Exam 3

# Part 1: Multiple Choice (2 points each)

## Directions: Please circle the *best* answer for each of the following questions.

1. Some solutes have solutions that do not conduct electricity. Which of the following terms best describes these solutes?
	1. Highly charged ions
	2. Ions with fractional charges
	3. Nonconductor
	4. Weak electrolyte
	5. Cation solutions
2. Consider the following particulate-level representation of a reaction. How would this reaction be classified?
	1. Combination
	2. Single Replacement
	3. Double Replacement
	4. Acid-base neutralization
	5. Decomposition
3. Which of the following is not necessarily evidence of a chemical reaction?
4. permanent color change
5. bubbles
6. formation of a precipitate
7. emission of light
8. all of the above
9. How many joules are in 4,000 kilocalories?
10. 16.74 joules
11. 1674 joules
12. 0.9560 joules
13. 9,560 joules
14. none of the above
15. How many moles of water can be formed from 2.10 moles of hydrogen and excess oxygen gas?

2 H2 (g) + O2 (g) → 2 H2O (l)

* 1. 1 mole water
	2. 1.10 moles water
	3. 2 moles water
	4. 2.10 moles water
	5. 5.50 moles water
1. Which of the following has a volume that consists of mostly empty space?
	1. I2 (s)
	2. Br2 (l)
	3. F2 (g)
	4. Na (s)
	5. H2O (l)
2. The temperature of a gas is a measure of
	1. the number of gas particles.
	2. the volumes of the gas particles.
	3. the amount of space between gas particles.
	4. the kinetic energy of the gas particles.
	5. all of the above
3. Which of the following does not represent a property of a gas?
4. low energy
5. indefinite shape
6. compressible
7. fast moving
8. all of the above
9. Calcium metal and copper(II) nitrate solution are mixed. Over time the blue solution slowly becomes colorless and a precipitate begins to form on the metal. Which of the following is correct?
	1. Calcium is more active than copper.
	2. The balanced reaction is: Ca (s) + Cu(NO3)2 (aq) → Ca(NO3)2 (aq) + Cu (s)
	3. This is a single replacement reaction.
	4. b and c
	5. all of the above
10. The best rule for disposal of waste from a chemistry lab is
	1. into chemical waste receptacles unless instructed otherwise.
	2. down the sink unless instructed otherwise.
	3. into trash cans unless instructed otherwise.
	4. both a and b
	5. all of the above

# Part 2: Short Answer

## Directions: Answer each of the following questions. Be sure to use complete sentences where appropriate. For full credit be sure to show all of your work.

1. What is meant by the physical state of a substance? What symbols are used to represent these physical states and what does each symbol mean (4 points)?

The physical state of a substance refers to whether the substance is a gas (g), a liquid (l), a solid (s), or an aqueous solution (aq).

1. Two solutions of lithium phosphate, Li3PO4, and chromium(II) chloride, CrCl2, are mixed (9 points).
	1. What is the evidence of reaction? \_\_\_\_\_\_There will be a precipitate. You should see some solid on the bottom of the test tube.
	2. Write the correctly balanced chemical equation, total ionic equation, and net ionic equation. Be sure to include state labels on your equations.

|  |  |
| --- | --- |
| Conventional | 2 Li3PO4 (aq) + 3 CrCl2 (aq) → 6 LiCl (aq) + Cr3(PO4)2 (s) |
| Total Ionic | 6 Li+ (aq) + 2 PO43- (aq) + 3 Cr3+ (aq) + 6 Cl- (aq) → 6 Li+ (aq) + 6 Cl- (aq) + Cr3(PO4)2 (s) |
| Net Ionic  | 2 PO43- (aq) + 3 Cr3+ (aq) → Cr3(PO4)2 (s) |

* 1. Identify the type of reaction as a combination reaction, a combustion reaction, a decomposition reaction, a single replacement reaction, a double replacement reaction, or an acid-base neutralization reaction.

