EQUILIBRIUM Core (SL & HL)

1. (a) Consider the equilibrium:

$$CO\,(g) + H_2O\,(g) \rightleftharpoons CO_2\,(g) + H_2\,(g)$$

(i) Write an expression for the equilibrium constant, K_c, for the reaction.

[1]

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(ii) Distinguish between the terms reaction quotient, Q, and equilibrium constant, K_c.

[1]

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(iii) State why this equilibrium reaction is considered homogeneous.

[1]

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(iv) Initially, an equal number of moles of CO (g) and H_2O (g) only are present in a cylinder and are allowed to reach equilibrium at 800°C. At 800°C, $K_c = 4.0$ for the reaction.

Sketch a graph to show the change in concentration of the reactants **and** products with time until the equilibrium is established.

[4]

(v) The forward reaction in (a) is exothermic. State and explain the effect on the value of K_c if temperature is increased.

[2]

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(vi) State the effect on the position of equilibrium and the value of K_c if a catalyst is used.

[2]

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2. (a) The Haber process is used to produce ammonia:

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$$

(i) State and explain how the equilibrium would be affected by increasing the volume of the container at constant temperature.

[3]

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(ii) The percentage yield of ammonia is 25% at 400°C and 11% at 500°C. State and explain whether the reaction is exothermic or endothermic in the forward direction.

[2]

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Total 16 marks (24 minutes)