Chemistry 115 Name

Dr. Cary Willard

Exam 2a March 21, 2013

 Multiple Choice (30 points)

 Nomenclature (14 points)

 Page 5 (18 points)

 Page 6 (20 points)

 Page 7 (18 points)

 Total (104 points)

All work must be shown to receive credit. Give all answers to the correct number of significant figures

$$℉=\left(℃×\frac{180℉}{100℃}\right)+32℉$$

$$℃=\left(℉-32℉\right)\frac{100℃}{180℉}$$

$$K=℃+273$$

454 g = 1 lb

2.54 cm = 1 in

946 mL = 1 qt

Avogadro’s number -- 6.022 x 1023 /mol

Grossmont College

Periodic Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  IA |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | VIIA | NOBLE GASES |
| 1**H**1.008 | IIA |  |  |  |  |  |  |  |  |  |  | IIIA | IVA | VA | VIA | 1**H**1.008 | 2**He**4.002 |
| 3**Li**6.941 | 4**Be**9.012 |  |  |  |  |  |  |  |  |  |  | 5**B**10.81 | 6**C**12.01 | 7**N**14.01 | 8**O**16.00 | 9**F**19.00 | 10**Ne**20.18 |
| 11**Na**23.00 | 12**Mg**24.30 | IIIB | IVB | VB | VIB | VIIB |  VIII VIII VIII | IB | IIB | 13**Al**27.00 | 14**Si**28.09 | 15**P**30.97 | 16**S**32.06 | 17**Cl**35.45 | 18**Ar**39.95 |
| 19**K**39.10 | 20**Ca**40.08 | 21**Sc**44.96 | 22**Ti**47.90 | 23**V**50.94 | 24**Cr**52.00 | 25**Mn**54.94 | 26**Fe**55.85 | 27**Co**58.93 | 28**Ni**58.70 | 29**Cu**63.55 | 30**Zn**65.38 | 31**Ga**69.72 | 32**Ge**72.59 | 33**As**74.92 | 34**Se**78.96 | 35**Br**79.90 | 36**Kr**83.80 |
| 37**Rb**85.47 | 38**Sr**87.62 | 39**Y**88.91 | 40**Zr**91.22 | 41**Nb**92.91 | 42**Mo**95.94 | 43**Tc**(99) | 44**Ru**101.1 | 45**Rh**102.9 | 46**Pd**106.4 | 47**Ag**107.9 | 48**Cd**112.4 | 49**In**114.8 | 50**Sn**118.7 | 51**Sb**121.8 | 52**Te**127.6 | 53**I**126.9 | 54**Xe**131.3 |
| 55**Cs**132.9 | 56**Ba**137.3 | 57**La**138.9 | 72**Hf**178.5 | 73**Ta**180.9 | 74**W**183.9 | 75**Re**186.2 | 76**Os**190.2 | 77**Ir**192.2 | 78**Pt**195.1 | 79**Au**197.0 | 80**Hg**200.6 | 81**Tl**204.4 | 82**Pb**207.2 | 83**Bi**209.0 | 84**Po**(209) | 85**At**(210) | 86**Rn**(222) |
| 87**Fr**(223) | 88**Ra**226.0 | 89**Ac**227.0 | 104**Rf**(261) | 105**Db**(262) | 106**Sg**(263) | 107**Bh**(262) | 108**Hs**(265) | 109**Mt**(266) | 110**??**(269) |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 58**Ce**140.1 | 59**Pr**140.9 | 60**Nd**144.2 | 61**Pm**(147) | 62**Sm**150.4 | 63**Eu**152.0 | 64**Gd**157.3 | 65**Tb**158.9 | 66**Dy**162.5 | 67**Ho**164.9 | 68**Er**167.3 | 69**Tm**168.9 | 70**Yb**173.0 | 71**Lu**175.0 |
| 90**Th**232.0 | 91**Pa**231.0 | 92**U**238.0 | 93**Np**(237) | 94**Pu**(244) | 95**Am**(243) | 96**Cm**(247) | 97**Bk**(247) | 98**Cf**(251) | 99**Es**(252) | 100**Fm**(257) | 101**Md**(258) | 102**No**(259) | 103**Lr**(260) |

