



## General Chemistry, First-Term Practice Items

### Study Question – Chapter 0 (Toolbox)

1A. A 15.75 g piece of iron is carefully placed into a graduated cylinder containing 10.0 mL of water. What is the final reading on the graduated cylinder and how will a 15.75 g piece of copper raise the water in comparison?

density / g·mL <sup>-1</sup>	
iron	7.87
copper	8.92

- (A) Final volume of 10.5 mL, and copper will raise the water less than iron.  
(B) Final volume of 10.5 mL, and copper will raise the water more than iron.  
(C) Final volume of 12.0 mL, and copper will raise the water less than iron.  
(D) Final volume of 12.0 mL, and copper will raise the water more than iron.

Work:

$$\frac{15.75 \text{ g Fe}}{7.87 \text{ g}} = 2.00 \text{ mL} + 2 \text{ mL} \therefore 12.0 \text{ mL total}$$

Cu has a higher density so divide by a larger # so less volume

### Practice Question – Chapter 0 (Toolbox)

1B. Which compound is named correctly?

- (A) SO<sub>3</sub>; sulfite ion  
(B) FePO<sub>4</sub>; iron(II) phosphate  
(C) H<sub>2</sub>S(aq); hydrosulfuric acid  
(D) CuSO<sub>4</sub>·5H<sub>2</sub>O; copper sulfate pentahydrate

binary acid = hydro + ic ending Hydro chlor ic acid = HCl  
oxy acids: -ite becomes -ous  
-ate becomes ic

Work:

(A) sulfur trioxide - not ionic

(B) Fe(III) phosphate

(C) H<sub>2</sub>S = hydrogen sulfide or hydro + ic so ✓

(D) ok but Cu(II) sulfate.

References below are to the ACS Exams General Chemistry Study Guide

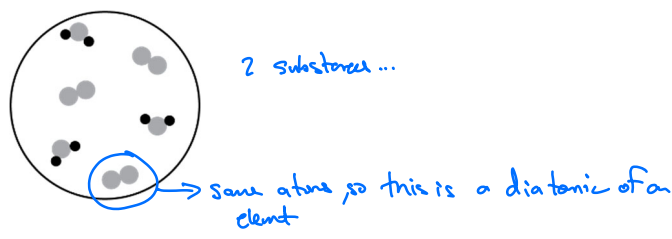
For more practice, please see: Study Questions: SQ3-6 (p. 1-5)

Practice Questions: PQ5-12, PQ-13 (p. 6-7)

Study Question – Chapter 0 (Toolbox)

2A. What is the classification of the diagram shown?

- (A) a pure compound ~~X~~
- (B) a mixture of two elements ~~X~~ molecules ≠ elements
- (C) a mixture of two compounds +
- (D) a mixture of one compound and one element *yes*



Work:



Practice Question – Chapter 0 (Toolbox)

2B. What is the longest length?

- (A)  $10^{-5}$  km
- (B) 1 m
- (C) 100 mm
- (D)  $10^7$  nm

Work:

get all to base unit of m:

$$A.) \frac{10^{-5} \text{ km} | 10^3 \text{ m}}{1 \text{ km}} = 10^{-2} \text{ m}$$

$$B.) 1 \text{ m}$$

$$C.) \frac{100 \text{ mm} | 1 \text{ m}}{10^3 \text{ mm}} = 0.1 \text{ m}$$

$$D.) \frac{10^7 \text{ nm} | 1 \text{ m}}{10^9 \text{ nm}} = 10^{-2} \text{ m}$$

For more practice, please see: Study Questions: SQ1, 7 (p. 1-5)  
 Practice Questions: PQ1-2, 14-15 (p. 6-7)

## Study Question – Chapter 1 (Atomic Structure)

 3A. How many protons, neutrons and electrons are in one atom of aluminum-27 ( $^{27}\text{Al}$ )?

	protons	neutrons	electrons
(A)	13	<del>13</del>	13
(B)	13	14	13
(C)	<del>14</del>	<del>13</del>	14
(D)	<del>13</del>	<del>27</del>	13

$$A = \text{mass \# of element}$$

$$Z = \text{atomic \# of element}$$

$$\text{Al} = \text{atomic \# of } 13 = 13 \text{ protons}$$

$$27 - 13 = 14 \text{ neutrons}$$

$$\text{atom not ion so } \#e^- = \# \text{ protons}$$

Work:

## Practice Question – Chapter 1 (Atomic Structure)

 3B. How many subatomic particles are in one ion of oxygen-18 ( $^{18}\text{O}^{2-}$ )?

	protons	neutrons	electrons
(A)	8	8	6
(B)	8	10	8
(C)	8	10	10
(D)	8	18	8

$$\text{mass \# } 18$$

$$\text{O atomic \# } 8 \text{ so } 8 \text{ protons}$$

$$18 - 8 = 10 \text{ neutrons}$$

$$8(+)\text{ so } 10(-)\text{ to get } 2- \text{ overall}$$

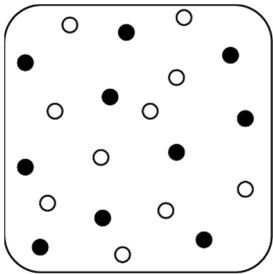
Work:

