**Year 12 Chemistry Topic Test #1 (Equilibrium) - 2011**

Name: **ANSWERS** Mark = \_\_\_\_\_ / 43

# Part 1: Multiple Choice Section 10 marks

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1. **C** 2. **D** 3. **C** 4. **D** 5. **C** 6. **D** 7. **B** 8. **D** 9. **A** 10. **B**

**Part 2: Short Answer Section 33 marks**

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1. Consider an equilibrium mixture due to the reaction:

CO(g) + 2 H2(g) ⇄ CH3OH(g) ΔH = – 91 kJ mol–1

Draw (i) rate-time and (ii) concentration-time sketches to show the return to equilibrium

when there is an increase in the volume of the cylinder containing the equilibrium mixture.

[ ––––––– forward reaction ------------- reverse reaction ]





[3 + 3 = 6 marks]

2. Gaseous ethanal, CH3CHO can decompose to form methane gas, CH4, and carbon

monoxide gas, CO. The activation energy for this process is 191 kJ for each mole of

ethanal decomposed. The reaction releases 10 kJ of energy for each mole of carbon

atoms involved in the reaction.

(a) Write an equation for the decomposition of ethanal including state symbols.

**CH3CHO(g) CH4(g) + CO(g) ✓✓**

(b) Give the value, including the sign, of the heat of reaction for the reaction you have

represented in part (a), above.

**– 20 kJ ✓**

(c) Sketch an energy profile diagram for the reaction. Your sketch should indicate

intervals labelled as "ΔH" and "activation energy". Show the magnitude of these

quantities. Label the axes and include the terms "activated complex" (or transition

state") and "reaction coordinate" in the appropriate places in your diagram.



3. Consider the following equilibrium:

Cr2O72–(aq) + 2 OH–(aq) ⇄ 2 CrO42–(aq) + H2O(l) ΔH = –97 kJ mol–1

Two test tubes were set up, each containing some of the equilibrium mixture. A different

change was imposed on each test tube.

Predict what would be observed and give reasons why.

|  |  |  |
| --- | --- | --- |
| Imposed change | Observations | Explanation using Le Chatelier's Principle |
| Temperature is decreased | **more yellow /**  **less orange ✓** | **According to LCP, a decrease in temperature**  **favours a shift in direction of exothermic reaction ✓**  **∴ a shift to the right ✓**  **∴ at new equilibrium:**  **🡑[ CrO42–], more yellow**  **🡓[ Cr2O72–], less orange ✓** |
| A little concentrated sulfuric acid is added | **more orange /**  **less yellow ✓** | **Addition of H+, causes 🡓[OH–]**  **(i.e. H+ + OH– 🡒 H2O) ✓**  **By LCP, there will be a shift to the left ✓**  **∴ at new equilibrium:**  **🡓[ CrO42–], less yellow**  **🡑[ Cr2O72–], more orange ✓** |

[4 + 4 = 8 marks]

4. The following equilibrium has a value for K of 0.042 at 25°C.

PC5(g) ⇄ PC3(g) + C2(g)

If 0.20 mol PC3, 0.20 mol C2 and 0.50 mol PC5 were mixed in a 1.0 L container at 25oC,

the reaction will shift left in order to establish equilibrium. Explain why.

**K (or Q) = [C2].[PC3]**

**[PC5]**

**∴ Q = (0.2)(0.2) = 0.08 ✓**

**(0.5)**

**Q = 0.08 > 0.042 = K ✓**

**∴ system will shift left in approaching equilibrium**

**i.e. ↓[C2]; ↓[PC3]; ↑[PC5] ✓**

[3 marks]

5. Tooth decay is the result of the dissolving of tooth enamel, Ca5(PO4)3OH(s).

In the mouth the following equilibrium is established:

Ca5(PO4)3OH(s)  ⇄ 5 Ca2+(aq) + 3 PO43–(aq) + OH–(aq)

When sugar ferments on teeth it produces acidic compounds. Explain, in terms of the

above equilibrium, the effect of these compounds on tooth enamel.

**Sugars cause 🡑[H+]**

**As [H+]🡑, [OH–]🡓 (i.e. H+ + OH– 🡒 H2O) ✓**

**By LCP, there will be a shift to the right ✓**

**∴ 🡓m(Ca5(PO4)3OH), leading to greater tooth decay ✓**

[3 marks]

6. Consider the reaction:

H2(g) + C2(g) ⇄ 2 HC(g) with K = 1.7 x 104 at 450°C

(a) Determine K of the following at 450°C:

2 HC(g) ⇄ H2(g) + C2(g)

**Reverse reaction**

**∴ K = 1 . = 5.88 x 10–5**

**1.7 x 104**

**✓ ✓**

[2 marks]

(b) If the pressure of the system H2(g) + C2(g) ⇄ 2 HC(g) was increased by

decreasing its volume at 450oC, then:

(i) in which direction would the system shift? **No shift ✓**

(ii) the value of K would **stay the same / remain unchanged ✓**

[2 marks]

(c) At 678oC, K= 1.34 x 105  for H2(g) + C2(g) ⇄ 2 HC(g).

Is the forward reaction for this system exothermic or endothermic? Explain.

**By LCP, 🡑T causes a shift in endothermic direction ✓**

**From data: as T🡑, K🡑, indicating a shift to right ✓**

**∴ forward reaction is endothermic ✓**

[3 marks]

**End of Test**