

Chemistry 1210 Spring 2024 Test 2

Friday, March 1, 2024

Time: 1 hour 50 minutes

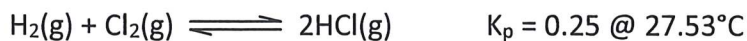
Name: ANSWERS

Student #: _____

*This test consists of six pages of questions, the formula sheet, and a periodic table. Please ensure that you have a complete test and, if you do not, obtain one from me **immediately**. There are **37.5** marks available. Good luck!*

- 1) [2 marks] A certain reaction has $\Delta H^\circ = 65.0$ kJ/mol and $K = 50.0$ at 25°C . What will be its value of K at 50°C ?
- a) 50.1 c) 3.09×10^8 e) None of these
b) 380.1 d) 1.25×10^{88}
- 2) [2 marks] The normal boiling point of hexane is 68.75°C , and its enthalpy of vaporization is 31 kJ/mol. Its vapour pressure at 22°C will be:
- a) 7.33×10^{-73} torr c) 7.51×10^{-3} torr e) 758.7 torr
b) 6.78×10^{-48} torr d) 135.1 torr

- 3) [5 marks total] A 10-litre flask was charged with 5 moles of H_2 , 5 moles of Cl_2 , and 10 moles of HCl , and the equilibrium



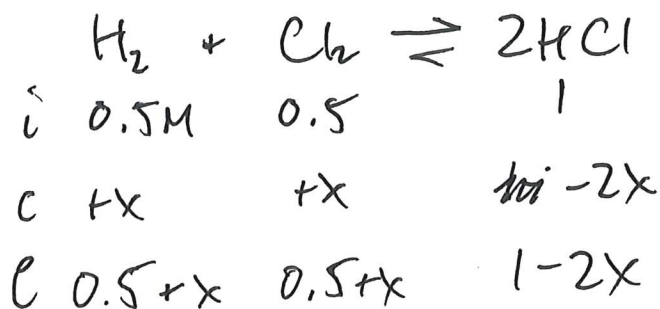
established.

- a) [1 mark] In which direction did the reaction shift to attain equilibrium? How do you know? (No marks for guessing. ☹)

$K_p + K_c$ are equal, so work
Problem in []s: $Q = \frac{1^2}{0.5^2} = 4$

Q too big, rxn \leftarrow to make it smaller.

- b) [4 marks] What were the equilibrium pressures of all species?



$$[HCl]_e = 1 - 2x = 0.4M$$

$$[H_2]_e = [Cl_2]_e = 0.8M$$

Since $P = [] \cdot RT$:

$$P_{H_2,e} = P_{Cl_2,e} = 20 \text{ bar}$$

$$P_{HCl,e} = 10 \text{ bar}$$

$$\frac{(1-2x)^2}{(0.5+x)^2} = 0.25$$

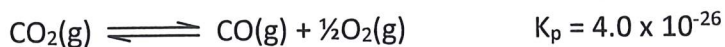
$$\frac{1-2x}{0.5+x} = 0.5$$

$$1-2x = 0.25 + 0.5x$$

$$2.5x = 0.75$$

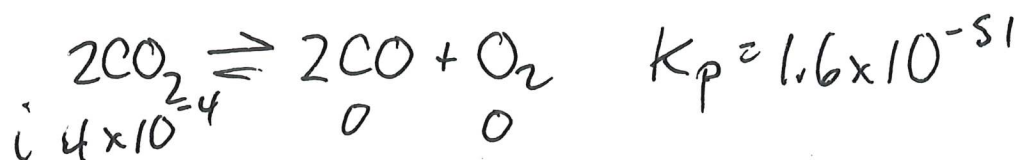
$$x = 0.3$$

4) [4 marks] A flask was charged with 4.0×10^{-4} bar of CO_2 and the equilibrium



established. Calculate the equilibrium pressures of all species.

