

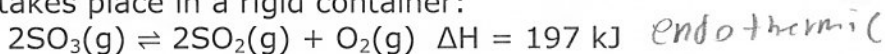
**Equilibrium Quiz #1**

12/13

Excell

Please read all questions carefully before answering. In order to receive full marks, please include complete and logical solutions to all problems, including units and where appropriate. Good luck ☺!

1. The following equilibrium takes place in a rigid container:



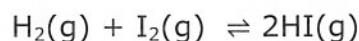
In which direction does the equilibrium shift as a result of each change? (3 marks K)

- Increasing the temperature:
- Increasing the pressure:
- Adding more oxygen gas:
- Removing some sulphur trioxide:
- Adding a catalyst:
- Adding some argon gas:

forward (right) ✓  
~~forward (right) X~~  
~~reverse (left) X~~  
 reverse (left) ✓  
~~reverse (left) X~~  
 no shift ✓  
~~no change X~~

2 1/2

2. The following equation describes the formation of HI(g):



$$K = 46.0 \text{ at } 490^\circ\text{C}$$

Initially 0.40 mol of hydrogen and 0.40 mol of iodine are injected into a 500.0 mL vessel. Find the concentration of all compounds at equilibrium. (5 marks = 4 marks T, 1 mark C)

	$\text{H}_2(\text{g})$	$\text{I}_2(\text{g})$	$2\text{HI}(\text{g})$
I	0.8 mol/L	0.8 mol/L	0 mol/L
C	-x	-x	2x
E	0.8 mol/L - x	0.8 mol/L - x	2x

$$\text{H}_2 \quad c = \frac{n}{V} = \frac{0.4 \text{ mol}}{0.5 \text{ L}} = 0.8 \text{ mol/L}$$

$$\text{I}_2 \quad c = \frac{n}{V} = \frac{0.4 \text{ mol}}{0.5 \text{ L}} = 0.8 \text{ mol/L}$$

Concentration of HI = 2x  
 $2(0.6178) = 1.2356 \text{ mol/L}$

$$K_{eq} = 46.0$$

$$K_{eq} = 46.0 = \frac{[2\text{HI}(\text{g})]^2}{[\text{H}_2(\text{g})][\text{I}_2(\text{g})]} = \frac{(2x)^2}{(0.8 \text{ mol/L} - x)(0.8 \text{ mol/L} - x)}$$

$$-b \pm \sqrt{b^2 - 4ac} = x$$

$$46.0 = \frac{4x^2}{0.64 - 1.6x + x^2}$$

$$x = \frac{73.6 \pm \sqrt{5416.96 - 4(42)(29.44)}}{2(42)}$$

$$= \frac{73.6 \pm 21.7}{84}$$

$$x = 0.6178$$

$$C_{\text{H}_2} = 0.1822 = 0.18 \text{ mol/L}$$

$$C_{\text{I}_2} = 0.18 \text{ mol/L}$$

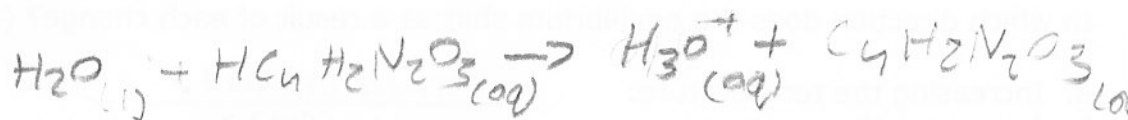
$$C_{2\text{HI}} = 1.2 \text{ mol/L}$$

x = 1.1346 is discarded (34) is in 100% concentration

2.5

3. Barbituric acid,  $\text{HC}_4\text{H}_2\text{N}_2\text{O}_3$ , has a  $K_a$  of  $9.8 \times 10^{-5}$ . If a solution of barbituric acid has a concentration of  $0.25 \text{ mol/L}$ , calculate the percent dissociation of the acid.  
(5 marks = 4 marks T, 1 mark C)

$$C = 0.25 \text{ mol/L} \quad \% = \frac{[\text{HA}] \text{ dissociated}}{[\text{HA}] \text{ Initial}}$$



$$K_a = \frac{[\text{C}_4\text{H}_2\text{N}_2\text{O}_3][\text{H}_3\text{O}^+]}{[\text{H}_2\text{O}][\text{HC}_4\text{H}_2\text{N}_2\text{O}_3]}$$

$$9.8 \times 10^{-5} = \frac{[\text{C}_4\text{H}_2\text{N}_2\text{O}_3][\text{H}_3\text{O}^+]}{(0.25 \text{ mol/L})}$$

$$\% = \frac{0.25 \text{ mol/L}}{0.25 \text{ mol/L}}$$

$$10^{-14} = K_a K_b$$

$$10^{-14} = (9.8 \times 10^{-5}) K_b$$

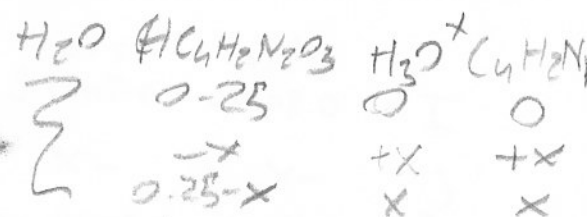
$$K_a \text{ to pH}$$

$$9.8 \times 10^{-5} = \frac{x^2}{0.25 - x}$$

$$2.45 \times 10^{-5} - 9.8 \times 10^{-5} x = x^2$$

$$x^2 + 9.8 \times 10^{-5} x - 2.45 \times 10^{-5} = 0$$

HT+1C



$$\% = \frac{9.8 \times 10^{-5}}{10^{-14}}$$

$$\frac{0.25}{9.8 \times 10^{-5}}$$

$$\% = 270$$

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