UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Ordinary Level

MARK SCHEME for the May/June 2007 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.

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Section A

A1 **(a)** vanadium(V) (oxide)
ALLOW: vanadium pentoxide/vanadium oxide/V_2O_5

(b) carbon (monoxide) [1]
ALLOW: CO

(c) copper(II) (oxide) [1]
ALLOW: copper oxide/CuO

(d) sulphur dioxide [1]
ALLOW: SO_2
NOT: sulphur oxide

(e) calcium (oxide)
ALLOW: CaO [1]

[Total: 5]

A2 **(a)** M_r ammonium sulphate = 132, and 2N = 28;
% = 100 × 28/132 = 21 or 21.2 [2]

(b) iron(II) – grey green/green solid or precipitate
(both colour and precipitate needed for the mark)
ALLOW: ppt [1]

iron(III) – red-brown/brown/rust(y)-coloured
(both colour and precipitate needed for the mark)
ALLOW: brick red
NOT: red/pink/reddish/orange/other combinations with red or brown [1]

ALLOW: 1 mark if both colours correct but no reference to precipitate

(c) **(i)** purple to colourless [1]
ALLOW: purple to (pale) yellow

(ii) (substances whose/atoms/ions/its) oxidation number increases/
oxidation number becomes more positive/
oxidation number becomes less negative/
decreases oxidation number of another substance etc. [1]

(d) **(i)** $\frac{22.5}{1000} \times 0.02 = 4.5 \times 10^{-4}$ (moles $KMnO_4$) [1]

(ii) $4.5 \times 10^{-4} \times 5 = 2.25 \times 10^{-3}$ (moles Fe^{2+})
$2.25 \times 10^{-3} \times 56 = 0.126$ g
ALLOW: 0.13 g [2]

[Total: 9]

A3 Ca^{2+} 20 (protons), 20 (neutrons), 18 (electrons)
Cl^- 17 (protons), 20 (neutrons), 18 (electrons)

[Total:

A4 **(a)** **A** and **B** [1]

(b) **D** [1]

(c) **E** [1]

(d) butene [1]
ALLOW: butylene/but-1-ene
REJECT: but-2-ene

[Total: 4]

A5 **(a)** **(i)** Na^+ and Cl^- (both required) [1]

(ii) anode: chlorine [1]
ALLOW: Cl_2 or as product of an equation
cathode: hydrogen [1]
ALLOW: H_2 or as product of equation
IF: hydrogen at anode and chlorine at cathode = 1 mark

(b) complete circuit with electrodes dipping into electrolyte and cell(s)/(dc) power supply; [1]
impure copper anode/positive electrode and pure copper cathode/negative electrode [1]
ALLOW: + and – on diagram with impure and pure copper
ALLOW: impure copper anode and copper cathode;
(electrolyte) is <u>aqueous</u> copper(II) sulphate [1]
ALLOW: copper sulphate <u>solution</u>/<u>aqueous</u> $CuSO_4$ etc.

(c) **(i)** bauxite [1]
ALLOW: alumina/cryolite/diaspore/gibbsite/bőhmite
NOT: aluminium oxide

(ii) carbon
ALLOW: graphite [1]

[Total: 8]

A6 **(a)** (solution) turns brown/orange/yellow
NOT: black/grey/purple solution/violet gas

(b) $Cl_2 + 2KI \rightarrow 2KCl + I_2$ [1]
ALLOW: $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$

(c) electrons lost/electron loss/electrons removed OWTTE [1]
ALLOW: oxidation number of iodine increases

(d) **(i)** No reaction because
astatine is less reactive than iodine ORA/
astatine is poorer oxidising agent than iodine ORA/
astatine releases electrons less well than iodine/
ALLOW: astatine lower in the group than iodine
ALLOW: reactivity decreases down the Group [1]
NOT: astatine less reactive (without reference to iodine/position in Group)

(ii) $2Na + At_2 \rightarrow 2NaAt$ [1]
ALLOW: multiples and $Na + \frac{1}{2} At_2 \rightarrow NaAt$

[Total: 5]

A7 **(a)** carbon dioxide/CO_2: [1]
limewater goes cloudy/white/milky/white precipitate [1]
(both limewater and result needed for one mark)
IF: another gas e.g. hydrogen then no marks

(b) $CaCO_3 \rightarrow CaO + CO_2$ [1]
IGNORE: state symbols
REJECT: balanced equation with other species on left or right

(c) **U** – copper
V – magnesium
X – calcium
Y – sodium
Z – zinc correct order = 2 marks

U – sodium
V – magnesium
X – zinc
Y – copper
Z – calcium order reversed = 1 mark [2]

reason e.g.
the more reactive the metal, the longer the time taken to decompose ORA/
the more reactive the metal, the slower the rate (of decomposition) ORA/
ALLOW: more reactive metal (carbonates) take longer to decompose
ALLOW: the more reactive the metal (carbonate) the more stable it is to heat(ing) [1]
NOT: the metals are in order of the reactivity series

(d) $0.01 \times 5/2 = 0.025$ [1]

