UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Ordinary Level

MARK SCHEME for the October/November 2008 question paper

5070 CHEMISTRY

5070/02 Paper 2 (Theory), maximum raw mark 75

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2008 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

Section A

A1 **(a)** **(i)** P [1]

(ii) He [1]

(iii) Cl [1]

(iv) N/P/As [1]

(v) Ni [1]

(vi) S and O (both needed for 1 mark) [1]
ALLOW: N and O (1 mark)

[Total: 6]

A2 **(a)** any **two** of:
- carbon dioxide disappears or vaporises

ALLOW: carbon dioxide melts/carbon dioxide block decreases in size/hole in block gets deeper
- black powder/black solid formed/black smuts/black fumes/sooty

ALLOW: black gas/black smoke
- white powder/white solid formed/white fumes

ALLOW: white gas
- bright light/flame

IGNORE: flame colour [2]
NOTE: greyish fumes/solid/powder/gas = 2 marks

(b) to stop Mg reacting with air (or oxygen)/to stop side reactions/to stop air getting in [1]
NOT: to stop oxidation of magnesium/to increase rate of reaction

(c) <u>low</u> temperature/the cold(ness)/it is cold/it is –60 °C [1]
NOT: surface area/temperature

(d) $2 \times 24\,g \rightarrow 810\,kJ$
$2\,g \rightarrow 810 \times 2/(2 \times 24) =$
33.75 (kJ)
OR
moles Mg = 2/24 = 0.083333
$810 \times 0.083333/2 = 33.75$ [2]
correct answer without working scores 2
1 mark for use of moles i.e. 2/24 or 2×24
2 marks for correct answer
ALLOW: 33.8/34
33.7/34.0/33.6 (from rounding up 0.083333) = 1 mark ONLY
67.5 = 1 mark ONLY

(e) magnesium in excess (no marks on its own)

- Mg 6/24 = 0.25 mol CO_2 4.4/44 = 0.1mol (1 mark)
- 2 moles Mg needed to 1 of CO_2/recognition of this/division by two or 2:1 ratio shown (1 mark)

OR 2 × 24 g magnesium → 44 g carbon dioxide (1 mark)
so 6 g magnesium gives 6 × 44/48 = 5.5 g carbon dioxide (1 mark)
(or reverse argument for carbon dioxide to calculate mass of magnesium)

(f) energy taken in to break bonds and energy given out in making bonds/
bond-breaking is endothermic **and** bond-making exothermic
more energy released than absorbed [2]
more energy released in bond-making than absorbed in bond-breaking ORA = 2 marks

[Total: 10]

A3 (a) methane/CH_4
carbon dioxide/CO_2 [2]

(b) correct structure of butanoic acid [1]
ALLOW: condensed structural formula or mixture of condensed and displayed formulae
ALL hydrogen atoms must be shown.

(c) (i) speeds up the reaction [1]
ALLOW: reduces time taken for the reaction (to complete)
ALLOW: reduces activation energy
ALLOW: makes oil quicker
NOT: changes/alters rate of reaction

(ii) $C_{22}H_{22}O_2 + 26\frac{1}{2}O_2 \rightarrow 22CO_2 + 11H_2O$
or multiples
(1 for correct reactants and products, 1 for balance) [2]
REJECT: if additional products/reactants

[Total: 6]

A4 (a) potassium chlorate is oxidant **and** P is reductant (1 mark)
ALLOW: oxygen/chlorine is oxidant and P is reductant
one of:
potassium chlorate loses oxygen/
phosphorus removes oxygen from potassium chlorate/
phosphorus gains oxygen/
potassium chlorate/chlorine/chlorate gains electrons/
phosphorus loses electrons/
oxidation number of phosphorus increases
oxidation number of chlorine (ALLOW: of potassium chlorate) decreases
ALLOW: increases/decreases in oxidation numbers in correct direction (numbers need not be correct) [2]

(b) **(i)** $P_2O_5 + H_2O \rightarrow 2HPO_3$
ALLOW: multiples
IGNORE: state symbols

(ii) effervescence/bubbling; NOT: carbon dioxide given off
turns red/pink [2]

(c) Sb_2S_3/S_3Sb_2 [1]
NOT: Sb_4S_6

[Total: 6]

A5 **(a)** **(i)** (thermal) decomposition [1]
NOT: endothermic

(ii) it is (a) basic (oxide)/it is a base/it is (an) alkaline oxide [1]
ALLOW: it is alkaline/an alkali (in solution)/has a high pH (when it reacts with water)/forms hydroxide ions (when reacts with water)
NOT: it contains hydroxide ions
NOT: answers about effect on plant growth

(b) **(i)** $CaO + H_2O \rightarrow Ca(OH)_2$ [1]
IGNORE: state symbols

(ii) any three of:
- pH increases inside beam ORA/
- carbon dioxide (in solution) is slightly acidic/
- on the surface CO_2 reacts with neutralises $Ca(OH)_2$ OR implication that pH neutral on the surface/
- reaction of carbon dioxide with calcium hydroxide reduces alkalinity (or lowers pH)/
- further inside (beam), less (or no) CO_2/little or no reaction (of carbon dioxide) with calcium hydroxide inside (beam)/
- crack allows carbon dioxide to enter the inside of the beam/
- near crack alkalinity less/pH lower OWTTE [3]