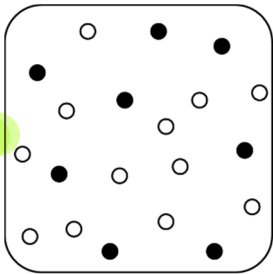
 For more practice, please see: Study Questions: SQ2-4, (p. 16-19)  
 Practice Questions: PQ4-13 (p. 20-22)

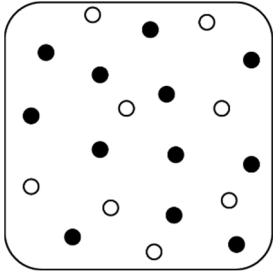
Study Question – Chapter 1 (Atomic Structure)

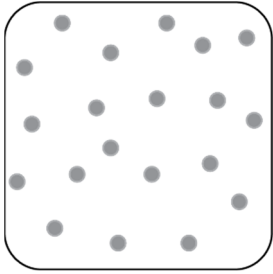
4A. There are two stable isotopes of gallium ( $Z = 31$ ), gallium-69 and gallium-71. Which figure best represents a sample of gallium?

○	= gallium-69
●	= gallium-71
●	= gallium-69.72

(A)   $\circ = 10$   
 $\bullet = 10$

(B)   $\circ = 12$   
 $\bullet = 8$  ✓

(C)   $\circ = 8$   
 $\bullet = 12$

(D) 

Work: mass on periodic table is a weighted average  
 $Ga = 69.723 \text{ g/mol}$  so more 69 than 71  
 but almost equal  
 $12/20 \cdot 69 + 8/20 \cdot 71 = 69.8$  ✓

Practice Question – Chapter 1 (Atomic Structure)

4B. Which set represents isotopes of the same element?

- (A)  ${}_{17}^{35}\text{Cl}$  and  ${}_{17}^{35}\text{Cl}^-$      
 (B)  ${}_{19}^{40}\text{K}$  and  ${}_{20}^{40}\text{Ca}$      
 (C)  ${}_{7}^{14}\text{N}$  and  ${}_{14}^{28}\text{Si}$      
 (D)  ${}_{16}^{34}\text{S}$  and  ${}_{16}^{36}\text{S}$

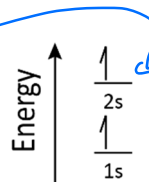
Work: isotope = same protons different # neutrons so different mass

A-) only charge is diff, mass not X  
 D) yep!

For more practice, please see: Study Questions: SQ1, 5-6 (p. 16-19)  
 Practice Questions: PQ1-3, 14-17 (p. 20-22)

Study Question – Chapter 2 (Electronic Structure)

5A. For the orbital diagram of helium shown, what is a possible set of quantum numbers of the excited electron?



- (A) (1, 0, 0, 1/2)      (B) (1, ~~1~~, 0, 1/2)      **(C) (2, 0, 0, 1/2)**      (D) (2, ~~1~~, 0, 1/2)

Work:

$n$ : principal QN ( $n$ ) = shell 1, 2, 3 etc... so here could be 1 or 2

$l$ : angular momentum QN: shape of orbital, so s, p, d  
 $s=0$ ,  $p=1$ ,  $d=2$  ( $n-1$ ) so here both are s so must be zero

$m_l$ : magnetic QN =  $-l \dots 0 \dots +l$  so only zero works

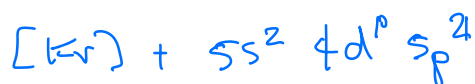
$m_s$ : spin QN:  $+1/2$  or  $-1/2$   $\uparrow$  or  $\downarrow$

Practice Question – Chapter 2 (Electronic Structure)

5B. What is the ground state electron configuration for tin ( $\text{Sn}$ ,  $Z = 50$ )?

- (A)  $[\text{Kr}] 4s^2 3d^{10} 4p^2$       (B)  $[\text{Kr}] 5s^2 4d^{10} 5p^2$   
 (C)  $[\text{Kr}] 5s^2 5d^{10} 5p^2$       (D)  $[\text{Kr}] 5s^2 5p^2$

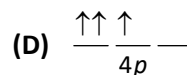
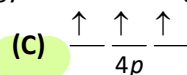
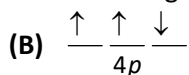
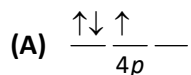
Work:



For more practice, please see: Study Questions: SQ3-6 (p. 26-31)  
 Practice Questions: PQ7-13 (p. 32-34)

## Study Question – Chapter 2 (Electronic Structure)

6A. What is the orbital diagram for the highest energy sublevel of a ground state atom of arsenic (As)?


 Work:  $3e^-$  in  $4p$  all unpaired

 Hund's rule - all  $e^-$  same spin until you double up

## Practice Question – Chapter 2 (Electronic Structure)

6B. Which element has the highest first ionization energy?

(A) As

(B) Ge

(C) Sb

(D) Sn

 Work: highest = holds onto  $e^-$  the most

As is the most EN and the smallest

 For more practice, please see: Study Questions: SQ7-11 (p. 26-31)  
 Practice Questions: PQ14-30 (p. 32-34)

## Study Question – Chapter 3 (Formula Calculations and the Mole)

7A. Which sample contains the greatest number of atoms?

