

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 $\times 2$ missed, max 1 in part (iv)
If wrong no marks in (i)
- (ii) $K_c = \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2}$ 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) $K_c = \frac{[\text{Y}][\text{H}_2\text{O}]^2}{[\text{X}][\text{CH}_3\text{OH}]^2}$ (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:
$$K_c = \frac{\left(\frac{0.13}{V}\right)\left(\frac{0.26}{V}\right)^2}{\left(\frac{0.12}{V}\right)\left(\frac{0.08}{V}\right)^2} \quad (1)$$

$$= 11(.4) \quad (1)$$

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

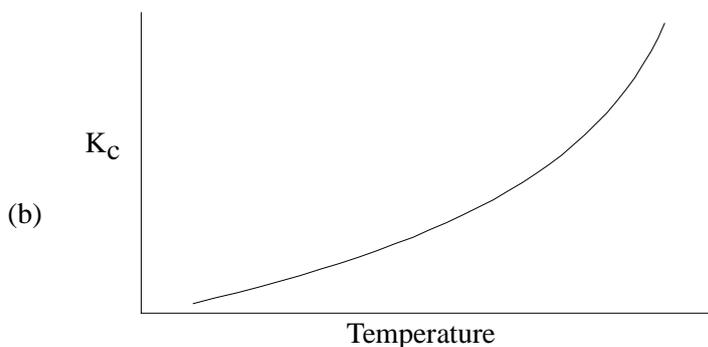
Units of K_c : none (1)

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

- (e) decrease (1) 3
1

[9]

3. (a) Equation $N_2 + O_2 \rightleftharpoons 2NO$ (1)
 K_c $[NO]^2 / [N_2][O_2]$ (1) 2



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) $K_c = \frac{[H_2][I_2]}{[HI]^2}$ (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 = $mv/1000 = 1.50 \times 72.5/1000 = 0.108$ 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)
 $K_C = \frac{[Ester][Water]}{[Acid][Alcohol]}$ (1)
Allow if used correctly
 $= \frac{(0.091)^2}{0.109 \times 0.019} = 3.7$ 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; $2\text{NH}_3 \rightleftharpoons \text{N}_2 + 3\text{H}_2$ (Must be decomposition) (1)
 K_c ; $[\text{N}_2][\text{H}_2]^3/[\text{NH}_3]^2$ (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]