Lanthanide series

Actinide series

Part 1 – Multiple Choice (30 points)

1. Which of the following exists in its natural state as a diatomic?
	1. iron
	2. bromine
	3. boron
	4. zirconium
2. Which is the correct name for Mg +2?
	1. manganese ion
	2. magnesium ion
	3. manganide
	4. magneside
3. What is the correct name for the Cu +2 ion?
	1. cobalt(II)
	2. copper(I)
	3. copper(II)
	4. chromium(II)
4. What is the correct name for N3-?
	1. nitrogen(III) ion
	2. nitrogen ion
	3. nitride(III) ion
	4. nitride ion
5. Which of the following is a cation?
	1. vanadium(II) ion
	2. fluoride ion
	3. hydroxide ion
	4. hydrogen carbonate ion
6. CrO42- is called a
	1. dichromate ion.
	2. chromium ion.
	3. chromate ion.
	4. chromium oxide ion.
7. The metals belonging to Group 2A form ions with a charge of
	1. +1.
	2. +2.
	3. –1.
	4. –2.
8. All chemical compounds must have a net charge of
	1. 0
	2. +1
	3. +2
	4. The charges of compounds can vary.
9. A substance is found to consist of 1.900 g of silver, 0.250 g of nitrogen, and 0.850 g of oxygen. What is the percent by mass of oxygen in the compound?
	1. 8.33%
	2. 63.3%
	3. 85.0%
	4. 28.3%
10. Which statement is **incorrect**?
	1. one mole contains 6.02  1023 molecules.
	2. one molar mass equals one mole.
	3. one mole equals 6.02  1023 g of a compound.
	4. one mole of water contains the same number of molecules as one mole of carbon dioxide.
11. In which pair would both compounds have the same empirical formula?
	1. C2H4 and C3H6
	2. K2CrO4 and K2Cr2O7
	3. NaHCO3 and Na2CO3
	4. FeCl3 and FeCl2
12. Which of the following contains the largest number of moles?
	1. 1.0 g of lithium
	2. 1.0 g of sodium
	3. 1.0 g of aluminum
	4. 1.0 g of silver
13. The following reaction: Mg + FeO → MgO + Fe, is an example of
	1. combination.
	2. decomposition.
	3. double-displacement.
	4. single-displacement.
14. The reaction: 2C + 3H2 → C2H6 + 84.0 kJ, is
	1. exothermic.
	2. endothermic.
	3. isothermic.
	4. protothermic.
15. In the following reaction: KOH + CuNO3 → KNO3 + CuOH
	1. KOH and KNO3 are reactants
	2. KNO3 and CuOH are reactants
	3. CuOH and KOH are products
	4. KOH and CuNO3 are reactants

Part 2 – Nomenclature (14 points) Fill in the following chart with the correct name or formula as appropriate.

|  |  |
| --- | --- |
| IUPAC name | Chemical formula |
| sodium phosphate | Na3PO4 |
| nitric acid | HNO3 |
| dinitrogen tetrabromide | N2Br4 |
| nickel(II) chloride | NiCl2 |
| magnesium hypobromite | Mg(BrO)2 |
| nickel(II) nitride | Ni3N2 |
| ammonium sulfide | (NH4)2S |

Part 2 – 56 points Give all answers to the correct number of significant figures and include units where appropriate. Show clear set-up for each problem to receive credit.