 (A) 1.0 g H<sub>2</sub>O

 (B) 1.0 g H<sub>2</sub>O<sub>2</sub>

 (C) 2.0 g H<sub>2</sub>O

 (D) 2.0 g H<sub>2</sub>O<sub>2</sub>

Work:

Hydrogen is lighter so more atoms per same mass  
 H<sub>2</sub>O 2.0g = more atoms than 1.0g

## Practice Question – Chapter 3 (Formula Calculations and the Mole)

 7B. What is the mass (in g) of  $3.75 \times 10^{22}$  molecules of methanol, CH<sub>3</sub>OH?

molar mass / g·mol <sup>-1</sup>	
CH <sub>3</sub> OH	32.05

(A) 0.0623 g

(B) 0.501 g

(C) 2.00 g

(D) 16.1 g

Work:

$$\frac{3.75 \times 10^{22} \text{ molecules CH}_3\text{OH}}{6.022 \times 10^{23} \text{ molecules / mol}} \times \frac{1 \text{ mol}}{1 \text{ mol}} \times \frac{32.05 \text{ g}}{1 \text{ mol}} = 2.00 \text{ g}$$

For more practice, please see: Study Questions: SQ1-5 (p. 37-42)

Practice Questions: PQ1-18 (p. 42-44)

## Study Question – Chapter 3 (Formula Calculations and the Mole)

8A. What is the empirical formula for a hydrocarbon containing 83.6% carbon and 16.4% hydrogen by mass?

(A) CH<sub>2</sub>

(B) CH<sub>2.33</sub>

(C) C<sub>3</sub>H<sub>7</sub>

(D) C<sub>5</sub>H

Work:

$$\frac{83.6\text{g C} / 12.011\text{g C}}{12.011\text{g C}} = \frac{6.96\text{ mol C}}{6.96} = 1 \times 3 = \boxed{\text{C}_3\text{H}_7}$$

$$\frac{16.4\text{g H} / 1.00794\text{g}}{1.00794\text{g}} = \frac{16.3}{6.96} = 2.33 \times 3$$

## Practice Question – Chapter 3 (Formula Calculations and the Mole)

8B. Which compound has the greatest percent composition by mass of chlorine?

(A) KClO<sub>3</sub>

(B) KClO<sub>4</sub>

(C) NaClO<sub>3</sub>

(D) NaClO<sub>4</sub>

Work:

Less oxygens = more mass % to Cl

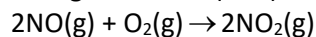
Na is less mass than K so (C)

For more practice, please see: Study Questions: SQ6-8 (p. 37-42)

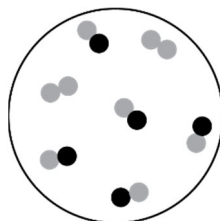
Practice Questions: PQ19-30 (p. 42-44)

## Study Question – Chapter 4 (Stoichiometry)

9A. Nitrogen monoxide (NO) can react with oxygen to produce nitrogen dioxide (NO<sub>2</sub>):



Given the reaction vessel shown, how many moles of NO<sub>2</sub> can be made if each molecule represents 1.0 mole?



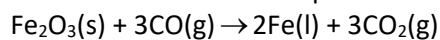
- (A) 2.0 mol NO<sub>2</sub>      (B) 2.5 mol NO<sub>2</sub>      (C) 4.0 mol NO<sub>2</sub>      (D) 5.0 mol NO<sub>2</sub>

Work:

5 moles NO and 2 mol O<sub>2</sub> 2:1 molar ratio in rxn  
O<sub>2</sub> is limiting so 4 moles of NO<sub>2</sub>  
are produced

## Practice Question – Chapter 4 (Stoichiometry)

9B. Iron(III) oxide can react with carbon monoxide to produce liquid iron and carbon dioxide:



What mass (in g) of carbon monoxide is needed to produce 275 g of iron?

- (A) 69.0 g      (B) 91.9 g      (C) 207 g      (D) 414 g

molar mass / g·mol <sup>-1</sup>	
CO	28.01
Fe	55.85

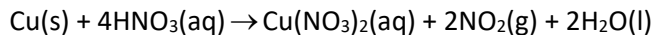
Work:

$$\frac{275\text{g Fe}}{55.85\text{g Fe}} \times \frac{1\text{mol Fe}}{2\text{mol Fe}} \times \frac{3\text{mol CO}}{1\text{mol CO}} \times \frac{28.01\text{g}}{1\text{mol CO}} =$$

For more practice, please see: Study Questions: SQ3-4 (p. 48-51)  
Practice Questions: PQ7-18 (p. 52-55)

Study Question – Chapter 4 (Stoichiometry)

**10A.** Copper will react with nitric acid (HNO<sub>3</sub>) to produce copper(II) nitrate (Cu(NO<sub>3</sub>)<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and water:



molar mass / g·mol <sup>-1</sup>	
Cu	63.55
NO <sub>2</sub>	46.01

Suppose NO<sub>2</sub> is produced at a percent yield of 85%. What mass (in g) of copper needs to be used in an excess of HNO<sub>3</sub> to experimentally produce 10.0 g of NO<sub>2</sub>?

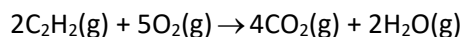
- (A) 5.9 g Cu      (B) 8.1 g Cu      (C) 12 g Cu      (D) 16 g Cu

Work: *because it's only produced at 85% we need to produce we are using 100%*  
 $10.0 \times 0.85 = 10.0 \text{g}$  so  $10.0 / 0.85 = 11.76 \text{g}$  if 100%

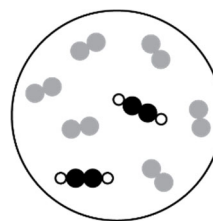
$$\frac{11.76 \text{g NO}_2}{46.01 \text{g NO}_2} \times \frac{1 \text{mol NO}_2}{2 \text{mol NO}_2} \times \frac{1 \text{mol Cu}}{1 \text{mol Cu}} \times \frac{63.55}{1 \text{mol Cu}} = 8.12 \text{g Cu}$$

Practice Question – Chapter 4 (Stoichiometry)

**10B.** Acetylene (C<sub>2</sub>H<sub>2</sub>) reacts with oxygen to produce carbon dioxide and water:



Given the diagram to the right, what is the limiting reactant and what does the reaction vessel look like when the reaction is over (assuming 100% yield)?



