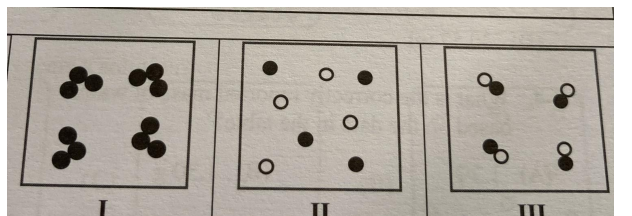


CHY 113 Sample Conceptual Questions

These questions give you an idea of the types of questions you can expect on the American Chemical Society (ACS) Conceptual Standardized Exam. This exam will assess your knowledge of the overall concepts studied in CHY 113. This is NOT an exhaustive representation of the topics you will find on the exam. In other words, you should NOT say “well, X topic was not on this list, and so it probably won’t be on the exam.” ANY concept/topic studied may be on the exam. All are important. Rather, this list provides you with an idea of the style and depth of the questions you will find. You should still use all resources available to you to study the concepts covered in the course.

Foundational concepts

- 1) In the name arsenic trichloride, the *tri-* prefix specifies
 - a) arsenic has an oxidation state of +3
 - b) the geometry of the molecule is trigonal pyramidal
 - c) arsenic is covalently bonded to three chlorine atoms**
 - d) arsenic (III) is ionically bonded to three chloride ions
- 2) What are the correct classifications for I, II, and III?



- | I | II | III |
|-------------------|----------------|-----------------|
| a) element | compound | mixture |
| b) element | mixture | compound |
| c) compound | mixture | element |
| d) mixture | element | compound |

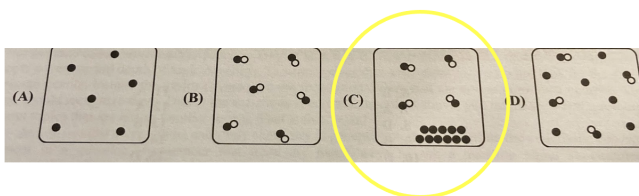
- 3) Which sample has the largest volume?

Densities	
aluminum 2.7 g/cm ³	copper 9.0 g/cm ³

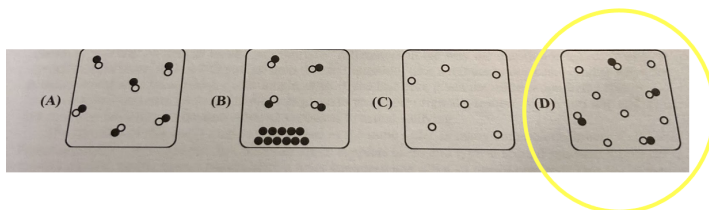
- a) 1.0 g aluminum
- b) 5.0 g aluminum**
- c) 1.0 g copper
- d) 5.0 g copper

CHY 113 Sample Conceptual Questions

4) Which diagram represents a heterogeneous mixture?

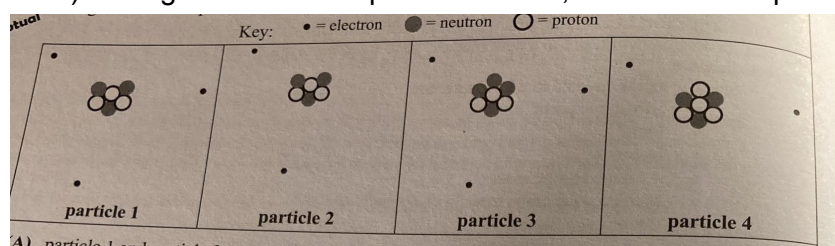


5) Which microscopic representation best represents a solution?



Atomic Structure

6) Using the models of particles below, which are isotopes of the same element?



