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

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

# Part 1: Multiple Choice Section 10 marks

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The next two questions are concerned with the reaction:

CO(g) + NO2(g) ⇄ CO2(g) + NO(g)

The potential energy diagram for the above reaction is shown below.

500

Potential Energy

kJ mol–1

400

300

200

100

0

-100

-200

Reaction Coordinate

1. For the reverse reaction, the heat of reaction (ΔH) and the activation energy (Ea) are:

A. ΔH = + 250 Ea = 150

B. ΔH = - 250 Ea = 150

C. ΔH = + 250 Ea = 400

D. ΔH = - 400 Ea = 250

2. At equilibrium, which one of the following statements is **true**?

A. The activations energies of the forward and reverse reactions are equal.

B. The rates of the forward and reverse reactions are zero.

C. The sum of the concentrations of the reactants equal the sum of concentrations of

the products.

D. The rate of production of CO equals the rate of production of CO2.

3. An experiment is carried out to investigate the effect of temperature change on the reaction

represented by the equation:

N2O4(g) ⇄ 2 NO2(g) ΔH = +54.8 kJ mol–1

What will result if the temperature increases?

A. The value of the equilibrium constant will remain the same, but equilibrium will be

reached more quickly.

B. The value of the equilibrium constant will remain the same but equilibrium will be

reached more slowly.

C. The value of the equilibrium constant will increase.

D. The value of the equilibrium constant will decrease.

4. Given the reaction:

A2(g) + B2(g) ⇄ 2 AB(g) + heat

An increase in the concentration of A2(g) will:

A. decrease the rate of production of AB(g) .

B. decrease the frequency of collisions between A2(g) and B2(g).

C. increase the rate of production of B2(g).

D. increase the frequency of collisions between A2(g) and B2(g).

5. Consider the equilibrium system:

N2(g) + 3 H2(g) ⇄ 2 NH3(g) ΔH = – 92 kJ mol–1

Which of the following best describes changes made to the system would result in the

changes shown at t1 and t2 respectively in the diagram below?

[NH3]

t1 t2 time

A. Temperature initially increased following by addition of a catalyst.

B. Temperature initially increased following by addition of extra ammonia gas.

C. Temperature initially decreased following by addition of extra ammonia gas.

D. Temperature initially decreased following by an increase in reaction volume.

6. The value of the equilibrium constant for the reaction:

H2(g) + CO2(g) ⇄ H2O(g) + CO(g) ΔH = +42 kJ mol–1

is 1.6 at 990oC. If equimolar amounts of H2, CO2, H2O and CO which were initially at 990oC were mixed in a thermally insulated vessel, the temperature of the gases would:

A. increase and the mass of H2 would increase.

B. increase and the mass of H2 would decrease.

C. decrease and the mass of H2 would increase.

D. decrease and the mass of H2 would decrease.

7. For the reaction: PC5(g) ⇄ PC3(g) + C2(g)

The initial rate of the forward reaction at constant temperature is **not** favoured by:

A. increasing the temperature.

B. introducing an inert gas at constant pressure.

C. introducing PC5 at constant volume.

D. decreasing volume of the container.

8. Raising the temperature of a reacting system increases the rate of the reaction but

does **not** increase the:

A. number of collisions.

B. fraction of reacting particles which possess energies greater than the activation

energy.

C. the average velocity of the reacting particles.

D. activation energy.

9. Consider the following equilibrium system:

CO(g) + C2(g) ⇄ COC2(g)

At a certain temperature, after equilibrium has been reached, the concentrations of the reactants and products were found to be the following:

[CO] = 0.30 mol L–1 [C2] = 0.20 mol L–1 [COC2] = 0.80 mol L–1

The numerical value of the equilibrium constant, K, for the system at this temperature is:

A. 13.3

B. 0.53

C. 0.75

D. 53

10. A change is made on a system at equilibrium and it is observed that the equilibrium position moves to the right (products side).

Which of the following is consistent with this observation?

A. 2 C2(g) + 7 O2(g) ⇄ 2 C2O7(g)

The pressure is increased by adding neon gas to the vessel.

B. H2(g) + I2(g)  ⇄ 2 HI(g)

The pressure is decreased by removal of some of the HI(g)

C. 2 H2(g) + O2(g) ⇄ 2 H2O(g) ΔH = – 484 kJ

The temperature is increased.

D. I2(s) ⇄ I2(aq)

More solid iodine is added.

**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 ]

rate

\_\_\_\_\_\_\_\_\_\_

-----------------

time

concentration

[CO] \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[CH3OH] \_\_\_\_\_\_\_\_\_\_\_\_\_\_

[H2] \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

time

[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.

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

represented in part (a), above.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(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.

[1 + 1 + 4 = 6 marks]

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 |  |  |
| A little concentrated sulfuric acid is added |  |  |

[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.

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[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.

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[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)

[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? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(ii) the value of K would \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[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.

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[3 marks]

**End of Test**