(iii) moles $HCl = 0.04 \times 18/1000 = 7.2 \times 10^{-4}$
(1 mark for showing $0.04 \times 18/1000$ (or 7.2×10^{-4} without working))

2 moles $HCl \equiv$ 1 mole $Ca(OH)_2$ (or implication of this i.e. 3.6×10^{-4})
(1 mark for indication in any way of correct 2:1 ratio i.e. ½ value of answer to 1st part of calculation)

concentration $Ca(OH)_2 = 3.6 \times 10^{-4} \times 1000/25 = 0.0144$ (mol/dm^3) [3]
correct answer without working = 3 marks
apply error carried forward between the parts
ALLOW: 0.014 NOT: 0.015
alternatively:

$$\frac{C_1 \times V_1}{C_2 \times V_2} = \frac{0.04 \times 18}{C_2 \times 25} \quad \text{(1 mark)}$$

$$\frac{C_1 \times V_1}{C_2 \times V_2} = \frac{n_1}{n_2} \quad \frac{0.04 \times 18}{C_2 \times 25} = \frac{2}{1} \quad \text{(2 marks)}$$

Correct answer from this = (3rd mark)

[Total: 9]

A6 (a) (i) to kill bacteria/to kill micro-organisms/to kill germs [1]
ALLOW: to disinfect the water/to sterilise the water
NOT: to kill viruses/to kill algae/to kill bugs
NOT: to clean the water/to make the water clear

(ii) sulphur dioxide/sulphite(s)/named sulphite [1]
ALLOW: (calcium) hypochlorite//chlorate(I)/hydrogen peroxide
ALLOW: correct formulae
NOT: bleaching powder

(b) two or more units polymerised with continuation bonds
ALLOW: correct structure with brackets, continuation bonds and 'n' at bottom right [1]

(c) any **two** of:
- aluminium oxide dissolves (in sodium hydroxide)/aluminium oxide forms a solution (in sodium hydroxide)/aluminium oxide is soluble (in excess sodium hydroxide)/
- iron(III) oxide does not dissolve (in excess sodium hydroxide)/iron(III) oxide is insoluble (in excess sodium hydroxide)

NOT: iron(III) forms a precipitate
- separate by filtration/allowing iron oxide to settle and drawing off solution/decanting

ALLOW: separate by centrifugation/use a centrifuge [2]
FOR ALL 3 points IGNORE: names of solids/solutions formed

(d) dissolves the aluminium oxide/alumina or
lowers melting point of the melt/aluminium oxide mixture OWTTE [1]
ALLOW: lowers the melting point of aluminium oxide
ALLOW: lowers the temperature at which electrolysis takes place
NOT: lowers the temperature (unqualified)

(e) (aluminium) covered with (aluminium) oxide layer/there is (aluminium) oxide on the su
ALLOW: protective layer formed by reaction with oxygen
NOT: wrong layer e.g. oxygen layer/layer of nitrogen
layer/aluminium oxide is unreactive/layer stops (chemical) reaction/protective layer formed
NOT: aluminium is unreactive [2]

[Total: 8]

Section B

B7 (a) reactants on left and products on right **and** products at lower level than reactants
catalysed reaction curve lower than that for uncatalysed
ALLOW: two separate diagrams for catalysed and uncatalysed reactions as long as they are to the same scale
enthalpy change correctly shown in words or as ΔH [3]

(b) (i) (fractional) distillation/fractionation/description of this i.e. gradually raising temperature of liquefied air and collecting fractions
ALLOW: Linde process/double distillation [1]

(ii) any **two** of:
- cracking/steam reforming/
- high temperature/stated temperature ALLOW: 300–1000 °C/

NOT heat (unqualified)
- use of catalyst

ALLOW: the following specified substances without the word catalyst aluminium oxide/zinc oxide/zeolites/copper/silicon dioxide/porous pot/correct symbols of formulae for these
ALLOW: the word catalyst with incorrect catalyst e.g. catalyst of copper sulphate [2]

(c) (i) increase in pressure increases yield/moves the equilibrium to the right/increases the forward reaction/decreases the back reaction/more products formed/more ammonia formed OWTTE
number of moles fewer on right (than left)/number of moles greater on left (than right)/(gas) volume smaller on right/(gas) volume larger on left/increased pressure favours side with fewer moles or lower volume OWTTE [2]

(ii) decreases yield/moves the equilibrium to the left/more reactants/less ammonia formed OWTTE
(forward) reaction is exothermic/reaction gives out energy/back reaction is endothermic [2]

[Total: 10]

B8 (a) (i) any **two** of:

- chromatography paper (with bottom of paper) in solvent

ALLOW: diagram showing this with solvent clearly labelled and paper dipping into solvent
ALLOW: named solvent

