Chemistry 115 Name KEY

Martin Larter

Exam 3 June 25, 2015

 Multiple Choice (30 points)

 Page 5 (29 points)

 Page 6 (24 points)

 Page 7 (18 points)

Page 8 (6 points)

 Total (107 points)

 Percent

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

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 I – Multiple Choice (30 points)

1. What is the maximum number of electrons that can occupy an orbital?

|  |  |  |
| --- | --- | --- |
| 1. 1
 | 1. 3
 | 1. **2**
 |
| 1. 5
 | 1. 4
 |  |

1. The characteristic bright line spectrum of an element is produced when electron(s)
	1. Move to higher energy levels
	2. **Fall back to lower energy levels**
	3. Are emitted as gamma radiation
	4. Are absorbed into the nucleus
	5. None of the above
2. Which of the following occur as the wavelength of a photon increases?
	1. the energy increases
	2. the speed decreases
	3. **the frequency decreases**
	4. Planck's constant decreases
	5. None of the above occur as the wavelength of a photon increases.
3. The number of electromagnetic waves that travel past a certain point in a given time is the \_\_\_\_\_ of the radiation.

|  |  |  |
| --- | --- | --- |
| 1. color
 | 1. speed
 | 1. count
 |
| 1. wavelength
 | 1. **frequency**
 |  |

1. The electron configuration of an atom shows
	1. The number of isotopes possible.
	2. A description of the shape of each electron energy level.
	3. **The number of electrons in each electron energy level.**
	4. A diagram of an atomic nucleus.
	5. The maximum number of electrons each electron energy level can hold.
2. The Schrödinger equation describes the behavior of electrons. According to it and quantum mechanics,
3. **An electron has a high probability of residing in a particular region of space around the nucleus called an orbital.**
4. An electron can reside anywhere in the atom except for the nucleus.
5. An electron exists in a stationary position just outside the nucleus of an atom.
6. Electrons are known to reside near the nucleus, but their location is impossible to predict.
7. An electron orbits the nucleus of an atom in a circular orbit.
8. The following figure shows a(an):

|  |  |  |
| --- | --- | --- |
| 1. f orbital
 | 1. d orbital
 | 1. s orbital
 |
| 1. **p orbital**
 | 1. none of the above
 |  |

1. Valence electrons are
2. The first ten electrons in an atom.
3. The outermost d electrons in an atom.
4. The unpaired electrons in an atom.
5. **The outermost s and p electrons in an atom.**
6. The innermost electrons in an atom.
7. What do the ions Ca2+, K+, S2-, and Br- have in common?
8. They have the same atomic radius.
9. **They have the same electron configuration.**
10. They have nothing in common.
11. They are all cations.
12. They are all anions.
13. The octet rule indicates that
14. All of the noble gases have eight total electrons.
15. The noble gases react with other compounds to get 8 valence electrons.
16. All of the Group A elements have 8 valence electrons.
17. All of the shells in an atom hold a maximum of 8 electrons.
18. **Atoms lose, gain, or share valence electrons to have 8 valence electrons.**
19. The VSEPR theory allows us to determine the \_\_\_\_\_\_\_\_.
	1. **shape of a molecule**
	2. charge on an ion
	3. color of a compound
	4. bond type for a molecule
	5. formula for a compound
20. Place the following elements in order of increasing atomic radius.

P Ba Cl

|  |  |  |
| --- | --- | --- |
| 1. Ba < P < Cl
 | 1. P < Cl < Ba
 | 1. **Cl < P < Ba**
 |
| 1. Cl < Ba < P
 | 1. Ba < Cl < P
 |  |

1. Covalent bonding is a

|  |  |  |
| --- | --- | --- |
| * 1. Loss of electrons.
 | * 1. Gain of electrons.
 | * 1. Transfer of electrons.
 |
| * 1. **Sharing of electrons.**
 | * 1. none of the above
 |  |

1. Indicate which is larger in each of the following two sets.

(I) Cr3+ or Cr (II) Se2- or Se

* 1. Cr3+ is larger than Cr and Se is larger than Se2-.
	2. **Cr is larger than Cr3+ and Se2- is larger than Se.**
	3. Cr is larger than Cr3+ and Se is larger than Se2-.
	4. Cr3+ is larger than Cr and Se2- is larger than Se.
	5. unable to determine which is larger
1. Place the following in order of increasing *Ionization energy*.

