

Chemistry 1105, Section R10
Spring 2003
Test #3

Friday, March 28, 2003

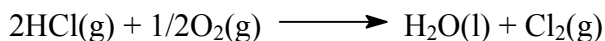
Time: 1 hour 50 minutes

Name: _____

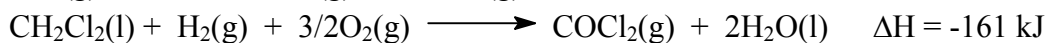
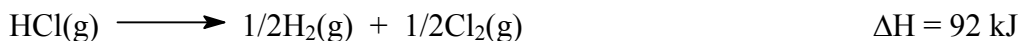
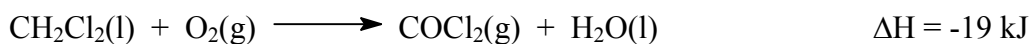
Student Number: _____

*This exam consists of **eight** pages of questions and a periodic table of the elements. Please ensure that you have a complete paper and, if you do not, obtain one from me **immediately**. Good luck!*

1) [2 marks] Calculate ΔH for the reaction

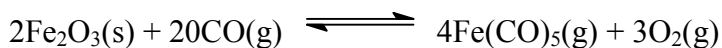


given the following data:



[Ans.: +42 kJ]

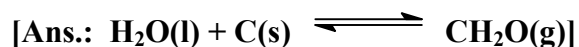
2) [4 marks] Given the following equilibrium:



and that the reaction is endothermic, indicate what effect (if any) the following changes would have on the equilibrium above, focusing on the value of K_c for the reaction and on the amount of $\text{Fe}_2\text{O}_3(\text{s})$ present. Your choices are **Increase**, **Decrease**, or **No Change**. *Note that for this question only, evaluation will be right minus wrong.*

Change	Effect on:					
	K_c			$\text{Fe}_2\text{O}_3(\text{s})$		
Cooling the reaction mixture	I	D	NC	I	D	NC
Adding $\text{CO}(\text{g})$	I	D	NC	I	D	NC
Adding $\text{O}_2(\text{g})$	I	D	NC	I	D	NC
Adding $\text{Na}(\text{s})$ (reacts with O_2)	I	D	NC	I	D	NC

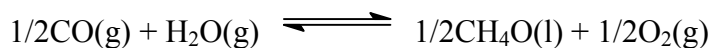
3) [1 mark] Write the reaction that has the equilibrium expression $K_c = [\text{H}_2\text{CO}]$



4) [3 marks] Given the following equilibria:

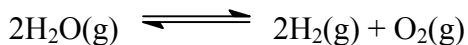


calculate K_c for the equilibrium



[Ans.: 1.25×10^{-40}]

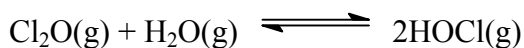
5) [3 marks] At very high temperatures, $\text{H}_2\text{O}(\text{g})$ may be made to dissociate into elemental hydrogen and oxygen:



In one such experiment, a 2.0-litre container was charged with 1.0 moles of $\text{H}_2\text{O}(\text{g})$ and, when equilibrium had been established, it was found that 1.625 percent of the $\text{H}_2\text{O}(\text{g})$ had decomposed. Calculate K_c for the equilibrium above.

[Ans.: 1.108×10^{-6}]

- 6) **[5 marks total]** Dichlorine monoxide and water vapour react to form gaseous hypochlorous acid via the following equilibrium:



K_c for this equilibrium is 0.25 at some temperature. In one experiment (carried out at that same temperature) a 4.0-litre flask was charged with 4.0 moles of Cl_2O , 4.0 moles of H_2O , and 8.0 moles of HOCl and equilibrium established.

- a) **[2 marks]** In which direction did the reaction shift (right or left) to establish equilibrium? How do you know?

- b) **[3 marks]** Calculate the equilibrium numbers of *moles* of all species present once equilibrium had been attained.

[Ans.: moles Cl_2O = moles H_2O = 6.4; moles HOCl = 3.2]

- 7) **[2 marks]** Which of $\text{Ca}(\text{ClO}_3)_2$, $\text{Ca}(\text{NO}_3)_2$, or CaCl_2 would you expect to act as a Bronsted base in solution and why?

8) **[16 marks total]** Calculate the pH of the following mixtures at 25°C (for which $K_w = 1.00 \times 10^{-14}$):

a) **[2 marks]** 10.00 mL of 1.000 M HCl and 90.00 mL of 0.1000 M NaOH

[Ans.: 2]

b) **[2 marks]** 10.00 mL of 2.000 M HNO₂ (mixed with nothing else).
 $K_a(\text{HNO}_2) = 4.5 \times 10^{-4}$.

[Ans.: 1.523]

c) **[3 marks]** 10.00 mL of 2.000 M HNO₂ mixed with 15.00 mL of 1.000 M NaNO₂

[Ans.: 3.222]

d) **[3 marks]** 10.00 mL of 2.000 M HNO_2 mixed with 10.00 mL of 1.000 M NaOH

[Ans.: 3.347]

e) **[4 marks]** 10.00 mL of 2.000 M HNO_2 mixed with 20.00 mL of 1.000 M NaOH

[Ans.: 8.523]

f) **[2 marks]** 10.00 mL of 2.000 M HNO_2 mixed with 21.00 mL of 1.000 M NaOH

[Ans.: 12.509]

- 9) **[3 marks]** A 1.7063-gram sample of a certain ionic solid of formula MCl_2 was dissolved in 100.0 grams of water ($k_f = 1.86^\circ\text{C}/M$). The freezing point of the solution was found to be 1.000°C less than that of pure water. What is the identity of the metal, M ? (*Hint: assume the solid is completely soluble in water.*)

[Ans.: Mg]

BONUS QUESTION

[4 marks] Calculate the pH of a 2.00 M solution of H_2SO_4 , for which $K_{a2} = 1.1 \times 10^{-2}$.

[Ans.: -0.303]