Double replacement reaction

1. Two solutions of sulfuric acid, H2SO4, and potassium carbonate, K2CO3, are mixed. Bubbles are observed in a clear, colorless solution. A burning splint is extinguished when it is placed into the reaction vessel (9 points).
	1. What is the identity of the gas? \_\_\_\_\_\_\_\_carbon dioxide, CO2\_\_\_\_\_
	2. Write the correctly balanced chemical equation, total ionic equation, and net ionic equation. Be sure to include state labels on your equations.

|  |  |
| --- | --- |
| Conventional | H2SO4 (aq) + K2CO3 (aq) → K2SO4 (aq) + H2CO3 (aq) H2SO4 (aq) + K2CO3 (aq) → K2SO4 (aq) + H2O (l) + CO2 (g) |
| Total Ionic | 2 H+ (aq) + SO42- (aq) + 2 K+ (aq) + CO32- (aq) → 2 K+ (aq) + SO42- (aq) + H2O (l) + CO2 (g) |
| Net Ionic  | 2 H+ (aq) + CO32- (aq) → H2O (l) + CO2 (g) |

1. When red phosphorus, P4, reacts with chlorine gas phosphorus trichloride is produced (14 points).
	* + - 1. Write the balanced chemical equation.

P4 (s) + 6 Cl2 (g) → 4 PCl3 (l) ΔHº= -1279 kJ

* + - * 1. Classify the type of chemical reaction taking place. \_combination or synthesis reaction
				2. Is the reaction exothermic or endothermic? \_\_\_\_\_exothermic reaction
				3. When 3.56 moles of red phosphorus are reacted with excess chlorine gas, how much heat is released?

$$3.56 mol P\_{4}×\frac{1279 kJ}{1 mol P\_{4}}=4553.25 kJ ≈4550 kJ released or-4550 kJ $$

* + - * 1. How many grams of phosphorus trichloride can be produced if 39.57 g of chlorine gas react with excess phosphorus?

$$39.57 g Cl\_{2}×\frac{1 mol Cl\_{2}}{70.906 g Cl\_{2}}×\frac{4 mol PCl\_{3}}{6 mol Cl\_{2}}×\frac{137.333 g PCl\_{3}}{1 mol PCl\_{3}}=51.09362452 g PCl\_{3}≈51.09 g PCl\_{3}$$

* + - * 1. If 35.667 g of phosphorus trichloride is actually produced, what is the percent yield?

$$\%yield=\frac{m\_{actual}}{m\_{theoretical}}×100=\frac{35.667 g}{51.09 g}×100=69.8120963\%≈69.81\%.$$

* + - * 1. What are some reasons why the percent yield could be less than 100%?

Incomplete reaction, impure reactants, side reactions

1. A balloon will burst if the volume exceeds 3.40 L. If 2.96 L of helium are put into the balloon at a temperature of 15oC, how high can the temperature go (°C) before it will burst (6 points)?

$$PV=nRT$$

$$\frac{V\_{1}}{T\_{1}}=\frac{V\_{2}}{T\_{2}}⇒T\_{2}=T\_{1}\left(\frac{V\_{2}}{V\_{1}}\right)=288K\left(\frac{3.40 L}{2.96 L}\right)=331K or 58℃$$

1. What does pressure measure? What does temperature measure (4 points)?

Pressure measures force per unit area. Temperature measures the average kinetic energy of the particles in a sample.

1. A fire extinguisher releases 1.96 x 10-3 kg gas that occupies 1.00 L at standard temperature, 0°C, and pressure, 760 mmHg. At STP 1 mole of gas is equivalent to 22.4 L of gas. What is the molar mass of the gas (6 points)?

$$\frac{1.96×10^{-3} kg}{1.00 L}×\frac{1000 g}{1 kg}×\frac{22.4 L}{1 mol}=43.9\frac{g}{mol}$$

