 Name: ________________________________

Chem 111 *2:30p section* *Final Exam*

This exam is composed of 50 questions, 14 of which require mathematics that require a calculator. Go initially through the exam and answer the questions you can answer *quickly*. Then go back and try the ones that are more challenging to you and/or that require calculations.

As discussed in the course syllabus, honesty and integrity are absolute essentials for this class. In fairness to others, dishonest behavior will be dealt with to the full extent of University regulations.

I hereby state that all answers on this exam are my own and that I have neither gained unfairly from others nor have I assisted others in obtaining an unfair advantage on this exam.

__________________________________ ..

Signature

$PV = nRT$ $\quad N_o = 6.022x10^{23}\,mol^{-1}$	$1\ mL = 1\ cm^3$	$h = 6.626x10^{-34}\ J\ s$
$E = h\nu = \frac{hc}{\lambda}$ $\quad \overline{u^2} = \frac{3RT}{M}$ $\quad \overline{K.E.} = \frac{1}{2}m\overline{u^2}$	$1\ atm = 760\ mm\ Hg$	$c = 2.998x10^8\ m\ s^{-1}$
$E_n^{H-atom} = -\frac{R_H hc}{n^2}$ $\quad R_H hc = 1312\ kJ\ mol^{-1}$	$\Delta H_{vap}(H_2O) = 40.65\ kJ\ mol^{-1}$	$R = 0.0820\ L\ \ atm\ K^{-1}\ \ mol^{-1}$
$R_H = 1.0974x10^7\ m^{-1}$	$\Delta H_{fus}(H_2O) = 6.00\ kJ\ mol^{-1}$	$R = 8.314\ J\ K^{-1}\ \ mol^{-1}$
	$d_{water} = 1.00\ g\ mL^{-1}$	$J = kg\ m^2\ s^{-2}$
	$\Delta E = q + w = \Delta H - P\Delta V$	

PERIODIC TABLE OF THE ELEMENTS

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
1 **H** 1.008																	2 **He** 4.003
3 **Li** 6.939	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** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	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** 58.71	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.61	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** 181.0	74 **W** 183.8	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 **Unq** (261)	105 **Unp** (262)	106 **Unh** (263)	107 **Uns** (262)	108 **Uno** (265)	109 **Une** (266)									

Solubility Rules for some ionic compounds in water

Soluble Ionic Compounds

1. All sodium (Na^+), potassium (K^+), and ammonium (NH_4^+) salts are SOLUBLE.
2. All nitrate (NO_3^-), acetate ($CH_3CO_2^-$), chlorate (ClO_3^-), and perchlorate (ClO_4^-) salts are SOLUBLE.
3. All chloride (Cl^-), bromide (Br^-), and iodide (I^-) salts are SOLUBLE -- EXCEPT those also containing: lead, silver, or mercury (I) (Pb^{2+},Ag^+, Hg^{2+}) which are NOT soluble.
4. All sulfate (SO_4^{2-}) salts are SOLUBLE - - EXCEPT those also containing: calcium, silver, mercury (I), strontium, barium, or lead (Ca^{2+}, Ag^+, Hg_2^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}) which are NOT soluble.

Not Soluble Ionic Compounds

5. Hydroxide (OH^-) and oxide (O^{2-}) compounds are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or barium (Na^+, K^+, Ba^{2+}) which are soluble.
6. Sulfide (S^{2-}) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, ammonium, or barium (Na^+, K^+, NH_4^+, Ba^{2+}) which are soluble.
7. Carbonate (CO_3^{2-}) and phosphate (PO_4^{3-}) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or ammonium (Na^+, K^+, NH_4^+), which are soluble.