- spot of mixture put (on line)

ALLOW: diagram showing this
NOT: diagrams showing original spot/base line below solvent level

- allow solvent to move up paper/pigments are separated as they move (vertically) up the paper

ALLOW: separated pigments on a diagram vertically aligned
NOT: single pigments originating from different spots on the base line [2]

(ii) distance spot moves ÷ distance of solvent front from base (starting) line
ALLOW: diagrams [1]
ALLOW: distance moved by substance ÷ distance moved by solvent
ALLOW: the ratio of the distance moved by the spot/substance to that moved by the solvent
NOT: the ratio of the distance moved by the solvent to that moved by the spot/substance

(b) (i) it/**X** is a reducing agent **or** it/**X** gets oxidised **or** potassium manganate(VII) oxidises **X**
NOT: reference to colour changes
NOT: potassium manganate(VII) is an oxidising agent (unqualified)

(ii) it/**X** does not contain a (C=C) double bond/**X** is saturated

(iii) it/**X** is a weak acid
ALLOW: **X** is a weaker acid (than hydrochloric)/**X** is weak/is not strong compared with hydrochloric acid [3]
NOT: **X** is not a strong acid

(c) (i) $C = \dfrac{2.67/12}{0.223}\quad H = \dfrac{0.220/1}{0.220}\quad O = \dfrac{7.11/16}{0.444}\quad \dfrac{(\div \text{by correct } A_r)}{(\div \text{by lowest figure})}$
simplest ratio = CHO_2 (any order) [3]

(ii) $C_2H_2O_4$ [1]

[Total: 10]

B9 **(a)** breaking down/splitting up/decomposition
(of electrolyte/compound/substance)
by electricity/electric current
ALLOW: causing a chemical reaction to occur by an electric current
ALLOW: producing elements (from compounds) by using an electric current

(b) **(i)** sodium, chloride, hydrogen, hydroxide (ALLOW: hydroxyl) (all 4 needed)
ALLOW: Na^+, Cl^-, H^+ and OH^- [1]
ALLOW: mixture of symbols and words
NOT: chlorine ions

(ii) $2Cl^- \rightarrow Cl_2 + 2e^-$ [1]
IGNORE: state symbols
ALLOW 2e instead of $2e^-$
ALLOW: $2Cl^- - 2e^- \rightarrow Cl_2$

(iii) hydrogen ions form hydrogen (gas)/hydrogen ions removed
hydroxide/OH^- ions (remaining in solution) are alkaline OR hydroxide/OH^- ions give high pH/alkalinity caused by OH^- ions [2]
NOT: hydroxide ions remain in solution (must be a link to pH)

(c) in solution ions can <u>move</u>
NOT: ions are free
ALLOW: ions carry the charge
REJECT: if reference to electrons moving
ions cannot move in solid/ions held together (by strong forces) [2]
IGNORE: electrons can't move for this mark
NOT: ions not present

(d) **(i)** reflux ALLOW: heat/high temperature/boil/warm
ALLOW: temperature range of 30–200 °C
NOT: distil
(sulphuric) acid catalyst/sulphuric acid [2]
ALLOW: other named mineral acids/hydrogen ion catalyst
NOT: acid without qualification (otherwise confusion with the lactic acid)
NOT: catalyst (unqualified)

(ii) structure of lactic acid correct i.e. $CH_3CHOHCO_2C_2H_5$ [1]
ALLOW: $RCO_2C_2H_5$
REJECT: if OH group altered

[Total: 10]

B10 (a) proton number = 53 in both isotopes **AND** electron number 53 in both
I-125 has 72 neutrons and I-131 has 78 neutrons (both needed)

(b) suitable reagent e.g. (aqueous) chlorine/(aqueous) bromine/nitric acid/(potassium) manganate(VII)/(potassium) permanganate/(sodium) dichromate/iron(III) ions
ALLOW: correct formulae
solution turns brown
ALLOW: solution turns yellow/orange [2]
IGNORE: colour of reagents at start
ALLOW: grey-black crystals or solid/grey crystals or solid/black crystals or solid
NOT: purple solution/iodine is formed

(c) $Zn + I_2 \rightarrow Zn^{2+} + 2I^-$ [2]
(1 mark for formulae, 1 mark for balance)
IGNORE: state symbols

(d) (i) this is a level of response question:
3 of the following points = 2 marks
2 of the following points = 1 mark
1 or 0 of these points = 0 mark

- high melting or boiling points/
- high density/
- form coloured compounds/

ALLOW: form coloured ions
NOT: they are coloured/they form coloured solutions

- form ions with different charges/different valencies/multiple valencies
- form complex ions/
- catalysis/they (or their compounds) are good catalysts [2]

IGNORE: general metallic properties/hard

(ii) Ti_2O_3/O_3Ti_2 [1]
NOT: Ti_4O_6

(iii) $TiCl_4 + 2H_2O \rightarrow TiO_2 + 4HCl$ [1]
ALLOW: multiples
IGNORE: state symbols

[Total: 10]