*O: 6*

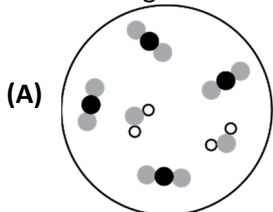
*C2H2 = 2*

*so C2H2 is limiting*

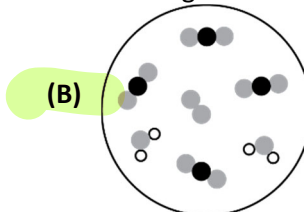
*make 4 CO2*

*2 H2O ; one water O2*

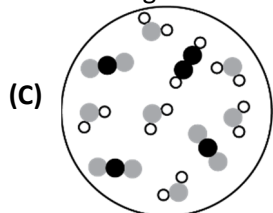
Limiting reactant = C<sub>2</sub>H<sub>2</sub>



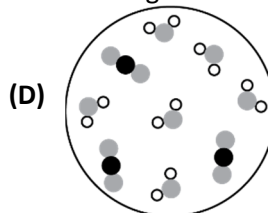
Limiting reactant = C<sub>2</sub>H<sub>2</sub>



Limiting reactant = O<sub>2</sub>



Limiting reactant = O<sub>2</sub>



Work:

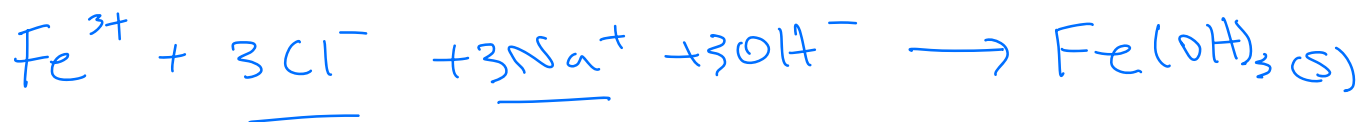
For more practice, please see: Study Questions: SQ5-7 (p. 48-51)  
 Practice Questions: PQ19-30 (p. 52-55)

## Study Question – Chapter 5 (Solutions and Aqueous Reactions)

11A. When iron(III) chloride ( $\text{FeCl}_3$ ) and sodium hydroxide ( $\text{NaOH}$ ) are mixed, the precipitate iron(III) hydroxide ( $\text{Fe}(\text{OH})_3$ ) forms. What are the spectator ions in this reaction?

- (A)  $\text{Fe}^{3+}$  and  $\text{Cl}^-$       (B)  $\text{Fe}^{3+}$  and  $\text{OH}^-$       (C)  $\text{Na}^+$  and  $\text{Cl}^-$       (D)  $\text{Na}^+$  and  $\text{OH}^-$

Work:



## Practice Question – Chapter 5 (Solutions and Aqueous Reactions)

11B. What is the oxidation number of nitrogen in  $\text{Fe}(\text{NO}_2)_3$ ?

- (A) +5      (B) +4      (C) +3      (D) -3

Work:



$$\begin{array}{l} \text{N: } 1x - = +3 \\ \text{O: } 2x - 2 = -4 \\ \hline \text{overall} = -1 \end{array}$$

For more practice, please see: Study Questions: SQ5-11 (p. 58-63)  
Practice Questions: PQ14-30 (p. 64-67)

## Study Question – Chapter 5 (Solutions and Aqueous Reactions)

12A. What mass (in g) of calcium chloride ( $\text{CaCl}_2$ ) is needed to make 125 mL of 0.100 M  $\text{Cl}^-$ ?

molar mass / $\text{g}\cdot\text{mol}^{-1}$	
$\text{CaCl}_2$	110.98

(A) 0.113 g

(B) 0.694 g

(C) 1.39 g

(D) 2.77 g

Work:

$$\frac{0.100 \text{ mol Cl}^-}{1} \times \frac{0.125 \cancel{\text{ L}}}{1} \times \frac{1 \text{ mol CaCl}_2}{2 \text{ mol Cl}^-} \times \frac{110.98}{1 \text{ mol}} = \boxed{0.694 \text{ g}}$$

## Practice Question – Chapter 5 (Solutions and Aqueous Reactions)

12B. What volume of water (in mL) must be added to a 1.25 M  $\text{HNO}_3$  solution to make 250. mL of a 0.575 M solution?

