

## CHEMISTRY 101/201 PLACEMENT

### **Instructions (Please read carefully)**

For each question, choose the one best answer. You may use the periodic table and a calculator. Allow yourself one hour to complete the placement self-test.

Answers are posted on the last page of the test. If you can answer most of the questions in each section correctly, Chem201 is the right entry point for you, otherwise, Chem101 or Chem160 should be your first chemistry course at Mount Holyoke. You do not need instructor's permission to register for Chem101 and Chem160.

If you are interested in enrolling in Chem201 as your first chemistry course at Mount Holyoke College, scores for each section, as well as the total score, should be submitted to Alan van Giessen <vangiess@mtholyoke.edu>. After assessments, if permission is granted, it is your responsibility to register for the course in ISIS. Chem201 is offered in the spring.

## I. Math Basics

1. If  $\text{pH} = -\log [\text{H}^+]$ , then which is true?

- (A)  $[\text{H}^+] = -e^{\text{pH}}$
- (B)  $[\text{H}^+] = -10^{\text{pH}}$
- (C)  $[\text{H}^+] = 10^{\text{pH}}$
- (D)  $[\text{H}^+] = e^{-\text{pH}}$

2. If  $\log(a^x) = 64$ , and  $\log a = 4$ , then  $x =$

- (A) 60
- (B) 16
- (C) 256
- (D) 4

3. Which of the following numbers is the equivalent of 1,096.3 written in scientific notation?

- (A)  $1.1 \times 10^3$
- (B)  $1.0963 \times 10^{-3}$
- (C)  $10.963 \times 10^2$
- (D)  $1.0963 \times 10^3$

4. What is the first derivative of  $3x^3 + \ln x + 2$ ?

- (A)  $9x^2 + 1/x + 2$
- (B)  $9x^2 + 1/\ln x + 2$
- (C)  $9x^2 + 1/\ln x$
- (D)  $9x^2 + 1/x$

5. Evaluate  $\int e^{2x} dx$

- (A)  $e^{2x} + c$
- (B)  $\frac{1}{2} e^{2x} + c$
- (C)  $2e^{2x} + c$
- (D)  $2e^{2x}$

## II. Stoichiometry and Solution Chemistry

1. How many mL of 8.00 M HCl are needed to prepare 150. mL of a 1.60 M HCl solution?

- (A) 30.0 mL                      (B) 24.0 mL  
(C) 18.8 mL                      (D) 12.0 mL

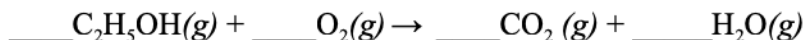
2. Analysis of a compound known to contain only Mg, P, and O gives this analysis.

21.8% Mg                      27.7% P                      50.3% O

What is its empirical formula?

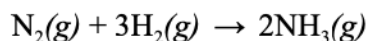
- (A)  $\text{MgPO}_2$                       (B)  $\text{MgPO}_3$   
(C)  $\text{Mg}_2\text{P}_2\text{O}_7$                       (D)  $\text{Mg}_3\text{P}_2\text{O}_8$

3. The reaction of ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , with oxygen is a popular classroom demonstration. Balance the equation to find the number of moles of gaseous products formed per mole of ethanol.



- (A) 2                      (B) 3                      (C) 4                      (D) 5

4. Ammonia is produced in accordance with this equation.



In a particular experiment, 0.25 mol of  $\text{NH}_3$  is formed when 0.5 mol of  $\text{N}_2$  is treated with 0.5 mol of  $\text{H}_2$ . What is the limiting reagent?

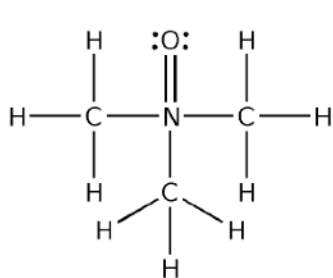
- (A)  $\text{N}_2$                       (B)  $\text{NH}_3$                       (C)  $\text{H}_2$                       (D)  $\text{N}_2$  and  $\text{H}_2$

5. The minerals chalcocite ( $\text{Cu}_2\text{S}$ ) and malachite ( $\text{Cu}_2\text{CO}_3(\text{OH})_2$ ) are two primary sources of copper. What is the oxidation state of copper in each of these minerals?

