



ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Mark scheme

June 2003

GCE

Chemistry

Unit CHM2

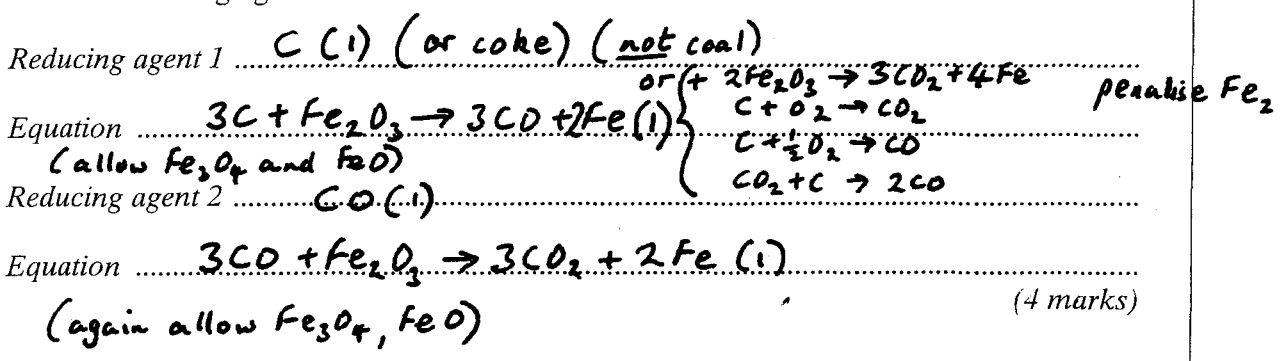
Copyright © 2003 AQA and its licensors. All rights reserved.

SECTION A

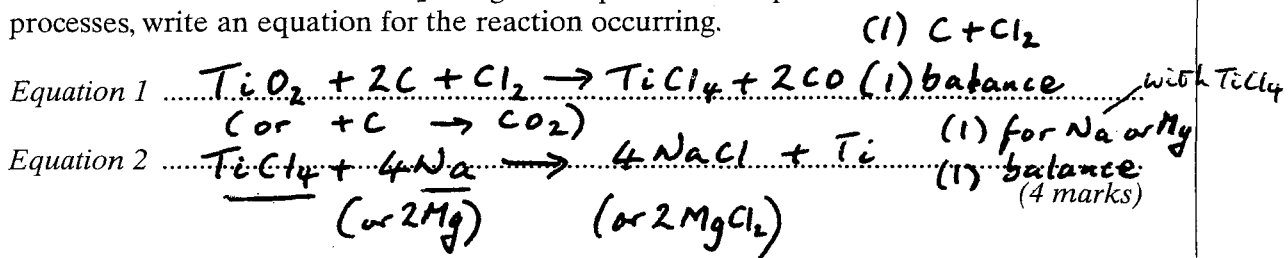
Answer all questions in the spaces provided.

- 1 (a) Iron is extracted in a Blast Furnace by a continuous reduction process. Identify two reducing agents present in the Blast Furnace. In each case, write an equation to show how the reducing agent reacts in the formation of iron.

equation must depend on correct reducing agent but allow coal



- (b) Titanium is extracted from TiO_2 using two separate batch processes. For each of these processes, write an equation for the reaction occurring.



- (c) Suggest in general terms how metals can be extracted from sulphide ores. Explain how pollution problems can arise from such extractions.

Extraction \rightarrow form metal oxide (1) (or metal oxide implied)

$\left. \begin{array}{l} \text{reduce} \\ \text{or react with suitable reducing agent} \end{array} \right\}$ (1) (consequential on formation of metal oxide)

Pollution problems $SO_2(l)$ or oxides of S not SO_3 alone (allow any sensible and correct reducing agent identified)

any mention of acid rain

or H_2SO_4

or erosion caused by acid rain

or correct problem due to acid rain

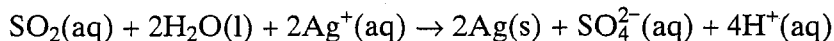
(1)

(4 marks)

2 (a) In terms of electrons, what happens to an oxidising agent during a redox reaction?

*gains electrons (1) allow { an electron
or accepts } electrons { or just 'gains' (1 mark)
or takes } electrons { or reduction is gain of electrons but NOT OIL RIG
do not allow mention of electron pair(s) even if stated*

(b) Consider the following redox reaction.



