Chemistry 1302B Practice Final Exam

- Questions -

Introduction
Dear Student,

Thank you for opening the Chemistry 1302B practice final exam question for Chemistry 1302B. This resource has been created by the Education Team at WebStraw. The Education Team consists of students that have previously taken and/or students that are currently taking Chemistry 1302B.

Purpose

This resource focuses on key concepts that are important for students to understand to succeed within this course. This resource was created by students for other students. Our goal is to help students (1) further develop their understanding of course content and (2) achieve greater academic success. (3) Our resource is also open access meaning there are no financial or legal barriers to students who wish to access and use our resource.

Instructions

Treat these practice questions like an actual exam: give yourself a set time to complete the questions and only refer to the hints when necessary. Upon completion of the Practice Questions, compare your thought-process and answers to the solutions provided.

Disclaimer

This resource is supplementary to your course content and is not meant to (1) replace any of the resources provided to you by your instructor nor is it meant to (2) be used as a tool to learn the course material from scratch. We assume that students who use this resource will have a basic understanding of the course content. As such, many of the solutions expect you to have the basic knowledge of understanding (e.g, knowing the formula for equilibrium). This resource does not contain everything you need to know for your evaluations. Please refer to the course material provided by your instructors if there are any discrepancies between our resource and your course content.

We wish you the best of luck on your exams!
The WebStraw Team

Note to Instructors: If this resource has been created for your course and you would like to collaborate with us, please email us at team@webstraw.ca

1. Ideal Gas Laws

Question Type: "Partial Pressure of Gas in a Beaker"

A scientist working for Webstraw Inc. is trying to develop hydrogen fuel. One of the steps involves making water vapor. A researcher has a beaker which contains a mixture of hydrogen and oxygen gas. Both gases are mixed at equal volumes and they have the same temperature and pressure. The following is the provided equation

$$H_{2(g)} + O_{2\,(g)} \rightarrow H_2O_{(g)}$$

When equal volumes of the gas are pumped into an empty 1L vessel and the reaction is pushed to completion, the scientist measures a total of 30 g of H_2O that has been synthesized. What is the partial pressure of each gas after the reaction completes? The temperature was measured at 10°C.

Space to Work

Hint: Determine which of the reagents is the limiting reagent.

1. Ideal Gas Laws

Question Type: "Relationship Between the Flow of Two Gases"

A vessel filled with 1.0 mol of CH_4 gas and 1.0 mol of He gas is placed in a large evacuated chamber. A small pinhole is then made in the vessel's walls. After a certain time, the vessel is found to contain 0.6 mol of helium. How many moles of CH_4 remain in the vessel at that moment.

a. 0.2 mol
b. 0.3 mol
c. 0.6 mol
d. 0.8 mol
e. 0.9 mol

Hint: What concept does the flow of gases through a tiny hole in a container allude to?

1. Ideal Gas Laws

Question Type: "Partial Pressures at Different Temperatures"

A sealed vessel contains only liquid water, water vapour, and nitrogen gas. At 50 °C, the total pressure inside the vessel is 93.5 kPa. After the temperature was raised to 65 °C, the total pressure increased to 110.0 kPa and some liquid water remained in the vessel. The water vapour pressure at 65 °C is 25.0 kPa. Calculate the water vapour pressure at 50 °C. Assume that the system is at equilibrium and that N_2 does not dissolve in water.

a. 11.6 kPa
b. 12.3 kPa
c. 16.5 kPa
d. 21.2 kPa
e. 28.1 kPa

2. Thermodynamics

Question Type: " Energy Required to Change States of Matter"

A brick of ice weighing 45g at -16°C is melted into liquid water until it reaches 10°C. Calculate how much energy in kJ was used to convert the ice into its final state.

Space to Work

Hint:
Specific heat capacity of water is 4.184 J/g*c
Specific heat capacity of ice is 2.05 J/g*c
The latent heat of fusion for water is 6.01 kJ/mol

2. Thermodynamics

Question Type: "Entropy"

Which of the following reactions will result in the greatest increase in the entropy of the system?

A) $2\ SO_2\ (g)\ + O_2\ (g) \rightarrow 2\ SO_3\ (g)$
B) $4\ C\ (s) + S_2\ (g)\ \rightarrow\ 4\ CS_2\ (l)$
C) $I_2\ (g)\ \rightarrow\ I_2\ (s)$
D) $AgCl\ (s) \rightarrow Ag^+\ (aq) + Cl^-\ (aq)$
E) $C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$

Space to Work

3. Electrochemistry

Question Type: "Lithium Ion Battery"

The Li-ion battery is based on the reactions:

$$LiC_6 \rightarrow Li^+ + C_6 + e^-$$

$$CoO_2 + Li^+ + e^- \rightarrow LiCoO_2$$

$$\textbf{Overall: } LiC_6 + CoO_2 \rightarrow LiCoO_2 + C_6$$

You fully charge Webstraw's premium remote that runs on a Lithium ion battery. What is the theoretical total mass of the reactants that will produce a constant current of 0.200 A for exactly 10 hours.