Some common ions:

PO_4^{3-} CN^- $CH_3CO_2^-$ NO_2^- NO_3^-

CO_3^{2-} SO_3^{2-} SO_4^{2-} CrO_4^{2-} MnO_4^-

Bond Dissociation Energies (kJ mol^{-1}) (gas phase)

Bond	D	Bond	D	Bond	D
H-H	436	C-C	346	N-N	163
C-H	413	C=C	610	N=N	418
C≡O	1046	C≡N	887	N≡N	945
N-H	391	O-O	146	C-O	358
O-H	463	O=O	498	C=O	745
C-F	485	F-F	155	N-F	283
C-Cl	339	Cl-Cl	242	N-Cl	192
C-I	213	I-I	151	N-I	169

1. In an endothermic process:
   1) work is performed on the surroundings
   2) heat is transferred to the surroundings
   3) work is performed on the system
   4) heat is transferred to the system

   (4)

Ch 6.1 – Energy: basic principles

2. A negative value of ΔE means that:
   1) heat is tranferred to the surroundings
   2) heat is transfered to the system
   3) energy in the form of heat and/or work is transferred to the surroundings
   4) energy in the form of heat and/or work is transferred to the system

   (3)

Ch 6.4 – Energy: 1st Law of Thermo

3. An automobile engine generates **2575** Joules of heat that must be carried away by the cooling system. The internal energy changes by **–3258** Joules in this process.

   How much work to push the pistons is available in this process?

   1) 4918 J 2) 5833 J 3) 683 J 4) 6283 J 5) 1277 J

   $\Delta E = q + w \qquad w = \Delta E - q = (-3258\ J) - (-2575\ J) = -683\ J$

   (3) w is negative. The system does work on the surroundings.

Ch 6.4 – Energy: 1st Law of Thermo

4. A 45.5 g sample of copper at 99.8 °C is dropped into a beaker containing 152 g of water at 18.5 °C. When thermal equilibrium is reached, what is the final temperature of the copper? The specific heat capacities of water and copper are 4.184 and 0.385 J g^{-1} K^{-1}, respectively.

   1) 25.3 °C 2) 12.5 °C 3) 37.0 °C 4) 90.1 °C 5) 20.7 °C

$$q_{metal} + q_{water} = 0$$

$$(0.385\ J\,g^{-1}\,K^{-1})(45.5g)(x - 99.8)K + (4.184\ J\,g^{-1}\,K^{-1})(152g)(x - 18.5)K = 0$$

$$(x - 99.8)K = \frac{-(4.184\ J\,g^{-1}\,K^{-1})}{(0.385\ J\,g^{-1}\,K^{-1})}\frac{(152g)}{(45.5g)}(x - 18.5)K = -36.30(x - 18.5)K$$

$$x - 99.8 = -36.30x - (18.5)(-36.30)$$

$$x + 36.30x = 99.8 + 671.6 = 771.4$$

$$x = 20.7$$

   (5) See also example 6.2 (Text problem 6-20)

Ch 6.2 – Specific heat capacity and heat transfer

5. Given the following information:

   $2\ N_2O\ (g) + 3\ O_2\ (g) \rightarrow 2\ N_2O_4\ (g)$ ΔH° = -145.8

   $2\ N_2O\ (g) \rightarrow 2\ N_2\ (g) + O_2\ (g)$ ΔH° = -164.2 kJ

   what is the standard enthalpy change for the reaction:

   $N_2\ (g) + 2\ O_2\ (g) \rightarrow N_2O_4\ (g)$ ΔH° = ?? kJ

   1) 9.2 kJ mol^{-1} 2) –146 kJ mol^{-1} 3) 155 kJ mol^{-1}
   4) 146 kJ mol^{-1} 5) not enough information to determine

   $N_2\ (g) + 1/2\ O_2\ (g) \rightarrow N_2O\ (g)$ ΔH° = -1/2 * -164.2 kJ

   $N_2O\ (g) + 3/2\ O_2\ (g) \rightarrow N_2O_4\ (g)$ ΔH° = 1/2 * -145.8 kJ

   (1) ΔH° = +9.2 kJ

Ch 6.7 – Hess's Law (Owl, Unit 6-6c)

