AQA A-Level Chemistry

Chemical equilibria mark scheme · goes with “Chemical equilibria” · whiteboardchemistry.com/revision/aqa-a-level-chemistry/exam-questions

Mark schemes

Chemical equilibria · 12 questions

Q1 · June 2024 · AS Paper 2 · Q7 · [17 marks]

(a) From orange to green

[1 mark]

(b) Propanal (allow name or structure)

If name and structure shown, both must be correct

Ignore aldehyde

[1 mark]

(c) M1 Dashed line from H in water to lone pair on an O in propanoic acid,

or

dashed line from lone pair on O in water to the H (of OH) in propanoic acid.

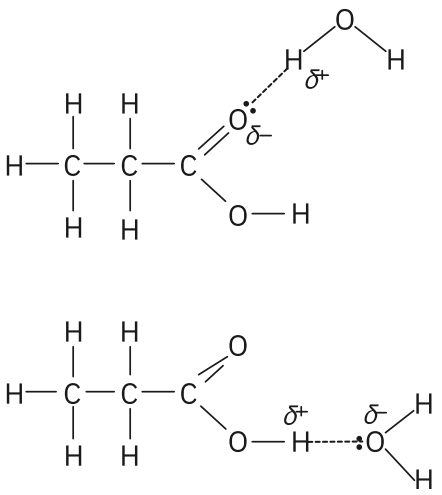
M2 for the H and O atoms in their H-bond:

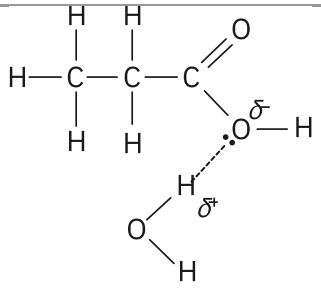
δ- and lone pair on O on one molecule,

δ+ on H (of OH) on the other molecule

M3 Linear O ..... H–O

3 examples of correct answers are shown in in the diagram





Accept a pair of dots/crosses or a shaped orbital (without or without two electrons) for lone pair

Ignore any partial charges on other atoms

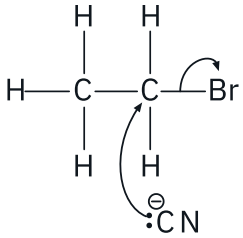
For linear in M3, accept a deviation up to 10°

If two H-bonds formed between an acid molecule and a water molecule, could score maximum of 1 mark for M1 or M2

Lose M1 if structure of water incorrect or the H-bonding is to another propanoic acid molecule (instead of water)

[3 marks]

(d) M1 Nucleophilic Substitution



M2 Arrow from lone pair on C of CN^- to the C of the CH_2Br group

M2 Allow the minus sign to be anywhere on the CN^- ion

M2 Penalise any extra arrows involving CN^- or covalent bond in NaCN

M3 Arrow from the C–Br bond to the Br

All arrows are double-headed. Penalise one mark from the total if half headed arrows are used. Do not penalise the "correct" use of "sticks". Penalise only once in mechanism for a line and two dots to show a bond

M3 Penalise formal charges or incorrect partial charges on C–Br bond

M3 Penalise any extra arrows involving Br

Ignore wrong organic product (if shown)

S_N1: allow S_N1 mechanism with M2 for breakage of C–Br bond and M3 for attack by CN^- on correct carbocation

[3 marks]

(e) Any one from:

- An alcohol/ethanol would be formed
- Water/it/hydroxide ions would act as the nucleophile/be involved with nucleophilic substitution
- Bromoethane is insoluble (in water)

Do not allow it/NaCN is insoluble (in water)

[1 mark]

(f)

$$K_c = \frac{[CH_3CH_2COOH]}{[C_2H_4][CO][H_2O]}$$

- Must be square brackets
- Ignore state symbols
- Ignore units

[1 mark]

(g) M1 Divides moles by volume (1.2 or 1200/1000)

M2 $K_c = \frac{(0.420/1.2)}{((0.078/1.2)(0.062/1.2)(0.062/1.2))}$ or $\frac{(0.350)}{((0.065)(0.052)(0.052))}$