- a) particles 1 and 2
 - b) particles 1 and 3**
 - c) particles 2 and 4
 - d) particles 3 and 4
- 7) The element thallium, Tl, has two stable isotopes, ^{203}Tl and ^{205}Tl . Which statement correctly describes the relationship between the relative abundances of these two isotopes?
- a) % abundance of ^{203}Tl > % abundance of ^{205}Tl
 - b) % abundance of ^{203}Tl = % abundance of ^{205}Tl
 - c) % abundance of ^{203}Tl < % abundance of ^{205}Tl**
 - d) not enough information is provided to determine the relationship
- 8) In all neutral atoms, there are equal numbers of
- a) protons and neutrons
 - b) positrons and electrons
 - c) neutrons and electrons
 - d) electrons and protons**

CHY 113 Sample Conceptual Questions

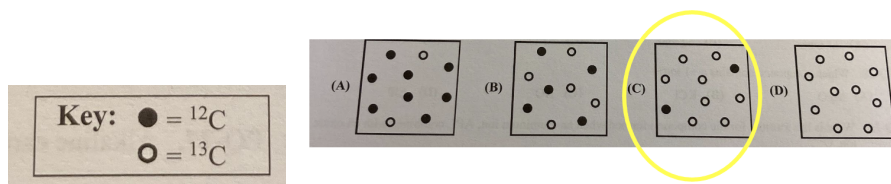
9) Which statement is true?

- a) The nucleus of an atom contains neutrons and electrons
- b) The atomic number of an element is the number of protons in one atom
- c) The mass number of an atom is the number of protons in the nucleus plus the number of electrons outside
- d) The number of electrons outside the nucleus is the same as the number of neutrons in the nucleus

10) A sodium ion differs from a sodium atom in that the sodium ion

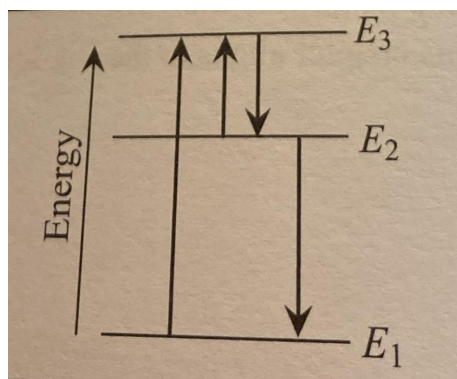
- a) has fewer electrons
- b) is an isotope of sodium
- c) exists only in solution
- d) has a negative charge on its nucleus

11) An enriched sample of carbon contains 20.0% ^{12}C and 80% ^{13}C . Which figure shows this sample?



Electronic structure

12) In the energy diagram, transitions between energy levels are denoted by arrows. Which transition corresponds to the absorption of the shortest wavelength of light?



- a) E_2 to E_1
- b) E_2 to E_3
- c) E_3 to E_2
- d) E_1 to E_3

13) Which set is **NOT** an allowable set of quantum numbers?

	n	ℓ	m_ℓ	m_s
(A)	3	2	-1	$+\frac{1}{2}$
(B)	4	0	-1	$+\frac{1}{2}$
(C)	3	1	-1	$+\frac{1}{2}$
(D)	4	0	0	$-\frac{1}{2}$

14) Which atom has the largest atomic radius?

- a) K
- b) I
- c) Rb
- d) Sn

15) Arrange the elements Li, Ne, Na, and Ar in increasing order of first ionization energy.

- a) $\text{Na} < \text{Li} < \text{Ar} < \text{Ne}$
- b) $\text{Li} < \text{Na} < \text{Ar} < \text{Ne}$
- c) $\text{Na} < \text{Li} < \text{Ne} < \text{Ar}$
- d) $\text{Ar} < \text{Ne} < \text{Na} < \text{Li}$

16) Which electronic transition in a hydrogen atom is associated with the largest *emission* of energy?

- a) $n=3$ to $n=1$
- b) $n=2$ to $n=3$
- c) $n=2$ to $n=4$
- d) $n=3$ to $n=2$

17) The size of metal atoms

- a) generally increases progressively from top to bottom in a group in the periodic table
- b) generally increases progressively from left to right in a period
- c) are smaller than those of corresponding ions
- d) do not change upon losing electrons

18) The first three ionization energies of element X are 590, 1145, and 4912 kJ mol⁻¹. What is the most likely formula for the stable ion of X?

