2 Aluminium oxide, Al_2O_3, and phosphorus(V) oxide, P_4O_{10}, are both used as reagents and catalysts.

(a) The melting point of Al_2O_3 is 2072 °C. The melting point of P_4O_{10} is 340 °C.

Explain the difference in the melting points of these two compounds.

.....

.....

.....

..... [3]

(b) A 5.00 dm^3 sealed flask contains 0.400 mol of CO(g) and 0.800 mol of H_2(g) and an Al_2O_3 catalyst. The flask is heated to a temperature of 290 °C and allowed to reach equilibrium. Equation 1 shows the reaction.

equation 1 $\quad CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

The equilibrium constant, K_c, of equation 1 is given.

$$K_c = \frac{[CH_3OH]}{[CO][H_2]^2}$$

(i) State the units of K_c.

..... [1]

(ii) The equilibrium mixture contains 0.280 mol of CH_3OH(g).

Calculate the value of K_c.

Give your answer to **three** significant figures.

value of K_c = ... [3]

(iii) State and explain the effect, if any, on the value of K_c when the overall pressure in the sealed flask is increased.

.....

..... [1]

(c) P_4O_{10} catalyses the reversible reaction of CO with H_2 to form CH_3OH.

equation 1 $\quad CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

P_4O_{10} then acts as a dehydrating agent, causing CH_3OH to form CH_3OCH_3.

(i) Explain how the presence of a catalyst affects a chemical reaction.

.....

.....

..... [1]

(ii) Construct an equation for the dehydration reaction of CH_3OH to form CH_3OCH_3.

..... [1]

(iii) Write an equation to show the reaction of P_4O_{10} with an excess of water.

..... [1]

[Total: 11]