(i) Identify the oxidising agent and the reducing agent in this reaction.

Oxidising agent *Ag⁺ (1) (or Ag I)*

Reducing agent *SO₂ (1) (or S^{IV}, not sulphur)*

(ii) Write a half-equation to show how sulphur dioxide is converted into sulphate ions in aqueous solution.

*SO₂ + 2H₂O → SO₄²⁻ + 4H⁺ + 2e⁻ (1) (allow e⁻ ie no charge)
(allow -e⁻ on L.H.S) (or H₂SO₄ + 2H⁺ + 2e⁻) penalise E⁻ once only (3 marks)*

(c) Fe²⁺ ions are oxidised to Fe³⁺ ions by ClO₃⁻ ions in acidic conditions. The ClO₃⁻ ions are reduced to Cl⁻ ions.

(i) Write a half-equation for the oxidation of Fe²⁺ ions in this reaction.

Fe²⁺ → Fe³⁺ + e⁻ (1)

(ii) Deduce the oxidation state of chlorine in ClO₃⁻ ions.

5 (1) (or V or +5)

(iii) Write a half-equation for the reduction of ClO₃⁻ ions to Cl⁻ ions in acidic conditions.

ClO₃⁻ + 6H⁺ + 6e⁻ → Cl⁻ + 3H₂O (1)

(iv) Hence, write an overall equation for the reaction.

ClO₃⁻ + 6H⁺ + 6Fe²⁺ → Cl⁻ + 3H₂O + 6Fe³⁺ (1)

(mark parts (i) to (iv) independently) (4 marks)

(d) Write an equation to show how sulphur is removed from impure iron obtained from the Blast Furnace. Identify the oxidising agent in this reaction.

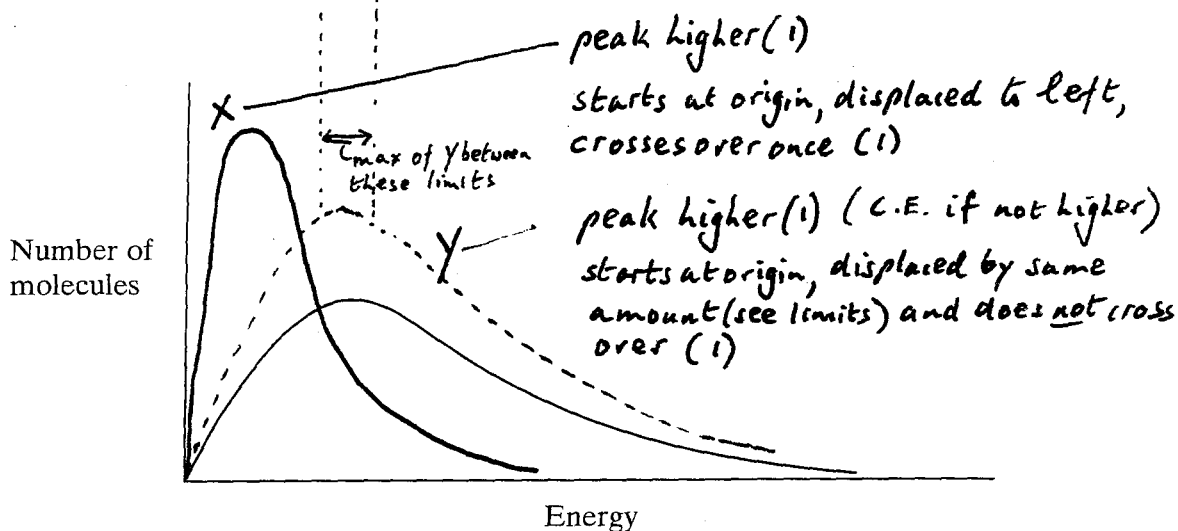
Equation *Mg + S → MgS (1) (allow FeS + Mg → MgS + Fe)
(allow Ca)*

Oxidising agent *S (1)*

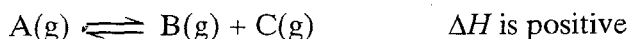
(only award mark if first answer given unless no first answer then can allow)

Turn over ▶

- 3 (a) A sample of a gas was sealed into a flask at temperature T and pressure P . The Maxwell-Boltzmann distribution of energies for the molecules in this sample is shown below.