(A) 70. mL

(B) 115 mL

(C) 135 mL

(D) 180. mL

Work:

$$M_1 V_1 = M_2 V_2 \quad V_1 = \frac{M_2 V_2}{M_1} = \frac{250 \text{ mL} \cdot 0.575 \text{ M}}{1.25 \text{ M}} = V_1 = 115 \text{ mL original volume}$$

$$\text{Water Volume} = 250 - 115 \text{ mL} = \boxed{135 \text{ mL}}$$

For more practice, please see: Study Questions: SQ1-4 (p. 58-63)  
Practice Questions: PQ1-10 (p. 64-67)

Study Question – Chapter 5 (Solutions and Aqueous Reactions)

**13A.** Aluminum nitrate ( $\text{Al}(\text{NO}_3)_3$ ) reacts with sodium sulfide ( $\text{Na}_2\text{S}$ ) to form a precipitate:  $2\text{Al}(\text{NO}_3)_3(\text{aq}) + 3\text{Na}_2\text{S}(\text{aq}) \rightarrow \text{Al}_2\text{S}_3(\text{s}) + 6\text{NaNO}_3(\text{aq})$

molar mass / $\text{g}\cdot\text{mol}^{-1}$	
$\text{Al}_2\text{S}_3$	150.17

When reacting 25.0 mL of the aluminum nitrate solution with an excess of sodium sulfide, 1.085 g of the precipitate is recovered at a 91.8% yield. What was the molar concentration of the aluminum nitrate solution?

- (A) 0.157 M      (B) 0.315 M      (C) 0.531 M      **(D) 0.630 M**

Work:

1st: theoretical yield =  $X - 0.918 = 1.085 \text{ g Solid}$      $X = 1.085 / 0.918 = 1.182 \text{ g Product (if 100\% yield)}$   
↑ % yield

2nd - work backwards:  $\frac{1.182 \text{ g Al}_2\text{S}_3}{150.17 \text{ g Al}_2\text{S}_3} \times \frac{1 \text{ mol Al}_2\text{S}_3}{1 \text{ mol Al}_2\text{S}_3} \times \frac{2 \text{ mol Al}(\text{NO}_3)_3}{1 \text{ mol Al}_2\text{S}_3} \times \frac{1}{0.0250 \text{ L soln}} = 0.630 \text{ M Al}(\text{NO}_3)_3$

Practice Question – Chapter 5 (Solutions and Aqueous Reactions)

**13B.** During a titration, a strong acid ( $\text{H}_2\text{SO}_4$ ) can react with a strong base (KOH) to produce water and a salt:  $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{KOH}(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{K}_2\text{SO}_4(\text{aq})$

If 38.45 mL of a 0.193 M solution of KOH is needed to neutralize 25.0 mL of  $\text{H}_2\text{SO}_4$ , what is the molar concentration of the  $\text{H}_2\text{SO}_4$  solution?

- (A) 0.125 M      **(B) 0.148 M**      (C) 0.297 M      (D) 0.594 M

Work:

$\frac{0.193 \text{ mol KOH}}{1 \text{ L}} \times \frac{0.03845 \text{ L}}{1} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol KOH}} \times \frac{1}{0.0250 \text{ L}} = 0.148 \text{ M H}_2\text{SO}_4$

For more practice, please see: Study Questions: SQ1-4 (p. 58-63)  
 Practice Questions: PQ11-13 (p. 64-67)

Study Question – Chapter 6 (Heat and Enthalpy)

**14A.** A 35 °C piece of copper with a mass of 25 g is placed into 25 mL of water at 25 °C. Both the metal and water reach the same final temperature. Assuming no heat is lost to the surroundings, what is true?

specific heat / J·g <sup>-1</sup> ·°C <sup>-1</sup>	
Cu	0.385
H <sub>2</sub> O	4.18

- (A)  $\Delta T_{\text{Cu}} > 0$       (B)  $\Delta T_{\text{water}} < 0$       (C)  $|\Delta T_{\text{Cu}}| > |\Delta T_{\text{water}}|$       (D)  $|\Delta T_{\text{Cu}}| < |\Delta T_{\text{water}}|$

Work:

~~X.A.)~~ No, the hot metal will cool off, so  $\Delta T_{\text{Cu}}$  is negative  $\Delta T = T_F - T_i = T_F > 25 < 35$  so...  $\sim 30$ ?  
 $30 - 35 = -5^\circ\text{C}$  (made up #)

~~X.B.)~~  $\Delta T_{\text{H}_2\text{O}}$  is positive,  $\Delta T = \sim 30 - 25 = \sim 5^\circ\text{C}$

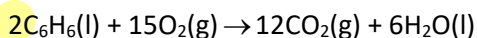
✓ C.) The heat capacity of the metal & the water are not the same, the heat lost & gained is the same

$C_m \Delta T = C_m \Delta t$   
 $0.385 \cdot 25 \cdot \Delta T_{\text{Cu}} = 4.18 \cdot 25 \cdot \Delta T_{\text{H}_2\text{O}}$

because  $C_{\text{H}_2\text{O}}$  is high,  $\Delta T_{\text{H}_2\text{O}}$  needs to be lower ✓

Practice Question – Chapter 6 (Heat and Enthalpy)

**14B.** What is the standard molar enthalpy of combustion of benzene (C<sub>6</sub>H<sub>6</sub>(l))?



$\Delta H_f^\circ / \text{kJ}\cdot\text{mol}^{-1}$	
C <sub>6</sub> H <sub>6</sub> (l)	49.2
CO <sub>2</sub> (g)	-393.5
H <sub>2</sub> O(l)	-285.8

- (A) -6535.2 kJ·mol<sup>-1</sup>      (B) -3267.6 kJ·mol<sup>-1</sup>      (C) -728.5 kJ·mol<sup>-1</sup>      (D) -630.1 kJ·mol<sup>-1</sup>

Work:

