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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 $J.mol^{-1}.K^{-1}$

$$\ln\frac{P_2}{P_1} = \frac{\Delta H^\circ_{VAP}}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right) \qquad \ln\frac{P_2}{40.1} = \frac{29,200}{8.314}\left(\frac{1}{246}-\frac{1}{263}\right)$$

$P_1 = 40.1$ $P_2 = ?$
$T_1 = 246$ $T_2 = 263$
$\Delta H^\circ_{VAP} = 29.2\ kJ.mol^{-1}$
$R = 8.314\ J.mol^{-1}K^{-1}$

$\ln P_2 - \ln 40.1 = 3512.1\ (2.6276\times10^{-4})$
$\ln P_2 - 3.691 = 0.923$
$\ln P_2 = 4.614$

100.9 Mm Hg

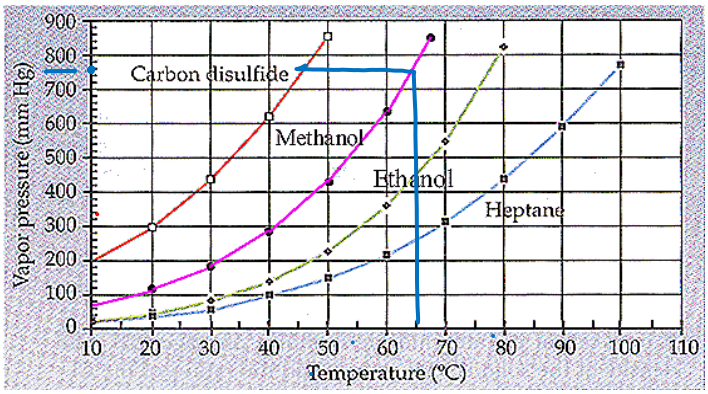
Question 2 (6 Points)

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)

760 ←



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: (<65°C, ~65°C, >65°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 = $36.5 g.mol^{-1}$, H_2O = $18.02 g.mol^{-1}$

Assume 100g :- 7.02g HCl 92.98g H_2O

$$7.02\,g\ HCl \left| \frac{1\ mol}{36.5\,g} \right. = 0.192\,mol \qquad 92.98\,g\ H_2O \left| \frac{1\ mol}{18.02\,g} \right. = 5.16\,mol$$

$$\chi = \frac{0.192}{0.192 + 5.16}$$

3.59×10^{-2}

Question 5
8 Points

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

C	0.21 m $CrSO_4$	$i = 2$
D	0.16 m CuCl	$i = 2$
A	0.19 m $Cu(NO_3)_2$	$i = 3$
B	0.44 m Glucose (**nonelectrolyte**)	$i = 1$

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 151.7 mm Hg?**

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

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

$$\chi_{solvent} = \frac{8.55}{8.55 + 0.265} = 0.97$$

$$P_{solution} = 0.97\,(23.8)$$

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

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

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

$[A]_t = 1.29\times10^{-2}$
$[A]_0 = 5.50\times10^{-2}$
$t = 59.6$
$k = ?$

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

$$59.6k = 59.3$$

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

0.995 $M^{-1}.s^{-1}$

Question 9
12 Points

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

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

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}

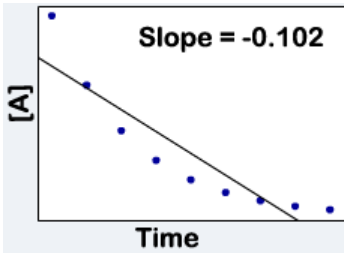
a) What is the **order of the reaction with respect to NO?** 2

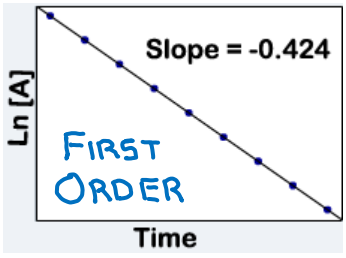
b) What is the **order of the reaction with respect to O_2?** 1

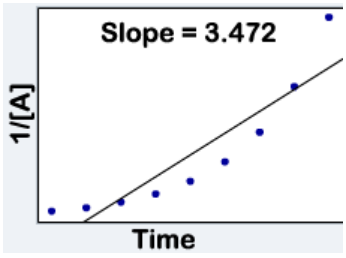
c) What is the **rate constant (k)?** 9.04×10^{3}

Question 10
8 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

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

$k = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{27.7} = 2.50 \times 10^{-2}$

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

$[A]_0 = 41.7$ $\quad t = 77.6$ days

$[A]_t = ?$ $\quad k = 2.50 \times 10^{-2}$

$$\ln \frac{[A]_t}{(41.7)} = -2.50 \times 10^{-2} (77.6)$$

$$\ln [A]_t - \ln 41.7 = -1.94$$

$$\ln [A]_t - 3.73 = -1.94$$

$$\ln [A]_t = 3.73 - 1.94 = 1.79$$

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 2nd order in NH_4NCO

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

Do Not Write Below This Line

Exam I Score