6. The root mean square speed of molecules in a sample of N_2 gas is 890 m/s. What is the temperature of the gas?

   1) 513 K 2) 890 K 3) 127 K 4) 456 K 5) 233 K

$$\overline{u^2} = \frac{3RT}{M}$$

(2)

$$T = \frac{M\sqrt{\overline{u^2}}^{\,2}}{3\,R} = \frac{28.0\ g\ mol^{-1}\left(890\ m\ s^{-1}\right)^2}{3\left(8.314\ J\ K^{-1}\ mol^{-1}\right)}\ \frac{J}{kg\ m^2\ s^{-2}}\ \frac{kg}{10^3\ g} = 890 K$$

Ch 12.6 – Kinetic theory of gases

7. A 3.28 mol sample of Ar gas is confined in a 62.5 liter container at 62.5 °C. If 1.28 mol of F_2 gas is added while maintaining constant temperature, the average kinetic energy per molecule will:

   1) decrease 2) remain the same 3) increase
   4) not enough information 5) I don't have a clue

   (2) Temperature determines average kinetic energy (Chapter 12)

Ch 12.6 – Kinetic theory of gases

8a. Which listing below correctly orders the molecules by increasing root mean square molecular speed (slowest → fastest)?

1) $CO_2 < Xe < N_2 < H_2$ 2) $Xe < CO_2 < N_2 < H_2$

3) $H_2 < N_2 < CO_2 < Xe$ 4) $H_2 < N_2 < Xe < CO_2$

(2) $\sqrt{\overline{u^2}} = \sqrt{\dfrac{3RT}{M}}$ **Molar masses: 131 > 48 > 28 > 2 (OWL 12-x)**

Ch 12.6 – kinetic theory, rms speed and molar mass.

9. A sample of Cl_2 gas is confined in a 2.0 liter container at 50 °C. Then 2.5 mol of He is added, holding both the volume and temperature constant. The pressure will increase because:

1) As the number of molecule-wall collisions increases, the force per collision increases.
2) With more molecules in the container, the molecules have higher average speeds.
3) With more molecules per unit volume, there are more molecules hitting the walls of the container.
4) With higher average speeds, on average the molecules hit the walls of the container with more force.
5) None of the Above

(3) (Chapter 12)

Ch 12.6 – Kinetic theory of gases

10. What is the average kinetic energy of an N_2 molecule confined in 3.1 L at 1.0 atm and 25°C?

1) $5.71 x 10^{3}$ J 2) $9.48 x 10^{3}$ J 3) $5.71 x 10^{-21}$ J 4) $6.17 x 10^{-21}$ J 5) $3.21 x 10^{-21}$ J

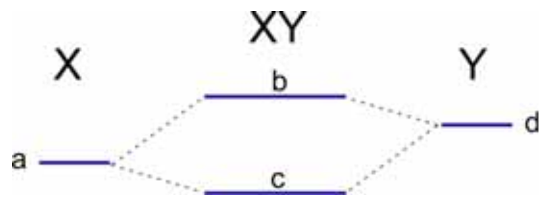
(4)

$$\overline{K.E.} = \frac{1}{2} m\overline{u^2} \text{ (per molecule)} \qquad \overline{u^2} = \frac{3RT}{M}$$

$$\overline{K.E.} = \frac{1}{2} m \frac{3RT}{M}\left(\frac{M\ N_o^{-1}}{m}\right) = \frac{3}{2}\frac{RT}{N_o} = \frac{3}{2}\frac{(8.314\ J\,K^{-1}\,mol^{-1})(25+273)K}{(6.022 x 10^{23}\,mol^{-1})} = 6.17 x 10^{-21}\,J$$

Ch 12.6 – Kinetic theory of gases

Consider the molecular orbital energy diagram shown at right.



