**Exam 3: Chem 1114 Fall 2016**

**Version A 100 points**

**Your name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. An unknown gas can have one of six identities:

O2 N2 CO2 H2O SO2 H2

MW 32 28 44 18 64 2

A 1.0 gram sample of the gas occupies 3.00 L at 300 K and a pressure of 0.2564 atm. Which gas are you working with and why (show work.) R=0.08206 atm L/K mol

n= PV/RT= 3\*0.2564/(0.082\*300)=0.031245

MW= #g/#mol =1/0.031245=32 g/mol=> O2

\_O2\_ gas ID

**4 pts**

2. A nitrogen oxide compound NxOy decomposes to form N2 and O2.

The possible choices for the compound are:

NO2🡪 ½ N2 + O2

NO 🡪 ½ N2 + ½ O2

N2O4 🡪 N2 + 2O2

The Ideal Gas fairy informs you that 1 mole of the mystery gas decomposes to N2 and O2 which then occupies 73.854 L at 1 atm and 300 K. R=0.08206 atm L/K mol

What is the identity of the original NxOy compound? (show work)

**n(final) = PV/RT= 73.854\*1/(0.082\*300)=3=> N2O4**

\_\_N2O4\_\_ NxOy ID

**4 pts**

3. A sample of gas weighing 20 grams occupies 2 L at 2.46 atm and 300 K. Given that

R=0.08206 atm L/K mole what is the molecular weight of the gas ?

**n=PV/RT= 2.46\*2/(0.082\*300) =0.2**

**MW= #g/#mol = 20/0.2=100 g/mol**

MW(g/mol)=\_100\_\_\_

4 pts

\_\_\_/12

**Exam 3A (continued) p. 2/5**

4.1 Circle all the true features of the Ideal Gas law below: (2 points)

a) R varies with temperature) b) PV=nRT irrespective of gas identity

c) Equal volumes, equal moles d) It explains why gases condense

4.1 Circle all the features of the kinetic theory of gases in the list below : (2 pts)

a) gas particles have no volume b) gas particles of all masses have equal velocity

c) gas particles undergo elastic collisions d) gas particles interact with each other

5.1. The ~ ratio of the electron orbit radius to the nuclear radius is:

a) 1:1

b) 10:1

c) 1000:1

d) 100,000:1

e) 1,000,000:1

5.2 The relative mass of protons (p) to neutrons(n) to electrons ( e) is:

a)p=n=1, p/e =100,000/1 b)p=e=1, p/n =2000/1

c)p=n=1, p/e =2000/1 d) p=e=2000, p/n=1/2000

5.3. According to Rutherford’s gold leaf experiment:

a) the nucleus is a small dot in the center of a diffuse cloud of electrons

b) the positive and negative material of an atom are smeared out in a `plum pudding’ fashion

c) electrons orbit in circles around a nucleus

d) neutrons exist.

5.4. A dried pea is about 1/16 in (0.0625 in) in radius. A pair of students have assigned the pea

the role of atomic nucleus. About how many feet away would the electron cloud be (to the nearest foot) ? (12 inches =1 foot)

0.0625 \*100,000=6250 in => 6250/12 ft=520.8 ft~521 ft

Radius of electron cloud\_\_\_\_\_521\_\_\_\_\_\_\_\_ ft

3 pts

6.1 Given that the wavelength of a wave of light, λ, is 3\*10-5 m, what is the frequency, f, of the light in s-1 given c= 3\*108 m/s

c/λ=3\*108/3\*10-5 =f = 1\*1013

f=\_\_\_\_\_\_1\*1013\_\_\_\_\_ s\_1

(2 pts)

6.2 A light wave is found to have a frequency, f= 1\*107 /s . What is wavelength λ of the

wave, given that c=3\*108 m/s.

**c/f=λ=3\*108/1\*107 =30 m**

λ = \_\_\_\_\_\_30\_\_\_\_\_\_\_\_\_ m

\_\_\_/14 (2 pts)

**Exam 3A (continued) p. 3/5**

6.3) A photon has an energy, E/photon= 6.63\*10-31 J. What is the frequency, f, of the

photon in 1/s given h=6.63\*10‑34 J\*s.

f=E/h =6.63\*10‑31/6.63\*10-34 =1000 s-1

f= \_\_\_\_\_1000\_\_\_\_\_\_\_\_\_\_\_\_ s-1

(3 pts)

6.4 A photon has a wavelength of 9.945\*10-6m. Given that hc=1.989\*10‑25 J\*m

What is the energy of the photon on J ?

