Chemistry 141 Name

Dr. Cary Willard

Exam 1a September 21, 2010

 Multiple Choice (30 points)

 Page 3 (8 points)

 Page 4 (18 points)

 Page 5 (16 points)

 Page 6 (28 points)

 Page 7 (14 points)

 Page 8 (15 points)

 Total (129 points)

 Percent (100 %)

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

Avogadros number = 6.022 x 1023 /mol

4 quarts = 1 gallon

36 in = 1 yard



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) |  |  |  |  |  |  |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 I – Multiple Choice (30 points)

Exam 1 multiple choice questions

1. Which of the following mixtures can be separated by filtration?
	1. sugar dissolved in coffee
	2. gasoline
	3. sand and water
	4. Jell-O
	5. Cupric nitrate and cupric chloride dissolved in acid.
2. John Dalton postulated that all matter (elements, compounds, or mixtures) is composed of small particles called atoms. For this proposition to be considered a valid scientific theory,
	1. it must be supported by extensive experimental evidence and testing.
	2. it must be impossible to disprove experimentally.
	3. all possible experiments must never find an exception to it.
	4. some experiments may find exceptions to it.
	5. it must be a hypothesis.
3. Given the following figure, which of the measurements listed is the best estimate of the length of the aluminum rod?



* 1. 1.8 cm
	2. 1.91 cm
	3. 1.910 cm
	4. 1.9 cm
	5. 2 cm
1. Dalton’s atomic theory of matter did *not* include which of the following statements?
	1. Each element is composed of atoms that are identical in size, mass, and reactive properties.
	2. Compounds are formed from different atoms in simple whole number ratios.
	3. Atoms can combine in several different proportions to make different compounds.
	4. Each element is made of a number of isotopes, some of which are radioactive.
2. Which would require more carbon to make: 1 g of CO2 or 1 g of CO?
	1. CO
	2. CO2
	3. They would take the *same* mass of carbon.
	4. They would take the *same* mass of carbon, but *different* masses of oxygen.
	5. Unable to determine from the data given
3. Indicate which of the following gives the correct number of protons, neutrons, and electrons for a 18O2– ion.

|  |  |  |
| --- | --- | --- |
| *Protons* | *Neutrons* | *Electrons* |

* 1. 8 10 8
	2. 8 8 10
	3. 8 10 10
	4. 8 8 8
	5. 10 8 10
1. Identify the binary compound that has ionic bonding.
	1. NO
	2. CH4
	3. Na2SO4
	4. H2O
	5. LiF
2. The Murrah Federal Building in Oklahoma City was destroyed on April 19, 1995, killing 168 people by a simple, but powerful, bomb made from 4800 lb of ammonium nitrate and nitromethane. What is the formula for ammonium nitrate?
	1. Am(NO3)2
	2. NH4NO3
	3. Am(NO3)
	4. NH4(NO3)2
	5. (Am)2NO3
3. The empirical formula for buckminsterfullerene is C1, but its molar mass is 720.6 g/mol. What is its molecular formula?
	1. C1
	2. C12
	3. C72
	4. C60
	5. Unable to determine
4. Combustion analysis of an organic compound to determine the percentages of carbon, hydrogen, and oxygen in the formula depends on which of the following assumption(s)?
	1. All the oxygen in the products comes from the added oxygen gas.
	2. The mass of the resulting carbon dioxide is equal to the mass of the carbon in the sample.
	3. The compound burns completely to form carbon dioxide and water.
	4. All the above
	5. No assumptions are made.
5. In syrups that contain water and sugar at high concentration, crystals of sugar often form, especially when they are stored in the refrigerator. These crystals can be redissolved by heating. What does this imply about these solutions?
	1. These are not true solutions because they contain dissolved solids.
	2. Sugar and water do not mix.
	3. The extent of solubility depends on temperature.
	4. Sugar is created in the refrigerator.
	5. The syrup freezes at temperatures higher than the freezing point of water.
6. If sodium sulfate is dissolved in water, which ion will have the highest concentration?
	1. sodium ion
	2. oxide ion
	3. sulfide ion
	4. sulfate ion
	5. sulfoxide ion
7. Tube worms that survive near geothermal vents of hydrogen sulfide rely on bacteria living inside them to obtain energy by the oxidation of H2S to SO42–. What is the overall change in the oxidation number of sulfur for this reaction?
	1. –2
	2. –6
	3. –8
	4. +2
	5. +8
8. In a demonstration of strong electrolytes, weak electrolytes, and nonelectrolytes, Professor Popsnorkle used a lightbulb apparatus that showed solution conduction of electricity by the brightness of the lightbulb. When pure water was tested, the bulb did not light. When some acetic acid was added to the water, the bulb burned dimly. When more acetic acid was added to the solution, the bulb burned a little more brightly. In his frustration to make the bulb shine brightly with acetic acid, Professor Popsnorkle started over by testing the beaker of the *pure* acetic acid. What was the result?
	1. The bulb did not light.
	2. The bulb burned dimly.
	3. The bulb burned more brightly than any of the others, but still not brightly.
	4. The bulb burned brightly.
	5. The bulb popped and burned out.
9. In carrying out a titration of a hydrochloric acid solution with a standard sodium hydroxide solution, a student went beyond the end point before reading the volume on the buret. That is, the measured volume was larger than the actual volume required to reach the end point. How will this error affect the calculated concentration of the hydrochloric acid?
	1. The calculated concentration will be smaller than the true concentration.
	2. The calculated concentration will be the true concentration.
	3. There is no way to tell how this error will affect the calculation.
	4. The student will fail chemistry.
	5. The calculated concentration will be larger than the true concentration.