1. (18 points) Oil of wintergreen is the methyl ester of hydroxybenzoic acid with the structure shown on the right. Its chemical formula is C8H8O3.
	1. Calculate the molar mass of oil of wintergreen.

$$molar mass=8\left({12.01 g}/{mol}\right)+8\left({1.008 g }/{mol}\right)+3\left({16.00 g}/{mol}\right)$$

$$=96.08+8.064+48.00$$

$$={152.14 g}/{mol}$$

* 1. Calculate the mass of 3.82 moles of oil of wintergreen.

$$?g C\_{8}H\_{8}O\_{3}=3.82 mol C\_{8}H\_{8}O\_{3}×\frac{152.14 g C\_{8}H\_{8}O\_{3}}{1 mol C\_{8}H\_{8}O\_{3}}=581 g C\_{8}H\_{8}O\_{3}$$

* 1. Calculate the number of molecules of oil of wintergreen in a sample containing 8.36 x 10-4 mol of oil of wintergreen.

$$?molec C\_{8}H\_{8}O\_{3}=8.36×10^{-4} mol C\_{8}H\_{8}O\_{3}×\frac{6.022×10^{23}molec C\_{8}H\_{8}O\_{3}}{1 mol C\_{8}H\_{8}O\_{3}}=5.03×10^{20} molec C\_{8}H\_{8}O\_{3}$$

* 1. Calculate the number of moles of carbon in a 8.35 mol sample of oil of wintergreen.

$$?mol C=8.35 mol C\_{8}H\_{8}O\_{3}×\frac{8 mol C}{1 mol C\_{8}H\_{8}O\_{3}}=66.8 mol C$$

* 1. Calculate the mass of oxygen in a 4.29 g sample of oil of wintergreen.

$$?g O=4.29 g C\_{8}H\_{8}O\_{3}×\frac{1 mol C\_{8}H\_{8}O\_{3}}{152.14 g C\_{8}H\_{8}O\_{3}}×\frac{3 mol O}{1 mol C\_{8}H\_{8}O\_{3}}×\frac{16.00 g O}{1 mol O}=1.35 g O$$

* 1. Calculate the mass of a sample of oil of wintergreen that contains 6.58 x 1019 atoms of hydrogen.

$$?g C\_{8}H\_{8}O\_{3}=6.58×10^{19}atoms H×\frac{1 mol H}{6.022×10^{23} atom H}×\frac{1 mol C\_{8}H\_{8}O\_{3}}{8 mol H}×\frac{152.14 g C\_{8}H\_{8}O\_{3}}{1 mol C\_{8}H\_{8}O\_{3}}=2.08×10^{-3} g C\_{8}H\_{8}O\_{3}$$

1. (6 points) Determine the empirical formula of methyl butyrate, the principle component of apple flavor. It is composed of 58.80% C, 9.87% H, and 31.33% O.

$$58.80 g C×\frac{1 mol C}{12.01 g C}=4.896 mol C$$

$$9.87 g H×\frac{1 mol H}{1.008 g H}=9.79 mol H$$

$$31.33 g O×\frac{1 mol O}{16.00 g O}=1.958 mol O$$

$$C\_{\frac{4.896}{1.958}}H\_{\frac{9.79}{1.958}}O\_{\frac{1.958}{1.958}}$$

$$C\_{2.50}H\_{5}O\_{1} or C\_{5}H\_{10}O\_{2} $$

1. (8 points) Balance the following chemical equations. Include state labels.
	1. Aqueous hydrochloric acid(HCl) reacts with solid manganese(IV) oxide (MnO2) to form aqueous manganese(II) chloride(MnCl2), liquid water, and chlorine gas(Cl2).

4 HCl(aq) + MnO2(s) 🡪 MnCl2(aq) + 2 H2O(l) + Cl2(g)

* 1. Mg(s) + 2 CuNO3(aq) 🡪 Mg(NO3)2(aq) + 2 Cu(s)

Mg(s) + 2 CuNO3(aq) 🡪 Mg(NO3)2(aq) + 2 Cu(s)

1. (6 points) Given the following two reactions, develop an activity series for Cr, Mn, and V.

|  |  |
| --- | --- |
|  | Circle the more active metal |
| Cr + MnCl2 🡪 no reaction |  Cr or Mn |
| V + MnCl2 🡪 Mn + VCl2 |  V or Mn |

Activity series

\_\_\_\_\_\_V\_\_\_\_\_\_\_ > \_\_\_\_\_\_\_Mn\_\_\_\_\_\_\_\_\_ > \_\_\_\_\_\_\_Cr\_\_\_\_\_\_

Would a reaction occur between Cr and VCl2?