M3 2017 (allow 1990 to 2020)

M4 $mol^{-2}\ dm^6$

For M1-3

- Correct answer scores M1-3
- Allow ECF from M1 to M2 for incorrect or no attempt to determine concentration in M1 (1401 scores M2+3 if moles not concentration used)
- Allow ECF from M2 to M3
- Incorrect K_c expression: allow ECF from (f) to (g)

M4 Units must be consistent with expression used in (g) (or (f) if calculation not attempted in (g))

[4 marks]

(h) M1 Yield will decrease

M2 The equilibrium shifts (left) in the endothermic direction

M2 Allow equilibrium shifts left as the forward reaction is exothermic

M2 Allow the equilibrium shifts (left) to the endothermic side

M2 Ignore reference to reaction being favoured

M3 To oppose the temperature increase/change/to decrease the temperature

Mark each point independently

[3 marks]

Q2 · June 2023 · Paper 3 · Q28 · [1 mark]

Answer: **A**

0.133

Q3 · June 2024 · Paper 1 · Q4 · [9 marks]

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

Mole fraction of H_2 = 0.23

Accept fractions

[2 marks]

(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 mark]

(c) The amount decreases.

[1 mark]

(d)

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

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

M2 $= \dfrac{(0.0321 \times 6000)}{((0.645 \times 6000) \times (0.323 \times 6000))} = \dfrac{192.6}{(3870 \times 1938)}$

M2 allow correct use of 6000 to calculate partial pressure

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

M3 Allow 2.57×10^{-5}

M4 kPa^{-1}

[4 marks]

(e) No effect

[1 mark]

Q4 · June 2022 · AS Paper 2 · Q20 · [1 mark]

Answer: **D**

Increase the temperature

Q5 · June 2022 · AS Paper 2 · Q19 · [1 mark]

Answer: **B**

3.8

Q6 · June 2022 · AS Paper 2 · Q18 · [1 mark]

Answer: **B**

$$K_c = \frac{[CH_3OH]}{([CO]\,[H_2]^2)}$$

Q7 · June 2023 · Paper 3 · Q13 · [1 mark]

Answer: **D**

6.87×10^{-4}

Q8 · June 2023 · AS Paper 2 · Q16 · [1 mark]

Answer: **D**

An increase in temperature decreases the value of K_c

Q9 · November 2021 · AS Paper 2 · Q20 · [1 mark]

Answer: **C**

The rate of the reverse reaction increases.

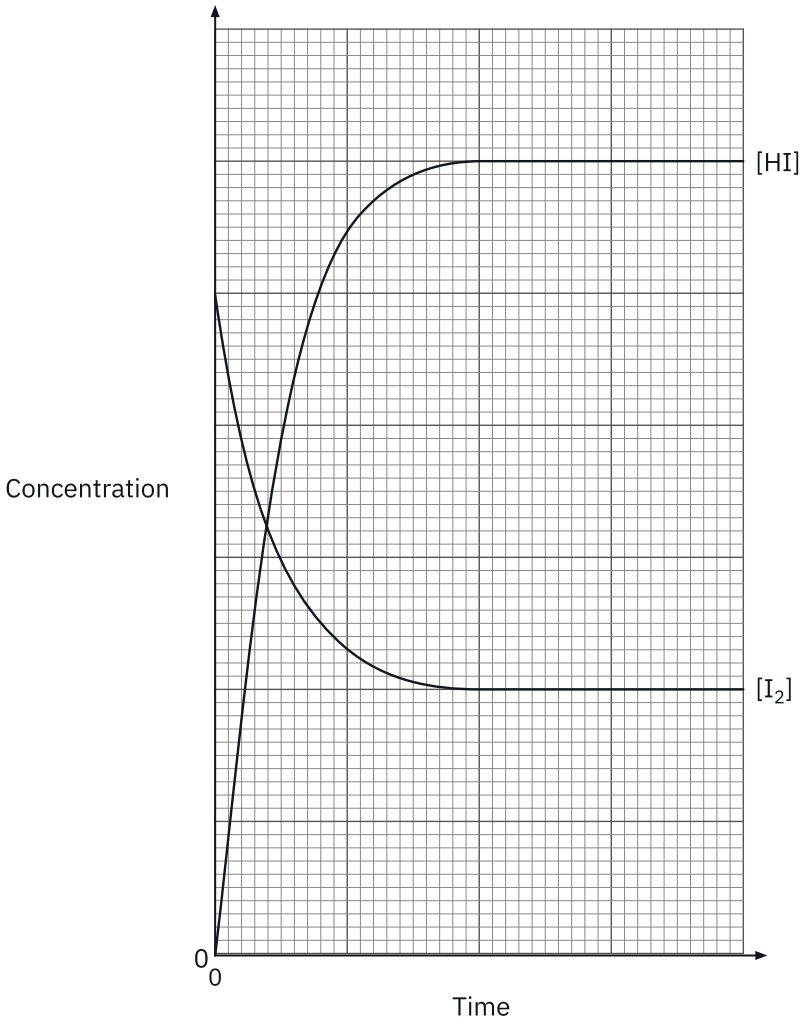
Q10 · June 2025 · AS Paper 1 · Q15 · [1 mark]

