

**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.*

$E = h\nu = \frac{hc}{\lambda}$ $E_n^{H-atom} = -\frac{R_H hc}{n^2}$ $1 \text{ mL} = 1 \text{ cm}^3$	<b>Some common ions:</b> $\text{PO}_4^{3-}$ $\text{CN}^-$ $\text{CH}_3\text{CO}_2^-$ $\text{NO}_2^-$ $\text{NO}_3^-$ $\text{CO}_3^{2-}$ $\text{SO}_3^{2-}$ $\text{SO}_4^{2-}$	$h = 6.626 \times 10^{-34} \text{ J s}$ $c = 2.998 \times 10^8 \text{ m s}^{-1}$ $N = 6.022 \times 10^{23} \text{ mol}^{-1}$ $R_H = 1.097 \times 10^7 \text{ m}^{-1}$
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1. What is the charge of the most common ion formed from **S**?

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

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

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

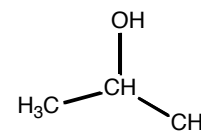
- 1) +1                      2) +2                      3) -1                      4) -2                      5) -3

**(2) +2** (OWL question)

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

- 1)  $\text{C}_3\text{OH}_8$               2)  $\text{C}_3\text{OH}_7$               3)  $\text{C}_3\text{O}_2\text{H}_7$               4)  $\text{C}_3\text{OH}_6$

**(1)**



4. Which choice below best (most accurately and completely) describes a proton?

- 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 resides at the nucleus of an atom

**(5)**

5.  $\text{CCl}_4$  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  $\text{Be}^{2+}$  and  $\text{SO}_4^{2-}$ ?

- 1)  $\text{Be}_2(\text{SO}_4)_3$     2)  $\text{Be}_2\text{SO}_4$     3)  $\text{Be}(\text{SO}_4)_2$     4)  $\text{BeSO}_4$     5)  $\text{Be}_2\text{SO}_2$

**(4)  $\text{BeSO}_4$  -  $\text{Be}^{2+} + \text{SO}_4^{2-}$**  (OWL question)

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

- 1)  $\text{CaF}$     2)  $\text{Ca}_2\text{F}$     3)  $\text{Ca}_2\text{F}_3$     4)  $\text{Ca}_3\text{F}_2$     5)  $\text{CaF}_2$

**(5)  $\text{CaF}_2$  -  $\text{Ca}^{2+} + 2\text{F}^-$**  (OWL question)

8. What is the formula of the ionic compound formed between the ions  $\text{Cr}^{2+}$  and  $\text{NO}_2^-$ ?

- 1)  $\text{CrNO}_2$     2)  $\text{Cr}_2\text{NO}_2$     3)  $\text{Cr}(\text{NO}_2)_3$     4)  $\text{Cr}(\text{NO}_2)_5$     5)  $\text{Cr}_2(\text{NO}_2)_5$

**(3)  $\text{Cr}(\text{NO}_2)_3$  -  $\text{Cr}^{3+} + 3\text{NO}_2^-$**  (OWL question)

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

- 1)  $\text{Ca}(\text{CH}_3\text{CO}_2)_2$     2)  $\text{NaCN}$     3)  $\text{CO}$     4)  $\text{AgO}$     5)  $\text{AgCl}$

**(3)  $\text{CO}$  - C does not want to have a charge of +2**

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

- 1)  $\text{HCO}_3^-$     2)  $\text{H}_2\text{CO}_3^-$     3)  $\text{H}_3\text{CO}_3$     4)  $\text{HCO}_3$     5)  $\text{CO}_3^{2-}$

**(1)  $\text{HCO}_3^-$**  (OWL question)

11. What is the molar mass of **selenium (Se) dioxide**?

- 1) 64 g/mol    2) 111 g/mol    3) 96 g/mol    4) 16 g/mol    5) 44 g/mol

**(2)  $\text{SeO}_2$   $1\left(78.96\frac{\text{g}}{\text{mol}}\right) + 2\left(15.9994\frac{\text{g}}{\text{mol}}\right) = 111\frac{\text{g}}{\text{mol}}$**  (OWL question)

