Breaking Bonds Sample Questions
WUCT 2018

In this exam, you will work with your team to answer as many questions as quickly and as accurately as possible in 60 minutes. Teams will choose a packet of one of three difficulties: easy, medium, or hard; each packet has 3 questions of the corresponding difficulty. Once your team completes the chosen packet, they may turn it in and exchange it for another packet of a difficulty of your choice.

No partial credit will be awarded. Students will be awarded credit based on their answer only.

The following questions are meant to be examples of the questions you might see on competition day. However, they may not represent the full scope of questions that may be asked.

Note that in the sample questions, only two questions are provided for medium difficulty and only one question is shown for hard difficulty. On competition day, each packet contains 3 questions of the corresponding difficulty.

Rules are subject to change. Check wuct.wustl.edu for the most updated rules.

We hope you have fun with Breaking Bonds!

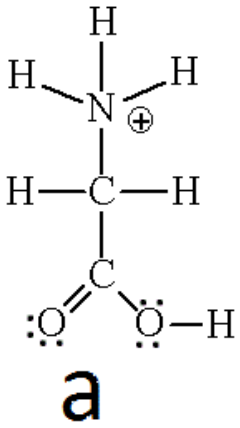
Team ID_____ School Name _____

EASY QUESTION 1

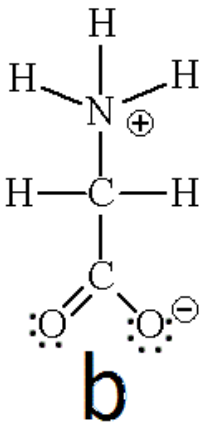
Team ID: _____

Acid/Base

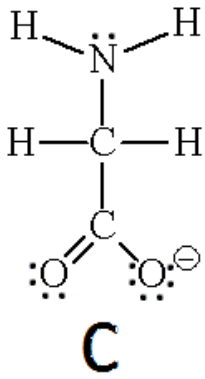
Amino acids are considered zwitterionic because they have both a positively- and negatively-charged sites. Consider the following three structures of the amino acid glycine. Using your knowledge of Bronsted-Lowry acids and bases, *determine if each structure of the glycine molecule depicted is in an acidic, basic, or neutral solution.*



a



b



c

a) Glycine "a" is in a solution that is _____ (acidic, basic, neutral)

b) Glycine "b" is in a solution that is _____ (acidic, basic, neutral)

c) Glycine "c" is in a solution that is _____ (acidic, basic, neutral)

EASY QUESTION 2

Team ID: _____

Electrochemistry

When 20.0 g of Zn metal was added to 3.0 mL of 6.0 M aqueous solution of HCl, bubbles formed on the metal surface. Write the net ionic equation of this reaction, including the physical state of each species involved. Indicate which species is the reducing agent. Determine the initial and final oxidation numbers of Zn.

EASY QUESTION 3

Team ID: _____

Chemical Reactions

Consider the following reaction:

$3C(s) + 4H_2(g) \rightarrow C_3H_8(g)$, $\Delta H = -58kJ$

How much heat (in kJ) is released when 8.0 g of C(s) were all consumed at 25 °C in this reaction?

MEDIUM QUESTION 1 Team ID: _____

Physical Properties

16.68 g of solid carbon and some amount of O_2 gas were sealed in a 2.0 L rigid vessel at 25 °C, initially. After all solid carbon reacted with O_2 and was converted to carbon dioxide gas at 25 °C, the final pressure inside the vessel is 17.0 atm. What was the initial pressure (in atm) inside the vessel? Assume the temperature remains constant at 25 °C throughout the reaction. Note: The gas constant R = 0.0821 $atm \times L \times mol^{-1} \times K^{-1}$

MEDIUM QUESTION 2 Team ID: _____

Equilibrium

Four salts containing chloride were mixed together: 9.7 g of solid NaCl, 13.4 g of solid AgCl, 523.0 mL of 0.40 M aqueous solution of $MgCl_2$, and 200.0 mL of 0.56 M aqueous solution of $FeCl_2$. *Determine the concentration (in M) of chloride in the mixed solution*. Assume the solid of any soluble salt is completely dissolved in the mixed solution, and the volume of any salt is negligible.

HARD QUESTION 1 Team ID: _____

Thermochemistry

In order to be reborn, phoenixes will store a lot of energy near the end of its lifetime and then burn itself. When scientists submerged a 1.0 kg phoenix in 10.0 L water in a sealed container (in accordance with ethical policies), they noted a 4 °C increase to water after this phoenix was fully combusted. Assume no heat was absorbed by the container.

Through other calculations, scientists also estimated that the change in entropy for the combustion reaction of the 1.0 kg phoenix was +550.0 J/K.

Using the information above, *determine the change (in kJ) in Gibbs free energy associated with the combustion of a 2.0 kg phoenix at 25 °C under the same condition.*

Assume that the changes in enthalpy and entropy of a phoenix's combustion are temperature independent and are directly proportional to the weight of the phoenix.

Density of water = 1.0 g/cm^3; 1 cm^3 = 1mL
Specific Heat of water = 4.184 $J \times K^{-1} \times g^{-1}$