Answer: **A**

$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

Q11 · June 2025 · AS Paper 1 · Q7 · [11 marks]

07.1



M1 = starts at zero and correct final concentration

M2 = gradient becomes zero at correct time

[2 marks]

07.2

M1 Yield would increase

M2 The <u>equilibrium</u> shifts in the endothermic direction (to the right)

M3 To oppose the temperature increase / to oppose the temperature change / to decrease the temperature

ignore reference to forward reaction being favoured

Mark each point independently

[3 marks]

07.3

M1: Expression for K_c $K_c = \dfrac{([CH_3OH][H_2O])}{([CO_2][H_2]^3)}$

M2: Amount of carbon dioxide reacted

$n(CO_2) = 1.20$ mol

M3: Equilibrium amounts of hydrogen, methanol and water

$n(H_2) = 6.00 - (3 \times M2)$ (mol)

$n(CH_3OH) = M2$ (mol)

$n(H_2O) = M2$ (mol)

M4: Converts their amounts to concentrations

$$[CH_3OH] = \frac{(M3\ n(CH_3OH))}{(4.60)}$$

$$[H_2O] = \frac{(M3\ n(H_2O))}{(4.60)}$$

$$[H_2] = \frac{(M3\ n(H_2))}{(4.60)}$$

$$[CO_2] = \frac{(1.30)}{(4.60)} = 0.283 \text{ mol dm}^{-3}$$

M5: calculation of K_c using M1 and M4

M6: units using their M1

Do not accept round brackets in expression for K_c

M3: Equilibrium amounts of hydrogen, methanol and water

$n(H_2) = 2.40$ mol

$n(CH_3OH) = 1.20$ mol

$n(H_2O) = 1.20$ mol

M4: Converts their amounts to concentrations

$$[CH_3OH] = \frac{(1.20)}{(4.60)} = 0.261 \text{ mol dm}^{-3}$$

$$[H_2O] = \frac{(1.20)}{(4.60)} = 0.261 \text{ mol dm}^{-3}$$

$$[H_2] = \frac{(2.40)}{(4.60)} = 0.522 \text{ mol dm}^{-3}$$

$$[CO_2] = \frac{(1.30)}{(4.60)} = 0.283 \text{ mol dm}^{-3}$$

M5: Calculation of K_c

$$K_c = \frac{(0.261 \times 0.261)}{(0.283 \times (0.522)^3)} = 1.69 \text{ / } 1.7(0) \text{ / } 1.7(2)$$

M6: Units

$mol^{-2}\ dm^6$

Alternative approach

M4: shows division by 4.60 in expression and cancels down

M5: calculation of K_c using M1 and M4

M6: units using their M1

[6 marks]

Q12 · June 2023 · Paper 3 · Q25 · [1 mark]

Answer: **C**

They have no effect on the value of the equilibrium constant.

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