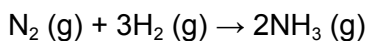
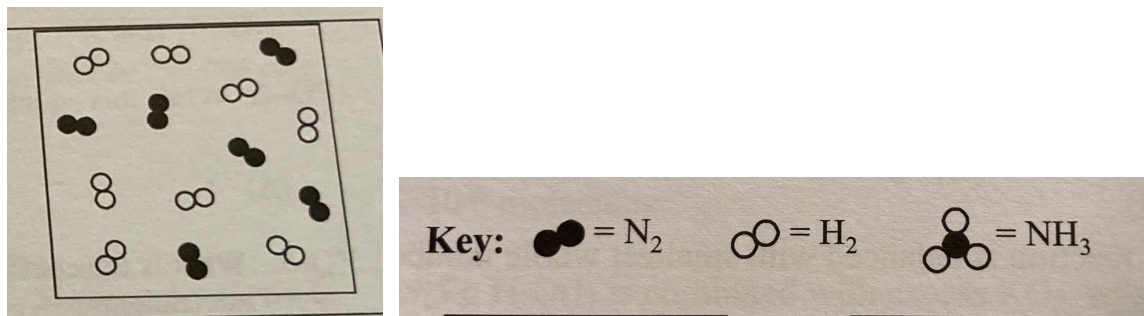
- a) X^+
- b) X^{2+}
- c) X^{3+}
- d) X^-

Formula Calculations and the Mole

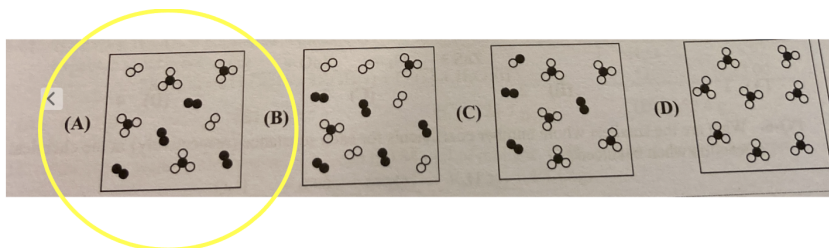
- 19) Avogadro's number equals the number of
- a) atoms in one mole of O_2
 - b) atoms in one mole of atoms
 - c) marbles in one mole of marbles
 - d) atoms in one mole of atoms and marbles in one mole of marbles
- 20) Which sample contains the least number of atoms?
- a) 1.00 g C
 - b) 1.00 g O_2
 - c) 1.00 g H_2
 - d) 1.00 g Fe
- 21) Which sample has the largest mass?
- a) 1 mole of sugar ($C_{12}H_{22}O_{11}$) molecules
 - b) 1 mole of lead (Pb) atoms
 - c) 1 mole of carbon dioxide (CO_2) molecules
 - d) All of these have the same mass
- 22) How many moles of hydrogen atoms are in six moles of $Ca(OH)_2$?
- a) 2
 - b) 6
 - c) 8
 - d) 12
- 23) In the compound $(NH_4)_2S_2O_3$, which element is present in the largest percent by mass?
- a) H
 - b) N
 - c) O
 - d) S

Stoichiometry

24) An initial mixture of N_2 and H_2 is shown below:



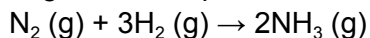
Which representation shows what would be present after the reaction is complete?



25) The limiting reagent for a given reaction can be recognized because it is the reagent that

- a) has the smallest coefficient in the balanced equation for the reaction
- b) has the smallest mass in the reaction mixture
- c) is present in the smallest molar quantity
- d) would be used up first**

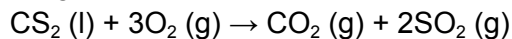
26) Equimolar amounts of nitrogen, hydrogen and argon are placed in a reaction chamber. The amount of which substance(s) will determine the amount of ammonia produced in the reaction below if the reaction goes to completion?