Space to Work

Hint: What does the reactions above tell us about the ratio of electrons to the reactants?

3. Electrochemistry

Question Type: "Cell Diagrams and Cell Potential I"

Which of the following is the correct abbreviated voltaic cell diagram that has a cell potential of 0.64V if the reaction proceeds spontaneously in the forward direction?

A) Pt (s) | Cl^- (aq), ClO^- (aq) || NO^{3-} (aq), NO^{2-} (aq) | Pt (s)
B) Pt (s) | NO^{3-} (aq), NO^{2-} (aq) || Cl^- (aq), ClO^- (aq) | Pt (s)
C) Pt (s) | Sn^{2+}, Sn^{4+} (aq) || Fe^{2+} (aq), Fe^{3+} (aq) | Pt (s)
D) Pt (s) | Fe^{2+} (aq), Fe^{3+} (aq) || Sn^{2+}, Sn^{4+} (aq) | Pt (s)

Space to Work

3. Electrochemistry

Question Type: "Cell Diagrams and Cell Potential II"

An electric circuit is created using 2 electrodes and various solutions in order to power a lightbulb. After placing the electrodes in solution, the lightbulb does not light up. You then try applying power to the system, but the lightbulb still does not light up. You conclude that the system is at equilibrium. Which one of the following cell diagrams corresponds to this scenario?

a) C (s, graphite) | Ce^{3+} (aq, 1M), Ce^{4+} (aq, 1M) || Pb^{2+} (aq, 1M) | Pb (s)
b) Zn (s) | Zn^{2+} (aq,1.0M) || H^{+} (aq, 0.5M) , H_2 (g, 1atm) | Pt (s)
c) Ag (s) | Ag^{+} (aq, 1M) || Ag^{+} (aq, 0.5M) | Ag (s)
d) Cu (s) | Cu^{2+} (aq, 0.175M) || Ag^{1+} (aq, 7.05 x 10^{-9}M) | Ag (s)

Space to Work

Hint: Determine the cell potentials for the given cell diagrams using standard redox reactions and the Nernst equation. Think about how the cell potential can give information on the equilibrium of a system.

3. Electrochemistry

Question Type: "Cell Potential for an Electrochemical Cell"

What is the cell potential of the following electrochemical cell at 25°C?
Co (s) | Co^{2+} (aq, 0.2 M) || $Fe3^{+}$ (aq, 0.7 M), Fe^{2+} (aq, 0.1) | Pt (s)

Space to Work

4. Chemical Kinetics

Question Type: "Catalyst"

Researcher Badi Fahodi uses an enzyme at a temperature of 322 K to catalyze a reaction, increasing the reaction rate by a factor of 7 x 10^4 relative to the uncatalyzed rate. At what temperature would he have to perform the same reaction in order to speed up the reaction rate by a magnitude of 10^3?

Space to Work

Hint: If k_1 is the rate of the uncatalyzed reaction and k_2 is the rate of the catalyzed reaction, then $(k_2/k_1) = 7x10^4$.

4. Chemical Kinetics

Question Type: "Rate Laws"

The reaction MF + IV → L gave the following data:

Run	*[MF] mol L^{-1}*	*[IV] mol L^{-1}*	*Initial rate, mol $L^{-1}S^{-1}$*
1	*0.10*	*0.20*	*$1.22x\ 10^{-4}$*
2	*0.20*	*0.10*	*$0.87x10^{-4}$*
3	*0.40*	*0.20*	*$2.52x10^{-4}$*

What would be the rate of this reaction when [MF] = 0.22 mol L -1 and [IV] = 0.11 mol L -1

Space to Work

Hint: Compare runs that will allow you to cancel out values in order to isolate for unknown variables

4. Chemical Kinetics

Question Type: "Half Life"

The half life of Zarahzonic gas ^{212}Zz is 4.8 days. If 4.0 grams of ^{212}Zz is present in the house and no more of the gas is introduced, what will be the amount (in mg) of Zarahzonic gas present in 44 days?

Space to Work

4. Chemical Kinetics

Question Type: "Plotted Reaction Kinetics"

The decomposition of 2 $Ni_2O_3 \rightarrow$ Ni + 3 O_2 yields a straight line with a slope of -0.40 hour^{-1} for a plot of ln[Ni_2O_3]. What order kinetics does this reaction follow and what is the half-life of Ni_2O_3 in seconds if its initial concentration is 0.20 M?

Space to Work

Hint: Given the initial concentration of Ni_2O_3, we can assume that the half-life concentration would be half of the initial.

