## *Chem 111 2:30p section Evening Exam #1*

This exam is composed of 20 questions, 6 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 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.*

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*Signature*

| | | |
|---|---|---|
| $E = h\nu = \frac{hc}{\lambda}$<br>$E_n^{H-atom} = -\frac{R_H hc}{n^2}$<br>1 mL = 1 $cm^3$ | **Some common ions:**<br>$PO_4^{3-}$ $CN^-$ $CH_3CO_2^-$<br>$NO_2^-$ $NO_3^-$ $CO_3^{2-}$<br>$SO_3^{2-}$ $SO_4^{2-}$ | $h = 6.626x10^{-34}\ J\ s$<br>$c = 2.9998x10^8\ m\ s^{-1}$<br>$N = 6.022x10^{23}\ mol^{-1}$<br>$R_H = 1.097x10^7\ m^{-1}$ |

**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) | | | | | | | | | |

b

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

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

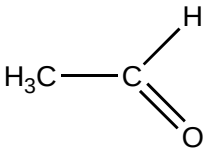
   **(3)** **(OWL question)**

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

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

   (1) **(OWL question)**

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




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

   (3)

4. The equation at right yields a result in

$$\frac{\left(kg\ m\ s^{-2}\right)\left(m\ s^{-1}\right)^{-1}}{\left(kg\right)}\left(s^{2}\right)$$

   1) length 2) mass 3) volume

   4) velocity 5) time

   **(5)**

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

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

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

6. What is the formula of the ionic compound formed in the reaction of elemental **Mg** and $\mathbf{O_2}$?

   1) MgO 2) $Mg_2O$ 3) $Mg_2O_3$ 4) $Mg_3O_2$ 5) $MgO_2$

   (1) **MgO - $Mg^{2+} + O^{2-}$** **(OWL question)**

7. What is the formula of the ionic compound formed between the ions $\mathbf{Fe^{2+}}$ and $\mathbf{P^{3-}}$?

   1) $FeP_3$ 2) $Fe_3P_2$ 3) $Fe_2P_3$ 4) $Fe_2P$ 5) none of these

   (2) **$Fe_3P_2$ - $3\ Fe^{2+} + 2\ P^{3-}$** **(OWL question)**

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

1) KF 2) NaCN 3) $CO_2$ 4) CaO 5) $FeCl_2$

(3) **$CO_2$ you can't separate it into stable ions**

9. What is the molar mass of **silicon dioxide**?

1) 64 g/mol 2) 32 g/mol 3) 60 g/mol 4) 28 g/mol 5) 44 g/mol

(3) **$SiO_2$** $1\left(28.09\ g\ mol^{-1}\right)+2\left(15.9994\ g\ mol^{-1}\right)=60.1\ g\ mol^{-1}$ **(OWL question)**

10. A sample of cyclobutane, $\mathbf{C_4H_8}$, contains 0.104 mol of the compound. What is the mass of this sample, in grams?

1) 56.1 g 2) 4.38 g 3) 42.1 g 4) 5.84 g 5) 18.7 g

**First we need the molar mass of $C_4H_8$:**

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

$$4\left(12.011\ g\ mol^{-1}\right)+8\left(1.0079\ g\ mol^{-1}\right)=56.11\ g\ mol^{-1}$$

**Use that to calculate the mass:**

(4) $(0.104mol)\left(56.11\ g\ mol^{-1}\right)=5.84g$ **(OWL question)**

11. What is the (mass) percent composition of **C** in $\mathbf{C_4H_8}$?

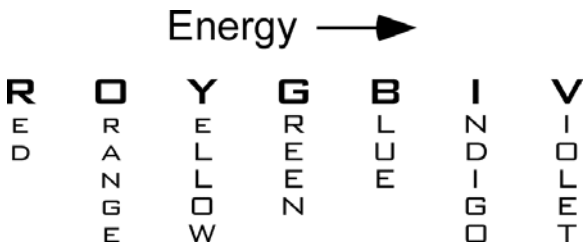
1) 85.6% 2) 14.4% 3) 50.0% 4) 88.3% 5) 11.7%