- a) argon
- b) hydrogen**
- c) nitrogen
- d) nitrogen and hydrogen

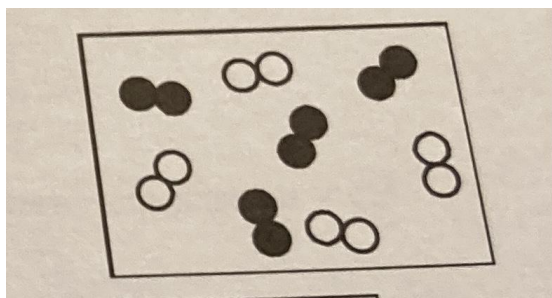
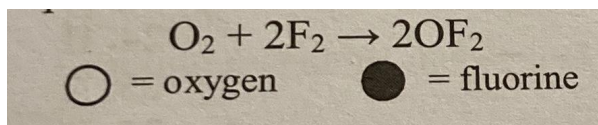
CHY 113 Sample Conceptual Questions

27) How many total molecules will be present when the reaction of 5,000 molecules of CS_2 with 15,000 molecules of O_2 goes to completion?

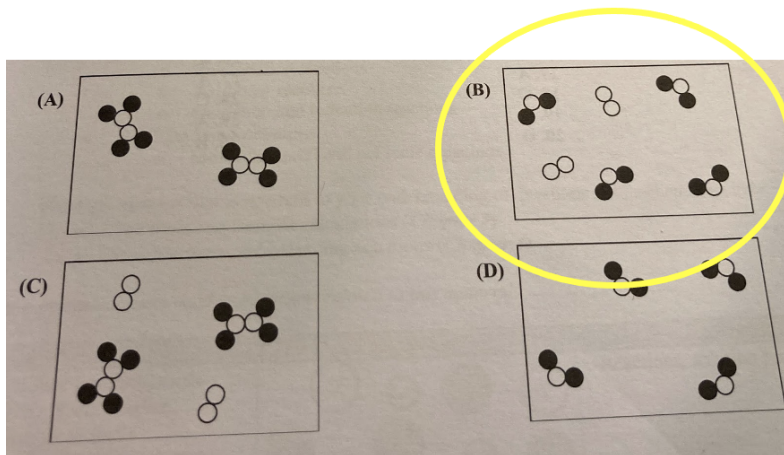


- a) 5,000
- b) 10,000
- c) 15,000
- d) 20,000

28) An initial reaction mixture of O_2 and F_2 is shown below.



Which representation shows what would be present after the reaction is complete?

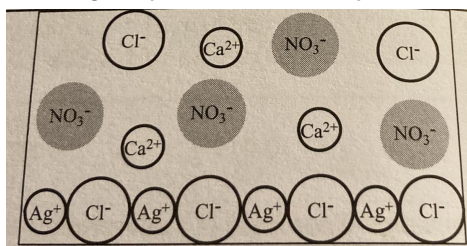
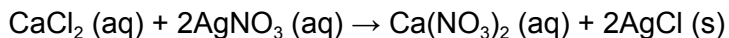


Solutions and Aqueous Reactions

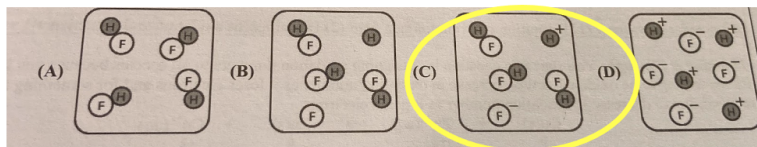
29) As water is added to a concentrated NaOH solution

- a) the moles of solute are decreasing, and the molarity is decreasing
- b) the moles of solute are decreasing and the volume is increasing
- c) the volume of the solution is increasing and the molarity is decreasing
- d) the volume of the solution is increasing and the molarity is increasing

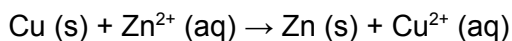
- 30) The figure below shows a particulate representation of the resultant solution and solid product after aqueous calcium chloride and aqueous silver nitrate react. Which species is/are present in excess?



