Chem 111 *9:05a section* *Evening Exam #1*

This exam is composed of 20 questions, 5 of which require mathematics that might 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 on 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.

$E = h\nu = \frac{hc}{\lambda}$ $E_n^{H-atom} = -\frac{R_H hc}{n^2}$ 1 mL = 1 cm^3	**Some common ions:** PO_4^{3-} CN^- $CH_3CO_2^-$ NO_2^- NO_3^- CO_3^{2-} SO_3^{2-} SO_4^{2-}	$h = 6.626x10^{-34}\ J\ s$ $c = 2.998x10^{8}\ m\ s^{-1}$ $N = 6.022x10^{23}\ mol^{-1}$ $R_H = 1.097x10^{7}\ m^{-1}$

1. What is the charge of the most common ion formed from **O**?

   1) +1 2) +2 3) -1 4) -2 5) -3

   (4) -2 **(OWL question)**

2. What is the charge of the most common ion formed from **Cs**?

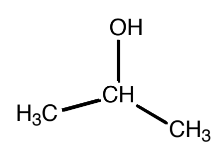
   1) +1 2) +2 3) -1 4) -2 5) -3

   (1) **+1** **(OWL question)**

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

   1) $C_3O_2H_7$ 2) C_3OH_7 3) C_3OH_8 4) C_3OH_6

   (3)



4. Which choice below best (most accurately and completely) describes an electron?

   1) a charged particle
   2) a wave
   3) a negatively charged particle with both wave and particle properties
   4) a small particle that lies at the heart of the nucleus of an atom
   5) a positively charged particle that orbits the nucleus of an atom

   (3)

5. **CH_4** is:

1) an element
2) an ionic compound
3) a nonionic compound
4) a homogeneous mixture
5) a heterogeneous mixture

(3) **(OWL question)**

6. What is the formula of the ionic compound expected to form between the ions **Na^+** and **SO_4^{2-}**?

1) $Na_2(SO_4)_3$ 2) Na_2SO_4 3) $Na(SO_4)_2$ 4) $NaSO_4$ 5) Na_2SO_2

(2) **Na_2SO_4 - $2Na^+ + SO_4^{2-}$** **(OWL question)**

7. What is the formula of the ionic compound formed in the reaction of elemental **Ca** and **O_2**?

1) CaO 2) Ca_2O 3) Ca_2O_3 4) Ca_3O_2 5) CaO_2

(1) **CaO - $Ca^{2+} + O^{2-}$** **(OWL question)**

8. What is the formula of the ionic compound formed between the ions **Co^{3+}** and **CN^-**?

1) CoCN 2) Co_2CN 3) $Co(CN)_3$ 4) $Co_3(CN)_2$ 5) $Co(CN)_2$

(3) **$Co(CN)_3$ - $Co^{3+} + 3CN^-$** **(OWL question)**

9. Which of the following is ***not*** an ionic compound?

1) $Ca(CH_3CO_2)_2$ 2) NaCN 3) CrO 4) H_2CO 5) AgCl

(4) **H_2CO you can't separate it into stable ions**

10. What is the formula for the **hydrogen carbonate** ion ?

1) H_3CO_3 2) $H_2CO_3^-$ 3) HCO_3^- 4) HCO_3 5) CO_3^{2-}

(3) **HCO_3^-** **(OWL question)**

11. What is the molar mass of **carbon dioxide**?

1) 64 g/mol 2) 32 g/mol 3) 96 g/mol 4) 16 g/mol 5) 44 g/mol

(5) **CO_2** $1\left(12.011\frac{\text{g}}{\text{mol}}\right) + 2\left(15.9994\frac{\text{g}}{\text{mol}}\right) = 44.0\frac{\text{g}}{\text{mol}}$ **(OWL question)**

12. Which of the following is a valid empirical formula?

1) $Co_2(SO_3)_3$ 2) $Co_4(SO_3)_6$ 3) $Co_6(SO_3)_9$

4) none is valid 5) all are valid

(1)

13. A sample of aspirin, $\mathbf{C_9H_8O_4}$, contains 0.104 mol of the compound. What is the mass of this sample, in grams?

