Name of the Student:_____
Max. Marks : 25 Marks **Time : 25 Minutes**

Mark Schemes

Q1.

(a) Lower yield at higher temperature

Allow converse arguments

Higher yield at lower temperature

1

So, equilibrium has shifted backwards/left/in the endothermic direction to oppose the increase in temperature

So, equilibrium has shifted forwards/right/in the exothermic direction to oppose the decrease in temperature

1

Ignore reference to pressure

(b) Increase

1

Lower yield at higher pressure

Higher yield at lower pressure

1

So, equilibrium has shifted backwards/to the side with fewest number of moles to oppose the increase in pressure

So, equilibrium has shifted forwards/to the side with highest number of moles to oppose the decrease in pressure

1

Ignore reference to temperature

(c) Increases the rate of forwards and reverse reactions equally

1

(d) $K_c = \frac{[NH_3]^2}{[H_2]^3[N_2]}$

M1: K_c expression

1

$0.118 = \frac{[NH_3]^2}{\left[{}^{0.0285}/_{0.150}\right]^3\left[{}^{0.0870}/_{0.150}\right]}$

M2: converts moles to concentration; divides mole quantities by 0.150

1

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$0.118 = \frac{[NH_3]^2}{[0.100]^3[0.500]}$

$[NH_3]^2 = 4.69 \times 10^{-4}$

M3: calculation of $[NH_3]^2$

1

$[NH_3] = 0.0217$ mol dm^{-3}

M4 = √M3

1

$n(NH_3) = 0.0217 \times 0.150 = 3.25 \times 10^{-3}$ mol

M5 = M4 × 0.150 (allow ecf on an incorrect volume used in M2)

If K_c upside down then can still score 4)

1

(e) $K_c = \frac{1}{0.118} = 8.47$

Allow 8.45 − 8.5

1

Units – $mol^2\ dm^{-6}$

1

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Q2.

(a) forward and reverse reactions proceeding at equal rates

1

concentrations (of reactants and products) remain constant
or
concentrations (of reactants and products) stay the same

*do **not** accept equal concentrations*
*do **not** accept concentrations are the same*
ignore closed system

1

allow answers in either order

(b) more moles of (gaseous) products (than (gaseous) reactants)
or
more moles on the RHS (than LHS)

allow molecules
*do **not** accept atoms*

1

(c) **M1** (at equilibrium) n(CO) = 0.32 (mol)

1

M2 total number of moles (at equilibrium) = 1.07 (mol)
or mole fraction (CO) = 0.299

1

M3 p (CO) = $\left(=\frac{0.320 \times 250}{1.07}\right)$ = 74.8 (kPa)

M3 = $\frac{M1 \times 250}{M2}$

allow 75 kPa
*an answer of 67.8 (kPa) = **2** marks max*

1

(d) $K_p = \frac{p(CH_3OH)}{p(H_2)^2 p(CO)}$

*do **not** accept square brackets*

1

(e) **M1** $p(H_2)^2 = \frac{p(CH_3OH)}{K_p \times p(CO)}$ **or** $\frac{5.45}{1.15 \times 10^{-6} \times 125}$

rearrangement with/without numbers

1

M2 $p(H_2) = \sqrt{37\ 913}$ **or** $p(H_2)^2 = 37\ 913$

1

M3 $p(H_2)$ = 194.7 (kPa)

M3 = $\sqrt{M2}$
allow 195 (kPa)

1

if rearrangement incorrect in M1 allow M3 only
if $p(H_2)$ is not squared in part (d) allow

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$p(H_2) = \frac{p(CH_3OH)}{K_p \times p(CO)}$ *for M1 and 37 913 for M2*
*(max **2**)*

(f) $= \left(\frac{1}{1.15 \times 10^{-6}}\right) = 8.7(0) \times 10^5$
allow 869 565

1

kPa^2

1

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