

II. 13.1 — The Solution Process

Chaos and randomness.

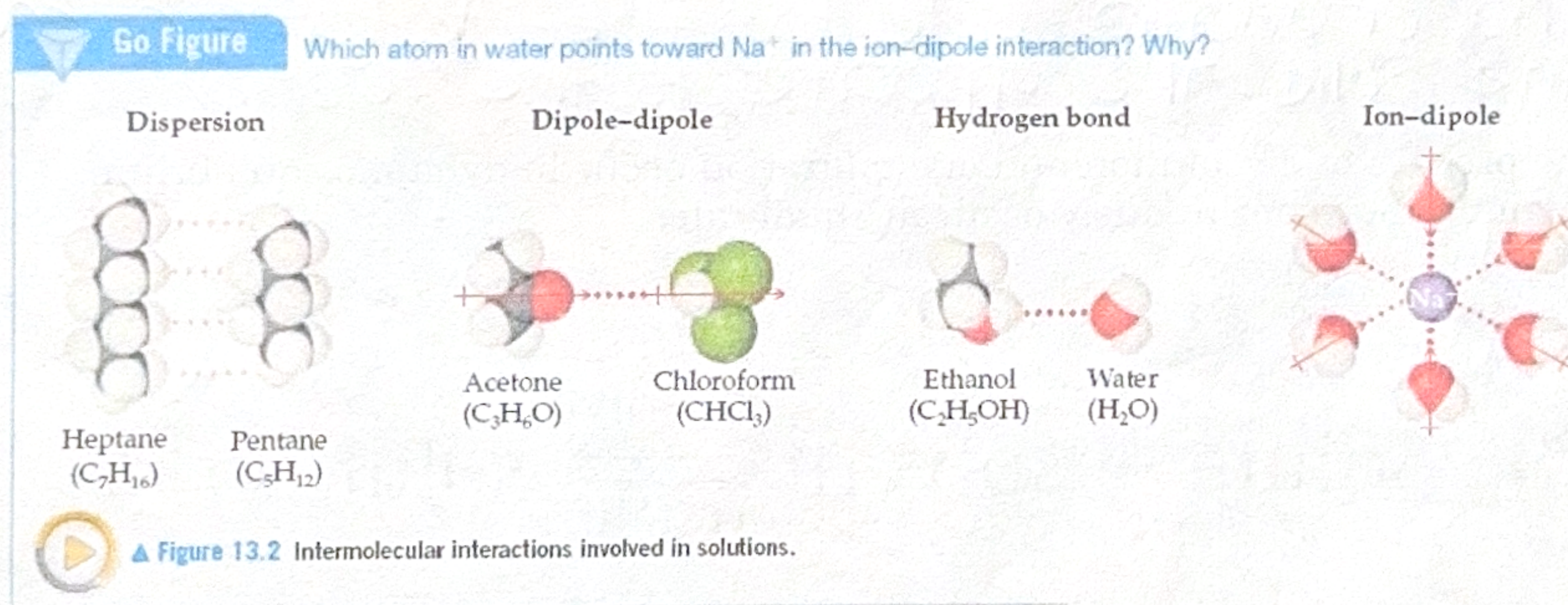
The formation of solutions is favored by the increase in Entropy that accompanies mixing.

Spontaneous Mixing

2nd Law of Thermodynamics
— Universe favors entropy

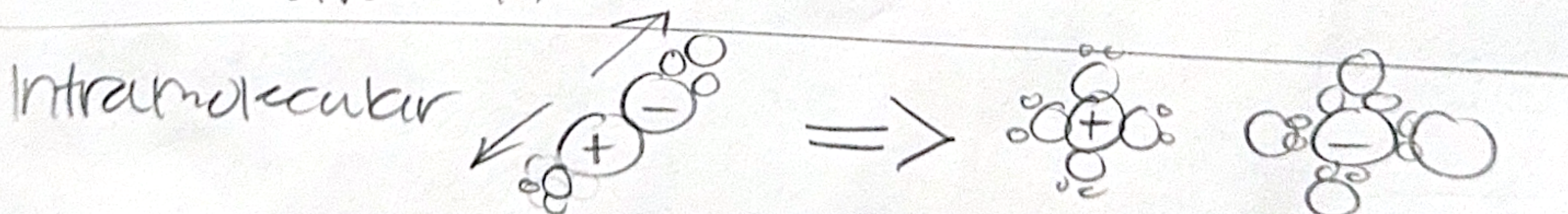
Three kinds of intermolecular interactions are involved in solution formation:

