Exam 3

# Part 1: Multiple Choice (2 points each)

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

1. Apart from environmental concerns, why is it unwise to dispose of chemical down the sink?
	1. Solids that are insoluble in water will remain the sink trap and perhaps react with subsequent chemical poured down the sink.
	2. Some chemicals can produce toxic gases when mixed with other chemicals in the sink trap.
	3. Some chemical may react unexpectedly with other chemicals in the sink trap.
	4. B and C
	5. All of the above
2. \_\_\_ is a synthesis reaction.
	1. Al(OH)3 (aq) + 3 HCl (aq) 🡪 AlCl3 (aq) + 3 H2O (l)
	2. 2 NaHCO3 (s) 🡪 Na2CO3 (s) + CO2 (g) + H2O (l)
	3. CuO (s) + H2 (g) 🡪 Cu (s) + H2O (l)
	4. all of the above
	5. none of the above
3. Some solute have solutions that conduct electricity, but poorly. 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
4. How many mole-to-mole conversion factors can be derived from the balanced equation:

CS2 (g) + 3 O2 (g) → CO2 (g) + 2 SO2 (g)

* 1. 12
	2. 8
	3. 6
	4. 4
	5. none of the above
1. At STP conditions, one moles of gas will occupy a volume of
2. 1.000 milliliter.
3. 1.000 liter.
4. 22.41 milliliters.
5. 22.41 liters.
6. none of the above
7. Avogadro’s number is 6.022 x 1023 \_\_\_\_\_ is equal to one \_\_\_\_\_\_\_.
	1. mol S, g S
	2. ions Na+, mol Na+
	3. molecules CH4, mol CH4
	4. atoms O, mol O
	5. b, c, and d
8. In a gas, which one of the following is true?
	1. The molecules are in constant contact with one another.
	2. The molecules move in straight-line motion in random directions.
	3. The molecules create pressure by colliding with each other.
	4. The molecules do not attract one another at all in the gas phase.
	5. none of the above
9. If the volume of a sample of fluorine gas is reduced by one-fourth at constant pressure, what happens to its Kelvin temperature?
10. It remains constant.
11. It decreased by one-fourth.
12. It increases by a factor of 4.
13. All of the above
14. None of the above

Answer the following questions about the reaction of A2 (light spheres) with B2 (dark spheres)



1. What is the limiting reactant?
	1. A2
	2. B2
	3. AB
	4. A2B2
	5. A3B
2. What is the balanced chemical equation?
	1. 3 A2 (g) + B2 (g) → 2 A3B (g)
	2. A2 (g) + B2 (g) → A3B (g)
	3. A (g) + B (g) → AB (g)
	4. A3B (g) → 3 A (g) + B2 (g)
	5. A2 (g) + B2 (g) → A3B (g)

# 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. Convert each of the following balanced molecular redox equations to balanced net ionic redox equations (9 points):
2. SnSO4 (aq) + 2 FeSO4 (aq) → Sn (s) + Fe2(SO4)3 (aq)

Sn2+ (aq) + SO42- (aq) + 2 Fe2+ (aq) + 2 SO42- (aq) → Sn (s) + 2 Fe3+ (aq) + 3 SO42- (aq)

Sn2+ (aq) + 2 Fe2+ (aq) → Sn (s) + 2 Fe3+ (aq)

1. PH3 (g) + 2 NO2 (g) → H3PO4 (aq) + N2 (g)

PH3 (g) + 2 NO2 (g) → H3PO4 (aq) + N2 (g)

1. 4 Zn (s) + 10 HNO3 (aq) → 4 Zn(NO3)2 (aq) + NH4NO3 (aq) + 3 H2O (l)

4 Zn (s) + 10 H+ (aq) + 10 NO3- (aq) → 4 Zn2+ (aq) + 8 NO3- (aq) + NH4+ (aq) + NO3- (aq) + 3 H2O­ (l)

1. Zn (s) + 10 H+ (aq) + NO3- (aq) → 4 Zn2+ (aq) + NH4+ (aq) + 3 H2O­ (l)
2. Given the following experimental observations (10 points):
* A sample of manganese is placed into a solution of lead(II) chloride and the manganese dissolves. A precipitate of elemental lead is observed to form.
* Another sample of manganese is placed into a solution of barium chloride and no reaction occurs.
	1. Write the equation for the reaction that takes place between lead(II) chloride and manganese. (manganese will form an ion with a +2 charge)

PbCl2 (aq) + Mn (s) → MnCl2 (aq) + Pb (s)

* 1. Which element is more active, lead or manganese? \_\_\_\_\_Mn\_\_\_\_
	2. Which element is more active, manganese or barium? \_\_\_\_Ba\_\_\_\_\_
	3. Would you expect a reaction to occur if you placed a sample of lead metal into a solution of barium chloride? Why or why not? (Hint: include the overall activity series in your answer)

No, because Pb<Mn and Mn<Ba so Pb<Ba meaning that lead is less active than barium and cannot replace it as an ion.

1. On a spaceship, to remove exhaled carbon dioxide from breathing air, lithium hydroxide is used. The reaction produces lithium bicarbonate (16 points).
	1. Write the balanced chemical equation.

LiOH (s) + CO2 (g) → LiHCO3 (s)

* 1. Identify the type of reaction (i.e. single replacement, double replacement, synthesis, decomposition).