4. Chemical Kinetics

Question Type: "Activation Energy with a Catalyst"

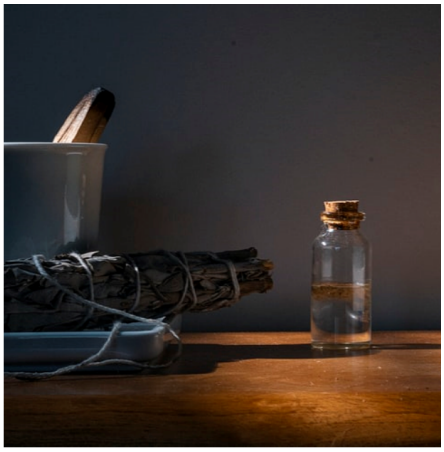
A reaction has a specific rate constant k = 1.3 x 10^{-3} mol L^{-1} s^{-1} at 25°C. If a catalyst increases the rate constant to 1.0 L mol^{-1} s^{-1} at the same temperature, calculate the change in activation energy in kJ mol^{-1} induced by the catalyst.

Space to Work

5. Equilibrium

Question Type: "Buffer Solution with a Specific pH"

In an enchanted forest, you encounter an apothecary who is willing to offer you a life elixir, however, they don't remember the exact amount of ingredients to add. If the elixir is made only from NaF and HF, how many grams of solid NaF must be added to 300 mL of 0.95M HF in order to produce a solution with a pH of 2.7? The K_a value for HF is 6.7×10^{-4}.



Space to Work

Hint: When calculating for the final mass, make sure to consider what compound's mass we are trying to find. All the calculations within the problem only give values relating to fluoride.

5. Equilibrium

Question Type: "Making Buffer Solutions"

Inspired by the ability of blood to maintain its pH, various solutions were studied to see if they shared the same property. Of the following reactions, how many of them will be able to maintain its pH? In other words, how many are buffer solutions?

1. 0.15mol of NaOH and 0.15mol of CH_3COOH
2. 0.10mol of CH_3COONa and 0.20mol of HCl
3. 0.20 mol of NH_4NO_3 and 0.10 mol of NaOH
4. 0.20mol of NaOH and 0.10mol of CH_3COONa
5. 0.25mol NH_4Cl and 0.10 mol NaOH

Space to Work

Hint: What ratio must an acid/base and their corresponding conjugate species be within in order to be considered a buffer solution?

5. Equilibrium

Question Type: "Solubility Constant"

A new fast food chain is in the process of designing their signature soft drink using compound X_2Z as the main ingredient. The food scientist on the team wants to know how much of the compound he can dissolve without supersaturating the solution as this will give the best flavour. The solubility of X_2Z in water at 25 ºC is 31.6 mg/L. Calculate the solubility product constant for X_2Z if its molar mass is 285.6 g/mol.

Space to Work

Hint: The compound will ionize fully into its components.

5. Equilibrium

Question Type: “Percent Ionization”

Faraz is designing a weak acidic drug to act in the duodenum, where he does not want the drug to be absorbed into the circulation. In order for this to work, he must know how much of the drug is ionized. A 0.46 M solution of this drug has a pH of 3.41. What is the % ionization of this drug? Assume the duodenum is neutral in pH.

Space to Work

5. Equilibrium

Question Type: "Reaction Mechanisms"

The following reaction occurs in three steps:

$$CHCl_3(g) + Cl_2(g) \rightarrow CCl\ (g) + HCl\ (g)$$

Step 1: $Cl_2\ (g) \leftrightharpoons 2Cl\ (g)$
Step 2: $CHCl_3\ (g) + Cl\ (g) \rightarrow CCl_3\ (g) + HCl\ (g)$
Step 3: $CCl_3\ (g) + Cl\ (g) \rightarrow CCl_4\ (g)$

What would the overall rate law be if Step 1 is a fast equilibrium, Step 2 was slow and Step 3 was fast?

Space to Work

Hint: Isolate for the intermediate to solve for the overall rate law.

5. Equilibrium

Question Type: "Equilibrium Constant Using Pressure Values"

A sample of SO_3 was injected into a sealed evacuated vessel at 600K. The initial pressure of SO_3 was 0.75 atm. After the system reached equilibrium, the total pressure increased to 0.93 atm at the same volume and temperature. What is the equilibrium constant for this reaction?

Space to Work

Hint: Find the equilibrium pressures and solve for the individual pressures of the reactants and products.

5. Equilibrium

Question Type: "Determining pH using Equilibrium Concentrations"

A buffer solution consists of 0.500 M NH_3 and 0.500 M NH_4Cl. If 1.00L of 0.100M HNO_3 is added to 1.00L of this buffer, what will be the pH of the resultant solution?

Space to Work

Hint: Find the equilibrium concentrations and calculate for $[H^+]$ using an equation for K_a.

5. Equilibrium

Question Type: "Acid Dissociation Constant Using Concentration Values"

The percent ionization of chlorous acid, $HClO_2$, in a 0.100 M aqueous solution is 28.1%. What is the pK_a value of chlorous acid?

Space to Work