$\Delta H_{\text{rxn}}^\circ = ? \sum [\Delta H_{\text{f,prod}}^\circ] - \sum [\Delta H_{\text{f,react}}^\circ]$

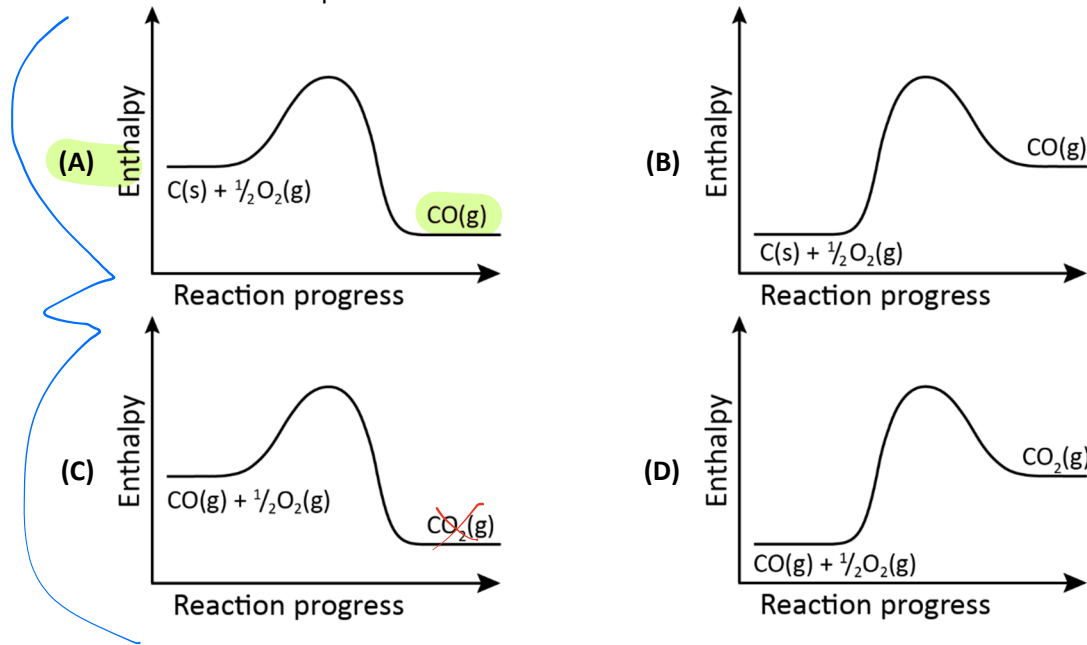
$= [12\text{mol} \cdot -393.5 + 6\text{mol} \cdot -285.8] - [2\text{mol} \cdot 49.2 + 15\text{mol} \cdot 0 \text{ (pure elem)}] = \frac{-6535.2 \text{ kJ}}{2 \text{ mol C}_6\text{H}_6} = \boxed{-3267.6 \text{ kJ/mol}}$

↑  
because it's reported per mol of substance

For more practice, please see: Study Questions: SQ2-5, 9 (p. 69-75)  
 Practice Questions: PQ3-12, 23-30 (p. 75-79)

Study Question – Chapter 6 (Heat and Enthalpy)

15A. The enthalpy of formation of CO(g) is  $-110.5 \text{ kJ}\cdot\text{mol}^{-1}$ . Which energy diagram shows this with the correct reactants and products?



Work:

only A or C show an exothermic process, C is the wrong product

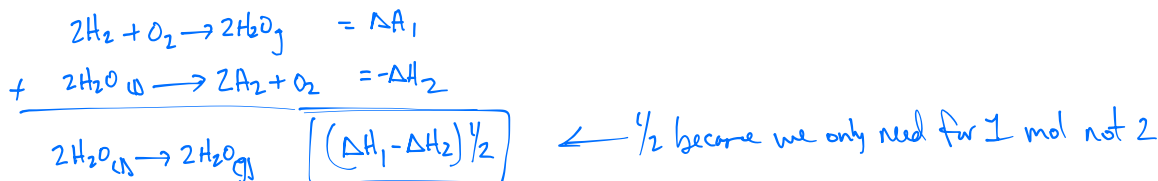
Practice Question – Chapter 6 (Heat and Enthalpy)

15B. What is the standard enthalpy of vaporization of water given the two thermochemical equations provided?

$2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{H}_2\text{O(g)}$	$\Delta H_1^\circ$
$2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{H}_2\text{O(l)}$	$\Delta H_2^\circ$

- (A)  $\Delta H_1^\circ - \Delta H_2^\circ$       (B)  $\Delta H_2^\circ - \Delta H_1^\circ$       (C)  $\frac{1}{2}(\Delta H_1^\circ - \Delta H_2^\circ)$       (D)  $\frac{1}{2}(\Delta H_2^\circ - \Delta H_1^\circ)$

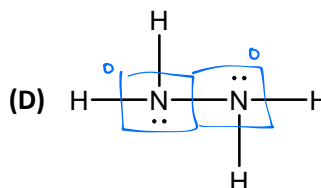
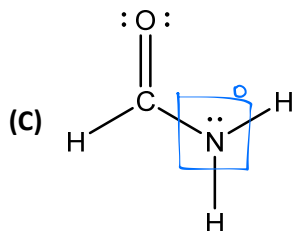
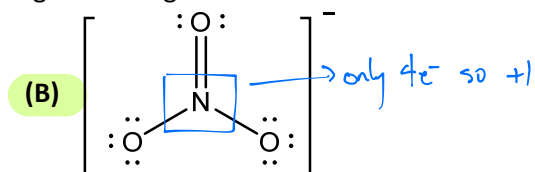
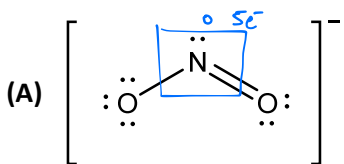
Work: Systems of equations approach:



For more practice, please see: Study Questions: SQ6-8 (p. 69-75)  
 Practice Questions: PQ13-22 (p. 75-79)

Study Question – Chapter 7 (Structure and Bonding)

16A. Which molecule or ion has a non-zero formal charge on nitrogen?