11. The energy level denoted "**c**" refers to:

1) a bonding molecular orbital

2) an antibonding molecular orbital

3) a nonbonding molecular orbital

4) an atomic orbital

(1) **(OWL question)**

Ch 10.3 – basic concepts of molecular orbitals

12. The electrons in the orbital represented by energy level "**c**":

1) are distributed more toward X   2) are distributed more toward Y

3) are equally distributed between X and Y

(1)

Ch 10, but also 8, 9 – concepts of electronegativities and energy. Covered in class.

13. The molecule XY is the diatomic He-H. What is its bond order?

1) 0.0   2) 0.5   3) 1.0   4) 1.5   5) 2.0

(2)

Ch 10, but also 8, 9 – concepts of electronegativities and energy. Covered in class.

14a. What is the energy of ultraviolet light with frequency $1.07x10^{15}$ Hz?

1) 126 kJ mol^{-1} 2) 196 kJ mol^{-1} 3) 427 kJ mol^{-1} 4) 544 kJ mol^{-1} 5) 832 kJ mol^{-1}

(3) $E = h\nu = \left(6.626x10^{-34}\ J\ s\right)\left(1.07x10^{15}\,Hz\right)\left(\frac{s^{-1}}{Hz}\right)\left(6.022x10^{23}\ photons\ mol^{-1}\right) = 427000\ J\ mol^{-1}$ **(OWL question)**

Ch 7.2 - light and energy.

15a. Consider two cases for emission from the hydrogen atom:

Case 1:
Electron goes from n=5 to n=2

Case 2:
Electron goes from n=6 to n=4

Compare the energies of the photons emitted:

1) $E_{case\ 1} > E_{case\ 2}$ 2) $E_{case\ 1} < E_{case\ 2}$ 3) $E_{case\ 1} = E_{case\ 2}$

$$E_n^{H-atom} = -\frac{R_H hc}{n^2} \qquad E_n^{H-atom} \propto -\frac{1}{n^2}$$

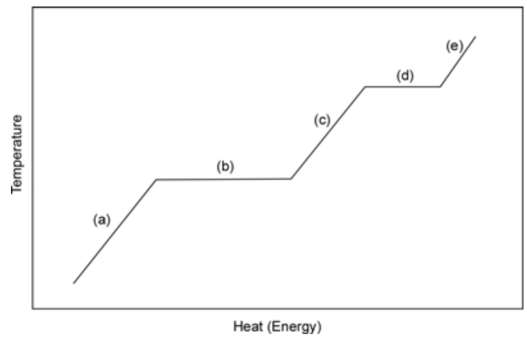
$$\therefore \quad \Delta E = E_f^{H-atom} - E_i^{H-atom} \propto -\frac{1}{n_f^2} - \left(-\frac{1}{n_i^2}\right) = \frac{1}{n_i^2} - \left(\frac{1}{n_f^2}\right)$$

$$\Delta E_{case1} \propto \frac{1}{2^2} - \left(\frac{1}{5^2}\right) = 4 \qquad \Delta E_{case2} \propto \frac{1}{4^2} - \left(\frac{1}{6^2}\right) = 29$$

(2)

Ch 7.3 – hydrogen atom and Rydberg.

16a. Consider the energy vs temperature diagram at right, describing the transitions of water from ice to steam:



The segment labeled (b) is described best with which parameter below:

1) $\Delta H°_{fus}$ 2) $\Delta H°_{vap}$ 3) C_{ice}

4) C_{liquid} 5) C_{steam}

(1) melting/freezing

Ch 6.3 – phase changes and heat capacities.

17a. The following information is given for mercury, Hg, at 1atm:

boiling pt = 357°C $H_{vap}^{357°C,1atm} = 59.3\ kJ\ mol^{-1}$ $C_{liquid\ Hg} = 0.139\ J\ g^{-1}\ K^{-1}$

melting pt = – 38.9°C $H_{fus}^{-38.9°C,1atm} = 2.33\ kJ\ mol^{-1}$ $C_{Hg\ vapor} = 0.061\ J\ g^{-1}\ K^{-1}$

At a pressure of 1 atm, what amount of heat is needed to vaporize a 46.8 g sample of liquid mercury at its normal boiling point of 357 °C?