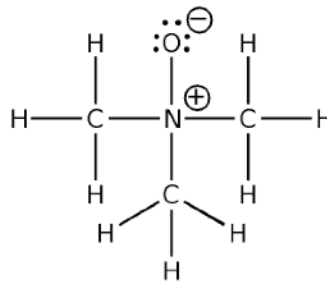
- (A) The oxidation state of copper in chalcocite is 2+, and in malachite it is 1+.  
(B) The oxidation state of copper in chalcocite is 1+, and in malachite it is 2+.  
(C) The oxidation state of copper in chalcocite is 1+, and in malachite it is 1+.  
(D) The oxidation state of copper in chalcocite is 2+, and in malachite it is 2+.

### III. Atomic Structure and Bonding

- Which element has an outer electron configuration of  $s^2p^4$ ?  
(A) Ca      (B) Cr      (C) Ge      (D) Se
- Which of these elements has the greatest electronegativity?  
(A) Br      (B) N      (C) O      (D) S
- Which set contains only covalently bonded molecules?  
(A)  $\text{BCl}_3$ ,  $\text{SiCl}_4$ ,  $\text{PCl}_3$       (B)  $\text{NH}_4\text{Br}$ ,  $\text{N}_2\text{H}_4$ ,  $\text{HBr}$   
(C)  $\text{I}_2$ ,  $\text{H}_2\text{S}$ ,  $\text{NaI}$       (D)  $\text{Al}$ ,  $\text{O}_3$ ,  $\text{As}_4$
- The concept of resonance is used to describe molecular structures which  
(A) oscillate between two structures.  
(B) have mirror images.  
(C) can be isolated in several isomeric forms.  
(D) have more than one possible Lewis structure.
- Study the two Lewis structures below, then choose the statement that is most true.



**A**



**B**

- Structure **A** and structure **B** are equally valid Lewis structures.
- Structure **B** is a better Lewis structure because the N atom in **A** has too many valence electrons.
- Structure **B** is a better Lewis structure because  $\text{N}=\text{O}$  double bonds, as in **A**, are not stable.
- Structure **A** is a better Lewis structure because separation of charge, as in **B**, is not favorable.

#### IV. Thermochemistry

- For which of these is  $\Delta H_f^\circ$  *not* equal to zero?  
(A)  $\text{Br}_2(l)$                       (B)  $\text{Fe}(s)$                       (C)  $\text{I}_2(s)$                       (D)  $\text{O}_3(g)$
- What is the standard enthalpy of formation of  $\text{MgO}(s)$  if 300.9 kJ is evolved when 20.15 g of  $\text{MgO}(s)$  is formed by the combustion of magnesium under standard conditions?  
(A)  $-601.8 \text{ kJmol}^{-1}$                       (B)  $-300.9 \text{ kJmol}^{-1}$   
(C)  $+300.9 \text{ kJmol}^{-1}$                       (D)  $+601.8 \text{ kJmol}^{-1}$
- How many molecules are in a deep breath of air whose volume is 2.55 L at body temperature ( $37^\circ\text{C}$ ) and a pressure of 1 atm?  
(A) 0.1 molecules                      (B) 0.84 molecules  
(C)  $6.0 \times 10^{22}$  molecules                      (D)  $5.1 \times 10^{23}$  molecules
- How is the vapor pressure of a liquid in a closed container affected when the quantity of liquid is doubled at constant temperature?  
(A) The vapor pressure increases.  
(B) The vapor pressure decreases.  
(C) The vapor pressure stays the same.  
(D) The vapor pressure may increase or decrease, depending on the liquid.
- Which combination of solutions of HCl and NaOH would produce the largest  $\Delta T$ ?  
(A) 50 mL of 1 M HCl with 50 mL of 1 M NaOH  
(B) 50 mL of 2 M HCl with 50 mL of 2 M NaOH  
(C) 100 mL of 1 M HCl with 50 mL of 2 M NaOH  
(D) 100 mL of 1 M HCl with 100 mL of 1 M NaOH

End of test. Answers are on the bottom of this page.

Answers:

- I. CBDDB
- II. ACDCB
- III. DCADB
- IV. DACC B