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

- 1)  $\text{Co}_8(\text{SO}_3)_{24}$                       2)  $\text{Co}_4(\text{SO}_3)_6$                       3)  $\text{Co}_6(\text{SO}_3)_9$   
 4) none is valid                      5) all are valid

(4)

13. A sample of citric acid,  $\text{C}_6\text{H}_9\text{O}_7$ , 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  $\text{C}_6\text{H}_9\text{O}_7$ :**

$$6(\text{molar mass of C}) + 9(\text{molar mass of H}) + 7(\text{molar mass of O}) =$$

$$6\left(12.011 \frac{\text{g}}{\text{mol}}\right) + 9\left(1.0079 \frac{\text{g}}{\text{mol}}\right) + 7\left(15.9994 \frac{\text{g}}{\text{mol}}\right) = 193.1 \frac{\text{g}}{\text{mol}}$$

**Use that to calculate the mass:**

$$(1) \quad (0.104 \text{ mol}) \left( \frac{193.1 \text{ g}}{\text{mol}} \right) = 20.1 \text{ g} \quad \text{(OWL question)}$$

14. What is the (mass) percent composition of C in  $\text{C}_6\text{H}_9\text{O}_7$ ?

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

**Mass of C in 1 mol of the compound:**  $(6 \text{ mol})(12.01 \text{ g/mol}) = 72.1 \text{ g}$

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

$$6\left(12.011 \frac{\text{g}}{\text{mol}}\right) + 9\left(1.0079 \frac{\text{g}}{\text{mol}}\right) + 7\left(15.9994 \frac{\text{g}}{\text{mol}}\right) = 193.1 \frac{\text{g}}{\text{mol}}$$

$$(2) \text{ Percent composition: } \frac{72.1 \text{ g C}}{193.1 \text{ g C}_6\text{H}_9\text{O}_7} 100\% = 37.3\% \quad \text{(OWL question)}$$

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 0.85 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) \$4.39/gal

$$(5) \quad \left( \frac{0.85 \text{ euro}}{\text{Liter}} \right) \left( \frac{1.0 \$}{0.88 \text{ euro}} \right) \left( \frac{4.546 \text{ L}}{\text{gallon}} \right) = \$4.39 / \text{gallon}$$

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

- 1) blue light ( $6.8 \times 10^{14}$  Hz)                      4) microwaves ( $2.4 \times 10^9$  Hz)  
 2) green light ( $6.0 \times 10^{14}$  Hz)                      5) x-rays ( $5.0 \times 10^{18}$  Hz)  
 3) red light ( $4.5 \times 10^{14}$  Hz)

**(5) It has the highest frequency. Remember that  $E = h\nu$**

17. What is the wavelength of ultraviolet light with frequency  $1.20 \times 10^{15}$  Hz?

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

$$(5) \quad \lambda = \left( \frac{2.9998 \times 10^8 \text{ m}}{\text{s}} \right) \left( \frac{1}{1.20 \times 10^{15} \text{ Hz}} \right) \left( \frac{\text{Hz} \cdot \text{s}}{1 \quad 1} \right) = 2.50 \times 10^{-7} \text{ m}$$

$$= 2.50 \times 10^{-7} \text{ m} \left( \frac{10^9 \text{ nm}}{\text{m}} \right) = 250 \text{ nm}$$

**(OWL question)**

18. What is the wavelength of the photon emitted from a hydrogen atom when the electron goes from  $n=9$  to  $n=3$ ?

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

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

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

$$\lambda = \frac{hc}{E} = \frac{hc}{-Rhc \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)} = \frac{1}{-R \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)} = \frac{1}{-(1.097 \times 10^7 \text{ m}^{-1}) \left( \frac{1}{3^2} - \frac{1}{9^2} \right)}$$

$$= \frac{1}{-(1.097 \times 10^7 \text{ m}^{-1}) \left( \frac{1}{9} - \frac{1}{81} \right)} = \frac{1}{-(1.097 \times 10^7 \text{ m}^{-1}) (0.09876)} = -9.23 \times 10^{-7} \text{ m} = 923 \text{ nm}$$

**(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.**

