4.2 ANSWERS TO EXAM QUESTIONS

1. (a) (i) Increase (if wrong no further marks in part (i)) 1
higher *P* gives lower yield or moves to left 1
Eqm shifts to reduce *P* or eqm favours side with fewer moles 1

(ii) Endothermic if wrong no further marks in part (ii) 1
increase *T* increases yield or moves to right 1
Eqm shifts to reduce *T* or eqm favours endothermic direction 1

(b) (i) Moles of iodine = 0.023 1
Moles of HI = 0.172 1
If × 2 missed, max 1 in part (iv)
If wrong no marks in (i)

(ii) $K_c = \frac{[H_2][I_2]}{[HI]^2}$ must be square brackets (penalise once in paper) 1
– if round, penalise but mark on in (iv)
if K_c wrong, no marks in (iv) either but mark on from a minor slip in formula

(iii) V cancels in K_c expression
or no moles same on top and bottom of expression
or total moles reactants = moles products,
i.e. total no of moles does not change 1

(iv) $K_c = \frac{(0.023)^2}{(0.172)^2}$ 1
$= 0.0179$ or 1.79×10^{-2}
Conseq on (i) 1
Allow 0.018 or 1.8×10^{-2}

(v) $K_c = 55.9$ or 56 1
Conseq i.e. (answer to (iv))$^{-1}$

[13]

2. (a) $K_c = \frac{[Y][H_2O]^2}{[X][CH_3OH]^2}$ **(1)**
if K_c expression wrong lose units mark in (e) also
must be [ ]

1

(b) *Moles of **X***: 0.25 - 0.13 = 0.12 **(1)**
Moles of methanol: 0.34 - 0.26 = 0.08 **(1)**
Moles of water: 0.26 **(1)** 3

(c) Equal no. of moles on each side of equation **(1)**
OR V cancels out (provided not incorrectly qualified)

1

(d) *Calculation*: $K_c = \dfrac{\left(\frac{0.13}{V}\right)\left(\frac{0.26}{V}\right)^2}{\left(\frac{0.12}{V}\right)\left(\frac{0.08}{V}\right)^2}$ **(1)**

= 11(.4) **(1)**

Can score all 3 conseq on (b) and (c)
If different values from (c) used allow units only
(conseq on correct K_c)

Units of K_c: none **(1)**

but lose this mark if K_c is wrong even if none given

3

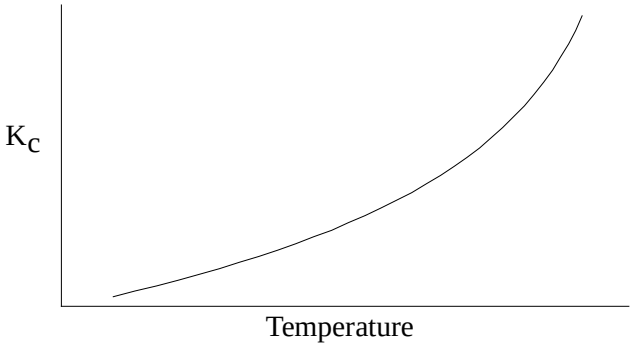
(e) decrease **(1)** 1

[9]

3. (a) *Equation* $N_2 + O_2 \rightleftharpoons 2NO$ **(1)**

K_c $[NO]^2 / [N_2]\,[O_2]$ **(1)** 2

(b)



As temperature increases K_c increases (or yield increases) **(1)**
Hence reaction endothermic **(1)** 2

(c) The product yield is very small **(1)**
Yield does not justify cost of producing high temp **(1)** 2

(d) (i) $2NO + O_2 \rightleftharpoons 2NO_2$ **(1)**

(ii) *Change in equilibrium position* Displaced to the right **(1)**
Change in equilibrium constant No change **(1)** 3

[9]

4. *(must state correct effect on yield or rate to score the reason mark)*

T effect: higher temp: yield greater or shifts equilibrium to right; 1
effect: higher temp: rate increased; 1
reason: endothermic

OR

more particles have $E>E_a$ 1

OR

more successful/productive collisions; 1

P effect: higher pressure: yield less or shifts equilibrium to left; 1

effect: higher pressure: rate increased;

reason: increase in gas moles L to R

OR

greater collision frequency; 1

(Q of L mark)

[6]

5. (a) $Kc = \frac{[H_2][I_2]}{[HI]^2}$ **(1)**

0.05 **or** 1/20 **(1)** 2

(b) (i) forward rate increases **(1)**

reverse rate increases **(1)**

allow 1 mark for just 'increased'
allow 2 marks for 'both increased' 2

(ii) no change **(1)** 1

(iii) no change **(1)** 1

[6]

6. (a) (i) Moles NaOH = mv/1000 = 1.50 × 72.5/1000 = 0.108 to 0.11 **(1)**
Moles of ethanoic acid at equilibrium = moles sodium hydroxide **(1)**
Moles ester = moles water (=moles acid reacted) **(1)**
= 0.200 – 0.108 = 0.090 to 0.92 **(1)**
Moles ethanol = 0.110 – 0.091 = 0.018 to 0.020 **(1)**
K_C = [Ester] [Water]/[Acid] [Alcohol] **(1)**
Allow if used correctly

$= (0.091)^2/0.109 \times 0.019 = 3.7$ to 4.9 **(1)** 7
Ignore units
NB Allow the answer 4 one mark as correct knowledge

(ii) Similar (types) of bond broken and made **(1)**
Same number of the bonds broken and made **(1)** 2
any number if equal
NB If a list given then the total number of each type of bond broken and made must be the same

[9]

7. (a) Homogeneous; All reactants in the same phase or state **(1)**

Dynamic; Continuous or 'on-going' **(1)**

Equilibrium: Concentrations of reactants and products constant or rates of forward and backward reactions equal **(1)**

Equation; $2NH_3 \rightleftharpoons N_2 + 3H_2$ (Must be decomposition) **(1)**

*K*c; $[N_2][H_2]^3/[NH_3]^2$ **(1)**

5

(b) Conditions:

decomposition favoured by high temp **(1)**

since the reaction endothermic or logical statement with application of Le Chatelier's principle **(1)**

decomposition favoured by low pressure **(1)**

2 mole gas giving 4 moles gas or more gas moles on right **(1)**

4

(c) In practise

low pressure means low production **(1)**
low pressure means low rate **(1)**

high temperature means high rate **(1)**
high temperature expensive **(1)**

Catalyst

equilibrium yield unaffected **(1)**
rates of forward and backwards reactions increased by an equal amount **(1)**
more hydrogen produced in a given time **(1)**

Max 6

[15]