1. Solute-solute interactions between solute particles must be overcome to disperse the solute particles through the solvent.
2. Solvent-solvent interactions between solvent particles must be overcome to make room for the solute particles in the solvent.
3. Solvent-solute interactions between the solvent and solute particles occur as the particles mix.



How does an Ion-dipole form when a salt is dissolved in water?

1. The ionic bond is torn apart like a stretched out rubber band.
2. The solvent molecules start to surround the ions.
3. = Solvation

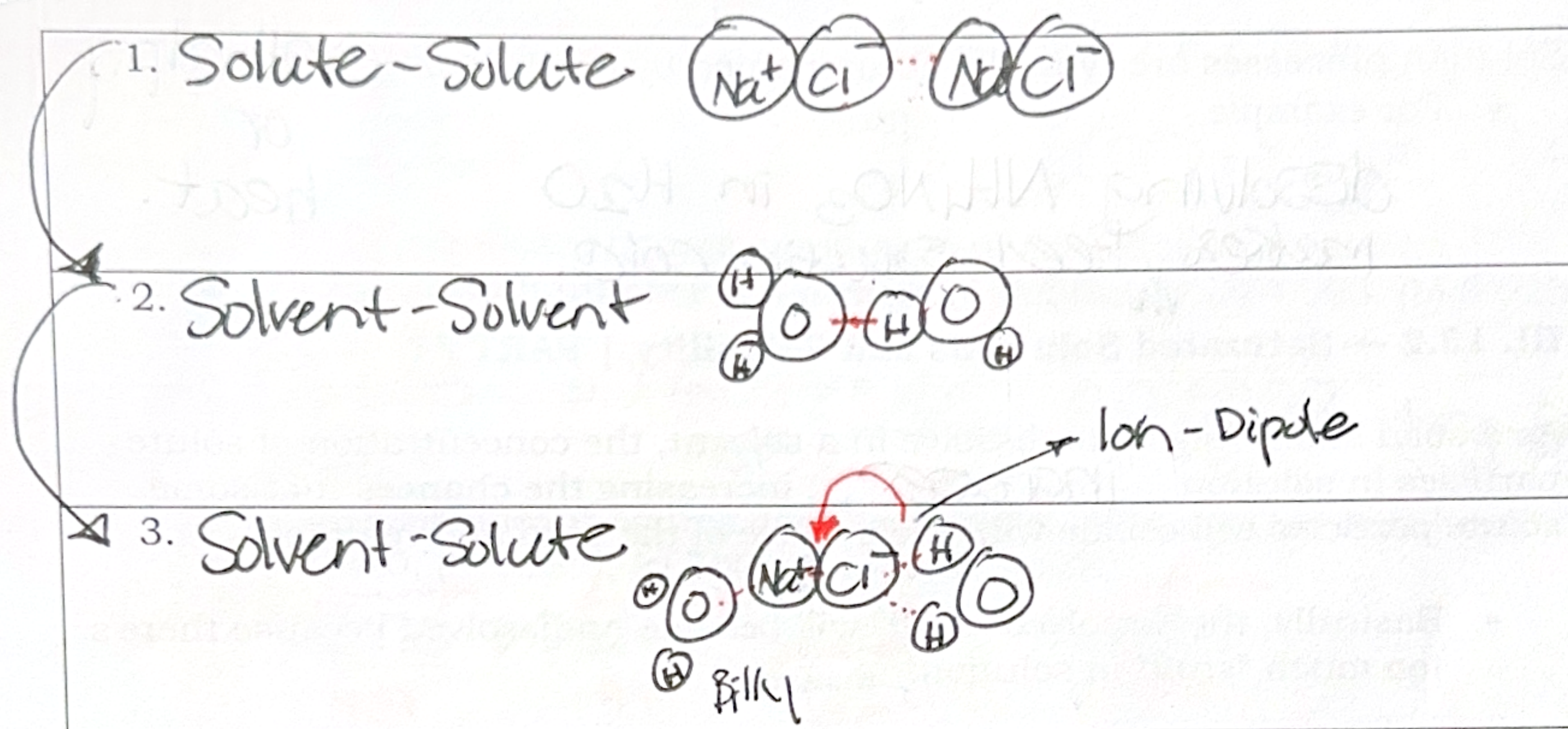


II. 13.1 — The Solution Process

The formation of solutions is favored by the increase in that accompanies mixing.

Spontaneity
entropy

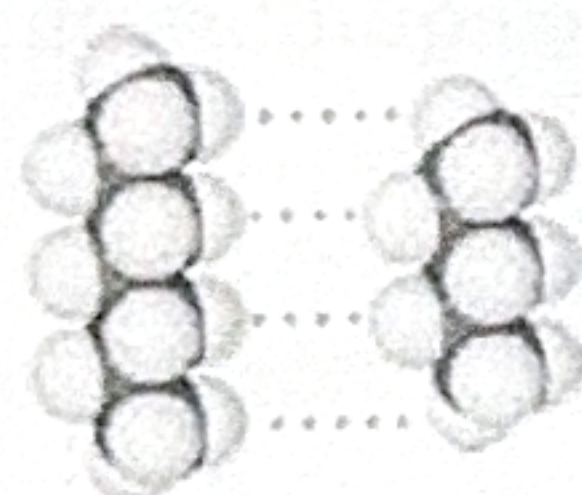
Three kinds of intermolecular interactions are involved in solution formation:



Go Figure

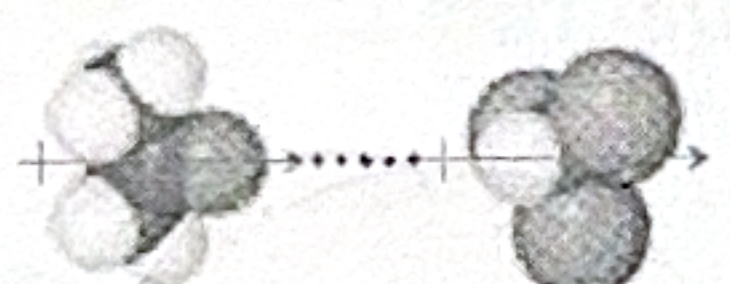
Which atom in water points toward Na^+ in the ion-dipole interaction? Why?

Dispersion



Heptane (C_7H_{16}) Pentane (C_5H_{12})

Dipole-dipole



Acetone ($\text{C}_3\text{H}_6\text{O}$) Chloroform (CHCl_3)

