Academic Free Response

Key ✓

Exam Review Problem Section. Name _____

Each of these problems should be solved in the space provided. You must show your work in order to receive credit.

1) The density of aluminum is 2.70 g/cm³. The volume of a solid piece of aluminum is 1.87 cm³. Calculate aluminum's mass.

$$\frac{1.87\,cm^3 \mid 2.70\,g}{1\,cm^3} = 5.04\,g$$

2) The specific heat of tin is 0.228 J/(g.K). A sample of tin absorbs 149 J as it is heated from 283 K to 292 K. What is the mass of the sample?

$Q = m C_p \Delta T$

$149\,J = m \times 0.228\frac{J}{gK} \times 9K$

$m = 72.6\,g$

3) If a 26.1 g sample of a material is heated from 175 K to 198 K, 68 J of energy is absorbed. What is the specific heat of the material?

$68\,J = (26.1\,g) \times C_p \times 23\,K$

$C_p = 0.113\frac{J}{gK}$

4) What is the mass of 5.8 moles of calcium?

$$\frac{5.8\,mol\,Ca \mid 40.0\,g\,Ca}{1.0\,mol\,Ca} = 232\,g\,Ca$$

5) How many moles of copper are present in 105.6 g Cu?

$$\frac{105.6\,g\,Cu \mid 1.0\,mol\,Cu \mid 6.022e23\,atoms}{63.55\,g\,Cu \mid 1.0\,mol\,Cu}$$

$= 1.66\,mol\,Cu$

$= 1.00 \times 10^{24}\,Cu\,atoms$

6) How many atoms are in 0.554 mol of carbon?

$$\frac{0.554\,mol\,C \mid 6.022e23\,atoms\,C}{1.0\,mol\,C}$$

$= 3.34 \times 10^{23}\,atoms\,C$

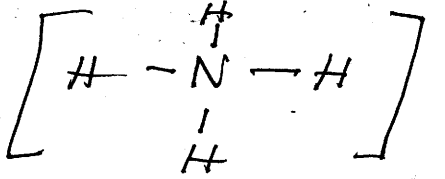
7) Write the correct chemical formula for the compound chromium(III) oxide.

Cr_2O_3

8) Write the correct chemical formula for the compound titanium(II) phosphate.

$Ti_3(PO_4)_2$

9) Draw a Lewis structure for the ammonium ion NH_4^+.



10) Calculate the percentage of aluminum in Al_2O_3.

$54 + 48 = 102$

$$\frac{54.0\,g\,Al}{102\,g\,Al} \times 100 = 0.529 \times 100 =$$

52.9% Al

11) Write a balanced chemical equation for the following reaction: aluminum plus copper(I) nitrate yields aluminum nitrate plus copper.

$Al_{(s)} + 3CuNO_{3(aq)} \rightarrow Al(NO_3)_3 + 3Cu_{(s)}$

$2N \times 14 = 28$
$8H \times 1 = 8$
$1S \times 32 = 32$
$4O \times 16 = 64$
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12) Write a balanced chemical equation for the following reaction. mercury(II) oxide (heated) yields mercury + oxygen.

$2\ HgO_{(s)} \xrightarrow{\Delta} 2Hg_{(s)} + O_{2\ (g)}$.

13) How many grams of ammonium sulfate can be produced if 40.0 mol of H_2SO_4 react with excess NH_3 according to the equation
$2NH_3(aq) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$?

Balanced ✓

$= 5,280\ g\ (NH_4)_2SO_4$

$\frac{40.0\ mol\ H_2SO_4}{1} \left| \frac{1\ mol\ (NH_4)_2SO_4}{1\ mol\ H_2SO_4} \right| \frac{132\ g}{1\ mol\ (NH_4)_2SO_4}$

14) What mass in grams of NaOH is produced if 25.0 g of sodium metal react with excess water according to the chemical equation
$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$?

Balanced?