**E=hc/λ=1.989\*10-25/9.945\*10-6 =2\*10-20**

E/photon= \_\_\_\_2\*10\_20\_\_ J

(3 pts)

7.1.) DeBroglie theorized:

a) H atom is a series of circular electron orbits

b) Plum Pudding model of atom

c) matter has wave-like properties: mv=h/λ

d) E=mc2

7.2. The symbols s,p,d,f

a) refer to the character of emissions lines of atoms observed by spectroscopists

b) were invented by Bohr to describe his electron orbits

c) specify particular wavelengths of light emitted by molecules

d) is derived from the Pax Romana characters SPQR

7.3. Rutherford’s atom:

a)resulted from observations of the Photoelectric effect

b) arose from observations derived from the Cathode Ray Tube

c) resulted from observations of the scattering of alpha particles through gold leaf

d)came from pure theory

7.4. Name two problems with Bohr’s atom:

1)\_\_\_\_\_\_\_\_\_\_\_\_Zeeman effect on H\_\_unexplained\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2)\_\_\_\_\_\_\_\_\_\_\_\_\_\_Model only works for H\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8.1. Provide the complete electronic configurations for the elements below:

(2 pts each /8 pts total)

1. B\_\_\_\_\_\_\_\_\_\_\_1s22s22p1\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Si\_\_\_\_\_\_\_\_\_\_1s22s2 2p63s2 3p4\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Al\_\_\_\_\_\_\_\_\_\_\_1s2 2s2 2p6 3s23p1\_\_\_\_\_\_\_\_\_\_\_

d) Cl\_\_\_\_\_\_\_\_\_\_\_\_1s2 2s2 2p6 3s23p5\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_/19

**Exam 3A (continued) p. 4/5**

8.2. Provide the correct pigeonhole descriptions for the elements and ions below:

Remember to subtract electrons if the element is +charged. (4 pts each/ 12 pts total)

1. Cu+1 [ Ar ] [Ar]3d104so
2. V [ Ar ] [Ar] 3d54so
3. Cr+1 [ Ar ] [Ar] 3d54so

9.1 Predict the likely formulas for the ionic compounds below: (2 pts each/ 6 pts total)

1. Ca + O= \_\_\_\_\_\_\_\_\_\_\_\_\_CaO\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Na + P= \_\_\_\_\_\_\_\_\_\_\_\_\_Na3P\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Li + S = \_\_\_\_\_\_\_\_\_\_\_\_Li2S\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9.2 Draw the Lewis structures for the compounds below assuming the octet rule is strictly

obeyed. Make sure to show all lone pairs: (4 pts each/12 pts total)

a) b) c)







**CO COCl2 SO2**

**d) Will SO2 show resonance ? Yes No (circle choice) 1 pt**

9.3. What are the formal charges for each element in the structures below ? ( 6 pts)

A





a) b)

B

S\_\_\_0\_\_\_ O\_\_\_\_\_\_0\_\_ P\_\_0\_\_\_ O \_\_\_0\_ ClB\_+1\_\_

\_\_\_/36

**Exam 3A (continued) p. 5/5**

10.1 Draw the best electronic structures (Lewis structures) for the compounds below

assuming that the best structure is the one that minimizes formal charge.

(3 pts each/9 pts total)





a) b) c)





**SO2 ClO4-1 POCl**3 (O and Cl

(Cl in center) all connect to P in center)

10.2 Draw the excited state of SiOF2 whose ground state condition is below. (2 pts)

ground state excited state





**10.3 VSEPR modeling**

1. **What is the shape of H2O ? \_\_\_bent\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
2. **What is the shape of N2 ? \_\_\_\_\_\_linear\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
3. **What is the shape of CF4 ? \_\_\_\_\_\_tetrahedral\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**10.4 T/F and fill in (5 points)**

a) What is the bond order for ClO4- in problem 10.1b ? \_\_\_\_\_\_7/4\_\_\_\_\_\_\_\_\_\_\_

c) An Ideal Gas **also** obeys the combined gas law: P1V1/T1=P2V2/T2  T F

d) The photoelectric effect experiment confirmed the notion of light T F

as a wave.

e) All covalent bonds contain 4 electrons T F

f) Cats rule. Dogs drool. T T

\_\_\_/19