

1. (a) Le Chatelier's Principle:

If a system in equilibrium is subjected to a constraint, a process will occur (1) which tends to counteract the constraint. /AW

(b) (i) While lower temperatures than 450°C would give a high yield of SO_3 , they would make the reaction rate too slow. /AW (1)

(ii) Cooling is necessary to favour the forward exothermic reaction. /AW (1)

(iii) Cost of thicker pipes to withstand the higher pressures will be too high. /AW (1)

(c) $K_p = \frac{P}{P_{\text{SO}_2} P_{\text{O}_2}}$ (1)

units = $\frac{\text{atm}}{(\text{atm})^2} = \frac{1}{\text{atm}}$ (1)

(d) (i) No change in K_p value. (1)

Increase in partial pressure of SO_2 is counter-balanced by increase in partial pressure of O_2 .

Extra SO_2 reacts to produce more SO_3 until equilibrium is re-established. /AW (1)

(ii) Addition of V_2O_5 catalyst has no effect on K_p . (1)

Catalyst only increases rate of attaining equilibrium, without changing proportions of reactants and products. /AW (1)

(iii) K_p value decreases. (1)
Endothermic decomposition of SO_3 to form more SO_2 and O_2 is favoured, thus lowering K_p . (1)

[Total: 12]

A) $K_p = \frac{P}{P_{\text{SO}_2} P_{\text{O}_2}}$

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