1) 4.21 kJ 2) 13.8 kJ 3) 0.561 kJ 4) 9.67 kJ 5) 1.85 kJ

(2) $q = nH_{vap}^{357°C,1atm} = \frac{m}{M}H_{vap}^{357°C,1atm} = \left(46.8g\frac{mol}{200.6g}\right)\left(59.3\ kJ\ mol^{-1}\right) = 13.8kJ$

Ch 6.3 – phase changes and heat capacities.

18a. At a pressure of 1 atm, what amount of heat is needed to take a 46.8 g sample of mercury from 300°C to 400°C?

1) 2.85 kJ 2) 15.4 kJ 3) 32.6 kJ 4) 9.67 kJ 5) 14.3 kJ

(5)

$$q = \frac{m}{M}C_{liquid\ Hg} + \frac{m}{M}H_{vap}^{357°C,1atm} + \frac{m}{M}C_{Hg\ vapor}$$

$$= \left[0.139\ J\ g^{-1}\ K^{-1}(46.8g)(357-300)K\right]\left(\frac{kJ}{10^3\ J}\right) + 13.8kJ + \left[0.061\ J\ g^{-1}\ K^{-1}(46.8g)(400-357)K\right]\left(\frac{kJ}{10^3\ J}\right)$$

$$= (0.37 + 13.8 + 0.123)kJ = 14.3kJ$$

Ch 6.3 – phase changes and heat capacities.

19a. Which ion has the largest radius?

1) K^{+} 2) Ca^{2+} 3) P^{3-} 4) S^{2-} 5) all the same

(3) – all are isoelectronic. P has the smallest nuclear charge, therefore attracts its electrons the least (OWL 8-12c)

Ch 8.6 – ionic radii trends

20a. Consider the following samples:

a) 0.531 moles of CH_4 in a 6.18 L container at a temperature of 308K
b) 0.281 moles of CH_4 in a 2.77 L container at a temperature of 388K
c) 0.569 moles of CH_4 in a 1.42 L container at a temperature of 453K
d) 0.212 moles of CH_4 in a 5.95 L container at a temperature of 298K

Which has the highest average molecular speed?

1) a 2) b 3) c 4) d 5) all the same

(3) $\sqrt{\overline{u^2}} = \sqrt{\frac{3RT}{M}}$ **M all the same; highest T, highest rms speed**

Ch 12.6 – kinetic theory, rms speed and molar mass.

21a. HNO_3 is (data at the front of the exam provide a clue):

1) a strong acid 2) a weak base 3) a weak acid
4) a strong base 5) none of the above

(1) **Chapter 5**

Ch 5.3 – Acids, but also solubility

22a. Reactions in water that produce gases tend to be:

1) unfavorable 2) ugly 3) favorable
4) endothermic 5) exothermic

(3) **Chapter 5**

Ch 5.5 – Gas forming rxns, but also Ch 6 concepts

23. Which reaction below is a redox reaction?

1) $NaOH\ (aq) + HNO_3\ (aq) \rightarrow NaNO_3\ (aq) + H_2O\ (l)$

2) $Na_2CO_3\ (aq) + 2\ HClO_4\ (aq) \rightarrow CO_2\ (g) + H_2O\ (l) + 2NaClO_4$

