Mark schemes

1

(a) *M1* $K_p = ({}_PY)^3.({}_PZ)^2/({}_PW)^2.({}_PX)$ *NB [ ] wrong* **1**

M2 temperature **1**

M3 increase **1**

M4 particles have more energy or greater velocity/speed **1**

M5 more collisions with $E > E_a$ or more successful collisions **1**

M6 Reaction exothermic or converse **1**

M7 Equilibrium moves in the left **1**

Marks for other answers

Increase in pressure or concentration	*allow M1, M5, M6*	*Max 3*
Addition of a catalyst;	*allow M1, M5, M6*	*Max 3*
Decrease in temperature;	*allow M1, M2, M6*	*Max 3*
Two or more changes made;	*allow M1, M6*	*Max 2*

(b) (i) Advantage; reaction goes to completion, not reversible or faster **1**

Disadvantage; reaction vigorous/dangerous

(exothermic must be qualified)

or HCl(g) evolved/toxic
or CH_3COCl expensive

NB Allow converse answers

Do not allow reactions with other reagents e.g. water or ease of separation **1**

(ii) $\Delta S = \Sigma S$ products $- \Sigma S$ reactants

1

$\Delta S = (259 + 187) - (201 + 161)$

1

$\Delta S = 84$ ($JK^{-1}\ mol^{-1}$) *(Ignore units)*

*Allow – 84 to score **(1)** mark*

1

$\Delta G = \Delta H - T\Delta S$

1

$= - 21.6 - 298 \times 84/1000$

$= - 46.6$ kJ mol^{-1} or $- 46\ 600$ J mol^{-1}

1

*Allow **(2)** for – 46.6 without units*

(Mark ΔG consequentially to incorrect ΔS)

(e.g. ΔS = –84 gives ΔG = +3.4 kJ mol^{-1})

1

[15]

2 A

[1]

3 (a) $K_p = \frac{P_{SO_2} \times P_{Cl_2}}{P_{SO_2Cl_2}}$ **(1)**

1

(b) 0.25 + 0.75 + 0.75 = 1.75 **(1) (1)**

2

(c) (i) *p* = Total pressure × mol fraction **(1)**

(ii) *Partial of SO_2Cl_2*: $125 \times \frac{0.25}{1.75}$ = 17.9 kPa **(1)**

Partial pressure of Cl_2: $125 \times \frac{0.75}{1.75}$ = 53.6 kPa **(1) (1)**

5

(d) $K_p = \frac{53.6 \times 53.6}{17.9}$ **(1)** = 161 **(1)** kPa **(1)**

3

(e) *Effect on K_p*: increase **(1)**
Explanation: increase T sends equilibrium in endothermic direction **(1)**

2

(f) no effect **(1)**

1

Notes

(a) If K_p has [ ] lose mark in (a) but allow full marks in (d)

If K_p wrong/upside down etc, allow max 2 in (d) for substitution of numbers **(1)** and consequential units **(1)**

(b) Mark for moles of SO_2Cl_2 can be scored in part (c) (ii) if not gained in (b)

1.75 get **(2)**

If moles of SO_2Cl_2 = 1, this is a Chemical Error, hence a 2 mark penalty

- If total moles given in (b) = 1.75, this scores [2] in (b); but if the no moles of SO_2Cl_2 = 1 in (c)(ii), lose both marks in (c)(ii) for pp of SO_2Cl_2 = (1/1.75) × 125, i.e. the 2 mark penalty is in (c)(ii).
- If total moles given in (b) = 2.5, score zero in (b), but can gain full marks in (c)(ii) consequentially, i.e. the 2 mark penalty is in (b).
- If moles of SO_2Cl_2 = 1 and total in (b) does not equal 2.5, still lose both in (b) but can get all 4 conseq in (c)(ii) for 1/x etc and 0.75/x etc

(c) (i) Allow "Total pressure = sum of partial pressures" for **(1)** or $p_A = x_A \times p_{tot}$

(ii) First mark is for mole fraction.
If either number in either mole fraction is not consequential on (b), then lose both marks for that partial p.

(d) If pCl_2 is not equal to pSO_2 or any number used in K_p is not conseq on (c)(ii), allow units only

SIG FIGS; must be 3 sig figs in (b) but then allow 2 sig figs in (c) and (d); (ignore extra figs) but penalise incorrect rounding

(e) If effect wrong, no marks for explanation.
If effect missing, e.g. answer states "equm shifts to right", mark on.
In the explanation, the word "endothermic" (or its equivalent) is essential.

[14]

4

(a) (i) *Moles of PCl_3*: 0.345 – 0.166 = 0.179 **(1)**

Moles of Cl_2: 0.268 – 0.166 = 0.102 **(1)**

3 sig figs

(ii) 0.447 **(1)**

allow 2 sig figs
conseq on (i)

3

(b) *Mole fraction of PCl_3*: 0.179/0.447 **(1)** = 0.4(00)

Partial pressure of PCl_3: pp = mol f^n × total P **(1)**
= 0.400 × 225 = 90 **(1)** kPa **(1)**

3

(c) (i) $K_p = \frac{P_{PCl_5}}{P_{PCl_3} \times P_{Cl_2}}$ **(1)**

ignore brackets except [ ]
must show P

(ii) $K_p = \frac{83.6}{90.1 \times 51.3}$ **(1)** = 1.8**(1)** × 10^{-2} **(1)** Kpa^{-1} **(1)** (or 1.81 × 10^{-5} Pa^{-1})

If 83.6 and 51.3 wrong way round, AE – 1,
answer = 6.81 × 10^{-3}
If K_p × in (i) allow max 2 for substitution of numbers and conseq units

4

(d) (i) increased **(1)**

(ii) increased **(1)**

2

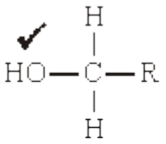
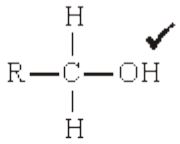
[12]

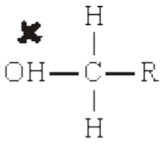
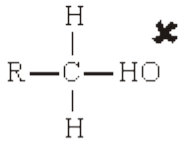
Organic points

(1) Curly arrows: must show movement of a pair of electrons,
i.e. from bond to atom or from lp to atom / space
e.g.

(2) Structures

penalise sticks (i.e. ) once per paper

 or  or $-NH_3$ ✓

 or  H_2N- ✓ etc

Penalise once per paper

allow CH_3- or $-CH_3$ or  or CH_3
or H_3C-

5 B **[1]**

6 C **[1]**

7 C **[1]**