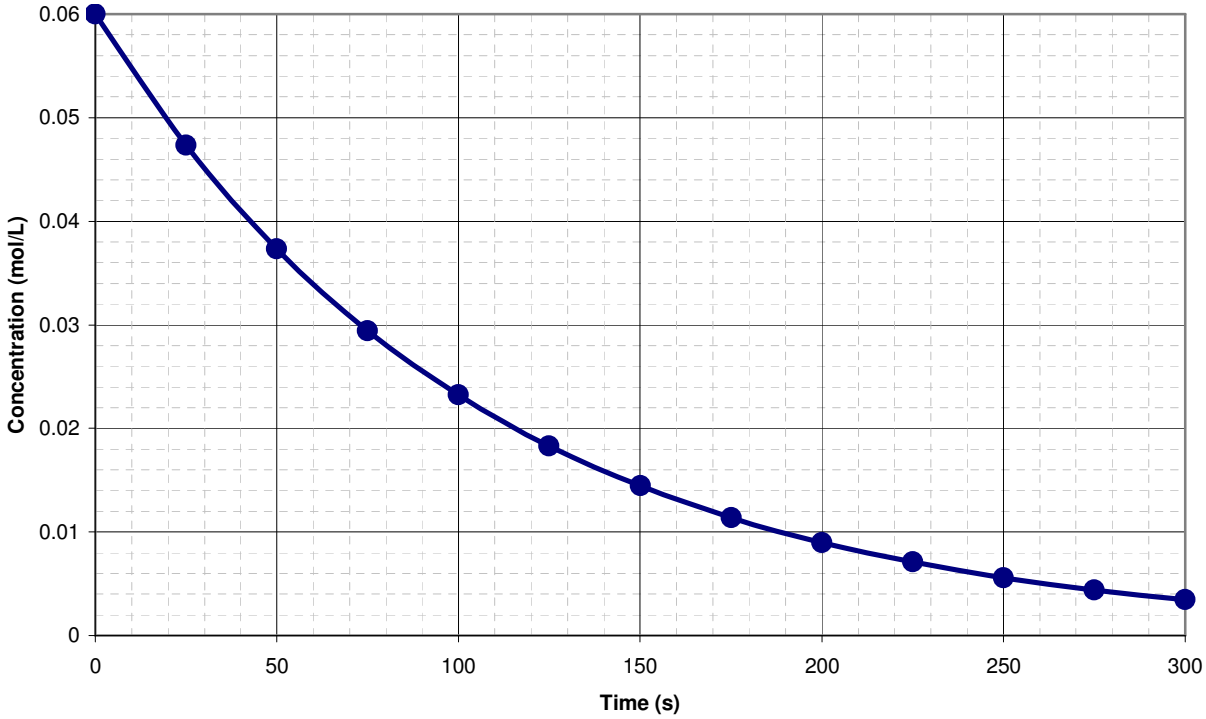
CHM106
Quiz I

The following plot follows the concentration of one of the species in a reaction versus time:



1. Is this species a reactant or product? How can you tell?

2. Calculate the average rate of reaction over the first 50 seconds of the reaction. Be sure to include units in your answer.

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Quiz II

The reaction $2\ NO + Cl_2 \rightarrow 2\ NOCl$ was studied at -10 °C. The following results were obtained:

[NO] (mol / L)	[Cl_2] (mol / L)	Rate (mol / L · min)
0.10	0.10	0.18
0.10	0.20	0.36
0.20	0.20	1.45

a) What is the rate law for this reaction?

b) What is the value of the rate constant?

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Quiz III

The reaction $NO_2 + CO \rightarrow NO + CO_2$ is thought to proceed through the following mechanism:

$$NO_2 + NO_2 \rightarrow N_2O_4 \qquad \text{Slow}$$
$$N_2O_4 + CO \rightarrow NO + CO_2 + NO_2 \qquad \text{Fast}$$

1. Write the rate law for this reaction.

2. What is the order of the reaction with respect to each of the reactants?

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Quiz IV

In aqueous solution, pyrophosphoric acid is in equilibrium with phosphoric acid:

$$H_4P_2O_{7(aq)} + H_2O_{(l)} \Leftrightarrow 2\ H_3PO_{4(aq)}$$

1. Write an equilibrium expression for this reaction.

2. If the concentration of pyrophosphoric acid at equilibrium is 1.54×10^{-3} M and the concentration of phosphoric acid at equilibrium is 1.12 M, what is the value of the equilibrium constant?