3) $CdCl_2\ (aq) + Na_2S\ (aq) \rightarrow CdS\ (s) + 2\ NaCl\ (aq)$

4) $Zn(OH)_2\ (s) + H_2SO_4\ (aq) \rightarrow ZnSO_4\ (aq) + 2\ H_2O\ (l)$

5) None of the above

(5) Look at redox changes – there are none. **Chapt 5 inspired by book**

Ch 5.7 – Redox

24. The net ionic equation for the reaction of zinc sulfate and sodium hydroxide is:

1) $Zn^{2+}\ (aq) + 2\ OH^{-}\ (aq) \rightarrow Zn(OH)_2\ (s) + Na_2SO_4\ (aq)$

2) $ZnSO_4\ (aq) + 2\ NaOH\ (aq) \rightarrow Zn(OH)_2\ (aq) + Na_2SO_4\ (aq)$

3) $Zn^{2+}\ (aq) + 2\ OH^{-}\ (aq) \rightarrow Zn(OH)_2\ (s)$

4) $Zn^{2+}\ (aq) + 2\ OH^{-}\ (aq) \rightarrow Zn(OH)_2\ (aq)$

5) No *net* reaction occurs

(3) hydroxide salts are generally insoluble **(OWL 5-2c)**

Ch 5.2 – Precipitation rxns

25a. Which element has the highest ionization energy?

1) In 2) Ga 3) Tl 4) B 5) all the same

(4) – IE trends (OWL 8-9b)

Ch 8.6 – ionization energy trends

26a. Draw the Lewis structure for **CO^{2-}**. What is the hybridization on carbon?

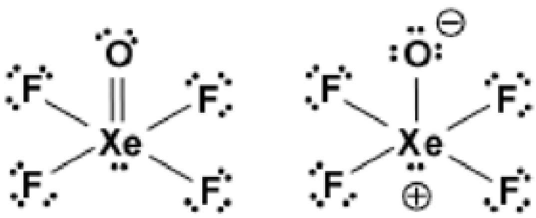
1) sp 2) sp^2 3) sp^3 4) sp^4 5) sp^3d

(2) sp^2  **(12 valence electrons) OWL 9-xx & 10**

Ch 10.2 and 9 – Lewis structures and hybridization

27a. Draw the Lewis structure for **$XeOF_4$** (Xe is the central atom). What is the hybridization on **Xe**?

1) sp^3d^3 2) sp^3d^2 3) sp^3d 4) sp^3 5) sp^2

(2) 

OWL 9-xx

Ch 10.2 & 9.7 – Hybridization

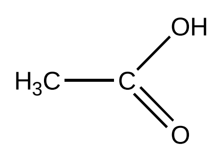
28a. The molecule **$XeOF_4$** is:

1) nonpolar 2) polar 3) can’t tell

(2) polar – the individual dipoles do not cancel out. OWL 9-10b

Ch 9.9 – Polarity

29a. The correct molecular formula for the molecule at right is:



1) $C_2O_2H_4$ 2) CO_2H_4 3) C_2OH_4 4) $C_2O_2H_3$

(1)

Ch 3 – molecular formulas

30a. A specific isotope of an ion from a given element has 7 protons, 8 neutrons, and 10 electrons. The ion is:

1) O^{2-} 2) Ne^{3-} 3) P^{3-} 4) N^{3-} 5) Mn^{3+}

(4) **(from an OWL question 3-3c)**

Ch 2.3 – atomic composition

31a. What is the formula of the ionic compound formed in the reaction of elemental **Sr** and **O_2**?

1) SrO_2 2) Sr_2O 3) Sr_2O_3 4) Sr_3O_2 5) SrO

(5) **SrO - Sr^{2+} + O^{2-}** **(OWL question)**

Ch 3.3 – ionic compounds

32a. What is the (mass) percent composition of **C** in $\mathbf{C_3H_6}$?

1) 88.3% 2) 14.4% 3) 50.0% 4) 85.6% 5) 11.7%

Mass of C in 1 mol of the compound: $(3mol)(12.01\ g\ mol^{-1}) = 36.03g$

Mass of 1 mol of the compound:

$$(1mol)\left[3(12.011\ g\ mol^{-1}) + 6(1.0079\ g\ mol^{-1})\right] = 42.08\text{g}$$

(4) **Percent composition:** $\dfrac{36.03g\ \text{C}}{42.08g\ \text{C}_3\text{H}_6}100\% = 85.6\%$ **(OWL question)**

Ch 3.6 – percent composition

33a. What is the wavelength of ultraviolet light with frequency $1.07\text{x}10^{15}$ Hz?

