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

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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.

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UNIVERSITY of CAMBRIDGE
International Examinations

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) low 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) [2]

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) $C_{22}H_{22}O_2 + 26½O_2 \rightarrow 22CO_2 + 11H_2O$
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) $P_2O_5 + H_2O \rightarrow 2HPO_3$ [1]
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:

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

$$\frac{C_1 \times V_1}{C_2 \times V_2} = \frac{n_1}{n_2} \quad \frac{0.04 \times 18}{C_2 \times 25} = \frac{2}{1}$$ (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 surface
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) $C = \frac{2.67/12}{0.223}$ $H = \frac{0.220/1}{0.220}$ $O = \frac{7.11/16}{0.444}$ $\frac{(\div \text{by correct } A_r)}{(\div \text{by lowest figure})}$
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 [1]
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) [2]

(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]