**Mass of C in 1 mol of the compound:** $(4mol)\left(12.01\ g\ mol^{-1}\right)=48.04g$

**Mass of 1 mol of the compound:**

$$(1mol)\left[4\left(12.011\ g\ mol^{-1}\right)+8\left(1.0079\ g\ mol^{-1}\right)\right]=56.11\text{g}$$

(1) **Percent composition:** $\dfrac{48.04g\ \text{C}}{56.11g\ \text{C}_4\text{H}_8}100\%=85.6\%$ **(OWL question)**




12. Which color of light has the shortest wavelength?

1) red 2) yellow 3) green 4) blue 5) violet

**(5) Remember that** $E = \frac{hc}{\lambda} = h\nu \quad \therefore \quad \lambda = \frac{hc}{E}$ and $\nu = \frac{E}{h}$

13. What is the wavelength of ultraviolet light with frequency $1.18 \times 10^{15}$ Hz?

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

(2) $\lambda = \left(\frac{2.9998 x 10^8 m}{s}\right)\left(\frac{1}{1.18 x 10^{15} Hz}\right)\left(\frac{Hz}{s^{-1}}\right)\left(\frac{10^9 nm}{m}\right) = 254 nm$ **(OWL question)**

14. What is the wavelength of the photon emitted by a hydrogen atom when the electron goes from n=10 to n=3?

The Rydberg constant R for the hydrogen atom is $1.097 \times 10^7$ $m^{-1}$.

1) 210 nm 2) 656 nm 3) 434 nm 4) 902 nm 5) 122 nm

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

$$\lambda = \frac{hc}{E} = \frac{hc}{-Rhc\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)} = \frac{1}{-R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)} = \frac{1}{-\left(1.097 x 10^7 m^{-1}\right)\left(\frac{1}{3^2} - \frac{1}{10^2}\right)} = -9.02 x 10^{-7} m = 902 nm$$

**(4) 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.**

15. A local radio station, WRNX, can be found at 100.9 MHz on the FM dial. The wavelength of this station's electromagnetic radiation is:

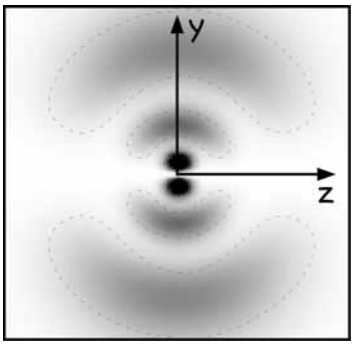
1) 2.97 m 2) 3.29 m 3) 3.39 m 4) 3.17 m 5) 8.85 m

**(1)** $\lambda = \frac{c}{\nu} = \frac{2.9998 x 10^8 m\, s^{-1}}{100.9 \text{ MHz}} \frac{MHz}{10^6 s^{-1}} = 2.97\ m$

**Inspired by OWL Unit 7-2c and Unit 7-3c**

16. The orbital depicted at right is:

1) $2p_z$ 2) $3p_x$ 3) $3p_z$ 4) $4p_z$ 5) $4p_y$




**(5) $4p_y$ – 2 spherical nodes, 1 surface nodes**
**Aligned along y axis**

17. Which of the following quantum number sets is ***not*** allowed?

1) n=+3 $l$=+1 $m_l$ = -2 $m_s$ = +1/2
2) n=+2 $l$=+1 $m_l$ = -1 $m_s$ = +1/2
3) n=+3 $l$=+1 $m_l$ = -1 $m_s$ = -1/2
4) n=+2 $l$=0 $m_l$ = 0 $m_s$ = +1/2
5) n=+3 $l$=0 $m_l$ = 0 $m_s$ = -1/2

**(1) $m_l$ = 0, ±1, … ±(l-1) therefore, with l=+1, $m_l$ cannot be -2**

18. What is the maximum number of orbitals that can be identified by the set of quantum numbers n=+5 $l$=+3 ?

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

**(5) for $l$ = 3, one can have $m_l$ = -3, -2, -1, 0, +1, +2, +3 (7 orbitals)**

19. The principle quantum number n specifies:

1) subshell orbital shape
2) orbital orientation
3) transition probability
4) orbital karma
5) energy and distance from nucleus

**(5) From OWL Unit 7-7b**

20. What is the catalog number for this class?

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

**(2)**