$\frac{25.0\ g\ Na}{23.0\ g\ Na} \left| \frac{2\ mol\ NaOH}{2\ mol\ Na} \right| \frac{40.0\ g\ NaOH}{1\ mol\ NaOH}$

$= 43.47\ g\ NaOH$

15) The volume of a gas is 350.0 mL when the pressure is 2.00 atm. At the same temperature, what is the pressure at which the volume of the gas is 1.0 L?

Boyle's Law

$P_1V_1 = P_2V_2$

$(2.00\ atm)(350.0\ mL) = (?\ atm)(1,000\ mL)$

0.7 atm

Boyles Law ✓

16) A sample of oxygen occupies 880 mL when the pressure is 760.00 mm Hg. At constant temperature, what volume does the gas occupy when pressure falls to 810.00 mm Hg?

$P_1V_1 = P_2V_2$

$(760\ mm\ Hg)(880\ mL) = (810.0\ mm\ Hg)V_2$

$826\ mL = V_2$

17) The volume of a gas is 10.0 L when the temperature is 15.0°C. If the temperature is increased to 25.0°C without changing the pressure, what is the new volume?

Charles

$\frac{10.0\ L}{288\ K} = \frac{V_2}{298\ K}$

$V_2 = 10.35\ L$

18) A solution contains 85.0 g of $NaNO_3$ and has a volume of 950 mL. Find the molarity of the solution.

$\frac{85.0\ g\ NaNO_3}{0.950\ L} \left| \frac{1.0\ mol\ NaNO_3}{85\ g\ NaNO_3} \right| = 1.05\ M\ NaNO_3$

$23 + 14 + 48 = 85$

19) What is the molarity of a solution of sucrose, $C_{12}H_{22}O_{11}$, that contains 225 g of sucrose in 4.50 L of solution?

$\frac{225\ g\ sucrose}{4.50\ L} \left| \frac{1\ mol\ sucrose}{342\ g\ sucrose} \right| = 0.146\ M\ sucrose$

$12 \times 12 = 144 + 22$
$11 \times 16 = 176$
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20) How many grams of NaOH are required to prepare 550. mL of a 0.450 M solution?

$$0.550\,L \left| \frac{0.450\,mol\,NaOH}{1.0\,L} \right| \frac{40.0\,g\,NaOH}{1.0\,mol\,NaOH} = \boxed{9.9\,g\,NaOH}$$

21) What is the pH of a solution with a $[OH^-]$ of 4.55×10^{-7} M?

$pOH = -\log(4.55e-7) = 6.342$

$pH = 14 - pOH = 14 - 6.342 = \boxed{7.66}$

22) What is the pH of a 0.0870 M KOH solution?

$pOH = -\log(0.0870) = 1.06$

$pH = 14 - pOH = 14 - 1.06 = \boxed{12.94}$

23) What is the hydronium ion concentration of a solution that has a pH of 3.90?

$[H_3O^+] = 2nd\ log\ -3.90$

$[H_3O^+] = 1.26 \times 10^{-4}\ M$

24) Calculate the molarity of a $Ca(OH)_2$ solution if 295 mL is completely titrate by 285 mL of 0.707 *M* HNO_3.

$M_a V_a = M_b V_b$

$(0.707\,M\,HNO_3)(285\,mL) = (M_b \times 2)(295\,mL)$

$M\ Ca(OH)_2 = 0.345\ M$

x2 because $Ca(OH)_2$ has 2 OH^-

25) Write the Equilibrium Expression for the reaction for each of the following:

a. $N_2(g) + 3\,H_2(g) \leftrightarrow 2\,NH_3(g)$

$$K_{eq} = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

b. $HC_2H_3O_2(aq) + H_2O(l) \leftrightarrow H_3O^+(aq) + C_2H_3O_2^-(aq)$

$$K_{eq} = \frac{[H_3O^+][C_2H_3O_2^-]}{[HC_2H_3O_2]}$$

c. Find the value for the equilibrium expression, Keq, shown in #25.a. if $[H_2] = 0.1$ M, $[N_2] = 0.06$ M and $[NH_3] = 6$ M

$$K_{eq} = \frac{(6\,M)^2}{(0.06\,M)(0.1\,M)^3} = 600{,}000$$

no Molar units in Keq