- (i) Using the axes above, sketch the curve that you would expect if this sample of gas at pressure P had been cooled. Label this curve **X**.
- (ii) Using the axes above, sketch the curve that you would expect if another sample of the same gas was sealed in the same flask at the original temperature, T , but at a higher pressure. Label this curve **Y**. (4 marks)
- (b) Gas **A** decomposes slowly to form gases **B** and **C**. An equilibrium is established as shown by the following equation.



- (i) In terms of the behaviour of molecules, state what must happen before molecules of **A** can react to form **B** and **C**.

collide (1)

with sufficient energy (or $E > E_a$) (1)

(or with correct orientation)

- (ii) Explain why the decomposition of **A** is faster at higher temperatures.

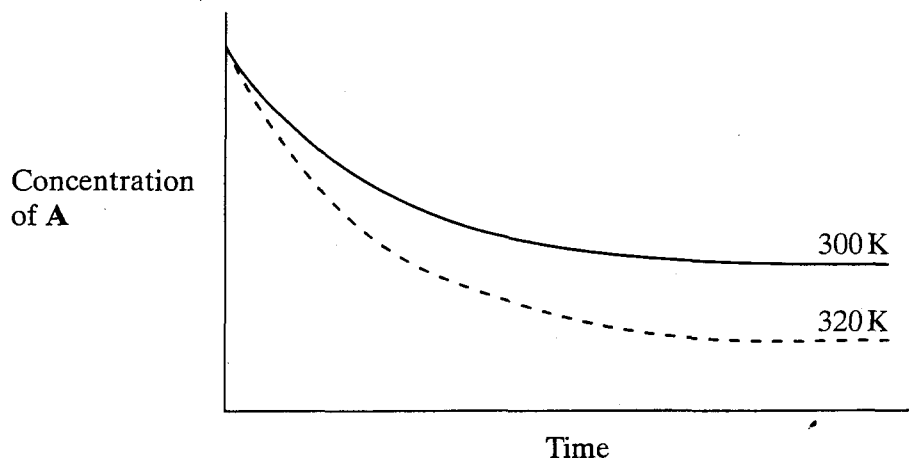
molecules (or particles) have more energy (or move faster) (1)

more molecules (or collisions) have $E > E_a$ (or sufficient energy) (1)

(or more collisions)

(4 marks)

- (c) The graphs below show how, starting from **A** alone, the concentration of **A** varies with time at temperatures of 300 K and 320 K for the reversible reaction given in part (b).



- (i) Suggest why, as shown on the graphs, the concentration of **A** remains constant after a time.

equilibrium reached (1)

(or rate forward reaction = rate backward)

- (ii) Explain why, at 320 K, the concentration of **A** falls to a lower value compared with the reaction at 300 K.

reaction is endothermic (1) (or $\Delta H +ve$ or reverse reaction exothermic)

endothermic reaction favoured (1)

(or reaction shifts to R

or moves forward

or more products formed)

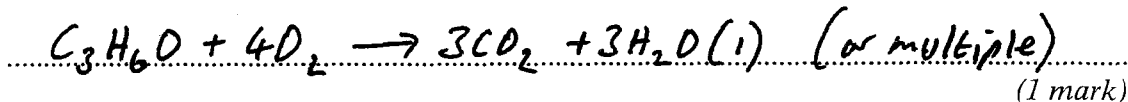
(3 marks)

11

TURN OVER FOR THE NEXT QUESTION

Turn over ►

- 4 (a) Write an equation for the complete combustion of propanone, C_3H_6O , to form carbon dioxide and water.



- (b) In a laboratory experiment, 1.45 g of propanone were burned completely in oxygen. The heat from this combustion was used to raise the temperature of 100 g of water from 293.1 K to 351.2 K.

- (i) Calculate the number of moles of propanone in the 1.45 g.