Double the reaction to get rid of fractions:



$$i \quad 4 \times 10^{-4} \quad 0 \quad 0$$

$$c \quad -2x \quad +2x \quad +x$$

$$e \quad 4 \times 10^{-4} - 2x \quad 2x \quad x$$

$$\frac{(2x)^2(x)}{(4 \times 10^{-4} - 2x)^2} = 1.6 \times 10^{-51}$$

$$\frac{4x^3}{(4 \times 10^{-4})^2} = 1.6 \times 10^{-51}$$

$$x^3 = 6.4 \times 10^{-59}$$

$$x = 4 \times 10^{-20}$$

So...

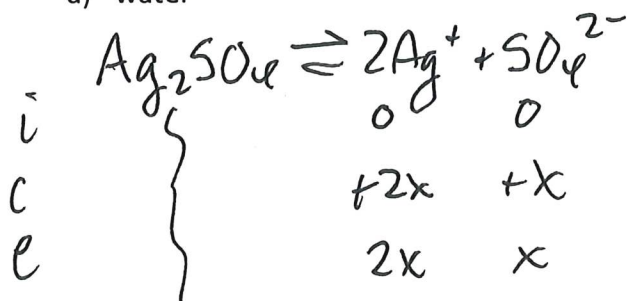
$$P_{\text{CO}_2, e} = 4 \times 10^{-4} \text{ bar}$$

$$P_{\text{CO}, e} = 8 \times 10^{-20} \text{ bar}$$

$$P_{\text{O}_2, e} = 4 \times 10^{-20} \text{ bar}$$

5) [6 marks] The K_{sp} of Ag_2SO_4 is 1.2×10^{-5} . How many grams of Ag_2SO_4 (311.8 g/mol) will dissolve in half a litre of:

a) water

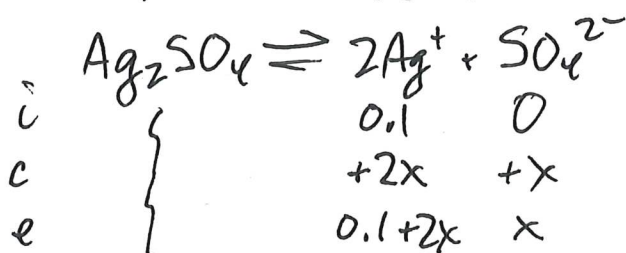


$$(2x)^2 \cdot x = 1.2 \times 10^{-5}$$

$$\Rightarrow x = 0.01442 \text{ M}$$

So 2.248 g will dissolve

b) a solution with $[AgNO_3] = 0.100 \text{ M}$



$$x = 1.2 \times 10^{-3} \text{ M}$$

So 0.187 g will dissolve

$$(0.1 + 2x)^2 \cdot x = 1.2 \times 10^{-5} \Rightarrow$$

6) [3 marks] You have a solution with $[CO_3^{2-}] = 3.28 \times 10^{-3} \text{ M}$ and $[Cl^-] = 1.7 \times 10^{-5} \text{ M}$. You choose to separate these two anions by adding solid $AgNO_3$. The K_{sp} of Ag_2CO_3 is 8.2×10^{-12} , and the K_{sp} of $AgCl$ is 1.7×10^{-10} . At the point of maximum separation, what percent of the first of the two anions to precipitate will remain in solution?

check Ag_2CO_3 : $[Ag^+]_e^2 \cdot (3.28 \times 10^{-3}) = 8.2 \times 10^{-12}$

$$\Rightarrow [Ag^+]_e = 5 \times 10^{-5} \text{ M}$$

check $AgCl$: $[Ag^+]_e \cdot (1.7 \times 10^{-5}) = 1.7 \times 10^{-10}$

$$\Rightarrow [Ag^+]_e = 1.0 \times 10^{-5}$$

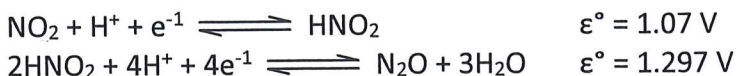
So Cl^- precipitates first.

