Problem Set # 1, October 2017

1. The molar mass of an insecticide, dibromoethane, is 187.9 g/mol. Its molecular formula is $C_2H_4Br_2$. How many atoms of carbon are in a sample of dibromoethane weighing 1.879 g?

(a) 6.022×10^{23} (b) 6.022×10^{21} (c) 6.022×10^{22} (d) 12.04×10^{44} (e) 1.204×10^{22}

2. 10.0 g of Al and 10.0 g Br_2 react according to the equation below.

$$2Al + 3Br_2 \rightarrow 2AlBr_3$$

What mass of $AlBr_3$ is formed, assuming 100% yield?

(a) 9.8 g (b) 11.1 g (c) 20.0 g (d) 94.8 g (e) 110 g

3. A 3.31 g sample of lead nitrate, $Pb(NO_3)_2$, molar mass 331 g/mol, is heated in an evacuated cylinder with a volume of 1.62 L. The salt decomposes when heated, according to the equation

$$2Pb(NO_3)_2\,(s) \rightarrow 2PbO\,(s) + 4NO_2\,(g) + O_2\,(g)$$

Assuming complete decomposition, what is the pressure in the cylinder after decomposition and cooling to 300 K? Neglect the volume of PbO (s).

(a) 0.380 atm (b) 0.446 atm (c) 0.0368 atm (d) 1.48 atm (e) 0.481 atm

4. A 3.00 g sample of an alloy containing only Pb and Sn was dissolved in nitric acid (HNO_3). When sulfuric acid was added to this solution, 2.93 g of $PbSO_4$ precipitated. Assuming that all the lead precipitated, what is the percentage of Sn in the sample?

(a) 33.3% (b) 19.7% (c) 53.0% (d) 66.7% (e) 1.00 %

5. Diazepam (Valium®) is an important organic compound used in the treatment of depression. One molecule of diazepam contains a single chlorine atom and the weight percentage of chlorine in diazepam is 12.45%. What is the molecular weight of diazepam?

(a) 105.4 (b) 201.3 (c) 242.5 (d) 284.8 (e) 303.6

6. For the reaction

$$H_2\,(g) + I\,(g) \rightleftharpoons 2HI\,(g)$$

K_p = 45.9 at 763 K. An equilibrium mixture at that temperature contains gaseous HI at a partial pressure of 4.00 atm and hydrogen gas at a partial pressure of 0.200 atm. What is the partial pressure of I_2?

(a) 0.400 atm (b) 0.436 atm (c) 1.74 atm (d) 0.576 atm (e) 15.3 atm

7. The formula of performic acid is

(a) CH_2O_3 (b) CH_2O_2 (c) CH_3O_2 (d) CH_3O_3 (e) $C_2H_4O_3$

8. One commercial system removes SO_2 emissions from smoke at 95.0°C by the following set of balanced reactions:

$$SO_2\,(g) + Cl_2 \rightarrow SO_2Cl_2\,(g)$$
$$SO_2Cl_2 + 2H_2O \rightarrow H_2SO_4 + 2HCl$$
$$H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4\,(s) + 2H_2O$$

Assuming the process is 95.0% efficient, how many grams of $CaSO_4$ may be produced from 1.00×10^2 grams of SO_2?

(a) 45.8 g (b) 49.1 g (c) 83.5 g (d) 202 g (e) 252 g

9. What are the oxidation numbers of sulfur in the thiosulfate ion, $S_2O_3^{2-}$, and the tetrathionate ion, $S_4O_6^{2-}$, respectively?

(a) -1, -2½ (b) -½, -2 (c) +½, +1 (d) +2, +2½ (e) +2, +3

10. Warm objects emit electromagnetic radiation in the infrared region. Heat lamps employ this principle to generate infrared radiation. Water absorbs infrared radiation with wavelengths near 2.80 μm. Suppose this radiation is absorbed by the water and converted to heat. A 1.00-L sample of water absorbs infrared radiation, and its temperature increases from 20.0°C to 30.0°C. How many photons of this radiation are used to heat the water?

(a) 5.90×10^{22} photons
(b) 5.90×10^{23} photons
(c) 2.95×10^{23} photons
(d) 8.46×10^{23} photons
(e) none of the above

11. A 25.0 mL sample of sodium sulfate solution was analyzed by adding an excess of barium chloride solution to produce barium sulfate crystals, which were filtered from the solution.

$$Na_2SO_4\,(aq) + BaCl_2\,(aq) \rightarrow 2NaCl\,(aq) + BaSO_4\,(s)$$

If 5.483 g of barium sulfate was obtained, what was the molarity of the original Na_2SO_4 solution?

(a) 1.04 M (b) 1.88 M (c) 0.47 M (d) 0.25 M (e) 0.94 M

12. The configuration for the valence electrons of an antimony atom are

(a) $5s^2\,5p^4$ (b) $6s^2\,6p^1$ (c) $5s^2\,5p^1$ (d) $6s^2\,6p^3$ (e) $5s^2\,5p^3$

13. Lauryl alcohol, $C_{12}H_{25}OH$, is prepared from coconut oil; it is used to make sodium lauryl sulfate, a synthetic detergent. What is the molality of lauryl alcohol in a solution of 17.1 g lauryl alcohol dissolved in 148 g ethanol, C_2H_5OH?

(a) 0.310 *m* (b) 0.620 *m* (c) 0.842 *m* (d) 1.41 *m* (e) 2.52 *m*

14. A buffer is made by dissolving 13.0 g of sodium dihydrogen phosphate, NaH_2PO_4, and 15.0 g of disodium hydrogen phosphate, Na_2HPO_4, in a litre of solution. What is the pH of the buffer?

(a) 7.84 (b) 7.47 (c) 7.20 (d) 6.85 (e) 6.63

15. Excess fluorine, F_2 (g), reacts at 150°C with bromine, Br_2 (g), to give a compound BrF_n. If 423 mL Br_2 (g) at 150°C and 748 mmHg produced 4.20 g BrF_n, what is n?

(a) 4 (b) 5 (c) 6 (d) 7 (e) 8