- a) Cl^- only
b) Ca^{2+} and Cl^-
 c) Ag^+ and NO_3^-
 d) Ca^{2+} , Cl^- , and NO_3^-
- 31) Which best illustrates how the weak acid, HF, exists in aqueous solution (water molecules not shown)?

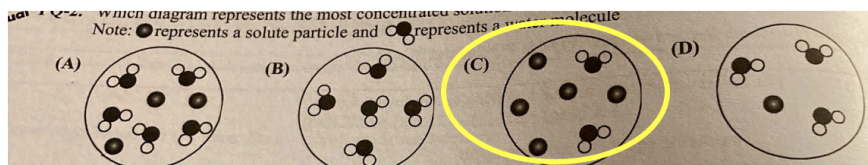


- 32) Which combination is correct for the reaction represented by this equation?



- | | oxidized | reduced |
|----|------------------|------------------------------------|
| a) | Cu | Zn^{2+} |
| b) | Cu^{2+} | Zn |
| c) | Zn | Cu^{2+} |
| d) | Zn^{2+} | Cu |

- 33) Which diagram represents the most concentrated solution?



CHY 113 Sample Conceptual Questions

- 34) An aqueous solution contains Mg^{2+} , Ag^+ , and Fe^{3+} ions. Aqueous solutions of K_2S , NaOH , and HCl are available. In what order should the reagents be added to precipitate each cation one at a time?

Ion	General Solubility Rules
Cl^- , Br^- , I^-	All are soluble except Ag^+ , Pb^{2+} , and Hg_2^{2+}
OH^-	All hydroxides are insoluble except those of Na^+ , K^+ ; hydroxides of Ba^{2+} and Ca^{2+} are slightly soluble
S^{2-}	All sulfides are insoluble except those of Na^+ , K^+ , NH_4^+ and Mg^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+}

- | | 1st | 2nd | 3rd |
|----|----------------------|----------------------|----------------------|
| a) | HCl | K_2S | NaOH |
| b) | HCl | NaOH | K_2S |
| c) | K_2S | HCl | NaOH |
| d) | NaOH | K_2S | HCl |

Heat and Enthalpy

- 35) One-gram samples of carbon and copper, originally at room temperature, reach equilibrium after being placed in 200 mL of boiling water. Which statement is correct?

Specific heat ($\text{J}/(\text{gK})$)

carbon 0.709

copper 0.385

- a) copper would absorb the same amount of energy as carbon and attain the same final temperature as carbon
- b) copper would absorb the same amount of energy as carbon and attain a higher final temperature than carbon
- c) copper would absorb less energy than carbon and attain the same final temperature as carbon
- d) copper would absorb more energy than carbon and attain the same final temperature as carbon
- 36) What is ΔH_f for $\text{HF}(\text{g})$?
- $$2\text{HF}(\text{g}) \rightarrow \text{H}_2(\text{g}) + \text{F}_2(\text{g}) \quad \Delta H_{\text{rxn}}$$
- a) $\Delta H_f = -\Delta H_{\text{rxn}}$
- b) $\Delta H_f = \frac{1}{2}(-\Delta H_{\text{rxn}})$
- c) $\Delta H_f = \frac{1}{2}(\Delta H_{\text{rxn}})$
- d) $\Delta H_f = \Delta H_{\text{rxn}}$

CHY 113 Sample Conceptual Questions

37) Given: Equation 1: $\text{SO}_2(\text{g}) \rightarrow \text{S}(\text{s}) + \text{O}_2(\text{g})$ ΔH_1

Equation 2: $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$ ΔH_2

Use this information to calculate the enthalpy of formation of $\text{SO}_3(\text{g})$

a) $\Delta H = \Delta H_1 + \frac{1}{2}\Delta H_2$

b) $\Delta H = -\Delta H_1 + \frac{1}{2}\Delta H_2$

c) $\Delta H = \Delta H_1 + \Delta H_2$

d) $\Delta H = -\Delta H_1 - \frac{1}{2}\Delta H_2$

38) Two metal samples, of the same mass and initially at 25°C , are heated so that each metal receives the same amount of thermal energy. Which metal will have the highest final temperature?