Synthesis/combination reaction

* 1. How much lithium bicarbonate could be produced if 25.577 g of lithium hydroxide are reacted with excess carbon dioxide?

$$25.577 g CO\_{2}×\frac{1 mol LiOH }{23.948 g LiOH}×\frac{1 mol LiHCO\_{3}}{1 mol LiOH}×\frac{67.957 g LiHCO\_{3}}{1 mol LiHCO\_{3}}=72.579 g LiHCO\_{3} $$

* 1. What is the percent yield of the reaction if 63.331 grams of lithium bicarbonate are actually produced?

$$\% yield=\frac{actual yield}{theoretical yield}×100\%= \frac{63.331 g LiHCO\_{3}}{72.579 g LiHCO\_{3}}×100\%=87.258\% yield$$

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

Incomplete reaction, impure reactants, side reactions…

1. Tungsten metal, W, used to make incandescent light-bulb filament. To obtain pure tungsten metal, solid tungsten(VI) oxide is reacted with hydrogen gas to produce tungsten metal and water (10 points).
	1. Balance the reaction: WO3 (s) + 3 H2 (g) → W (s) + 3 H2O (l)
	2. How many moles of tungsten(VI) oxide are need to produce 2.53 moles of water?

$$2.53 mol H\_{2}O×\frac{1 mol WO\_{3}}{3 mol H\_{2}O}=0.843 mol WO\_{3} $$

* 1. How many molecules of tungsten(VI) oxide are needed to produce 10.00 g of tungsten?

$10.00 g W×\frac{1 mol W}{183.9 g W}×\frac{1 mol WO\_{3}}{1 mol W}×\frac{6.022 ×10^{23} molec WO\_{3}}{1 mol WO\_{3}}=3.276×10^{23} molec WO\_{3}$

1. For each of the following pairs of pressure measurements, indicate whether the first listed measurement is larger than, equal to, or smaller than the second listed measurement (4 points).
	1. 578 mm Hg and 1.01 atm smaller than
	2. 14.21 psi and 775 torr smaller than
	3. 29.92 in Hg and 101325 Pa equal to
	4. 3.57 atm and 3.36 bar greater than
2. A plastic glove when attached to a flask gives the system a flexible volume. See the illustration below. From a starting point of 257 mL at 22 °C, to what volume will the system change if the temperature rises to 137 °C due to the heating by the laboratory burner (6 points)?



V1 = 257 mL

T1 = 22 °C + 273 = 295 K

V2 = ?

T2 = 137 °C + 273 = 410 K

$$\frac{V\_{1}}{T\_{1}}=\frac{V\_{2}}{T\_{2}}⟹V\_{2}=\frac{T\_{2}V\_{1}}{T\_{1}}=\frac{\left(410 K\right)\left(257 mL\right)}{\left(295 K\right)}=357 mL $$

1. Gaseous chlorine dioxide is used to bleach wood pulp and 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
	2. How many liters of ClO2 will be produced by 558 L Cl2?

$$558 L Cl\_{2}×\frac{2 L ClO\_{2}}{1 L Cl\_{2}}=1116 L ClO\_{2} ≈1110 L ClO\_{2} or 1.11×10^{3} L ClO\_{2} $$

1. Nitrogen dioxide gas reacts with water vapor to produce oxygen and ammonia gases. Suppose that 12.8 g of nitrogen dioxide gas reacts with 5.00 L of water vapor at 375 °C and 725 torr, (20 points)?
	1. how many moles of nitrogen dioxide gas are there initially?

$$12.8 g NO\_{2}×\frac{1 mol NO\_{2}}{46.005 g NO\_{2}}=0.278230627 mol NO\_{2}≈0.278 mol NO\_{2}$$

* 1. how many moles of water vapor are there initially?

V = 5.00 L

T = 375 °C + 273.15 = 648.15 K ≈ 648 K

P = 725 torr

R = 0.08206 L atm/mol K

$$PV=nRT⇒n=\frac{PV}{RT}$$

$$n=\frac{(725 torr)(5.00 L)}{\left(0.08206\frac{L atm}{mol K}\right)(648 K)}×\frac{1 atm }{760 torr}=0.089699062 mol H\_{2}O≈0.0897 mol H\_{2}O$$

* 1. what is the limiting reagent? Complete the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 4 NO2 (g) + |  6 H2O (g) → | 5 O2 (g) +  | 4 NH3 (g) |
| I | 0.278 mol  | 0.0897 mol  | 0 mol  | 0 mol  |
| C | -4x | -6x | +5x | +4x |
| E | 0.278 mol – 4x =0.278 mol – 4(0.0**149**5 mol) =0.2182 mol ≈ 0.218 mol  | 0.0897 mol – 6x =0.0897 mol – 6(0.0**149**5 mol) =0 mol  | 5x = 5(0.0**149**5 mol) =0.07475 mol ≈ 0.0748 mol  | 4x =4(0.0**149**5 mol) =0.0598 mol  |

 Determine the liming reagent by comparing the theoretical mole ratio to the actual mole ratio:

|  |  |  |
| --- | --- | --- |
| Theoretical mole ratio$$\frac{6 mol H\_{2}O }{4 mol NO\_{2}}=\frac{1.5 mol H\_{2}O }{1 mol NO\_{2}}$$ | Actual mole ratio$$\frac{0.0897 mol H\_{2}O }{0.278 mol NO\_{2}}=\frac{0.322 mol H\_{2}O }{1 mol NO\_{2}}$$ | Limiting reagent isH2O |

* 1. what does x equal?

$$0.0897 mol-6 x=0 mol $$

$$x=0.01495 mol $$

* 1. how many grams of ammonia can be produced?

$$0.598 mol NH\_{3}×\frac{17.031 g NH\_{3} }{1 mol NH\_{3}}=1.0184538 g NH\_{3} ≈1.02 g NH\_{3}$$