$\frac{1.45}{58} = 0.0250$ (1) (allow 0.025 or allow conseq on wrong Mr)

- (ii) Calculate the heat energy required to raise the temperature of 100 g of water from 293.1 K to 351.2 K. (The specific heat capacity of water is $4.18 \text{ JK}^{-1} \text{ g}^{-1}$)

Heat released = $m c \Delta T$
 $= 100 \times 4.18 \times 58.1$ (1) (if 1.45 used in place of 100, C.E. = 0)
 $= 24300 \text{ J}$ (1) (allow 24200 to 24300) (ignore decimal places)
 (or 24.3 kJ) units tied to answer

(if we $0.1 \times 4.18 \times 58.1$ allow $\frac{1}{2}$ for 24.3 with no units)

- (iii) Hence, calculate a value, in kJ mol^{-1} , for the enthalpy of combustion of propanone.

$\frac{24.3}{0.0250} = -972 \text{ (kJ mol}^{-1}\text{)}$ (1) (allow -968 to -973)
 (allow +972)
 allow no units (allow conseq (5 marks))
 penalise wrong units

- (c) In a similar experiment, the enthalpy of combustion of butanone, C_4H_8O , was found to be $-1290 \text{ kJ mol}^{-1}$. A data book value for the same reaction is $\Delta H_c^\ominus = -2430 \text{ kJ mol}^{-1}$.

- (i) Suggest one reason why the experimental value is very different from the data book value.

Heat loss (1) (do not allow incomplete combustion)
 or energy loss

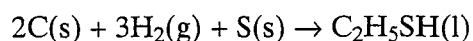
- (ii) This data book value of ΔH_c^\ominus for butanone ($-2430 \text{ kJ mol}^{-1}$) refers to the formation of carbon dioxide gas and water in the gaseous state. How would this value differ if it referred to the formation of water in the liquid state? Explain your answer.

Difference more negative (or more exothermic) (1) Q.O.L. mark

Explanation heat (or energy) released when water vapour condenses (1)
 (or heat/energy required to vaporise water)
 (or water molecules have more energy in the gaseous state) (3 marks)

- (d) Calculate a value for the standard enthalpy of formation for liquid ethanethiol, C_2H_5SH . Use the equation given below and enthalpy of combustion data from the following table.

| Substance | $C_2H_5SH(l)$ | $C(s)$ | $H_2(g)$ | $S(s)$ |
|------------------------------------|---------------|--------|----------|--------|
| $\Delta H_c^\ominus / kJ mol^{-1}$ | -1170 | -394 | -286 | -297 |



$$\Delta H = \sum \Delta H_{\text{reactants}} - \sum \Delta H_{\text{products}} \quad (1)$$

(or cycle $2C + 3H_2 + S \rightarrow C_2H_5SH$)

\downarrow \downarrow \downarrow \nearrow
 CO_2 H_2O SO_2 $-\Delta H_c C_2H_5SH$

(3 marks)

$$= (2 \times -394) + (3 \times -286) + (-297) - (-1170) \quad (1)$$

$$= -773 \quad (1) \quad \text{ignore units even if wrong.}$$

(allow $\frac{1}{3}$ for +773)

TURN OVER FOR THE NEXT QUESTION

12

CHM2 June 2003
Q5 marking scheme

(a) increases from fluorine to iodine (1)

sizes of molecules increase (1) (*P.O.L. mark*)
(or molecules have more electrons or mass of molecules increases)

Magnitude of intermolecular forces or VdW forces increase (1) (*or more vdw forces*)

More energy required to separate molecules (or particles) (1)
(or more energy to break intermolecular forces)
or intermolecular forces more difficult to break

4

(b) with NaCl white ppt (1)
 soluble in ammonia (1)

note, if ppt clearly refers to wrong substance (eg NaCl) then C:E = 0

with NaBr cream (or off white or beige) ppt (1)
 partially soluble (or insoluble) in ammonia (1)

(ignore references to conc ammonia)

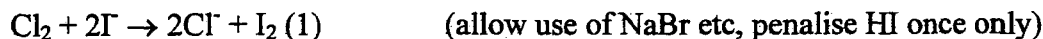
(if obviously added silver nitrate mixed with ammonia allow: NaCl: no change (2)
 NaBr: cream ppt (2))

4

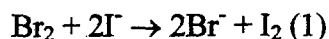
(c) oxidising ability decreases from chlorine to iodine (or down the Group) (1)



Br₂ red-brown (or yellow or orange) liquid (or solution but not solid)(1)



I₂ brown solution/black solid (1) (do not allow any reference to purple)



Yellow/orange/red-brown/brown solution goes brown/darker brown solution
/black solid (1)

7
15