OCR
Oxford Cambridge and RSA

A Level Chemistry B (Salters)

H433/01 Fundamentals of chemistry

Question Set 24

1 **(a)** An important source of hydrogen is from the steam reforming reaction shown in **equation 33.1** below.

$$CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g) \quad \Delta_r H = +206\,kJ\,mol^{-1}$$ **Equation 33.1**

The position of equilibrium can be changed by altering the conditions.

Complete the table to show the effects on the yield of hydrogen and the value of the equilibriumconstant, K_c.

	Increasing temperature	**Increasing pressure**
Effect on yield of hydrogen		
Effect on the value of K_c		

[2]

(b) 2.00 moles of methane and 1.00 mole of steam are allowed to reach equilibrium in a 1.00 dm^3container. At equilibrium 0.66 mole of steam remains.

Calculate a value for the equilibrium constant and give its units.

K_c = ... units **[3]**

(c) **(i)** The entropy change for the forward reaction in **equation 33.1**, $\Delta_{sys}S$ = +214.5 $J\,K^{-1}\,mol^{-1}$.

How does the sign of $\Delta_{sys}S$ relate to the equation for the reaction? **[1]**

(ii) The entropy values for some of the gases in **equation 33.1** are shown below.

Gas	Entropy, S / JK^{-1}mol^{-1}
CH_4	+186.3
H_2O	+188.7
CO	+197.7

Use the value of $\Delta_{sys}S$ and the entropy values in the table to calculate the entropy of $H_2(g)$.

entropy of $H_2(g)$ ……J K^{-1} mol^{-} **[2]**

(d) Calculate whether the forward reaction in **equation 33.1** is feasible at 1000 K. **[2]**

(e) (i) The steam reforming reaction shown in **equation 33.1** makes hydrogen. Much of the hydrogen is used in the manufacture of ammonia.

Calculate the atom economy of the reaction in **equation 33.1** when making hydrogen.

atom economy = ……% **[1]**

(e) (ii) How is carbon monoxide described when it is formed alongside the required product (hydrogen)?

[1]

(f) The carbon monoxide can be used in the exothermic water gas shift reaction.

$CO(g) + H_2O(g) \quad H_2(g) + CO_2(g)$ $\Delta_r H = -41$ kJ mol^{-1}

The water gas shift reaction often takes place in the same industrial plant as steam reforming. Suggest **two** advantages of the water gas shift reaction taking place with steam reforming.

1 .....

2 .....

[2]

Total Marks for Question Set 24: 14