**IB Chemistry – HL**

**Topic 7 Questions**

**1.** For the reaction below

H2(g) + I2(g)  2HI(g)

at a certain temperature, the equilibrium concentrations are (in mol dm–3)

[H2] = 0.30, [I2] = 0.30, [HI] = 3.0

What is the value of *K*?

A. 5.0 B. 10 C. 15 D. 100

**2.** The value of the equilibrium constant for the reaction

2HI(g)  H2(g) + I2(g)

is 0.25 at 440°C. What would the value of the equilibrium constant be for the following reaction at the same temperature?

H2(g) + I2(g)  2HI(g)

A. 0.25 B. 0.50

C. 2.0 D. 4.0

**3.** Hydrogen and carbon dioxide react as shown in the equation below.

H2(g) + CO2(g)  H2O(g) + CO(g)

For this reaction the values of *K*c with different temperatures are

|  |  |
| --- | --- |
| Temperature / K | *K*c |
| 500 | 7.76×10–3 |
| 700 | 1.23×10–1 |
| 900 | 6.01×10–1 |

Which statement for the reaction is correct?

A. The forward reaction is endothermic.

B. H2O(g) and CO(g) are more stable than H2(g) and CO2(g).

C. The reaction goes almost to completion at high temperatures.

D. The reverse reaction is favoured by high temperatures.

**4.** The expression for the equilibrium constant for a reaction is

*K*c = 

At a certain temperature the values of [A], [B] and [C] are all 0.2 mol dm–3. What happens to the value of *K*c when all three values are doubled to 0.4 mol dm–3?

A. It is halved.

B. It does not change.

C. It doubles.

D. It increases by a factor of four.

**5.** A 1.0 dm3 reaction vessel initially contains 6.0 mol of **P** and 6.0 mol of **Q**. At equilibrium 4.0 mol of **R** is present. What is the value of *K*c for the following reaction?

P(g) + Q(g)  R(g) + S(g)

A. 0.11 B. 0.25

C. 0.44 D. 4.00

**6.** For the reaction below:

H2(g) + I2(g)  2HI(g)

at a certain temperature, the equilibrium concentrations, in mol dm–3, are

[H2(g)] = 0.30, [I2(g)] = 0.30, [HI(g)] = 3.0

What is the value of *K*?

A. 1.0×10–2

B. 10

C. 33

D. 1.0×102

**7.** A liquid and its vapour are at equilibrium inside a sealed container. Which change will alter the equilibrium vapour pressure of the liquid in the container?

A. Adding more liquid

B. Adding more vapour

C. Decreasing the volume of the container

D. Decreasing the temperature

**8.** The equilibrium between nitrogen dioxide (dark brown) and dinitrogen tetroxide (colourless) is represented by the following equation.

2NO2(g)  N2O4(g) ∆*H* = negative *K*c= 1 at 328K

(a) Write the equilibrium constant expression, *K*c.

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(1)

(b) State and explain the effect of an increase in temperature on the value of Kc.

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(2)

(c) State and explain the visible change that takes place as a result of a decrease in pressure, after equilibrium is re-established.

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(2)

(d) Two moles of NO2(g) and two moles of N2O4(g) were placed in an empty 1 dm3   
container and allowed to come to equilibrium at 328 K. Predict, with reference to  
the value of *K*c, whether the equilibrium mixture would contain more or less than two moles of NO2(g).

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(2)

(Total 7 marks)

**9.** (a) The equation for the decomposition of hydrogen iodide is

2HI(g)  H2(g) + I2(g) *H*Ө = +52 kJ

Predict and explain the effect on the position of equilibrium of

(i) increasing the pressure, at constant temperature.

(2)

(ii) increasing the temperature, at constant pressure.

(2)

(iii) adding a catalyst, at constant temperature and pressure.

(2)

(b) Deduce the expression for *K*c for the forward reaction.

(1)

(c) The equilibrium formed during this reaction was investigated in two experiments carried out at different temperatures. The results are shown in the table below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Experiment | Initial concentration / mol dm–3 | | | Equilibrium concentration / mol dm–3 | | |
| number | [HI] | [H2] | [I2] | [HI] | [H2] | [I2] |
| 1 | 0.06 | 0.00 | 0.00 |  | 0.01 |  |
| 2 | 0.00 | 0.04 | 0.04 | 0.04 |  |  |

(i) For each experiment, deduce the concentrations of the other species present at equilibrium. Calculate the values of *K*c for the forward reaction for each experiment.

(6)

(ii) Use the two calculated values of *K*c to deduce which of the two experiments was carried out at the higher temperature, and explain your choice. (If you were not able to calculate the values of *K*c in (c)(i), assume that the values are 0.1 for experiment 1 and 0.2 for experiment 2, although these are not the correct values.)

(2)

(Total 15 marks)

**10.** The equation for another reaction used in industry is

CO(g) + H2O(g)  H2(g) + CO2(g) *H*Ө = 42 kJ

(i) Under certain conditions of temperature and pressure, 2.0 mol of carbon monoxide and 3.2 mol of steam were left to reach equilibrium. At equilibrium, 1.6 mol of both hydrogen and carbon dioxide were present.

Calculate the amounts of carbon monoxide and steam at equilibrium and the value of *K*c.

(3)

(ii) Under the same conditions of temperature and pressure, 2.0 mol of carbon monoxide and 2.0 mol of steam were left to reach equilibrium.

Calculate the amounts of each reactant and product at equilibrium.

(If you were unable to calculate a value for *K*c in (i) use the value 9.0, although this is not the correct value.)

(2)

(Total 5 marks)

**IB Chemistry – HL**

**Topic 7 Answers**

**1.** D

**2.** D

**3.** A

**4.** B

**5.** D

**6.** D

**7.** D

**8.** *No ECF throughout this question.*

(a)  1

(b) *K*c decreases;   
forward reaction is exothermic/∆*H* is negative/equilibrium  
moves to left/*OWTTE*; 2

(c) (mixture will get) darker/darker than expected;

equilibrium position moves to the left/towards reactants as there is an   
increase in the number of moles of gas from right to left; 2

(d) (equilibrium mixture contains) less (than 2 moles NO2);

given values make  *i.e.* too much NO2/*OWTTE*; 2

[7]

**9.** (a) (i) no effect;

equal gas moles on each side; 2

(ii) shift to right;

forward reaction absorbs heat/endothermic/*OWTTE*; 2

(iii) no effect;

catalyst speeds up both forward and reverse reactions equally; 2

(b)  1

Ignore state symbols.

(c) (i) *experiment 1* [HI] = 0.04 (mol dm3);

[I2] = 0.01 (mol dm3);



*ECF from above values.*

*experiment 2* [H2] = 0.02 (mol dm3);

[I2] = 0.02 (mol dm3);

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ECF from above values.

(ii) experiment 2 (at higher temperature);

higher *K*c value/equilibrium shifted to right; 2

[15]

**10.** (i) CO = 0.4 (mol);

H2O = 1.6 (mol);

*Kc* (= 1.62÷0.4×1.6) = 4.0/4; 3

Apply ECF from Kc expression.

Ignore units.

(ii) H2 and CO2/products = 1.33/1.3 (mol);

CO and H2O/reactants = 0.67/0.7 (mol); 2

Using Kc = 9.0, values for H2 and CO2 are 1.5 and values for CO and H2O are 0.5.

[5]