K Ca Rb

|  |  |  |
| --- | --- | --- |
| * 1. Ca < K < Rb
 | * 1. Rb < Ca < K
 | * 1. Ca < Rb < K
 |
| * 1. K < Ca < Rb
 | * 1. **Rb < K < Ca**
 |  |

Part 2: Short answer (77 points)

1. (8 points) Name the following compounds or Give the correct formula for the following compounds

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Formula | Compound name |  | Formula | Compound name |
| Na3PO3 | **sodium phosphite** |  | **ZnO** | zinc oxide |
| Ti2O3 | **titanium(III) oxide** |  | **Al2(SO4)3** | aluminum sulfate |
| HC2H3O2 | **Acetic acid** |  | **N2O4** | dinitrogen tetroxide |
| SF6 | **sulfur hexafluoride** |  | **HNO2 (aq)** | nitrous acid |

1. (12 points) Complete the following 3 items for each set of reactants shown below:
2. Determine the type of reaction that would most likely occur (your options are: precipitation, acid-base neutralization, combination, decomposition, single-replacement, combustion, or No Reaction),
3. Predict the products of reaction (**including phases**!), and Balance the equation.

|  |  |  |
| --- | --- | --- |
| **Rxn Type** | **Reactants** | **Products** |
| single-replacement | \_\_\_**3**\_ Mg (s) + \_\_**2**\_ Al(NO3)3 (aq) → | **3 Mg(NO3)2 (aq) + 2 Al (s)** |
| precipitation | \_\_**3**\_\_ BaCl2 (aq) + \_\_\_Al2(SO4)3 (aq) → | **3 BaSO4 (s) + 2 AlCl3 (aq)** |
| combustion | \_\_**2**\_\_ C4H10(l) + \_\_**13**\_\_ O2(g) → | **8 CO2 (g) + 10 H2O (g)** |

1. (9 points) Write the complete and condensed electron configuration for

|  |  |  |
| --- | --- | --- |
| Element/Ion | Complete electron configuration | Condensed electron configuration |
| 1. Chlorine
 | **1s2 2s2 2p6 3s2 3p5** | **[Ne] 3s2 3p5** |
| 1. Niobium, Nb
 | **1s2 2s2 2p6 3s2 3p6 4s2 3d10 4p6 5s2** | **[Kr] 5s2 4d3** |
| 1. Nb2+ ion
 | **1s2 2s2 2p6 3s2 3p6 4s2 3d10 4p6 5s0 4d3** | **[Kr] 5s0 4d3** |

1. (3 points) Draw Lewis Electron Dot Structures for phosphorous

 

1. (9 points) Draw Lewis electron dot structures for the following molecules/ ions

|  |  |  |
| --- | --- | --- |
| Molecular formula | Valence Electrons | Lewis structure |
| CF2O | **24 e-** |  |
| BrO3- | **26 e-** |  |
| HC2F | **16 e-** |  |

1. (8 points) Predict the orbital or molecular geometry of the numbered atoms (shapes: linear, bent, trigonal planar, trigonal pyramidal, or tetrahedral):

Molecular geometry N **trigonal pyramidal**

Molecular geometry S **bent**

Orbital geometry P **trigonal planar**

Molecular geometry C1 **tetrahedral**

1. (4 points) Draw Lewis Electron Dot Structures for the carbonate ion (HCO2−). Include reasonable resonance structures. (carbon is the central atom)



1. (18 points) Matches contain tetraphosphorous trisulfide which when combined with an oxidizing agent such as potassium chlorate will ignite when shocked. The balanced equation for the reaction which takes place when a match is lit is shown below. Answer the following questions using this balanced chemical equation.

Potassium tetraphosphorus potassium tetraphosphorus sulfur

 chlorate trisulfide chloride decoxide dioxide

16 KClO3 + 3 P4S3 🡪 16 KCl + 3 P4O10 + 9 SO2 + 8954 kJ

* 1. How many moles of potassium chlorate can react with 5.91 moles of tetraphosphorus trisulfide?

$$?mol KClO\_{3}=5.91 mol P\_{4}S\_{3}×\frac{16 mol KClO\_{3}}{3 mol P\_{4}S\_{3} }=31.5 mol KClO\_{3}$$

