Oxford Cambridge and RSA

AS Level Chemistry A

H032/01 Breadth in chemistry

Question Set 21

1. This question is about ammonia, NH_3.

(a) In industry, ammonia is made from nitrogen and hydrogen. This is a reversible reaction, as shown in **equilibrium 24.1** below.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ\,mol^{-1} \qquad \textbf{Equilibrium 24.1}$$

(i) Explain how le Chatelier's principle can be used to predict the conditions of temperature and pressure for a maximum **equilibrium** yield of ammonia.

[4]

(ii) Using certain conditions, **equilibrium 24.1** has the equilibrium concentrations in the table.

Substance	Equilibrium concentration /mol dm^{-3}
$N_2(g)$	1.25
$H_2(g)$	2.75
$NH_3(g)$	0.862

Calculate the numerical value for K_c for **equilibrium 24.1** under these conditions.

Give your answer to an appropriate number of significant figures and in standard form.

[2]

(b) Ammonia is used to make nitric acid. The first stage of the reaction is shown below.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g) \qquad \Delta H = -908\,kJ\,mol^{-1}$$

Standard enthalpy changes of formation, $\Delta_f H^\ominus$, are given in the table.

Substance	$\Delta_f H^\ominus$ /kJ mol^{-1}
$NH_3(g)$	−46
$O_2(g)$	0
$H_2O(g)$	−242

(i) State the conditions of temperature and pressure used for standard enthalpy measurements.

[1]

(ii) Calculate the standard enthalpy change of formation, in kJ mol^{-1}, for NO(g).

Give your answer to a **whole number**.

[3]

Total Marks for Question Set 21: 10