No

1. (18 points) Breathalyzers estimate the amount of alcohol in the blood by measuring the alcohol in the breath. The breathalyzer uses the redox reaction below to determine the amount of alcohol in the blood. Answer the following questions using this balanced chemical equation.

 3 C2H5OH + 10 H2CrO4 🡪 3 CH3CO2H + 8 Cr2(CrO4)3 + 13 H2O + 2674 kJ

 ethanol chromic acid acetic acid chromium(III) chromate water

 46.07 g/mol 118.0 g/mol 60.05 g/mo 452.0 g/mol 18.02 g/mol

* 1. How many moles of chromic acid can react with 6.34 moles of ethanol?

$$?mol H\_{2}CrO\_{4}=6.34 mol C\_{2}H\_{5}OH×\frac{10 mol H\_{2}CrO\_{4}}{3 mol C\_{2}H\_{5}OH }=21.1 mol H\_{2}CrO\_{4}$$

* 1. How many mg of ethanol are in a sample of a driver’s breath that produces 42.5 mg of acetic acid?

$$?mg C\_{2}H\_{5}OH=42.5 mg CH\_{3}CO\_{2}H×\frac{1 g CH\_{3}CO\_{2}H}{1000 mg CH\_{3}CO\_{2}H} ×\frac{1 mol CH\_{3}CO\_{2}H}{60.05 g CH\_{3}CO\_{2}H}×\frac{3 mol C\_{2}H\_{5}OH}{3 mol CH\_{3}CO\_{2}H}×\frac{46.07 g C\_{2}H\_{5}OH}{1 mol C\_{2}H\_{5}OH}×\frac{1000 mg C\_{2}H\_{5}OH}{1 g C\_{2}H\_{5}OH}=32.6 mg C\_{2}H\_{5}OH$$

* 1. How much energy will be produced if 16.8 grams of chromic acid react with excess ethanol?

$$?kJ=16.8 g H\_{2}CrO\_{4}×\frac{1 mol H\_{2}CrO\_{4}}{118.0 g H\_{2}CrO\_{4}}×\frac{2674 kJ}{10 mol H\_{2}CrO\_{4}}=38.1 kJ$$

* 1. If 50.3 grams of ethanol react with excess chromic acid to produce 79.4 grams of water, what is the percent yield of the reaction?

$$?g H\_{2}O=50.3 g C\_{2}H\_{5}OH×\frac{1 mol C\_{2}H\_{5}OH}{46.07 g C\_{2}H\_{5}OH}×\frac{13 mol H\_{2}O }{3 mol C\_{2}H\_{5}OH}×\frac{18.02 g H\_{2}O}{1 mol H\_{2}O}=85.3 g H\_{2}O $$

$$?\% yield=\left(\frac{actual yield}{theoretical yield}\right)×100=\left(\frac{79.4 g}{85.3 g}\right)×100=93.1\% yield$$

* 1. If 9.25 g of ethanol are allowed to react with 73.3 g or chromic acid, how many g of acetic acid should be produced?

$$?g CH\_{3}CO\_{2}H=9.25 g C\_{2}H\_{5}OH×\frac{1 mol C\_{2}H\_{5}OH}{46.07 g C\_{2}H\_{5}OH}×\frac{3 mol CH\_{3}CO\_{2}H }{3 mol C\_{2}H\_{5}OH}×\frac{60.05 g CH\_{3}CO\_{2}H}{1 mol CH\_{3}CO\_{2}H }=12.1 g CH\_{3}CO\_{2}H $$

$$?g CH\_{3}CO\_{2}H=73.3 g H\_{2}CrO\_{4}×\frac{1 mol H\_{2}CrO\_{4}}{118.0 g H\_{2}CrO\_{4}}×\frac{3 mol CH\_{3}CO\_{2}H }{10 mol H\_{2}CrO\_{4}}×\frac{60.05 g CH\_{3}CO\_{2}H}{1 mol CH\_{3}CO\_{2}H }=11.2 g CH\_{3}CO\_{2}H $$

Chromic acid is limiting and only 11.2 g of acetic acid will be produced.