Part 2 - Problems

1. (8 points) The level of water in a rectangular swimming pool needs to be lowered 6.00 inches. If the pool is 35.0 feet long and 16.0 wide, and the water is siphoned out at a rate of 5.23 gal/min, how many hours will the siphoning take?

$$volume of water to be siphoned=0.500 ft×35.0 ft×16.0 ft=280 ft^{3}$$

$$?min=280 ft^{3}×\left(\frac{12 in}{1 ft}\right)^{3}×\left(\frac{2.54 cm}{1 in}\right)^{3}×\frac{1 mL}{1 cm^{3}}×\frac{1 L }{1000 mL }×\frac{1.06 qt }{1 L }×\frac{1 gal }{4 qt }×\frac{1 min}{5.23 gal}=$$

1. (8 points) The volumes of a 50.00 mL pipet, and a 250.0 mL graduated cylinder were determined by weighing the amount of water they delivered. The pertinent information is given in the table; all volumes are in mL. For each device rate the **precision** and **accuracy** as good, fair or poor. The balance used for the measurements was calibrated and thereby known to be accurate.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Item** | **rated volume** | **Rated uncertainty** | **number of trials** | **average value** | **σ** | **precision** | **accuracy** |
| Pipet | 50.00 | 0.05 | 7 | 50.04 | 0.09 | poor | good |
| Explain your reasoningAccuracy is within the specs, precision is not. |
| Cylinder | 250 | 4 | 5 | 235 | 4 | fair | poor |
| Explain your reasoningAccuracy is way off! Precision just barely falls into the specs. |

1. (5 points) Give the IUPAC name for the following compounds
	1. Mn2(CO3)3 manganese(III) carbonate
	2. Ca(ClO4)2  calcium perchlorate
	3. S6O hexasulfur monoxide or hexasulfur oxide
	4. CoS2 cobalt(IV) sulfide
	5. NaMnO4 sodium permanganate
2. (5 points) Write the correct formula for each of the following compounds
	1. potassium selenide K2Se
	2. Phosphorus pentaiodide PI5
	3. Silver sulfite Ag2SO3
	4. Ferric hydroxide Fe(OH)3
	5. Phosphoric acid H3PO4
3. (6 points) A novel vanadium compound consisting of 14.7% vanadium by mass is thought to be able to mimic the structure of insulin and is being tested as a treatment for diabetes. If each molecule contains 1 atom of vanadium, what is the molar mass of the compound?

