

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) $K_c = \frac{[H_2][I_2]}{[HI]^2}$ 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

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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

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

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

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

3

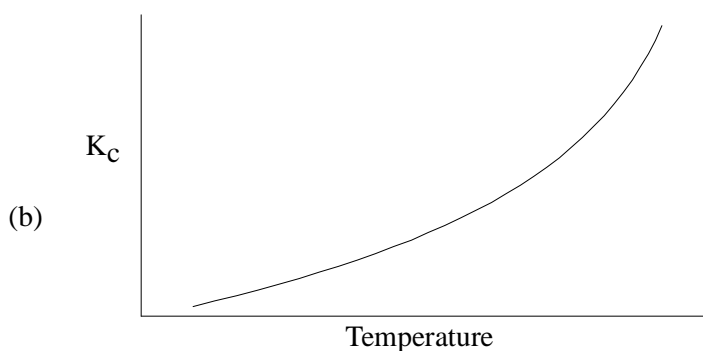
(e) decrease (1)

1

[9]

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

2



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

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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)
 $K_C = [Ester][Water]/[Acid][Alcohol]$ (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; $2\text{NH}_3 \rightleftharpoons \text{N}_2 + 3\text{H}_2$ (Must be decomposition) (1)
 K_c ; $[\text{N}_2][\text{H}_2]^3/[\text{NH}_3]^2$ (1)

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- (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]