1) 209 nm 2) 254 nm 3) 280 nm 4) 190 nm 5) 350 nm

(3) $\lambda = \left(\dfrac{2.9998x10^8 m}{s}\right)\left(\dfrac{1}{1.07x10^{15}\ Hz}\right)\left(\dfrac{Hz}{s^{-1}}\right)\left(\dfrac{10^9 nm}{m}\right) = 280nm$ **(OWL question)**

Ch 7.1 – wavelength & frequency

34a. What is the maximum number of orbitals that can be identified by the set of quantum numbers n=+5 *l*=+2 ?

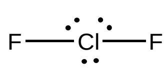
1) 2 2) 3 3) 5 4) 6 5) 7

(3) for *l* = 2, one can have m_l = -2, -1, 0, +1, +2 (5 orbitals)

Ch 7.5 – quantum numbers

35a. Consider the molecule ClF_2^- How many lone **pairs** are on the central atom?

1) 1 2) 2 3) 3 4) 4 5) 0

(3) 

Ch 9.6 – octet rule beyond 2nd row

36a. Light is given off by a sodium or mercury containing street light when the atoms are excited. The light you see arises for which of the following reasons?

1) Electrons are moving from a given energy level to one of higher n

2) Electrons are being removed from the atom, thereby creating a metal cation

3) Electrons are moving from a given energy level to one of lower n

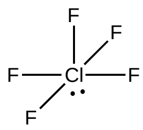
(3) **(end of chapter question)**

Ch 7.3 – atomic energy levels

37a. Consider the molecule ClF_5 What is the electron pair geometry?

1) Trigonal bipyramidal 2) Octahedral 3) linear

4) Trigonal planer 5) Tetrahedral

(2) 

Ch 9.7 – electron pair geometry

38a. Which of the following has the highest affinity for electrons?

1) P 2) N 3) As 4) O 5) Se

(4) (OWL 8-11)

Ch 8.6 – electron affinity

39a. In ionizing elemental sodium to Na^+, from which orbital is an electron removed?

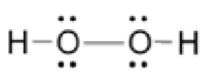
1) 1s 2) 2s 3) 3s 4) 2p 5) 3p

(3) (OWL 8-11)

Ch 8.5 – electron configuration and ionization

40a. In the symmetrical molecule **hydrogen peroxide** HOOH, what is the approximate HOO bond angle?

1) 180° 2) 90° 3) 109° 4) 120° 5) 60°

(3)  **- tetrahedral at the O**

Ch 9.7 – molecular geometry

As we demonstrated in class, reaction of iodine (I_2) and aqueous ammonia (NH_3) produces nitrogen triiodide (NI_3) according to the following reaction:

$$3\ I_2\ (s) + 4\ NH_4OH\ (aq) \rightarrow NI_3\ (s) + 3\ NH_4I\ (aq) + 4\ H_2O$$

41. If you completely react 0.678 g of iodine (I_2), what mass of NI_3 can be produced?

1) 0.276 g 2) 0.678 g 3) 0.226 g 4) 0.351 g 5) 0.876 g

$$M_{I_2} = 2(126.9\ g\ mol^{-1}) = 253.8\ g\ mol^{-1} \qquad n_{I_2} = \frac{0.678g}{253.8\ g\ mol^{-1}} = 2.67x10^{-3}\ mol$$

(4)

$$n_{NI_3} = \frac{1}{3}n_{I_2} = 8.90x10^{-4}\ mol \qquad M_{NI_3} = 14.01 + 3(126.9\ g\ mol^{-1}) = 394.7\ g\ mol^{-1}$$

$$m_{NI_3} = n_{NI_3}(M_{NI_3}) = (8.90x10^{-4}\ mol)(394.7\ g\ mol^{-1}) = 0.351\ g$$

