3 Nitrogen can be reacted with hydrogen in the presence of a catalyst to make ammonia in the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ mol}^{-1}$$

(a) Describe and explain the effect of increasing the pressure on the rate of this reaction.

……

……

…… **[2]**

(b) A mixture of N_2 and H_2 was left to react until it reached equilibrium. The equilibrium mixture had the following composition:

N_2	1.20 mol dm^{-3}
H_2	2.00 mol dm^{-3}
NH_3	0.877 mol dm^{-3}

(i) Calculate a value for K_c for this equilibrium.

K_c = …… $dm^6\ mol^{-2}$ **[3]**

(ii) Explain how the following changes would affect the amount of NH_3 present in the equilibrium mixture.

Use of a catalyst:

……

……

A higher temperature:

……

……

[3]

(c) 1.00 tonne of ammonia from the Haber process is reacted with carbon dioxide to prepare the fertiliser urea, NH_2CONH_2.

$$2NH_3(g) + CO_2(g) \rightarrow NH_2CONH_2(s) + H_2O(l)$$

1.35 tonnes of urea are formed.

Calculate the percentage yield of urea.

Show **all** your working.

yield = ... % **[3]**