

Chemistry 11 Fall 2007
Examination #2 ANSWER KEY

For the first portion of this exam, select the best answer choice for the questions below and mark the answers on your scantron. Then answer the free response questions that follow (100 pts. total; multiple choice 2 pts. each).

- Of the following, which would be most *immiscible* in $\text{CCl}_4(l)$?
 - NH_3
 - $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
 - CO_2
 - I_2
 - $\text{CH}_3\text{CH}_2\text{CH}_3$
- Determine the mass (in g) of 0.250 mol of CaCO_3 .
 - 4.00×10^2 g
 - 25.0 g**
 - 4.00×10^{-2} g
 - 2.50×10^{-3} g
 - 17.0 g
- Calculate the number of chromium atoms in 78.82 g of $\text{K}_2\text{Cr}_2\text{O}_7$.
 - 2.248×10^{24} Cr atoms
 - 1.124×10^{24} Cr atoms
 - 3.227×10^{23} Cr atoms**
 - 1.613×10^{23} Cr atoms
 - 6.626×10^{23} Cr atoms
- Select the strongest electrolyte from the given set below:
 - $\text{C}_{12}\text{H}_{22}\text{O}_{11}(\text{aq})$
 - $\text{MgCl}_2(\text{aq})$**
 - $\text{HF}(\text{aq})$
 - $\text{HC}_2\text{H}_3\text{O}_2(\text{aq})$
 - pure H_2O

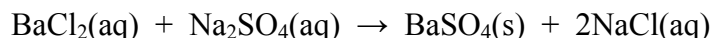
5. Consider the following liquids with similar molar masses. Predict which has the *weakest* intermolecular attractions based on the vapor pressure data provided below at 20 °C:
- A. acetic acid (vapor pressure = 14 mm Hg)
 - B. ethyl chloride (vapor pressure = 1050 mm Hg)
 - C. ethyl methyl ether (vapor pressure = 1260 mm Hg)
 - D. butane (vapor pressure = 1550 mm Hg)**
 - E. isopropyl alcohol (vapor pressure = 35 mm Hg)
6. In the combustion of 0.1127 g of glucose ($C_6H_{12}O_6$), what mass (in g) of CO_2 is produced? *Hint: begin with the balanced chemical equation!*
- A. 0.0451 g
 - B. 0.0825 g
 - C. 0.1652 g**
 - D. 0.4132 g
 - E. 1.466 g
7. Which intermolecular force found in CH_2Cl_2 is the *strongest*?
- A. London dispersion forces
 - B. Dipole-dipole forces**
 - C. Hydrogen bonding
 - D. Van der Waals forces
 - E. None of the above
8. Gases tend to behave ideally at:
- A. low temperature and low pressure
 - B. low temperature and high pressure
 - C. high temperature and low pressure**
 - D. high temperature and high pressure
 - E. low volumes
9. The phenomenon in which a steel needle can (with proper care) be made to float on the surface of some water illustrates a property of liquids known as:
- A. polarizability
 - B. dynamic equilibrium
 - C. vapor pressure
 - D. surface tension**
 - E. saturation

10. Determine the pH of a 0.0039 M H_3O^+ solution.
- A. 1.41
 - B. 2.41**
 - C. 3.41
 - D. 7.00
 - E. 3.90
11. Which of the following pairs are INVERSELY proportional?
- A. V and n
 - B. V and T
 - C. P and T
 - D. T and n**
 - E. P and n
12. Which of the following statements are consistent with the Kinetic Molecular Theory of Gases?
- A. Gases are compressible because the volume of atoms is almost entirely open space.
 - B. Gases assume the shape and volume of their container because they are in constant, random motion.
 - C. Gas particles collide with each other without losing any energy.
 - D. The average kinetic energy of molecules does NOT change with time as long as the temperature remains constant.
 - E. All of the above statements are consistent with the Kinetic Molecular Theory.**
13. When a liquid is in dynamic equilibrium with its vapor at a given temperature, which of the following is true?
- A. There is no transfer of molecules between the liquid and vapor phases.
 - B. Evaporation and condensation occur at equal rates.**
 - C. The rate of evaporation can never fully equal the rate of condensation.
 - D. Vapor molecules escape the heated system.
 - E. Boiling of the liquid ceases to occur.

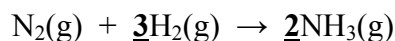
For Questions 14 – 15, consider the following: a 9.00 M solution HNO_3 of unknown volume is diluted to make 6.50 L of a 1.25 M solution.

14. Determine the volume of the 9.00 M solution needed for the dilution.
- A. 748 mL
 - B. 903 mL**
 - C. 1.10 L
 - D. 1.73 L
 - E. 6.50 L
15. How much water must be added to the 9.00 M solution in order to make the dilution?
- A. 5.75 L
 - B. 5.60 L**
 - C. 5.40 L
 - D. 4.77 L
 - E. 6.50 L
16. Consider that a 4.0 L sample of $\text{N}_2(\text{g})$ at 760 mm Hg is compressed at constant temperature to 3.2 atm. What is the final gas volume?
- A. 94.6 L
 - B. 78.3 L
 - C. 1.13 L
 - D. 1.25 L**
 - E. 0.252 L
17. Atoms of the same element that have different numbers of neutrons in their nuclei are called what?
- A. cations
 - B. anions
 - C. isoelectronic
 - D. isotopes**
 - E. radioactive

18. How many mL of 0.218 M sodium sulfate react with exactly 25.34 mL of 0.113 M BaCl₂ given the following balanced reaction?