At PoMS: $(5 \times 10^{-5}) [Cl^-]_e = 1.7 \times 10^{-10}$

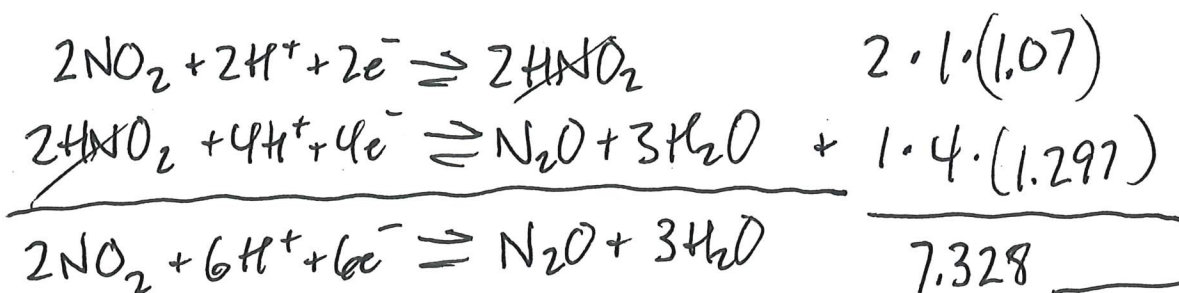
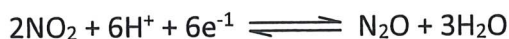
$$\Rightarrow [Cl^-]_e = 3.4 \times 10^{-6} \text{ M}$$

$$\frac{3.4 \times 10^{-6}}{1.7 \times 10^{-5}} \times 100 = 20\%$$

9) [3 marks] Given the half-reactions:

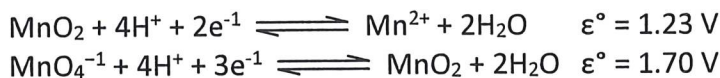


calculate ϵ° for:

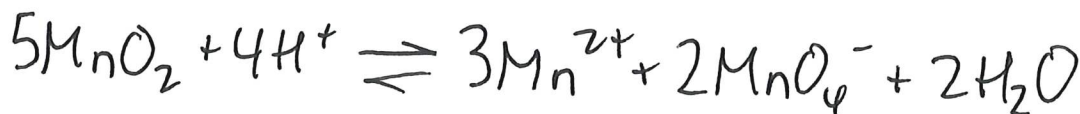
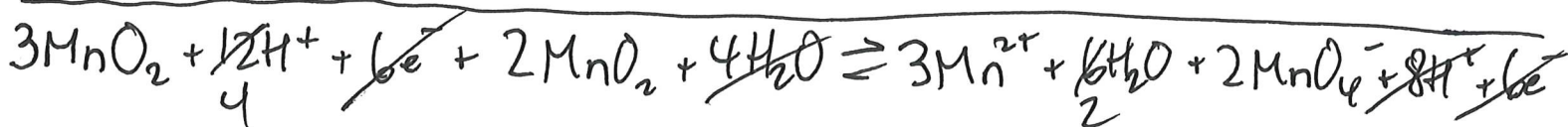
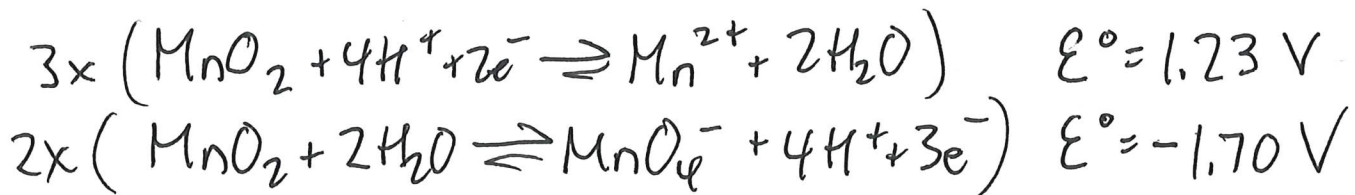


$$6 \cdot \epsilon^\circ = 7.328 \Rightarrow \epsilon^\circ = 1.221 \text{ V}$$

10) [3 marks] Given the half-reactions:



Will MnO_2 disproportionate? Calculate ϵ° for the disproportionation to prove your answer.



$$6 \cdot \epsilon^\circ_{\text{TOT}} = 3 \times 2 \times (1.23) + 2 \times 3 \times (-1.70)$$

$$= -0.47 \text{ V}$$

6

$\epsilon^\circ < 0$, so NO_2 will not disproportionate