Chem 112 **Spring 2020** **Exam I** **Whelan**

SID | | | | | | | | | Last Key First Answer

Question 1 10 Points

The **vapor pressure** of **bromoethane** is **40.1 mm Hg at 246K**. Assuming that its **molar heat of vaporization** is constant at **29.2 kJ/mol**, determine the **vapor pressure** of **bromoethane (C_2H_5Br)** at **263K**.

Must Show Work for Full Credit - R = 8.314 $J.mol^{-1}.K^{-1}$

$$\ln\frac{P_2}{P_1} = \frac{\Delta H^\circ_{VAP}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$P_1 = 40.1$ $T_1 = 246$

$P_2 = ?$ $T_2 = 263$

$\Delta H^\circ_{VAP} = 29{,}200\ J.mol^{-1}$

$$\ln\frac{P_2}{40.1} = \frac{29{,}200}{8.314}\left(\frac{1}{246} - \frac{1}{263}\right)$$

$$\ln P_2 - \ln(40.1) = 3512.1\ (2.63\times10^{-4})$$

$$\ln P_2 - 3.6914 = 0.9228$$

$$\ln P_2 = 0.9228 + 3.6914$$

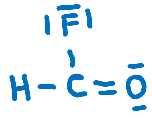
$$= 4.6142$$

100.9 Mm Hg

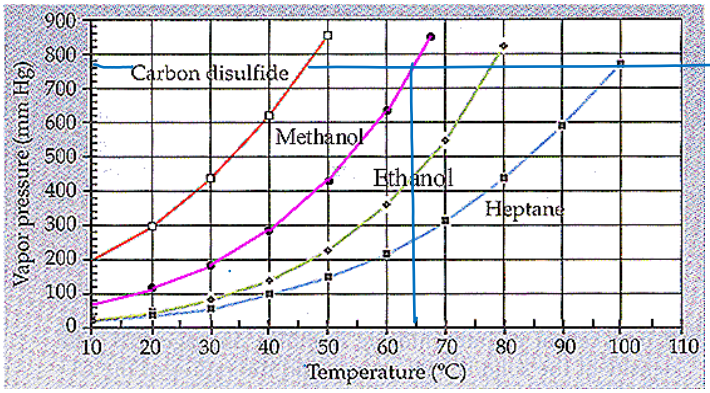
Question 2 6 Points

What **type(s)** of **intermolecular forces** are expected between **HFCO** molecules? Circle all those that apply. (**C** is the central atom)

- ☐ **Ion – Ion**
- ◯ **Dipole – Dipole**
- ◯ **Induced Dipole – Induced Dipole**
- ☐ **Ion – Dipole**
- ☐ **Hydrogen bonding**



Question 3 6 Points



A plot of **vapor pressures** vs **temperature**, is depicted **above**.

a) The molecule with the **weakest intermolecular forces**? Carbon disulfide

b) The **Normal Boiling Point** of **Methanol** is: (<60°C, ~65°C, >70°C) ~ 65°C

Question 4
8 Points

An aqueous solution is **7.02 % by mass hydrochloric acid**, HCl. What is the **mole fraction** of **hydrochloric acid** in the solution?

Must Show Work for Full Credit: Molar Masses, HCl = 36.5g.mol^{-1}, H_2O = 18.02g.mol^{-1}

Assume 100g solution ∴ 7.02g HCl and 92.98 g H_2O

$$7.02\text{g HCl} \left| \frac{1\text{ mol}}{36.5\text{g}} \right. = 0.192\text{ mol}$$

$$92.8\text{g } H_2O \left| \frac{1\text{mol}}{18.02\text{g}} \right. = 5.15\text{ mol}$$

$$\chi_{HCl} = \frac{0.192}{0.192 + 5.15}$$

3.59×10^{-2}

Question 5
12 Points

Match the following aqueous solutions with the appropriate letter from the column on the right. **Assume complete dissociation of electrolytes.**

D 0.21 m $CrSO_4$ $i = 2$

C 0.16 m $CuCl_2$ $i = 3$

A 0.13 m $Fe(NO_3)_3$ $i = 4$

B 0.50 m Glucose (**nonelectrolyte**)

A. **Lowest** freezing point
B. **Second lowest** freezing point
C. **Third lowest** freezing point
D. **Highest** freezing point

Question 6
6 Points

The **Vapor Pressure** of 4 substances was measured at **25°C** and they were found to be **143.0 mmHg**, **67.9 mm Hg**, **151.7 mmHg**, **514.4 mmHg**
The four substances measured are given below. Which one of the four **would you anticipate** having the **Vapor Pressure of 143.0 mm Hg?**

- ☒ CH_3OH
- ☐ C_6H_{14}
- ☐ C_5H_{12}
- ☐ CH_3CH_2OH

Question 7
7 Points

The **vapor pressure** of water (H_2O) is **23.8 mm Hg at 25°C**. What is the vapor pressure of a solution consisting of **8.55 mol of water** and **0.265 mol of a nonvolatile nonelectrolyte?**