- A. **13.1 mL**
B. 26.3 mL
C. 24.6 mL
D. 2.86 mL
E. 25.34 mL
19. What is the weight of glycine in a 400 g sample of a solution which is 2.5% (w/w)?
- A. 1.0 g
B. 2.5 g
C. **10. g**
D. 25 g
E. 160 g
20. How many protons, neutrons, and electrons are there in ⁵⁸Fe⁺³?
- A. 58 protons, 26 neutrons, and 55 electrons
B. 26 protons, 58 neutrons, and 23 electrons
C. 26 protons, 23 neutrons, and 58 electrons
D. **26 protons, 32 neutrons, and 23 electrons**
E. 26 protons, 32 neutrons, and 29 electrons
21. (6 pts.) What is the volume (in L) of a sample of ethane at 194 °C and 111 kPa if it occupies 405 cm³ at 298 K and 1800 mm Hg?
- $$\frac{P_o V_o}{T_o} = \frac{P_f V_f}{T_f} \quad \text{***Make sure to convert T, V, and P!}$$
- $$V_f = \frac{T_f P_o V_o}{P_f T_o} = \boxed{1.37 \text{ L}}$$
22. (16 pts. total) Consider the Haber Process for the synthesis of ammonia when 30.0 g N₂ and 10.0 g H₂ react:



- A. (3 pts.) Write the balanced chemical equation for this process. **See above**
- B. (10 pts.) What is the theoretical yield of NH₃ (in grams)? Clearly label both the limiting and excess reagents.

$$\text{g NH}_3 = 30.0 \text{ g N}_2 \times \frac{1 \text{ mol N}_2}{28.0 \text{ g}} \times \frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} \times \frac{17.0 \text{ g NH}_3}{1 \text{ mol}} = \boxed{36.4 \text{ g NH}_3}$$

$$\text{g NH}_3 = 10.0 \text{ g H}_2 \times \frac{1 \text{ mol H}_2}{2.0 \text{ g}} \times \frac{2 \text{ mol NH}_3}{3 \text{ mol N}_2} \times \frac{17.0 \text{ g NH}_3}{1 \text{ mol}} = 56.7 \text{ g NH}_3$$

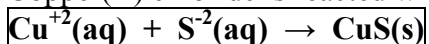
***The limiting reactant is N₂; the excess reagent is H₂.

- C. (3 pts.) Determine the percent yield of the reaction if 32.1 g of the product is obtained.

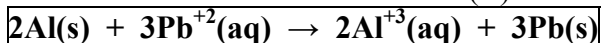
$$\% \text{ Yield} = 100 * (\text{Actual/Theoretical}) = 100 * (32.1 \text{ g} / 36.4 \text{ g}) = \boxed{88.2\%}$$

23. (20 pts. total; 4 pts. each) Write BALANCED equations (net ionic where appropriate) for each laboratory situation. Assume that solutions are aqueous unless otherwise indicated. Write NR if no reaction occurs.

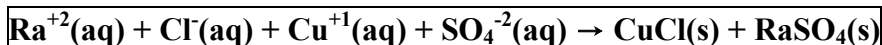
- A. Copper(II) chloride is reacted with ammonium sulfide.



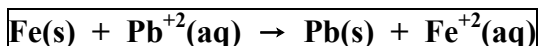
- B. Solid aluminum is reacted with lead(II) acetate.



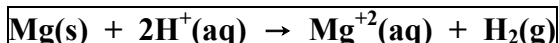
- C. Radium chloride is mixed with copper(I) sulfate.



- D. Iron metal is added to a solution of lead(II) nitrate.



- E. Solid magnesium is reacted with hydrobromic acid, HBr(aq).



24. (6 pts.) What is the molar mass (in g/mol) of a gas if 0.0494 g of the gas occupies a volume of 100 mL at a temperature of 15 °C and a pressure of 4.09 x 10³ Pa?

$$\text{mass} = 0.0494 \text{ g}$$

$$\text{PV} = n\text{RT} \Rightarrow n = 1.71 \times 10^{-4} \text{ mol} \quad \text{***Make sure to convert T, V, and P!}$$

$$\text{Molar Mass (g/mol)} = \boxed{290.6 \text{ g/mol}}$$

25. (12 pts. total; 2 pts. each) **SHORT ANSWER!** Fill-in the blanks regarding the various items below:
- A. The process of **inhalation or inspiration** begins when the diaphragm contracts and the rib cage expands, causing an increase in the volume of the thoracic cavity.
 - B. With each beat of the heart, blood is pushed into the arteries, causing a temporary increase in blood pressure called the **systolic** pressure.
 - C. The most important example of an acid/base buffer system in the body is the **carbonic acid/sodium hydrogen carbonate (bicarbonate)** system.
 - D. The second most important example of an acid/base buffer system in the body is the **hydrogen phosphate ion/dihydrogen phosphate ion** system.
 - E. As blood moves down the arteries and the heart prepares for another beat, the blood pressure drops temporarily, and the lowest pressure reached is called the **diastolic** pressure.
 - F. In certain diseases, the chest becomes paralyzed, and the affected person cannot move either the diaphragm or the rib cage. In such a case, a **respirator** is used to help the person breathe.