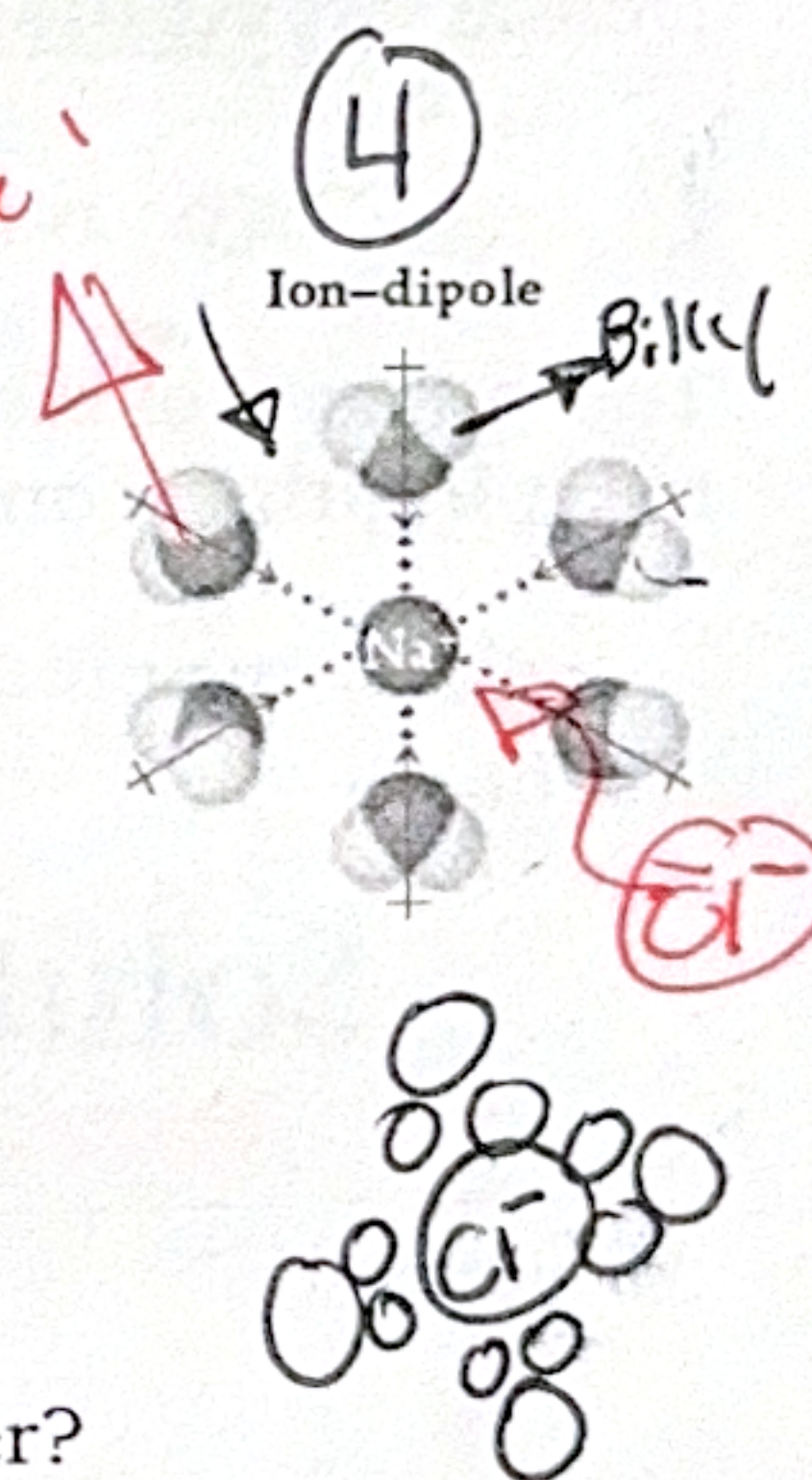
Hydrogen bond



Ethanol ($\text{C}_2\text{H}_5\text{OH}$) Water (H_2O)



▲ Figure 13.2 Intermolecular interactions involved in solutions.



How does an Ion-dipole form when a salt is dissolved in water?

- 1.
- 2.
- 3.

Define **Solvation** - The clustering of solvent molecules around a solute particle.

Define **Hydration** - Solvation when the solvent is water.

Solution processes are typically accompanied by changes in enthalpy → Heat

- For example,

dissolving NH_4NO_3 in H_2O makes the solution feel cold.

III. 13.2 — Saturated Solutions and Solubility | PART #1

As a solid solute begins to dissolve in a solvent, the concentration of solute particles in solution increases, increasing the chances that some solute particles will collide with the surface of the solid and reattach.

- Basically, the dissolved "stuff" will become undissolved because there's too much "stuff" in solution.

Define **Crystallization** - The process in which molecules, ions, or atoms come together to form a crystalline solid. The opposite is the solution process.

The process of dissolution and crystallization occur in dynamic equilibrium, meaning they continuously occur at equal rates.