$$\frac{?g cmpd}{mol}=\frac{100 g cmpd}{14.7 g V}×\frac{50.94 g V}{1 mol V}×\frac{1 mol V}{1 mol compound}=\frac{346 g compound}{1 mol}$$

1. (10 points) Serotonin is a biomolecule composed of C, H, N, and O which is partially responsible for signaling the brain that we have had enough to eat. A 0.500 g sample of serotonin was subjected to combustion analysis forming 1.25 g of CO2 and 0.307 g of H2O. A second 0.350 g sample was reduced to convert all of the nitrogen to ammonia, forming 0.0677 g NH3. Determine the empirical formula of serotonin.

$$1.25 g CO\_{2}×\frac{1 mol CO\_{2}}{44.01 g CO\_{2}}×\frac{1 mol C}{1 mol CO\_{2}}×\frac{12.01 g C}{1 mol C}=0.3411 g C$$

$$\left(\frac{0.3411 g C}{0.500 g sample}\right)×100(\%)=68.2\% C$$

$$0.307 g H\_{2}O×\frac{1 mol H\_{2}O}{18.02 g H\_{2}O}×\frac{2 mol H}{ mol H\_{2}O}×\frac{1.008 g H}{1 mol H}=0.0343 g H$$

$$\left(\frac{0.0343 g H}{0.500 g sample}\right)×100(\%)=6.87\% H$$

$$0.0677 g NH\_{3}×\frac{1 mol NH\_{3}}{17.03 g NH\_{3}}×\frac{1 mol N}{1 mol NH\_{3}}×\frac{14.01 g N}{1 mol N}=0.0557 g N$$

$$\left(\frac{0.0557 g N}{0.350 g sample}\right)×100(\%)=15.9\% N$$

$$\% O=100\%-\left(68.22\% C+6.87\% H+15.9 \% N\right)=9.03\% O$$

$$68.22 g C×\frac{1 mol C}{12.01 g C}=5.68 mol C$$

$$6.87 g H×\frac{1 mol H}{1.008 g H}=6.81 mol H$$

$$15.9 g N×\frac{1 mol N}{14.01 g N}=1.13 mol N$$

$$9.03 g O×\frac{1 mol O}{16.00 g O}=0.564 mol O$$

$$C\_{\frac{5.68}{0.564}}H\_{\frac{6.81}{0.564}}O\_{\frac{.564}{.564}}N\_{\frac{1.13}{.564}}$$

$C\_{10}H\_{12}ON\_{2}$

1. (28 points) Tumeric is commonly used as a spice in Indian and Southeast Asian dishes. Tumeric contains a high concentration of curcumin (C20H18O6), a potential anticancer drug and a possible treatment for cystic fibrosis. Answer the following questions regarding curcumin.
	1. Calculate the molar mass of curcumin.

$$?molar mass$$

$$=20 at C\left(\frac{12.01 amu}{atom C}\right)+18 at H\left(\frac{1.008 amu}{1 atom H}\right)+6 at O\left(\frac{16.00 amu}{1 atom O}\right)$$

$$=240.2 amu C+18.14 amu H+96.00 amu O$$

$$=$$

* 1. Calculate the mass of curcumin that contains 6.297 x 1025 atoms of carbon.

$$?g C\_{20}H\_{18}O\_{6}$$

$$=6.297×10^{25}at C×\frac{1 mole C}{ 6.022×10^{23}atom C}×\frac{1 mol C\_{20}H\_{18}O\_{6}}{20 mol C}×\frac{354.3 g C\_{20}H\_{18}O\_{6}}{1 mol C\_{20}H\_{18}O\_{6}}$$

$$=$$

* 1. Calculate the number of moles of hydrogen in 7.98 moles of curcumin.

$$?mol H=7.98 mol C\_{20}H\_{18}O\_{6}×\frac{18 mol H}{1 mol C\_{20}H\_{18}O\_{6}}=$$

* 1. Calculate the number of molecules of curcumin that contains 792 atoms of oxygen.

