UNITS 1 & 2 FREE RESPONSE REVIEW

General Chemistry

1. [5 POINTS]

A sample of an unknown hydrocarbon was burned in air.

(a) When the hydrocarbon sample was burned in a reaction that went to completion, 2.2 grams of water and 3.6 liters of carbon dioxide were produced under standard conditions. What is the empirical formula of the hydrocarbon? **[2 POINTS]**

(b) If the molar mass of the compound was determined to be 28.1 g/mol, what is the molecular formula of the hydrocarbon? **[2 POINTS]**

(c) Write the balanced equation for the combustion reaction that took place in (a). **[1 POINT]**

Foglino, Paul. *Cracking the AP*. 2013 ed. New York: Random House, 2012. Print.

UNIT 3 FREE RESPONSE REVIEW
Electrochemistry

2. [9 POINTS]

A strip of Ni Metal is placed in a 1.0 M solution of $Ni(NO_3)_2$ and a strip of Ag metal is placed in a 1.0 M solution of $AgNO_3$. An electrochemical cell is created when the two solutions are connected by a salt bridge and the two metal strips are connected by wires to a voltmeter.

Standard Reduction Potentials at 25°C	
Reduction Half-Reaction	E°(V)
$Au^{3+} + 3e^- \rightarrow Au(s)$	+ 1.50
$Ag^+ + e^- \rightarrow Ag(s)$	+ 0.80
$Ni^{2+} + 2e^- \rightarrow Ni(s)$	− 0.25
$Na+ + e^- \rightarrow Na(s)$	− 2.71

(a) Write the balanced chemical equation for the overall reaction that occurs in the cell, and calculate the cell potential, E°. **[2 POINTS]**

(b) Calculate how many grams of metal will be deposited on the cathode if the cell is allowed to run at constant current of 1.5 amperes for 8.00 minutes. **[2 POINTS]**

(c) Calculate the value of the standard free energy change, ΔG°, for the cell reaction. **[2 POINTS]**

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(d) Predict: will the cell potential, E_{cell}, at 25°C for the cell shown above be higher, lower, or equal to the standard cell potential E^{o}_{cell}, if the initial concentration of $Ni(NO_3)_2$ is 0.100 M and the initial concentration of $AgNO_3$ is 1.20 M. **[2 POINTS]**

(e) Is the reaction in the cell thermodynamically favorable under conditions described in part (d)? Justify your answer. **[1 POINT]**

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UNIT 4 FREE RESPONSE REVIEW
Thermochemistry and Thermodynamics

3. [8 POINTS]

$$CH_4(g) + 2O_2(g) \quad CO_2(g) + 2H_2O(l)$$

The above reaction for the combustion of methane gas has a standard entropy change, $\Delta S°$, with a value of 242.7 J/mol•K. The following data are also available.

Compound	$\Delta H°_f$ (kJ/mol)
$CH_4(g)$	−74.8
$H_2O(l)$	−285.9
$CO_2(g)$	−393.5

(a) What are the values of $\Delta H°_f$ and $\Delta G°_f$ for $O_2(g)$? **[1 POINT]**

(b) Calculate the standard change in enthalpy, $\Delta H°$, for the combustion of methane. **[2 POINTS]**

(c) Calculate the standard free energy change, $\Delta G°$, for the combustion of methane. **[2 POINTS]**

(d) How would the value of $\Delta S°$ for the reaction be affected if the water produced in the combustion remained in the gas phase? **[1 POINT]**

(e) A 20.0 g sample of $CH_4(g)$ underwent combustion in a bomb colorimeter with excess oxygen gas.

(i) Calculate the mass of carbon dioxide produced. **[1 POINT]**

(ii) Calculate the heat released by the reaction. **[1 POINT]**

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UNIT 5 FREE RESPONSE REVIEW

Kinetics

4. [8 POINTS]

$$A + 2B \rightarrow 2C$$

The following results were obtained in experiments designed to study the rate of the reaction above:

Experiment	Initial [A] (mol/L)	Initial [B] (mol/L)	Initial rate of disappearance of A (M/sec)
1	0.05	0.05	3.0×10^{-3}
2	0.05	0.10	6.0×10^{-3}
3	0.10	0.10	1.2×10^{-2}
4	0.20	0.10	2.4×10^{-2}

(a) Determine the order of the reaction with respect to A. Justify your response. **[1 POINT]**

(b) Determine the order of the reaction with respect to B. Justify your response. **[1 POINT]**

(c) Write the rate law for the reaction. **[1 POINT]**

(d) Calculate the value of the rate constant, k, for the reaction. Include the units. **[2 POINTS]**

(e) If another experiment is attempted with [A] and [B], both 0.020-molar, what would be the initial rate of disappearance of A? **[1 POINT]**

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UNIT 5 FREE RESPONSE REVIEW

Kinetics

(f) The following reaction mechanism was proposed for the reaction above:

$$A + B \rightarrow C + D$$

$$D + B \rightarrow C$$

(i) Show the mechanism is consistent with the balanced reaction. **[1 POINT]**

(ii) Show which step is the rate-determining step, and explain your choice. **[1 POINT]**

(iii) In the mechanism, would D be classified as a catalyst or an intermediate? Justify your response. **[1 POINT]**

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