* 1. How many kilograms of tetraphosphorus decoxide can be formed from the reaction of 46.2 g of tetraphosphorus trisulfide with excess potassium chlorate?

$$?g P\_{4}O\_{10}=46.2 g P\_{4}S\_{3} ×\frac{1 mol P\_{4}S\_{3}}{220.1 g P\_{4}S\_{3}}×\frac{3 mol P\_{4}O\_{10}}{3 mol P\_{4}S\_{3}}×\frac{283.9 g P\_{4}O\_{10}}{1 mol P\_{4}O\_{10}}× \frac{1 kg}{1000 g}=0.0596 kg P\_{4}O\_{10}$$

* 1. How much energy will be produced if 500.0 grams of potassium chlorate react with excess P4S3?

$$?kJ=500.0 g KClO\_{3}×\frac{1 mol KClO\_{3}}{122.6 g KClO\_{3}}×\frac{8954 kJ}{16 mol KClO\_{3}}=2282 kJ$$

* 1. If 135 grams of tetraphosphorus trisulfide react with excess potassium chlorate to produce 103 grams of sulfur dioxide, what is the percent yield of the reaction?

$$?g SO\_{2}=135 g P\_{4}S\_{3} ×\frac{1 mol P\_{4}S\_{3}}{220.1 g P\_{4}S\_{3}}×\frac{9 mol SO\_{2}}{3 mol P\_{4}S\_{3}}×\frac{64.07 g SO\_{2}}{1 mol SO\_{2}}=118 g SO\_{2} $$

$$?\% yield=\left(\frac{actual yield}{theoretical yield}\right)×100=\left(\frac{103 g}{118 g}\right)×100=87.3\% yield$$

* 1. If 35.0 grams of tetraphosphorous trisulfide react with 90.0 g potassium chlorate, What is the limiting reactant and how many grams of tetraphosphorus decoxide should be produced?

$$?g P\_{4}O\_{10}=35.0 g P\_{4}S\_{3} ×\frac{1 mol P\_{4}S\_{3}}{220.1 g P\_{4}S\_{3}}×\frac{3 mol P\_{4}O\_{10}}{3 mol P\_{4}S\_{3}}×\frac{283.9 g P\_{4}O\_{10}}{1 mol P\_{4}O\_{10}}=45.1 g P\_{4}O\_{10}$$

$$?g P\_{4}O\_{10}=90.0 g KClO\_{3}×\frac{1 mol KClO\_{3}}{122.6 g KClO\_{3}}×\frac{3 mol P\_{4}O\_{10}}{16 mol KClO\_{3}}×\frac{283.9 g P\_{4}O\_{10}}{1 mol P\_{4}O\_{10}}=39.3 g P\_{4}O\_{10}$$

**Potassium chlorate is limiting and only 39.3 g of tetraphosphorus decoxide will be produced.**

1. (6 points) Draw an orbital diagram of the valence electrons of Nickel and explain the placement of the electrons in the orbitals (hint: Pauli's Exclusion Principle, Hund's Rule)



**Pauli's Exclusion Principle:** Each orbital can hold two electrons with opposite spins

**Hund's Rule** Electrons enter orbitals of equal energy one at a time with parallel spin to minimize repulsion only when each equal energy orbital contains in electron do you begin to pair the electrons gives those opposite spin.

**Activity Series**

**Li K Ba Sr Ca Na Mg Al Mn Zn Fe Cd Co Ni Sn Pb (H) Cu Ag Hg Au**

 **Solubility Rules for Ionic Compounds**

**Compounds containing the following ions are generally *soluble* in water:**

1. **Alkali metal ions and ammonium ion**
2. **Acetate ion**
3. **Nitrate ion**
4. **Halide ions (X) (AgX, Hg2X2, and PbX2 are insoluble exceptions)**
5. **Sulfate ion (SrSO4, BaSO4, and PbSO4, are insoluble exceptions)**

**Compounds containing the following ions are generally *insoluble* in water:**

1. **Carbonate ion (see rule 1 exceptions, which are soluble)**
2. **Chromate ion (see rule 1 exceptions, which are soluble)**
3. **Phosphate ion (see rule 1 exceptions, which are soluble)**
4. **Sulfide ion (CaS, SrS, BaS, and rule 1 exceptions are soluble)**
5. **Hydroxide ion [Ca(OH)2, Sr(OH)2, Ba(OH)2, and rule 1 exceptions are soluble]**