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Quiz V

The hydrocarbon cyclopentadiene (C_5H_6) exists in equilibrium with its dimer ($C_{10}H_{12}$):

$$2\ C_5H_6 \Leftrightarrow C_{10}H_{12}$$

For a given set of conditions, the equilibrium constant for this reaction is 1.24×10^4. Initially, a solution is 0.100 M in cyclopentadiene with no dimer present. Calculate the equilibrium concentrations of C_5H_6 and $C_{10}H_{12}$.

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Quiz VI

Hydriodic acid (HI) is a strong acid.

1. Write a balanced chemical equation for the dissociation of HI in water.

2. For this process, identify which species is an acid, a base, a conjugate acid, and a conjugate base.

3. What is the pH of a 0.015 M HI solution?

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Quiz VII

Cyanic acid (HOCN) has a $K_a = 3.46 \times 10^{-4}$. What is the pH of a 0.20 M HOCN solution?

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Quiz VIII

Benzoic acid (C_6H_5COOH) has a $K_a = 6.25x10^{-5}$. What is the pH of a 0.150 M solution of potassium benzoate (C_6H_5COOK)?

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Quiz IX

Propanoic acid ($CH_3CH_2CO_2H$) has a $K_a = 1.337x10^{-5}$. What is the pH of a solution that is 1.0 M in propanoic acid and 0.5 M in potassium propanoate ($CH_3CH_2CO_2K$)?

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Quiz X

1.0 L of a phosphoric acid / dihydrogen phosphate buffer is prepared with $[H_3PO_4] = 0.500$ M and $[H_2PO_4^-] = 1.00$ M. For phosphoric acid, $pK_a = 2.148$. Recall that $pH = pK_a + \log\frac{[A^-]}{[HA]}$.

1. What is the pH of this buffer?

2. 0.100 mol of solid KOH is added to this buffer. What is the new pH of the solution?

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Quiz XI

A solution of 10.0 mL of 0.100 M $HClO_4$ is titrated with 0.050 M KOH.

1. What is the pH before any KOH is added?

2. What volume of KOH must be added to reach the equivalence point? What is the pH at this point in the titration?

3. What is the pH of the solution after 50.0 mL of KOH has been added?

4. Sketch the titration curve (pH vs volume KOH) for this titration. Label the three points calculated above on the plot.

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Quiz XII

Consider the vaporization of liquid water:

$$H_2O(l) \rightarrow H_2O(g)$$

1. For this process, is ΔS_{system} positive or negative? Explain.

2. This process requires 40.66 kJ/mol of water. Is $\Delta S_{surroundings}$ positive or negative? Explain.

3. In order for this process to be spontaneous, what must the sum of ΔS_{system} and $\Delta S_{surroundings}$ be?

4. For what temperatures is this process spontaneous?

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Quiz XIII

Consider the combustion of methane:

$$CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(g)$$

Substance	ΔH_f^0 (kJ / mol)	S^0 (J / mol · K)
$CH_4(g)$	-393.5	213.8
$O_2(g)$	0	205.2
$CO_2(g)$	-74.4	186.3
$H_2O(g)$	-241.8	188.8

1. What is the value for ΔH^0 for this reaction?

2. What is the value for ΔS^0 for this reaction?

3. What is the value for ΔG^0 for this reaction?

4. Is this reaction spontaneous at 25 °C?

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Quiz XIV

Acetic acid reacts with ethanol to form ethyl acetate and water:

$$CH_3COOH(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$$

Substance	ΔH_f^0 (kJ / mol)	S^0 (J / mol · K)
$CH_3COOH(l)$	-277.7	160.7
$C_2H_5OH(l)$	-484.5	159.8
$CH_3COOC_2H_5(l)$	-479.3	257.7
$H_2O(l)$	-285.8	70.0

1. What is the value for ΔH^0 for this reaction?

2. What is the value for ΔS^0 for this reaction?

3. What is the value for ΔG^0 for this reaction?

4. Is this reaction spontaneous at 25 °C?

5. What is the value of the equilibrium constant for this reaction?

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Quiz XV

Solid manganese (IV) oxide reacts with chromium metal to produce manganese (II) ions and chromium (III) ions.

1. Using the method of half-reactions, balance this oxidation-reduction reaction. Show your work.

2. Sketch an electrochemical cell for this process. Assume that $MnO_2(s)$ acts as an electrode in one half-cell and that the appropriate metal electrode is present in the other half-cell. In your sketch, label which half-cell contains the oxidation reaction and which half-cell contains the reduction reaction. Also label which electrode is the cathode and which electrode is the anode.