Work:

Practice Question – Chapter 7 (Structure and Bonding)

16B. Which compound has the highest lattice energy?

(A) CaO

(B) KCl

(C) MgO

(D) NaCl

Work: More charge = bigger lattice energy - so  $\text{Ca}^{2+} \text{O}^{2-}$  or  $\text{Mg}^{2+} \text{O}^{2-}$

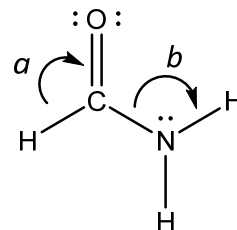
Smaller atoms/ions = closer = higher lattice energy = MgO

For more practice, please see: Study Questions: SQ1-5 (p. 82-91)  
 Practice Questions: PQ1-12, 15-16 (p. 91-95)

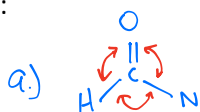
Study Question – Chapter 7 (Structure and Bonding)

17A. What are the two marked bond angles in the structure shown?

- (A)  $a = 120^\circ$  and  $b = 120^\circ$
- (B)  $a = 109.5^\circ$  and  $b = 120^\circ$
- (C)  $a = 120^\circ$  and  $b = 109.5^\circ$**
- (D)  $a = 109.5^\circ$  and  $b = 109.5^\circ$



Work:



3 charge clouds  $\approx 120^\circ$   
 $360/3 \approx 120^\circ$

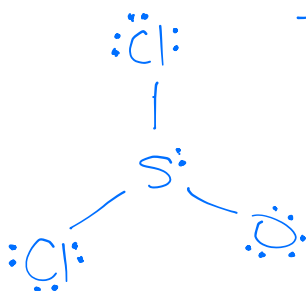


Practice Question – Chapter 7 (Structure and Bonding)

17B. What is the shape of  $\text{SOCl}_2$ ?

- (A) t-shaped
- (B) tetrahedral
- (C) trigonal planar
- (D) trigonal pyramidal**

Work:  $\sum e = 6 + 6 + 2 \times 7 = 26 e^-$   
 $- 6 \text{ bonding} = 20 e^-$  (outer most  $e^-$  is)



Electroniz = 4 charge clouds = tetrahedral

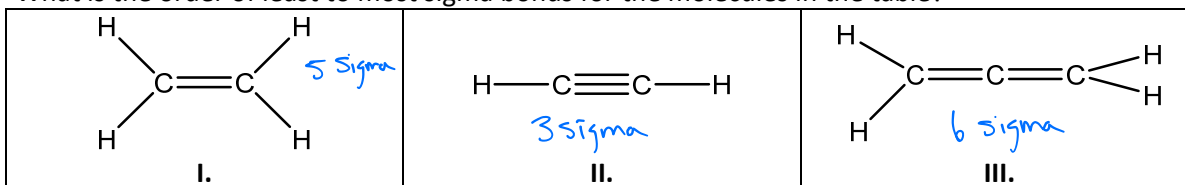
Molecular: lone pair affects shape but not a bond, so a 3 sided pyramid  
 trigonal pyramidal



For more practice, please see: Study Questions: SQ8-9 (p. 82-91)  
 Practice Questions: PQ17-20 (p. 91-95)

Study Question – Chapter 7 (Structure and Bonding)

18A. What is the order of least to most sigma bonds for the molecules in the table?



(A) I. < II. < III.

(B) I. = III. < II.

(C) II. < I. = III.

**(D) II. < I. < III.**

Work:

The 1st bond is always sigma

Practice Question – Chapter 7 (Structure and Bonding)

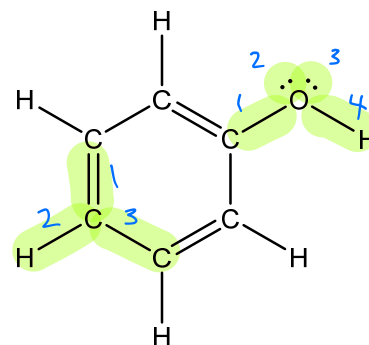
18B. What is the hybridization on any carbon atom and the oxygen atom in phenol (shown)?

