Chemistry 1105 R11 Fall 2023 Test 2

Friday, October 27, 2023   Time: 1 hour 50 minutes

Name: _____   Student #: _____

*This test consists of **nine** pages of questions, a page containing useful constants and conversions, and a periodic table. Please ensure that you have a complete test and, if you do not, obtain one from me **immediately**. There are **49** marks available. Good luck!*

1) **[4 marks]** Give the oxidation number of sulphur (S) in the following compounds or ions:

SO_2^{2+} _____ SO_4^{2-} _____ SO_2F_2 _____ K_2SOF_2 _____

2) **[5 marks total]** Given the following (unbalanced) redox reaction, occurring in acidic solution:

$$Cr_2O_7^{2-} + C_6H_6 \longrightarrow CO_2 + Cr^{3+}$$
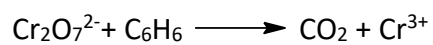
a) **[3 marks]** Balance the reaction.

b) **[0.5 marks]** Identify the oxidizing agent.

c) **[0.5 marks]** Identify the species being reduced.

d) **[1 mark]** How many electrons are transferred in the overall process?

3) **[3 marks]** A 1456.6-mg sample of a compound of formula M_3PO_4 (where M is an unknown element) was reacted with excess $CaCl_2$ and 790.9 mg of $Ca_3(PO_4)_2$ (310.174 g/mol) collected:

$$2M_3PO_4(aq) + 3CaCl_2(aq) \longrightarrow 6MCl(aq) + Ca_3(PO_4)_2(s)$$
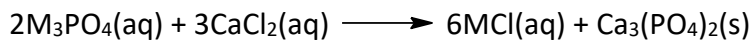
What is the metal, M?

4) **[4 marks]** A certain volume of 12.4 M HCl was taken and diluted to 200.0 mL to make solution A. 25.00 mL aliquot of solution A was then taken and diluted to 500.0 mL to form solution B. The concentration of solution B was found to be 0.0310 M. How many mL of 12.4 M HCl were used to make solution A?

5) **[3 marks]** A 102.5-mg sample of KHP (204.2 g/mol) required 26.70 mL of $Ca(OH)_2$ to titrate:

$$Ca(OH)_2(aq) + 2KHP(aq) \longrightarrow Ca(KP)_2(aq) + 2H_2O(l)$$
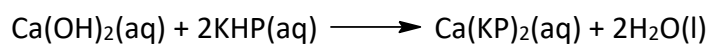
What was the concentration of the $Ca(OH)_2$? Give your answer in moles/L.

6) **[2 marks]** Calculate the percent by mass of sulphur in $Al_2(SO_4)_3$.

7) **[6 marks]** Zonisamide is an antibiotic – a "sulfa drug" in particular. It consists of 45.276% carbon, 3.799% hydrogen, 13.200% nitrogen, 22.616% oxygen, and (maybe obviously) the rest Sulphur, all by mass.

a) What is the empirical formula of Zonisamide?

b) If Zonisamide were a gas, it would have a density of 0.100 g/L at 8.81 torr pressure and 26.66°C. What is the molecular formula of Zonisamide?

8) **[6 marks]** Ibuprofen is an anti-inflammatory drug. It consists of carbon, hydrogen, and oxygen.

a) If you burn a 1237.7-mg sample of ibuprofen, you'll collect 3432.7 mg of CO_2 (44.009 g/mol) and 972.8 mg of H_2O (18.015 g/mol). What is the empirical formula of ibuprofen?

b) Ibuprofen is mildly acidic and, as an acid, reacts with bases like $Mg(OH)_2$ according to the balanced equation:

2(Ibuprofen) + $Mg(OH)_2$ ⟶ products
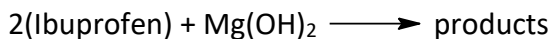
A fresh 226.9-mg sample of ibuprofen required 27.50 mL of 0.0200 M $Mg(OH)_2$ for complete reaction. What is the molecular formula of ibuprofen?

9) **[3 marks]** A solution of H_2SO_4 (98.077 g/mol) has a density of 1.0234 g/mL. A 20.00-mL aliquot of this solution required 32.38 mL of 0.5156 M NaOH for complete reaction:

$$H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$$
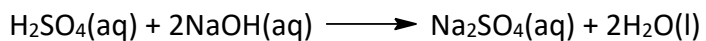
What is the percent by mass of H_2SO_4 in the original H_2SO_4 solution?

10) **[3 marks]** How many grams of 80.00-percent pure NaCl (58.443 g/mol) are required to collect exactly 10.00 grams of $PbCl_2$ (278.1 g/mol) if the reaction

$$2NaCl(aq) + Pb(NO_3)_2(aq) \longrightarrow PbCl_2(s) + 2NaNO_3(aq)$$
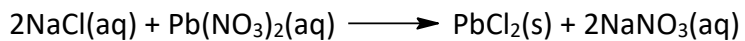
proceeds with a 62.50 percent yield?

11) **[4 marks]** If you mix 20.00 mL of 0.00300 M $Mg(OH)_2$ with 20.00 mL of 0.00150 M H_3PO_4:

$3Mg(OH)_2(aq) + 2H_3PO_4(aq) \longrightarrow Mg_3(PO_4)_2(s) + 6H_2O(l)$
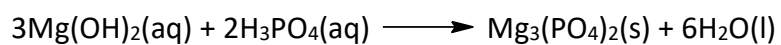
How many mL of H_2O (18.015 g/mol) should be produced? The density of H_2O is 0.9984 g/mL.

12) **[6 marks total]** The air we breathe has $X_{O2} = 0.21$ and $X_{N2} = 0.79$ (approximately). Imagine you had a room (filled with air) at 22.8°C at a total pressure of 758.9 torr. The room has a height of 3 metres, a length of 6 metres, and a depth of 8 metres.

    a) **[4 marks]** How many kg of oxygen and of nitrogen would be in the room? The volume of the room is given by length x width x depth, and $1 \text{ L} = 1 \text{ dm}^3$

    b) **[2 marks]** Calculate the partial pressures of O_2 and N_2 in the room. Give your answer in torr.