4. Calculate the standard cell potential for this reaction. A table of reduction potentials is available on the back side of this quiz.

5. Give the line notation for this electrochemical cell.

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Quiz XVI

Suppose we are interested in the following galvanic cell:

$$Ag \mid Ag^{+} \parallel Cr^{3+} \mid Cr$$

The following are data from the table of standard reduction potentials:

Half-reaction	$\mathscr{E}^0$
$Ag^{+} + e^{-} \rightarrow Ag$	0.80 V
$Cr^{3+} + 3e^{-} \rightarrow Cr$	-0.73 V

1. Write the spontaneous, balanced chemical equation for this reaction.

2. What is the standard cell potential for this reaction?

3. If the concentration of $[Ag^{+}] = 5.00$ M and the concentration of $[Cr^{3+}] = 1.00$ M, what is the potential of this cell? Recall that the Nernst equation is $\mathscr{E} = \mathscr{E}^0 - \frac{RT}{n\mathrm{F}} \ln Q$ and the value of Faraday's constant is 96,485 C / mol.

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Quiz XVII

Carbon-14 has a half-life of 5,730 years for the process of beta decay.

1. Write a balanced nuclear equation for this process. What new nucleus is produced?

2. If a sample initially contains 13.2300 mg of ^{14}C and currently has 3.3075 mg of carbon-14, how long has the sample been decaying?

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Quiz XVIII

The mass of a proton is 1.67262×10^{-24} g and the mass of a neutron is 1.67493×10^{-26} g.

1. What should the mass of ^{3}He be?

2. The actual mass of helium-3 is 5.00823×10^{-24}g. What is the mass defect for the formation of a helium-3 nucleus from two protons and a neutron?

3. How much energy is released in this process (in J/mol)? The speed of light is 3.00×10^{8} m/s.

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Quiz XIX

Write balanced chemical equations that show the reaction of potassium metal with:

1. Chlorine gas

2. Water

3. Hydrogen gas

4. Oxygen (to form the superoxide)

5. Sulfur

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Quiz XX

Predict whether each of the following oxides will be covalent or ionic in character.

1. KO_2

2. SiO_2

3. B_2O_3

4. SnO_2

5. MgO

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Quiz XXI

Write balanced chemical equations showing that the following nonmetal oxides generate acidic solutions when dissolved in water:

1. SO_2

2. P_2O_5

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Quiz XXII

When copper (II) sulfate is dissolved in water, a light blue solution is formed.

1. In solution, copper exists as $Cu(H_2O)_6SO_4$. Name this compound.

2. If ammonia is added to the solution, it turns to a very deep blue. The copper ion has been converted to $Cu(NH_3)_4^{2+}$. Name this complex ion.

3. For each complex, what geometry does the transition metal have? If there is more than one possible geometry, list them all.

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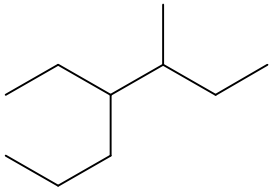
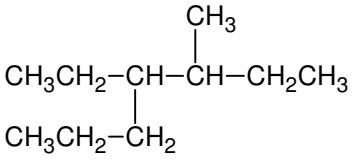
Quiz XXIII

1. Draw the structure of the molecule 2,2-dimethylhexane.

2. Provide an unambiguous, systematic name for the compound shown below (as both a structural formula and a line-angle drawing)





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Quiz XXIV

For each problem, draw the structure of a molecule containing the specified functional group that has *exactly* five carbon atoms.

1. Alcohol

2. Ketone

3. Carboxylic acid

4. Ether

5. Amine

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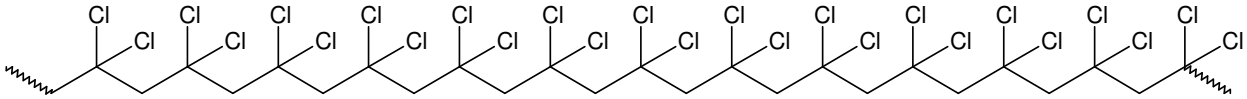
Quiz XXV

Saran is a polymer formed into films that find use in the kitchen to wrap food. A portion of a saran polymer is shown below.



1. What is the repeating unit for this polymer?

2. What alkene monomer was used to make this polymer?

3. Give an unambiguous, systematic name for the monomer.