Saginaw Valley State University — Fall 2000

CHEM 101 — Exam 3 – Chapters 8-10 — S. N. Goldie

Name: KEY___KEY___KEY___KEY___KEY___KEY___KEY___KEY___KEY___

1. Supply answers to all questions on paper provided.
2. Programmable calculators are permitted only if the proctor has cleared the memory.
3. Partial credit will be limited. All questions are of equal weight.
4. There are 100 points possible for this examination. Your score will be reported as a percentage of 100.

1. Calculate the molecular mass of mercury (II) nitrate.

   $Hg(NO_3)_2$ (1 Hg @ 200.59 + (2 N @ 14) + (2*3 O @ 16) = 324.59 g/mol

2. Calculate the number of moles of oxygen atoms in 50.0g of oxygen atoms.

$$\frac{50.0\text{ g O}}{1}\times\frac{1\text{ mole O}}{16\text{ g O}} = 3.125\text{ moles O}$$

3. Calculate the number of moles of oxygen molecules in 50.0g of oxygen gas.

$$\frac{50.0\text{ g O}_2}{1}\times\frac{1\text{ mole O}_2}{32\text{ g O}_2} = 1.56\text{ moles O}_2$$

4. Determine the empirical formula and the molecular formula for a compound that has been analyzed to have 37.8% C, 6.3% H, and 55.8% chlorine. The molecular mass is 127.0g/mol.

$$37.8\%\text{ C} = 37.8\text{ g C} = \frac{37.8\text{g C}}{}\times\frac{1\text{mole C}}{12\text{g C}} = 3.15\text{ moles C} \div 1.59\text{moles Cl} = 2$$

$$6.3\%\text{ H} = 6.3\text{g H} = \frac{6.3\text{g H}}{}\times\frac{1\text{mole H}}{1\text{g H}} = 6.3\text{ moles H} \div 1.59\text{moles Cl} = 4$$

$$55.8\%\text{ Cl} = 55.8\text{g Cl} = \frac{55.8\text{g Cl}}{}\times\frac{1\text{mole Cl}}{35\text{g Cl}} = 1.59\text{ moles Cl} \div 1.59\text{ moles Cl} = 1$$

   Empirical formula is $C_2H_4Cl_1$. Empirical mass is then 63g/mol. The molecular mass given was 127 g/mol. The ratio is 127/63 = 2. Multiply the subscripts by the factor you obtain, which is 2. The molecular formula is $C_4H_8Cl_2$.

Balance the following chemical equations by inspection:

5. $Ba(NO_3)_2 + H_2SO_4 \rightarrow BaSO_4 + 2HNO_3$
6. $(NH_4)_2S + HgBr_2 \rightarrow 2NH_4Br + HgS$
7. $Ba + 2H_2O \rightarrow Ba(OH)_2 + H_2$.

Balance the following reaction equations and classify each as a combination reaction, decomposition reaction, single-replacement reaction, double-replacement reaction, or neutralization reaction:

8. $2KNO_3$ (s) $\rightarrow$ $2KNO_2$ (s) + O_2 (g) - Decomposition
9. $Pb(C_2H_3O_2)_2 + K_2SO_4 \rightarrow PbSO_4$ (s) + $2KC_2H_3O_2$ – Double displacement
10. $BaCO_3 + 2HNO_3 \rightarrow Ba(NO_3)_2 + H_2O$ (l) + CO_2 (g) – Double displacement or neutralization

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11. Calculate the number of grams of oxygen that can be produced by heating 3.50 g of potassium chlorate:

$2KClO_3\ (s) \rightarrow 2KCl\ (s) + 3O_2\ (g)$

$KClO_3$ = 1 K @ 39 + 1 Cl @ 35 + 3 O @16 = 122 g/mol

$$\frac{3.50 \text{ g } KClO_3}{1} \times \frac{1 \text{ mole } KClO_3}{122 \text{ g } KClO_3} \times \frac{3 \text{ moles } O_2}{2 \text{ moles } KClO_3} \times \frac{32\text{g } O_2}{1 \text{ mole } O_2} = 1.37\text{g } O_2$$

12. The normal dose of the anti-inflammatory ibuprofen is 200mg. Calculate the number of molecules in this dose. The molar mass of ibuprofen is 206 g/mol.

$$\frac{200\text{mg ibuprofen}}{1} \times \frac{1 \text{ g ibuprofen}}{1000 \text{ mg ibuprofen}} \times \frac{1 \text{ mole ibuprofen}}{206 \text{ g ibuprofen}} \times \frac{6.022 \times 10^{23} \text{ molecules ibuprofen}}{1 \text{ mole ibuprofen}} = 5.84 \times 10^{20} \text{molecules ibuprofen}$$

A 36.0 g sample of calcium hydroxide is allowed to react with a 40.5 g sample of phosphoric acid, to produce calcium phosphate and water.

13. Write the balanced chemical equation for this reaction. Instructor will supply answer if necessary for 5 pt. penalty.

$3\ Ca(OH)_2 + 2H_3PO_4 \rightarrow Ca_3(PO_4)_2\ (s) + 6\ H_2O\ (l)$

74 g/mol   98   310   18

14. What is the limiting reactant? Calcium hydroxide ($Ca(OH)_2$)

15. How many grams of calcium phosphate can be produced?

$$\frac{36 \text{ g } Ca(OH)_2}{1} \times \frac{1 \text{ mole } Ca(OH)_2}{74 \text{ g } Ca(OH)_2} \times \frac{1 \text{ moles } Ca_3(PO_4)_2}{3 \text{ moles } Ca(OH)_2} \times \frac{310\text{g } Ca_3(PO_4)_2}{1 \text{ mole } Ca_3(PO_4)_2} = 50.22 \text{ g } Ca_3(PO_4)_2$$

16. If 45.2 g of calcium phosphate is actually obtained, what is the percent yield?

$$\%\text{Yield} = \frac{\text{Actual}}{\text{Theoretical}} \times 100 = \frac{45.2 \text{ g } Ca_3(PO_4)_2}{50.22 \text{ g } Ca_3(PO_4)_2} \times 100 = 90\%$$

17. Calculate the number of moles of excess reagent remaining at the end of the reaction. Identify what the non-limiting reagent is.

$$\frac{36 \text{ g } Ca(OH)_2}{1} \times \frac{1 \text{ mole } Ca(OH)_2}{74 \text{ g } Ca(OH)_2} \times \frac{2 \text{ moles } H_3PO_4}{3 \text{ moles } Ca(OH)_2} = 0.324 \text{ moles } H_3PO_4$$

$$0.410 \text{ moles } H_3PO_4 - 0.324 \text{ moles } H_3PO_4 = 0.086 \text{ moles } H_3PO_4$$

18. How much calcium hydroxide is remaining at the end of the reaction? – None; it is the limiting reactant.

19. Describe the difference between an exothermic and an endothermic reaction. In an exothermic reaction, energy is released. In an endothermic reaction, energy is added to the system.

20. Describe what a combustion reaction is. Combustion is the reaction of anything with oxygen in the presence of heat to produce carbon dioxide and water.