Must Show Work for Full Credit

$P_{sol} = \chi_{solvent} \times P^{\circ}_{solvent}$

$$\chi_{solvent} = \frac{8.55}{8.55 + 0.265} = 0.970$$

$P_{sol} = 23.8\,(0.970)$

23.1 mm Hg

Question 8
10 Points

The gas phase decomposition of hydrogen peroxide at 400°C is **second order** in H_2O_2.

$$H_2O_2(g) = H_2O(g) + \tfrac{1}{2}\ O_2(g)$$

In one experiment, when the initial concentration of H_2O_2 was **5.50×10^{-2} M**, the concentration of H_2O_2 dropped to **1.29×10^{-2} M** after **59.6 seconds had passed**. Based on this data, the **rate constant (k)** for the reaction is:

Must Show Work for Full Credit

$$\frac{1}{[A]_t} = \frac{1}{[A]_0} + kt$$

$[A]_0 = 5.30\times10^{-2}$

$[A]_t = 1.29\times10^{-2}$

$t = 59.6$ sec

$k = ?$

$$\frac{1}{1.29\times10^{-2}} = \frac{1}{5.50\times10^{-2}} + 59.6k$$

$$59.6k = \frac{1}{5.50\times10^{-2}} - \frac{1}{1.29\times10^{-2}}$$

$$59.6k = 59.3$$

$$k = \frac{59.3}{59.6}$$

0.996 $M^{-1}.s^{-1}$

Question 9
12 Points

The following **initial rate data** are for the oxidation of nitrogen monoxide by oxygen at 25°C:

$$2\ NO + O_2 = 2\ NO_2$$

I. Rate $= k[NO]^x[O_2]^y$

Experiment	$[NO]_0$ M	$[O_2]_0$ M	Initial Rate, $M.s^{-1}$
1	9.10×10^{-3}	5.61×10^{-4}	4.20×10^{-4}
2	1.82×10^{-2}	5.61×10^{-4}	1.68×10^{-3}
⇒ 3	9.10×10^{-3}	1.12×10^{-3}	8.38×10^{-4}

$8.38\times10^{-4} = k(9.10\times10^{-3})^2(1.12\times10^{-3})$

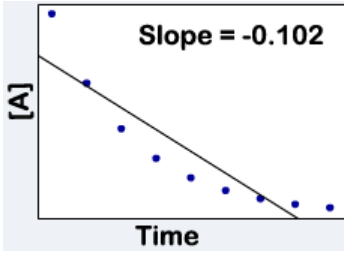
a) What is the **order of the reaction with respect to NO?** 2

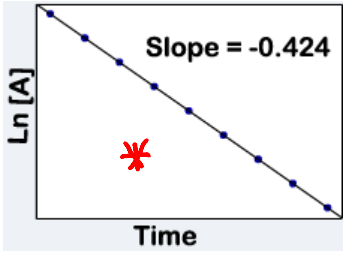
b) What is the **order of the reaction with respect to O_2?** 1

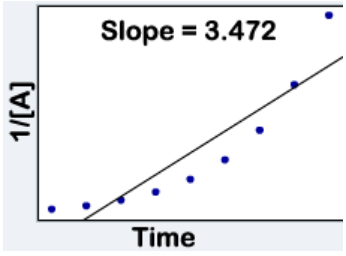
c) What is the **rate constant (k)?** 9.04×10^{3}

Question 10
4 Points

The following plots pertain to the reaction **A = B** in which the **concentration of A** was monitored over 8 minutes







From these plots the it can be determined that the **Rate** = 0.424 $[A]^{1}$

Question 11
10 Points

Chromium-51 is a radioisotope that is used to assess the lifetime of red blood cells **The half-life** of chromium-51 is **27.7 days**. If you **begin** with **41.7 mg** of this isotope, what **mass remains** after **77.6 days have passed? Since the decomposition is a radioactive decay reaction, it is first order.**

Must Show Work for Full Credit

$$k = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{27.7}$$

$$k = 2.50 \times 10^{-2}$$

$$\ln \frac{[A]_t}{[A]_0} = -kt$$

$[A]_0 = 41.7$
$[A]_t = ?$
$t = 77.6$
$k = 2.50 \times 10^{-2}$

$$\ln[A]_t - \ln(41.7) = -2.50\times10^{-2}(77.6)$$
$$\ln[A]_t - 3.731 = -1.94$$
$$\ln[A]_t = 3.731 - 1.94 = 1.791$$

5.99 mg

Question 12
9 Points

In a study of the rearrangement of ammonium cyanate to urea in aqueous solution at **50°C**

$$NH_4NCO(aq) = (NH_2)_2CO(aq)$$

the **concentration of NH_4NCO** was followed as a function of time.

It was found that **a graph** of **1/[NH_4NCO] versus time in minutes** gave a **straight line** with a **slope of 1.47×10^{-2} $M^{-1}min^{-1}$** and a **y-intercept of 2.65 M^{-1}**.

Based on this plot the:

a) the reaction is 2 order in **NH_4NCO**

b) and the rate constant for the reaction is: 1.47×10^{-2} $M^{-1}min^{-1}$ **(units)**

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