Ch 3 – Stoichiometry & limiting reagent

42. Nitrogen triiodide (NI_3) is unstable, reacting to form N_2 (g) and I_2 (g), and evolving heat.

$$2\ NI_3\ (s) \rightarrow N_2\ (g) + 3\ I_2\ (g)$$

Spontaneous decomposition of 1.0 g of NI_3 (s) produces what volume of gas at 200°C and 1 atm pressure?

1) 28.7 L 2) 0.197 L 3) 0.098 L 4) 14.4 L 5) 0.731 L

$$M = (14.0 + 3(126.9))\ g\ mol^{-1} = 394.7\ g\ mol^{-1}$$

(2)

$$n_{NI_3} = \frac{1.0g}{394.7\ g\ mol^{-1}} = 2.53x10^{-3} mol$$

$$n_{gas} = n_{N_2} + n_{I_2} = \frac{1}{2}n_{NI_3} + \frac{3}{2}n_{NI_3} = 2n_{NI_3} = 5.07x10^{-3} mol$$

$$V = \frac{nRT}{P} = \frac{(5.07x10^{-3} mol)(0.082057\ L\ atm\ K^{-1}\ mol^{-1})((200 + 273)K)}{1\ atm} = 0.197\ L$$

Ch 3 & 12 – Stoichiometry and gases

43. Using the Table of Bond Dissociation Energies at the front of the exam, predict ΔH° for the spontaneous decomposition of nitrogen triiodide above.

1) -256 kJ mol^{-1} 2) -927 kJ mol^{-1} 3) -35 kJ mol^{-1}
4) -384 kJ mol^{-1} 5) +927 kJ mol^{-1}

(4)

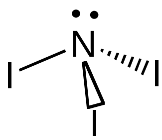
$$\Delta H° = \sum D_{(Bonds\ broken)} - \sum D_{(Bonds\ formed)}$$

$$\Delta H° = \{[6(169)] - [945 + 3(151)]\}kJ = (1014 - 1398)kJ = -384\ kJ$$

Ch 9.10 – Bond properties

44. What is the molecular geometry of nitrogen triiodide?

1) tetrahedral 2) square planar 3) trigonal pyramidal
4) octahedral 5) trigonal planar



(3)

45. What is the hybridization on N in nitrogen trioiodide?

1) sp 2) sp^2 3) sp^3 4) sp^4 5) sp^3d

(3)

Ch 10.2 – Orbital hybridization

46. Which do you expect to have the longest bond length?

1) NF_3 2) NCl_3 3) NBr_3 4) NI_3 5) can't tell

(4)

Ch 8.6 – Atomic properties/trends

47. In class, we saw the following reaction (unbalanced).

$$Al\ (s) + Br_2\ (l) \rightarrow AlBr_3\ (s)$$

In the correctly balanced reaction, what is the stoichiometry coefficient preceding Al (all coefficients should be integral)?

1) 1 2) 2 3) 3 4) 4 5) 6

(2) **2 Al (s) + 3 Br_2 (l) → 2 $AlBr_3$ (s)**

Ch 4 (but everywhere!) – Balancing reactions

48. In the reaction above of aluminum and bromine, which is the oxidizing agent?

1) Al (s) 2) Br_2 (l)

(2) **Br in Br_2 is reduced, therefore it is the oxidizing agent**

Ch 5.7 - Redox reactions

49. What is the electron pair geometry in $AlBr_3$?

1) tetrahedral 2) trigonal planar 3) square planar
4) octahedral 5) trigonal pyramidal

(2)

Ch 9.7 – Molecular Shapes

50. What is the catalog number for this class?

1) 111 2) 345 3) 86 4) 3.14159 5) 68.6 g

(1)