Exam 3

# Part 1: Multiple Choice (2 points each)

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

1. Which of the following is evidence of a chemical reaction?
2. permanent color change
3. bubbles
4. formation of a precipitate
5. emission of light
6. all of the above
7. Which of the following does not represent a property of a gas?
8. low energy
9. indefinite shape
10. compressible
11. fast moving
12. all of the above
13. Which of the following could cause the temperature to decrease in a gaseous system?
14. increasing the volume
15. decreasing the number of gas molecules
16. decreasing the pressure
17. all of the above
18. none of the above
19. Which equality expression is true for: 4 NH3 (g) + 5 O2 (g) → 4 NO (g) + 6 H2O (g)?
	1. 4 mol NH3 = 6 mol H2O
	2. 5 mol O2 = 4 mol NO
	3. 2 mol NH3 = 3 mol H2O
	4. 4 mol NO = 4 mol NH3
	5. all of the above
20. How many joules are in 52.4 calories?
21. 219 joules
22. 12.5239 joules
23. 52400 joules
24. 4000 joules
25. none of the above
26. Which of the following samples contains 6 moles of atoms?
27. 2 moles of CO2
28. 3 moles of NaCl
29. 6 moles of O2
30. a and b
31. all of the above

Answer the following questions about the reaction Al (l) + MnO2 (l) 🡪 Mn (l) + Al2O3 (s)

1. What are the coefficients of the above reaction?
2. 4, 3, 3, 2
3. 8, 6, 6, 4
4. 2, 1, 1, 1
5. 1, 1, 1, 1
6. none of the above
7. Classify the above reaction as:
8. synthesis reaction
9. combustion reaction
10. decomposition reaction
11. single displacement rxn
12. precipitation reaction
13. When pouring a liquid from a reagent bottle it should be poured into a
14. graduated cylinder.
15. a beaker first then transferred.
16. into a bottle.
17. scoopula.
18. all of the above
19. Apart from environmental concerns, why is it unwise to dispose of chemical down the sink?
20. Solids that are insoluble in water will remain the sink trap and perhaps react with subsequent chemical poured down the sink.
21. Some chemicals can produce toxic gases when mixed with other chemicals in the sink trap.
22. Some chemical may react unexpectedly with other chemicals in the sink trap.
23. B and C
24. 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. A balloon will burst if the volume exceeds 4.57 L. If 2.96 L of helium are put into the balloon at a temperature of 35oC, how high can the temperature go (°C) before it will burst (6 points)?

$$PV=nRT$$

$$\frac{V\_{1}}{T\_{1}}=\frac{V\_{2}}{T\_{2}}⇒T\_{2}=T\_{1}\left(\frac{V\_{2}}{V\_{1}}\right)=308K\left(\frac{4.57 L}{2.96 L}\right)=475.527027 K≈476 K or 203℃$$

1. A sample of methane gas, CH4, occupies a volume of 6.87 L at 37oC and 2.05 atm pressure. How many moles of methane are in the sample (5 points)?

P = 2.05 atm

V = 6.87 L

T = 37°C + 273 = 310 K

$$PV=nRT$$

$$n=\frac{PV}{RT}=\frac{\left(6.87 L\right)\left(2.05 atm\right)mol K}{\left(0.08206 L atm\right)\left(310 K\right)}=0.553 mol CH\_{4} $$

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. 3.45 g of an unknown noble gas at 45 °C and 1.58 atm is stored in a 2.83 L flask (10 points).
	1. What is the density of the gas?

m = 3.45 g

T = 45 °C + 273.15 = 318.15 K ≈ 318 K

P = 1.32 atm

V = 2.83 L

$$D=\frac{m}{V}=\frac{3.45 g}{2.83 L}=1.22\frac{g}{L}$$

* 1. What is the molar mass of the gas?

$$MM=\frac{DRT}{P}=\frac{\left(1.22\frac{g}{L}\right)\left(0.08206 \frac{L atm}{mol K}\right)(318 K)}{(1.58 atm)}=20.15\frac{g}{mol}≈20.2\frac{g}{mol}$$

* 1. Based on the molar mass, the unknown noble gas is probably \_\_\_\_\_neon\_\_\_\_\_\_\_\_.
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. Hydrochloric acid and sodium acetate are mixed; the total ionic reaction is shown below (9 points): H+ (aq) + Cl- (aq) + Na+ (aq) + C2H3O2- (aq) → HC2H3O2 (aq) + Na+ (aq) + Cl- (aq)
	1. What type of reaction is taking place? \_\_\_\_\_\_\_double replacement\_\_\_\_\_\_\_\_\_\_\_\_
	2. What are the spectator ions? \_\_\_\_\_\_\_Na+, Cl-\_\_\_\_\_\_\_\_\_\_\_\_\_
	3. Write the balanced conventional equation:

HCl (aq) + NaC2H3O2 (aq) → HC2H3O2 (aq) + NaCl (aq)

* 1. Write the balanced net ionic equation:

H+ (aq) + C2H3O2- (aq) → HC2H3O2 (aq)

* 1. What evidence would you likely observe that a reaction has taken place?