$$?molec C\_{20}H\_{18}O\_{6}=793 atom O×\frac{1 molec C\_{20}H\_{18}O\_{6}}{6 atom O}=$$

* 1. Calculate the mass in grams of one molecule of curcumin.

$$?\frac{g C\_{20}H\_{18}O\_{6}}{molecule}=\frac{354.3 g C\_{20}H\_{18}O\_{6}}{1 mol C\_{20}H\_{18}O\_{6}}×\frac{1 mol C\_{20}H\_{18}O\_{6}}{6.022×10^{23}molecule C\_{20}H\_{18}O\_{6}}$$

$$=$$

* 1. If 3.64 g of curcumin is dissolved in ether to make 25.0 mL of solution, what is the concentration of the solution in moles/L?

$$?M=\frac{3.64 g C\_{20}H\_{18}O\_{6}}{0.0250 L soln}×\frac{1 mol C\_{20}H\_{18}O\_{6}}{354.3 g C\_{20}H\_{18}O\_{6}}=0.411 M C\_{20}H\_{18}O\_{6}$$

* 1. If the density of the solution from part f is 0.724 g/mL, what is the mass percent of curcumin in the solution?

$$?\% C\_{20}H\_{18}O\_{6}=\left(\frac{0.411 mol C\_{20}H\_{18}O\_{6}}{1000 mL soln}×\frac{354.3 g C\_{20}H\_{18}O\_{6}}{1 mol C\_{20}H\_{18}O\_{6}}×\frac{1 mL soln}{0.724 g soln}\right)×100=20.1 \% C\_{20}H\_{18}O\_{6}$$

1. (9 points) Complete the following precipitation reaction with balanced molecular, total ionic, and net ionic equations.

Conventional equation

 V2(CO3)3*(s)* + 6 HNO3*(aq)* 🡪 2 V(NO3)3*(aq)* + 3 H2CO3*(aq)* 🡪 3 H2O(l) + 3 CO2(g)

Balanced total ionic equation

V2(CO3)3*(s)* + 6 H+1(aq) 6 NO3-1*(aq)* 🡪 2 V+3(aq) + 6 NO3-1 *(aq)* + 3 H2O(l) + 3 CO2(g)

Balanced net ionic equation

V2(CO3)3*(s)* + 6 H+1(aq) 🡪 2 V+3(aq) + 3 H2O(l) + 3 CO2(g)

Conventional equation

 2 K3PO4*(aq)* + 3 Cs2Cr2O7*(aq)* 🡪 2 Cs3PO4*(aq)* + 3 K2Cr2O7*(aq)*

Balanced total ionic equation

6 K+1(aq) + 2 PO4-3*(aq)* + 6 Cs+1(aq) + 3 Cr2O7-2*(aq)* 🡪 6 Cs+1(aq) + 2 PO4-3*(aq)* + 6 K+1(aq) + 3 Cr2O7-2*(aq)*

Balanced net ionic equation

No reaction

Conventional equation

 Na2C2O4*(aq)* + 2 HBr*(aq)* 🡪 2 NaBr*(aq)* + H2C2O3*(aq)*

Balanced total ionic equation

2Na+1*(aq)* + C2O4-2*(aq)* + 2 H+1(aq) + 2 Br-1*(aq)* 🡪 2Na+1*(aq)* + H2C2O4*(aq) +* 2 Br-1*(aq)*

Balanced net ionic equation

C2O4-2*(aq)* + 2 H+1(aq*)* 🡪 H2C2O4*(aq)*

1. (8 points) Citric acid (C6H8O7, molar mass 192.12) is a triprotic acid extracted from citrus furits and pineapple waste that is used in beverages and jellies to provide tartness. A 15.00 mL sample was diluted to 250.0 mL, and 40.00 mL of this diluted sample were titrated with 31.85 mL of 0.2018 M NaOH. Calculate the concentration molarity of citric acid in the diluted sample and in the original sample.