1) 20.1 g 2) 12.5 g 3) 37.3 g 4) 0.0730 g 5) 18.7 g

First we need the molar mass of $C_9H_8O_4$:

$$9(\text{molar mass of C}) + 8(\text{molar mass of H}) + 4(\text{molar mass of O}) =$$

$$9\left(12.011\frac{\text{g}}{\text{mol}}\right) + 8\left(1.0079\frac{\text{g}}{\text{mol}}\right) + 4\left(15.9994\frac{\text{g}}{\text{mol}}\right) = 180.2\frac{\text{g}}{\text{mol}}$$

Use that to calculate the mass:

(5) $(0.104\,mol)\left(\frac{108.10\,g}{mol}\right) = 18.74\,g$ **(OWL question)**

14. What is the (mass) percent composition of **C** in $\mathbf{C_9H_8O_4}$?

1) 9% 2) 37.3% 3) 61.2% 4) 81.8% 5) 60.0%

Mass of C in 1 mol of the compound: $(9\,mol)(12.01\,g/mol) = 108\,g$

Mass of 1 mol of the compound:

$$(1\,mol)\left[9\left(12.011\frac{\text{g}}{\text{mol}}\right) + 8\left(1.0079\frac{\text{g}}{\text{mol}}\right) + 4\left(15.9994\frac{\text{g}}{\text{mol}}\right)\right] = 180.2\text{g}$$

(5) **Percent composition:** $\frac{108\,g\ \text{C}}{180.2\,g\ \text{C}_9\text{H}_8\text{O}_4}100\% = 60.0\%$ **(OWL question)**

15. You've decided you don't like Chemistry after all and have decided to travel Europe instead. You're driving a rental car through France and see petrol selling at 0.75 euros per liter.

0.88 euro = 1.0 US dollar 4.546 liters = 1 gallon

How much does petrol cost in U.S. dollars per gallon?

1) \$3.87/gal 2) \$0.69/gal 3) \$2.44/gal 4) \$3.15/gal 5) \$4.72/gal

(1) $\left(\frac{0.75\,euro}{Liter}\right)\left(\frac{1.0\$}{0.88\,euro}\right)\left(\frac{4.546\,L}{gallon}\right) = \$3.87/gallon$

16. Which radiation below has the longest wavelength (don't use your calculator!)?

1) blue light ($6.8x10^{14}$ Hz)
2) green light ($6.0x10^{14}$ Hz)
3) red light ($4.5x10^{14}$ Hz)
4) microwaves ($2.4x10^{9}$ Hz)
5) x-rays ($5.0x10^{18}$ Hz)

(4) It has the lowest frequency. Remember that $\lambda = c/\nu$

17. What is the wavelength of ultraviolet light with frequency $1.43x10^{15}$ Hz?

1) 209 nm 2) 300 nm 3) 500 nm 4) 162 nm 5) 250 nm

(1)

$$\lambda = \left(\frac{2.9998x10^8 m}{s}\right)\left(\frac{1}{1.43x10^{15} Hz}\right)\left(\frac{Hz}{1}\frac{s}{1}\right) = 2.09x10^{-7} m$$

$$= 2.09x10^{-7} m\left(\frac{10^9 nm}{m}\right) = 209 nm$$

(OWL question)

18. What is the wavelength of the photon emitted from a hydrogen atom when the electron goes from n=7 to n=2?
The Rydberg constant R for the hydrogen atom is $1.097x10^{7}$ m^{-1}.

1) 0.023 nm 2) 397 nm 3) 434 nm 4) 923 nm 5) 22 nm

$$E = E_f - E_i = \left(-\frac{Rhc}{n_f^2}\right) - \left(-\frac{Rhc}{n_i^2}\right) = -Rhc\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$\lambda = \frac{hc}{E} = \frac{hc}{-Rhc\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)} = \frac{1}{-R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)} = \frac{1}{-(1.097x10^7 m^{-1})\left(\frac{1}{2^2} - \frac{1}{7^2}\right)}$$

$$= \frac{1}{-(1.097x10^7 m^{-1})\left(\frac{1}{4} - \frac{1}{49}\right)} = \frac{1}{-(1.097x10^7 m^{-1})(0.2296)} = -3.97x10^{-7} m = 397 nm$$

(2) What happened to the negative sign? A negative wavelength makes no sense. This reflects that E is negative. That is, that energy is *emitted* in this transition. Had we done the longer calculation (solved for E first), we would have dropped the negative sign at that point.

19. In the above question, is light emitted or absorbed?

1) absorbed 2) emitted 3) neither absorbed nor emitted 4) can't tell

(2) You can get this from the calculation above, or more simply, if you note that higher "n" values are at higher energy, then this is

clearly a transition from higher to lower energy – energy must be given off (emitted as a photon).

20. What is the catalog number for this class?

1) 111 2) 123 3) 222 4) 3.14159 5) 68.6 g

(1)

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)									