You may feel heat or see waviness in the solution because a slightly ioniziable substance, acetic acid, HC2H3O2, has been formed. You can test the pH of the solution strong acids have a low pH ~1, while weak acids have a slightly higher pH ~3.

1. Given the following data determine the relative activities of the metals from each equation series for Ca, Cd, Mg, and Ni (8 points).
	1. Identify each metal as more active or less active:

Mg (s) + Cd(NO3)2 (aq) → Cd (s) + Mg(NO3)2 (aq) Mg >Cd

Ca (s) + Mg(NO3)2 (aq) → Ca(NO3)2 (aq) + Mg (s) Ca >Mg

Ni (s) + Cd(NO3)2 (aq) → no reaction Cd >Ni

* 1. Using the data from the first part of this problem, determine the activity series for Ca, Cd, Mg, and Ni.

 Ca > Mg > Cd > Ni

* 1. Predict what would happen if a strip of nickel were dropped into a solution of Mg(NO3)2.

No reaction would occur

1. In an experiment, 4.14 g of the element phosphorus combined with chlorine gas to produce 27.80 g of a white solid compound (14 points).
	1. What is the empirical formula of the compound?

P (s) + Cl2 (g) 🡪 PxCly (s)

4.14 g + x = 27.80 g

x = 23.66 g Cl2

$$4.14 g P×\frac{1 mol P}{30.97 g P}= \frac{0.133677753 mol P}{0.133677753 mol P}=1 $$

$$23.66 g Cl\_{2}×\frac{1 mol Cl\_{2}}{70.90 g Cl\_{2}}×\frac{2 mol Cl}{1 mol Cl\_{2}}=\frac{0.6674189 mol Cl}{0.133677753 mol P}=4.992744753≈5$$

Empirical formula is PCl5

* 1. Write the balanced molecular equation of the reaction.

2 P (s) + 5 Cl2 (g) → 2 PCl5 (s)

* 1. What type of reaction is this? \_\_\_\_\_This is a combination or synthesis reaction.
1. Given the reaction: 2 Al (s) + 3 NH4NO3 (s) → 3 N2 (g) + 6 H2O (l) + Al2O3 (s) (20 points)
	1. How many moles of NH4NO3 are required to react with 8.47 mol Al?

$$?mol NH\_{4}NO\_{3}=8.47 mol Al×\frac{3 mol NH\_{4}NO\_{3}}{2 mol Al}=$$

* 1. How many grams of nitrogen gas will be produced when 3.15 mol of aluminum are reacted with excess NH4NO3?

$$?g N\_{2}=3.15 mol Al ×\frac{3 mol N\_{2}}{2 mol Al}×\frac{28.02 g N\_{2}}{1 mol N\_{2}}=$$

* 1. If 95.2 grams of N2 are produced in part b, what is the percent yield of the reaction?

$$?\% yield=\left(\frac{actual yield}{theoretical yield}\right)×100\%=\left(\frac{95.2 g}{132 g}\right)×100\%=$$

* 1. How many atoms of Al will react with 89 formula units of NH4NO3?

$$?atom Al=89 units NH\_{4}NO\_{3}×\frac{2 atom Al}{3 units NH\_{4}NO\_{3}}=$$

* 1. How many molecules of water will be produced by the combustion of 3.75 g of Al?

$$?molec H\_{2}O =3.75 g Al×\frac{1 mol Al}{26.98 g Al}×\frac{6.022 ×10^{23}atom Al}{1 mol Al}×\frac{6 molec H\_{2}O}{2 atom Al}=$$

* 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

$$0.0500 mol Al\_{2}O\_{3}×\frac{101.96 g Al\_{2}O\_{3}}{1 mol Al\_{2}O\_{3}}=5.098 g Al\_{2}O\_{3}≈5.10 g Al\_{2}O\_{3} $$