Specific heat ($\text{J}/(\text{gK})$)

metal X 0.350

metal Y 0.895

a) X

b) Y

c) both will have the same temperature

d) it cannot be determined

39) When a cold block of aluminum at 0°C is placed in room temperature water at 21°C in an insulated cup, the water and the aluminum end up at a final temperature of 19°C .

Assuming there was no heat loss to the surroundings, which statement best describes the energy exchanged in this process?

a) the block of aluminum lost the energy the water gained

b) the block of aluminum gained the energy the water lost

c) the block of aluminum gained less energy compared to the energy lost by the water

d) the block of aluminum gained more energy compared to the energy lost by the water

40) A student mixes 100 mL of 0.50 M NaOH with 100 mL of 0.50 M HCl in a styrofoam cup and observes a temperature increase of ΔT_1 . When she repeats the experiment using 200 mL of each solution, she observes a temperature change of ΔT_2 . If no heat is lost to the surroundings or absorbed by the styrofoam cup, what is the relationship between ΔT_1 and ΔT_2 ?

a) $\Delta T_2 = 4\Delta T_1$

b) $\Delta T_2 = 2\Delta T_1$

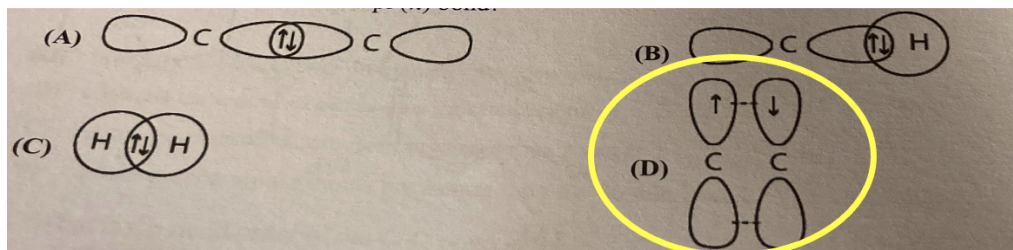
c) $\Delta T_2 = 0.5\Delta T_1$

d) $\Delta T_2 = \Delta T_1$

CHY 113 Sample Conceptual Questions

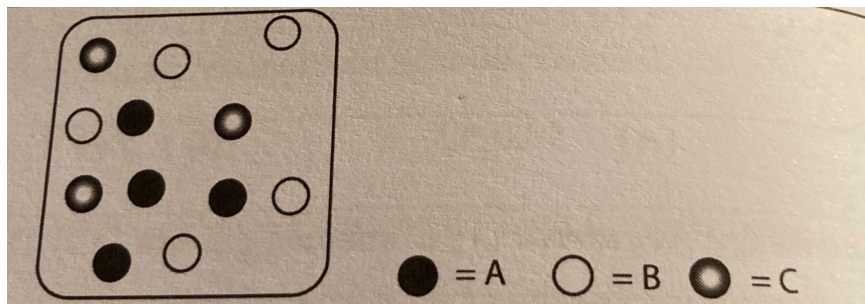
Structure and Bonding

- 41) An O=O bond is _____ than an O-O bond.
- a) longer and stronger
 - b) longer and weaker
 - c) shorter and stronger
 - d) shorter and weaker
- 42) Which molecule is nonpolar but contains polar bonds?
- a) CO₂
 - b) SO₂
 - c) O₂
 - d) CH₂Cl₂
- 43) Which statement best describes ionic bonding in lithium fluoride?
- a) the positive and negative charges of the ions cancel out
 - b) a lithium atom shares one electron with a fluorine atom
 - c) an electron is transferred from a lithium atom to a fluorine atom
 - d) an electrostatic attraction exists between lithium ions and fluoride ions
- 44) Which figure illustrates a pi (Π) bond?