(A) C = sp and O = sp<sup>2</sup>

(B) C = sp and O = sp<sup>3</sup>

(C) C = sp<sup>2</sup> and O = sp<sup>2</sup>

**(D) C = sp<sup>2</sup> and O = sp<sup>3</sup>**



Count # of areas of bonding or lone pairs

C:  $s + p + p = sp^2$   
           1   2   3

O:  $s + p + p + p = sp^3$

Work:

For more practice, please see: Study Questions: SQ11-12 (p. 82-91)  
 Practice Questions: PQ24-28 (p. 91-95)

Study Question – Chapter 8 (States of Matter)

19A. What is the density of argon at 125°C and 2.0 atm of pressure?

molar mass / g·mol <sup>-1</sup>	
Ar	39.95

- (A) 0.61 g·L<sup>-1</sup>      (B) 1.8 g·L<sup>-1</sup>      (C) 2.5 g·L<sup>-1</sup>      (D) 7.8 g·L<sup>-1</sup>

Work:  $PV = nRT$      $D = \frac{m}{V}$

$$\text{Mass} = n \cdot \frac{\text{g/mol}}{\text{molar mass}}$$

$P = 2 \text{ atm}$      $V = ?$      $n = ?$  just use  
 $R = 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$      $T = 398 \text{ K}$

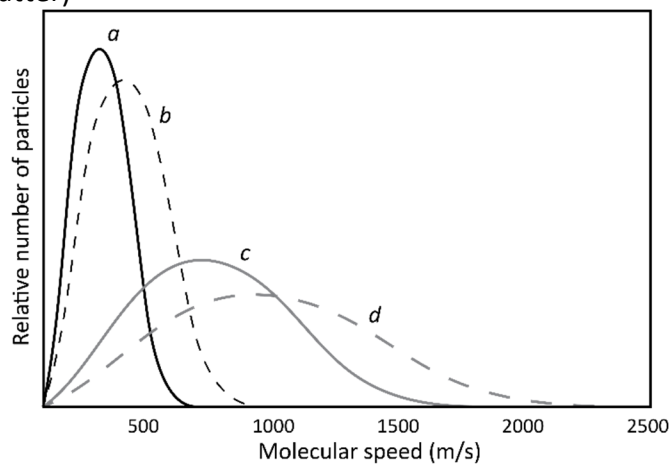
$$V = \frac{nRT}{P} = \frac{1 \cdot 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \cdot 398 \text{ K}}{2 \text{ atm}} = 16.35 \text{ L}$$

$$D = \frac{39.95 \text{ g}}{16.35 \text{ L}} \approx 2.4 \text{ g/L}$$

Practice Question – Chapter 8 (States of Matter)

19B. For the gases plotted in the figure, what is known?

- (A) Gas *b* is hotter than gas *a*.  
 (B) Gas *c* is lighter than gas *d*.  
 (C) If all of the gases are the same gas, gas *d* is the coldest.  
 (D) If all of the gases are at the same temperature, gas *a* is the heaviest.



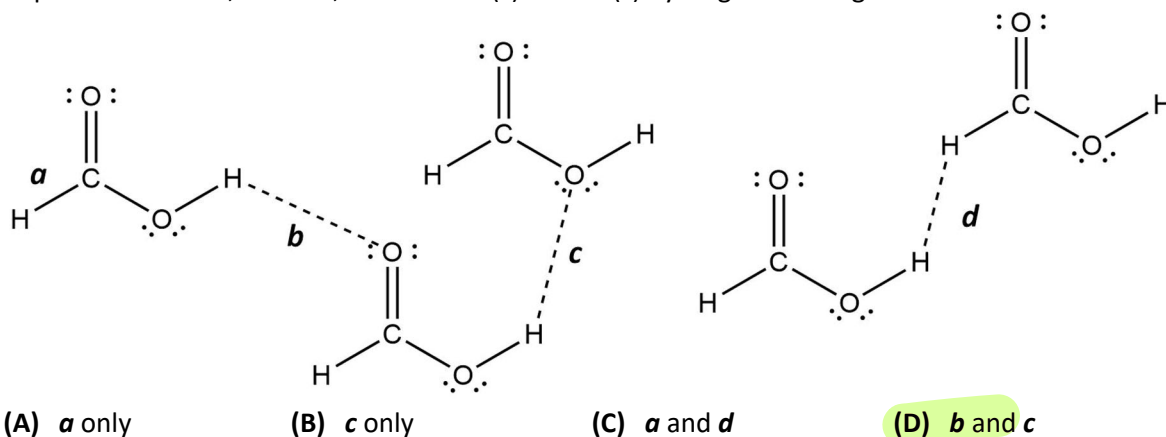
Work:

distribution of speeds spreads out with temp so...  
 larger gases = slower speeds

For more practice, please see: Study Questions: SQ1-6 (p. 98-104)  
 Practice Questions: PQ1-17 (p. 104-108)

Study Question – Chapter 8 (States of Matter)

20A. In pure formic acid,  $\text{HCOOH}$ , which letter(s) denote(s) hydrogen bonding?



Work:

*H → lone pair on a neighboring lone pair on a N O F*

Practice Question – Chapter 8 (States of Matter)

20B. Between  $\text{NF}_3$  and  $\text{NCl}_3$ , which substance has the highest boiling point and why?

- (A)  $\text{NCl}_3$ , because it is polar and  $\text{NF}_3$  isn't.
- (B)  $\text{NF}_3$ , because it is polar and  $\text{NCl}_3$  isn't.
- (C)  $\text{NCl}_3$ , because it has more electrons than  $\text{NF}_3$ .
- (D)  $\text{NF}_3$ , because it can participate in hydrogen bonding and  $\text{NCl}_3$  can't.

Work:

*$\text{NCl}_3$ , Cl has more electrons and is bigger. We don't cover this at UWG until Chem 1212*

For more practice, please see: Study Questions: SQ7-9 (p. 98-104)  
Practice Questions: PQ18-25 (p. 104-108)



**Good luck on your final exam!**

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