Mark schemes

## Q1.

A

*0.133*

**[1]**

## Q2.

(a) Total amount of gas at equilibrium = 4.00 mol

Mole fraction of $H_2$ = 0.23

*Accept fractions*

**2**

(b) (The amount in) moles of products is the same as reactants (so the units (of partial pressure) cancel out)

*Allow equal moles/molecules/particles on both sides (so units cancel)*

**1**

(c) The amount decreases.

**1**

(d)

M1 $K_p = \frac{p(CH_3CH_2OH)}{p(C_2H_4)\,p(H_2O)}$

*M1 allow p or pp for partial pressure; round brackets not necessary BUT penalise square brackets.*

M2 = $\frac{0.0321\times6000}{(0.645\times6000)\times(0.323\times6000)} = \frac{192.6}{3870\times1938}$

*M2 allow correct use of 6000 to calculate partial pressure*

**M3** $K_p = 2.56 \times 10^{-5}$

*M3 Allow* $2.57 \times 10^{-5}$

**M4** $kPa^{-1}$

**4**

(e) No effect

**1**

**[9]**

## Q3.

(a) M1 0.176

M2 0.549

M3 0.275

*Allow answers to 2 significant figures*

**3**

(b) 21.1 (kPa)

*Allow answer to question **(a)** x 120 and answer in kPa*

*Allow 21.6 (kPa)*

*Answer using given value of 0.380 mol = 45.6(kPa)*

**1**

(c) M1 $K_p = \frac{p(NO)^2 p(O_2)}{p(NO_2)^2}$

M2 $= \frac{K_p \times \text{mol frac } (NO_2)^2}{\text{mol frac } (NO)^2 \times \text{mol frac } (O_2)}$ OR $\frac{59.7 \times (0.31)^2}{(0.46)^2 \times (0.23)}$

M3 = 117.9 (kPa) or 118 (kPa)

*Do **not** allow square brackets*

*Rearrangement*

**3**

(d) Decrease

No change

**2**

(e) M1 Reaction is endothermic OR exothermic in backwards direction

M2 Equilibrium shifts/moves in backwards direction/to the left to raise the temp/oppose the decrease in temp

**2**

**[11]**

## Q4.

(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 = √M2*

*allow 195 (kPa)*

1

*if rearrangement incorrect in M1 allow M3 only*

*if $p(H_2)$ is not squared in part (d) allow*

$p(H_2) = \frac{p(CH_3OH)}{K_p \times p(CO)}$ *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

**[12]**