$$\frac{?mol citric acid}{L dilute sample}=\frac{31.85 mL×\frac{0.2018 mol NaOH}{1000 mL}×\frac{1 mol H\_{3}Cit}{3 mol NaOH}}{0.04000 L dilute sample}$$

$$=\frac{0.002142 mol H\_{3}Cit }{0.04000 L dilute}=\frac{0.05356 mol H\_{3}Cit }{ L dilute} $$

$$M\_{conc}V\_{conc}=M\_{dil}V\_{dil}\rightarrow M\_{conc}=M\_{dil}\left(\frac{V\_{dil}}{V\_{conc}}\right)=0.05356 M\left(\frac{250.0 mL}{15.00 mL}\right)=0.8927 M$$

1. (6 points) Given the following data, determine the major and minor species in solution.
	1. A solution of benzoic acid (HC7H5O2) a monoprotic acid is determined to have poor conductivity.

Major species HC7H5O2

Minor species H+1 and C7H5O2-1

* 1. A solution of sodium phosphate in water has good conductivity.

Major species Na+1 and PO4-2

Minor species

* 1. A solution of sulfuric acid in isobutene does not conduct electricity.

Major species H2SO4

Minor species

1. (15 points) You mix 386.0 mL of 0.2754 M sodium phosphate with 381.7 mL of 0.6684 M vanadium(II) chloride. Write the reaction and determine the number of grams of vanadium(III) carbonate produced, and the final concentration of all ions in the solution.

Balanced chemical equation (Check with me before you go on to be sure this is correct.)

2 Na3PO4(aq) + 3 VCl2(aq) 🡪 6 NaCl(aq) + V3(PO4)2(s)

$$?mol Na\_{3}PO\_{4}=386.0 mL×\frac{0.2754 mol Na\_{3}PO\_{4} }{1000 mL}=0.1064 mol Na\_{3}PO\_{4}$$

$$?mol VCl\_{2}=381.7 mL×\frac{0.6684 mol VCl\_{2} }{1000 mL}=0.2551 mol VCl\_{2}$$

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | X = 0.05321 mol |  | X=0.08504mol |  |  |  |  |
|  | 2 Na3PO4(aq) | + | 3 VCl2(aq) | 🡪 | 6 NaCl(aq) | + | V3(PO4)2(s) |
| I | 0.1064 mol |  | 0.2551 mol |  | 0 mol |  | 0 mol |
|  | -2x |  | -3x |  | +6x |  | + x |
| E | 0.07876 – 2x |  | 0.2551-3x |  | 6x |  | 1x |
|  | =0.1064-2(.0532)=0.0 mol |  | =0.2551-3(.0532)=0.0955 mol |  | =6(0.0532)=0.3192 mol |  | =0.0532 mol |

$$0.0532 mol V\_{3}\left(PO\_{4}\right)\_{2}×\frac{342.8 g V\_{3}\left(PO\_{4}\right)\_{2}}{1 mol V\_{3}\left(PO\_{4}\right)\_{2}}=$$

$$\left[Na^{+1}\right]=\frac{3\left(0 mol Na^{+1}\right)+0.3192 mol Na^{+1}}{0.7677 L solution}= \frac{0.3192 mol Na^{+1}}{0.7677 L}=$$

$$\left[PO\_{4}^{-3}\right]=\frac{0 mol PO\_{4}^{-3}}{0.7677 L solution}=$$

$$\left[V^{+2}\right]=\frac{0.0955 mol V^{+2}}{0.7677 L solution}=$$

$$\left[Cl^{-1}\right]=\frac{2\left(0.0955 mol Cl^{-1}\right)+0.3192 mol Cl^{-1}}{0.7677 L solution}=\frac{0.5102 mol Cl^{-1}}{0.7677 L }=$$

concentrations of all ions present after mixing.

Moles V3(PO4)2 produced 0.0532 Mass V3(PO4)2 produced 18.2 g

Moles Na+1 = 0.3192 mol [Na+1] = 0.4158

Moles PO4-3 = 0.0 [PO4-3] = 0.0 M

Moles V+2 = 0.0955 mol [V+2] = 0.124 M

Moles Cl-1 = 0.5102mol [Cl-1] = 0.6645 M