States of Matter

- 45) If the diagram shown is representative of the particles in a sample of ideal gases, which statement is true?



- a) A has the largest partial pressure
- b) B has the largest partial pressure
- c) C has the largest partial pressure
- d) All partial pressures are equal

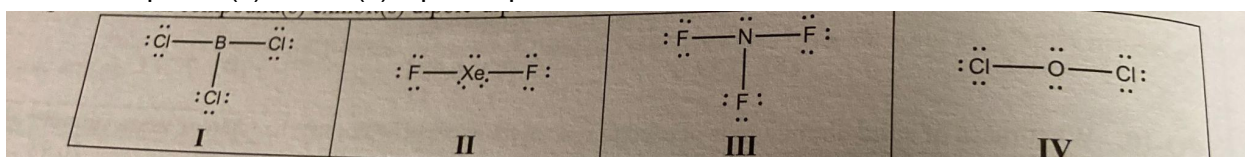
46) What happens to the volume of a fixed amount of gas if both the pressure and absolute temperature are doubled?

- a) halved
- b) doubles
- c) quadruples
- d) no change

47) According to kinetic molecular theory, why does the pressure increase as the temperature of an ideal gas increases?

- I. The gas molecules collide more frequently with the wall
 - II. The gas molecules collide more energetically with the wall
- a) Only I
 - b) Only II
 - c) Both I and II
 - d) Neither I nor II

48) Which compound(s) exhibit(s) dipole-dipole forces?



- a) I and II
- b) III only
- c) III and IV
- d) II, III, and IV

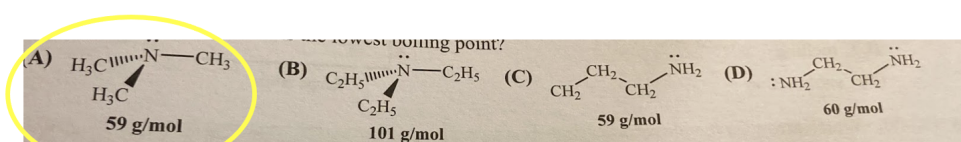
49) Why is the boiling point of Br_2 higher than that of Cl_2 ?

- a) Br_2 has greater molar mass and is therefore easier to vaporize
- b) Br is less electronegative and therefore its bonding is more ionic
- c) Br is more electronegative and therefore has greater dipole-dipole forces
- d) Br_2 is more polarizable and therefore has greater London dispersion forces

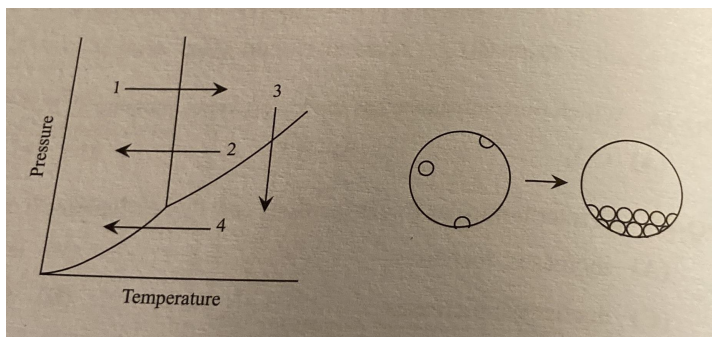
50) Which substance has the lowest boiling point?

- a) CH_4
- b) CCl_4
- c) CBr_4
- d) Cl_4

51) Which substance has the lowest boiling point?



52) Which arrow on the phase diagram corresponds to the particle-level phase change shown?



- a) 1
- b) 2
- c) 3
- d) 4