SCH4U – Fall 2018A

Equilibrium Quiz #1 12½/13 Excell

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

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

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g) \quad \Delta H = 197 \text{ kJ}$$ endothermic

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

a. Increasing the temperature: forward (right) ✓
b. Increasing the pressure: forward (right) X
c. Adding more oxygen gas: reverse (left) ✓
d. Removing some sulphur trioxide: reverse (left) ✓
e. Adding a catalyst: no shift ✓
f. Adding some argon gas: no change ✓

2½

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

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad K = 46.0 \text{ at } 490°C$$

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

	$H_{2(g)}$	$I_{2(g)}$	$2HI_{(g)}$
I	0.8mol/L	0.8mol/L	0mol/L
C	−x	−x	2x
E	0.8mol/L − x	0.8mol/L − x	2x

H_2 $c = \frac{n}{V} = \frac{0.4\text{ mol}}{0.5\text{L}} = 0.8\text{mol/L}$

I_2 $c = \frac{n}{V} = \frac{0.4\text{ mol}}{0.5\text{L}} = 0.8\text{mol/L}$

(concentration of HI = 2x)

$2(0.6178) = 1.2356\text{ mol/L}$

$K_{eq} = 46.0$

$$K_{eq} = 46.0 = \frac{[2HI_{(g)}]^2}{[H_{2(g)}][I_{2(g)}]} = \frac{(2x)^2}{(0.8\text{mol/L} - x)(0.8\text{mol/L} - x)}$$

4T+1C

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

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

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

$x = 1.1346$ ∈ discarded (result is in moles, not concentration)

$x = 0.6178$

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

$46.0(0.64 - 1.6x + x^2) = 4x^2$

$29.44 - 73.6x + 46x^2 = 4x^2$

$42x^2 - 73.6x + 29.44$

$C_{H_2} = 0.1822 = 0.18\text{ mol/L}$

$C_{I_2} = 0.18\text{ mol/L}$ ✓

$C_{2HI} = 1.2\text{ mol/L}$ ✓

2.5

Name:

3. Barbituric acid, $HC_4H_2N_2O_3$, has a Ka of 9.8×10^{-5}. If a solution of bartituric acid has a concentration of 0.25 mol/L, calculate the percent dissociation of the acid. (5 marks = 4 marks T, 1 mark C)

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

$H_2O_{(l)} + HC_4H_2N_2O_{3(aq)} \rightarrow H_3O^+_{(aq)} + C_4H_2N_2O_{3(aq)}$

$K_a = \frac{[C_4H_2N_2O_3][H_3O^+]}{[H_2O][HC_4H_2N_2O_3]}$

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

$9.8 \times 10^{-5} = \frac{[C_4H_2N_2O_3][H_3O^+]}{(0.25\ mol/L)}$

$10^{-14} = Ka \times Kb$

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

	H_2O	$HC_4H_2N_2O_3$	H_3O^+	$C_4H_2N_2O_3$
I		0.25	0	0
C		$-x$	$+x$	$+x$
E		$0.25-x$	x	x

$\% = \frac{9.8 \times 10^{-5}}{10^{-14}}$ $\quad \frac{0.25}{9.8 \times 10^{-5}}$ ✓

Ka to pH

$\% = 2790$

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

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

2790

4T+1C