Or

$$PV=nRT and MM=\frac{m}{n}, so MM=\frac{mRT}{PV}$$

$$MM=\frac{\left(1.96×10^{-3} kg\right)\left(0.08206 \frac{L atm}{mol K}\right)(273 K)}{(760 mmHg)(1.00 L)}×\frac{760 mmHg}{1 atm}×\frac{1000 g}{1 kg}=43.9\frac{g}{mol}$$

1. Gaseous chlorine dioxide is used to bleach wood pulp ad in water treatment. It is produced by the reaction of chlorine with sodium chlorite (5 points).
	1. Balance the reaction: Cl2 (g) + 2 NaClO2 (g) → 2 ClO2 (g) + 2 NaCl (s)
	2. How many liters of ClO2 will be produced by 283 L Cl2?

$$283 L Cl\_{2}×\frac{2 L ClO\_{2}}{1 L Cl\_{2}}=566 L ClO\_{2} $$

1. A 35.0 L flask is filled with 381 g of oxygen gas (O2) at a temperature of 27oC (8 points).
	* + - 1. How many moles of oxygen are contained in the flask?

$$?mol O\_{2}=381 g O\_{2}×\frac{1 mol O\_{2}}{31.998 g O\_{2}}=11.9 mol O\_{2}$$

* + - * 1. What is the pressure (in atm) of oxygen gas in the flask?

$$PV=nRT\rightarrow \rightarrow P=\frac{nRT}{V}=\frac{\left(11.9 mol\right)\left(0.08206 L atm\right)\left(300 K\right) }{\left(35.0 L\right)mol K}=8.37 atm$$

* + - * 1. What is the pressure in lb/in2(psi) of oxygen gas in the flask?

$$?psi=8.37 atm×\frac{14.7 psi}{1 atm}=123 psi$$

1. Given the reaction: 2 Al (s) + 3 NH4NO3 (s) → 3 N2 (g) + 6 H2O (l) + Al2O3 (s) (15 points)
	1. How many atoms of Al will react with 132 formula units of NH4NO3?

$$?atom Al=132 formula units NH\_{4}NO\_{3}×\frac{2 atom Al}{3 formula units NH\_{4}NO\_{3}}=$$

* 1. How many molecules of water will be produced by the combustion of 5.00 g of Al?

$$?molec H\_{2}O =5.00 g Al×\frac{1 mol Al}{26.98 g Al}×\frac{6.022 ×10^{23}atom Al}{1 mol Al}×\frac{6 molecules H\_{2}O}{2 atom Al}=$$

* 1. How many grams of Al2O3 will be produced by the reaction of 0.150 moles of Al with 0.150 moles of NH4NO3? Use an ICE table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 2 Al (s) + | 3 NH4NO3 (s) → | 3 N2 (g) + | 6 H2O (l) + |  Al2O3 (s) |
| Initial moles | 0.150 mol  | 0.150 mol  | 0.000 mol | 0.000 mol  | 0.000 mol |
| Change moles | -2x | -3x | +3x | +6x | +x |
| End moles  | 0.150 mol – 2x = 0.150 mol – 2(0.0500 mol) =0.050 mol  | 0.150 mol – 3x = 0.150 mol – 3(0.0750 mol ) =0 mol  | 3x =3(0.0500 mol ) = 0.150 mol  | 6x = 6(0.0500 mol) =0.300 mol  | x =0.0500 mol  |

Compare ratios:

|  |  |  |
| --- | --- | --- |
| Theoretical mole ratio $$\frac{Al}{NH\_{4}NO\_{3}}= \frac{2 mol }{3 mol }=0.666 $$ | Actual mole ratio$$\frac{Al}{NH\_{4}NO\_{3}}=\frac{0.150 mol }{0.150 mol }=1$$ | Limiting Reagent is NH4NO3 |

x = 0.150 mol -3x

0.150 mol = 3x

x = 0.0500 mol

$$0.0500 mol Al\_{2}O\_{3}×\frac{101.96 g Al\_{2}O\_{3}}{1 mol Al\_{2}O\_{3}}=5.10 g Al\_{2}O\_{3} $$