4.2 TEST MS

1. (a) *Total moles* $n = pV/RT$ **(1)**

$= 1.59 \times 10^6 \times 1.04 \times 10^{-3}/(8.31 \times 380) = 0.524$ moles **(1)**

Moles of methanol $0.524 - 0.122 - 0.298 = 0.104$ moles **(1)** 3

(b) $K_c = \dfrac{[CH_3OH]}{[CO][H_2]^2}$ **(1)**

$= \dfrac{0.104}{0.122} \times \left(\dfrac{1.04}{0.298}\right)^2$

$= 10.4$ **(1)**

$dm^6\ mol^{-2}$ **(1)** 3

[6]

2. (a) (i) $C + 3D \longrightarrow 2A + B$ 1

(ii) $mol^{-1}dm^3$ 1

(iii) (forward reaction is) exothermic or more products formed 1

(b) (i) for N_2O_4 Mr = 92.0 1

Mol = $\dfrac{36.8}{92.0} = 0.400$ 1

(ii) mol N_2O_4 reacted = 0.400 – 0.180 = 0.220 1

mol NO_2 formed = 0.440 1

(iii) $Kc = \dfrac{(NO_2)^2}{(N_2O_4)}$ 1

$= \dfrac{(0.44/16)^2}{(0.18/16)}$ 1

$= 0.067$ 1

(iv) move to NO_2/ to right / forwards 1

none 1

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3. (a) (i) moles of C_2F_2 = 0.40 mark independently from HC1 1

moles of HC1 = 0.80 **not** consequential 1

(ii) $K_c = \dfrac{[C_2F_4][HCl]^2}{[CHClF_2]^2}$

wrong K_c means they can only score for units in (iii) consequ on their K_c 1

(iii) $K_c = \dfrac{(0.40/18.5)(0.8/18.5)^2}{(0.20/18.5)^2}$ 1

= 0.35 1

mol dm^{-3} 1

(b) (i) increase 1

(ii) decrease 1

[8]

4. (a) (i) *Number of moles of O_2 at equilibrium:* $\dfrac{7.04}{32}$ = 0.22 **(1)** 1

Number of moles of NO at equilibrium: 0.44 **(1)**
OR 2 × mol of oxygen

(ii) *Original number of moles of NO_2:* $\dfrac{21.3}{46}$ = 0.46(3) **(1)**

Number of moles of NO_2 at equilibrium: 0.46(3) – 0.44 = 0.02(3) **(1)**
OR conseq on mol NO above

3

(b) *Expression for K_C*: $K_C = \dfrac{[NO]^2[O_2]}{[NO_2]}$ **(1)**

Calculation: $K_C = \dfrac{\left(\dfrac{0.44}{11.5}\right)^2 \times \left(\dfrac{0.22}{11.5}\right)}{\left(\dfrac{0.023}{11.5}\right)^2}$ = 7.0(0) mol dm^{-3}

(1) (1) (1)

If mol NO_2 = 0.02; K_C = 9.26 (9.3)
or conseq on values from (a)
If vol missed, score only K_C and units
If K_C wrong: max 2 for correct use of vol and conseq units
If K_C wrong and no vol: max 1 for conseq units

3

(c) $pV = nRT$ **(1)**

$T = \dfrac{pV}{nR} = \dfrac{(3.30 \times 10^5) \times (11.5 \times 10^{-3})}{0.683 \times 8.31}$ **(1)**

(1) for using 11.5 × 10^{-3} as V

T = 669 K **(1)** 4

(d) *Yield of oxygen:* increased **(1)**
Value of K_c*:* no effect **(1)** 2

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5. (a) (i) exothermic **(1)**

yield decreases as temperature increases **(1)**
(this mark dependent on first mark) 2

(ii) vanadium (V) oxide / vanadium pentoxide / V_20_5 **(1)**

yield of sulphur trioxide unchanged **(1)**
not just reference to position of equilibrium

(both / forward and reverse reaction) rates increase **(1)**
equally **(1)** 4

(iii) advantage – higher yield of (sulphur trioxide) / equilibrium moves to the right **(1)**
not "saves energy costs"
disadvantage – slower rate of reaction / lower throughput **(1)** 2

(b) (i) rate increased **(1)** 1

(ii) % yield increased / more SO_3 / equilibrium shifts to the right **(1)**

fewer (gas) moles on right hand side of equation increased pressure favours **(1)**
smaller number of mols / molecules / volume 2

[11]