1.

Methanol is produced by the reaction of carbon monoxide with hydrogen, as shown in the equation below:

$$CO_{(g)} + 2H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$$

Equilibrium is established in a closed system under high pressure in the presence of a catalyst.

	CO	H_2	CH_3OH
initial moles	5.0	5.0	0
moles at equilibrium			2.0

Calculate the number of moles of CO and H_2 at equilibrium.

(2 marks)

2.

The reaction of ethene (C_2H_4) with steam can produce ethanol, as shown in the equation below:

$$C_2H_{4(g)} + H_2O_{(g)} \rightleftharpoons C_2H_5OH_{(g)} \qquad \Delta H = -45 \text{ kJ mol}^{-1}$$

An equilibrium mixture of the gases in a 2.00 L closed container was analysed and found to contain 1.0 mol of ethene, 1.2 mol of water, and 0.050 mol of ethanol.

The equilibrium mixture was established by starting with ethene and water.

Calculate the number of moles of ethene and water present initially.

(3 marks)

3.

One process for the production of ethanol is shown in the equilibrium reaction below:

$$C_2H_{4(g)} + H_2O_{(g)} \rightleftharpoons C_2H_5OH_{(g)}$$

In one reaction, 2.0 mol of C_2H_4 and 1.2 mol of H_2O were placed in an evacuated and sealed 1 L flask. At equilibrium, 1.9 mol of C_2H_4 remained unreacted.

Calculate the number of moles of C_2H_5OH and H_2O present at equilibrium.

(3 marks)

4.

Dinitrogen tetroxide, N_2O_4, is used as a fuel in spacecraft. One reaction in the production of N_2O_4, as shown in the equation below, was investigated in a laboratory.

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$

In this investigation, 1.3 mol of $NO_{2(g)}$ was placed in an empty 1.00 L flask, which was then sealed and heated to 127°C. When the system reached equilibrium, 0.24 mol of $N_2O_{4(g)}$ was present in the flask.

Show that at 127°C, $K_c = 0.36$.

(3 marks)

ANSWERS

1.

CO: 3.0 mol
H_2: 1.0 mol

2.

ethene: 1.05 mol
water: 1.25 mol

3.

C_2H_5OH: 0.1 mol
H_2O: 1.1 mol

4.

0.82 mol of NO_2 at equilibrium