A8 (a) displayed formula for ethanoic acid
ALLOW: OH in place of O – H
NOT: CO_2H/COOH for carboxylic acid group

(b) $2Cu + O_2 + 4H^+ \rightarrow 2Cu^{2+} + 2H_2O$ [2]
correct formulae of reactants and products (1 mark)
correct balance (2nd mark)

(c) M_r of $[Cu(CH_3CO_2)_2]_2.Cu(OH)_2 = 462$;
$x = 5$ [2]

[Total: 5]

Section B

B9 (a) sodium: sodium hydroxide and hydrogen ; [1]
ALLOW: correct formulae/correct formulae in equation
NOT: sodium oxide/metallic hydroxide
magnesium: magnesium hydroxide and hydrogen; [1]
ALLOW: correct formulae/correct formulae in equation
NOT: magnesium oxide
(1 mark can be scored for hydrogen in both of the above OR sodium hydroxide and magnesium hydroxide in the above)
sodium reacts (much) faster than magnesium ORA [1]
ALLOW: any indication from observations e.g. lots of bubbles when sodium reacts with water and none/hardly any when magnesium reacts

(b) correct electronic structure of Na^+ **and** O^{2-} drawn with charge on top right [1]
ALLOW: 2,8 and symbol Na^+ **and** 2,8 and symbol O^{2-}
REJECT: charges in middle of the atom
Formula: Na_2O [1]

(c) $4Al + 3O_2 \rightarrow 2Al_2O_3$ [1]
ALLOW: multiples and $2Al + 1½\ O_2 \rightarrow Al_2O_3$

(d) Any **two** from:
high melting point or high boiling point
insoluble in water
does not conduct electricity/poor electrical conductor/electrical insulator
does not conduct heat/poor conductor of heat
ALLOW: solid or hard [2]

(e) **one** physical property: low melting point/low boiling point/poor or non-conductor of electricity/poor or non-conductor of heat; [1]
NOT: gas/liquid
one chemical property: reacts with water to give acid/reacts with alkalis (or named alkali) to give salt [1]
ALLOW: acidic oxide/acidic in nature
ALLOW: (for acid) $HClO_4$/perchloric acid formed/(for alkali) $NaClO_4$

[Total: 10]

B10 (a) **X** = activation energy;
ALLOW: E_a
Z = enthalpy change (of reaction); [2]
ALLOW: ΔH
NOT: energy change/heat given out

(b) (i) energy change is positive/enthalpy change is positive/
energy of 2NO is above that of N_2 and O_2/
energy of N_2 and O_2 is below that of 2NO/
energy of product(s) is above that of reactants/
energy of reactants is below that of product(s) [1]
NOT: it (unspecified) gains energy
NOT: the product is above the reactants

(ii) bond breaking is endothermic/absorbs energy/takes in energy; [1]
bond making is exothermic/releases energy/gives out energy; [1]
more energy is absorbed than released [1]
[**NOTE:** 3rd mark can only be scored if first two marks have been gained]
REJECT: answers in terms of energy involved in bond making/breaking
[more energy absorbed in bond breaking than release in bond making
OWTTE = 3 marks]

(c) (i) activation energy lowered/provides surface for molecules to react/makes the reaction go by quicker alternative pathway
NOT: allows more frequent collisions [1]

(ii) 2.4/2 = 1.2 dm^3 (unit required) [1]

(iii) **either:**
$\frac{1.0}{1.2} \times 100$ (1 mark) = 83/83.3% (1 mark) [2]
ALLOW: ecf from part **(ii)**
or:
1.0/24 = 0.04166 (mol N_2)
moles NO = 2 × 0.04166 = 0.0833 (moles) (1 mark)
predicted moles NO = 2.4/24 = 0.1 (moles)
100 × 0.0833/0.1 = 83/83.3% (2nd mark)

[Total: 10]

B11 (a) $C_nH_{2n+1}OH$
ALLOW: other letters e.g. x for n
NOT: $C_nH_{2n+2}O$

(b) carbon dioxide and water (both needed) [1]
ALLOW: correct formulae/steam for water

(c) (i) **for first mark**
$C_2H_4 + H_2O \rightarrow C_2H_5OH$ [1]
[NOT: C_2H_6O for ethanol]
for second mark any **two** of:
high temperature/
ALLOW: 200°C to 400°C (usual = 300°C)
high pressure/
ALLOW: 50–100 atm (usual = 70 atm)
acid catalyst/phosphoric acid
REJECT: other named acids
IGNORE: silica/zeolite [1]

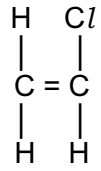
(ii) **either:**
M_r for glucose 180 and ethanol 46 ; [1]
180 g glucose → 92 g ethanol; [1]
36 × 92/180 = 18.4 tonnes (unit needed) [1]
or:
moles glucose = $36 \times 10^6/180 = 0.2 \times 10^6$ moles (1 mark)
0.2×10^6 moles glucose → 0.4×10^6 moles ethanol (1 mark)
$0.4 \times 10^6 \times 46 = 18.4$ tonnes (1 mark)

(iii) ethene obtained from <u>crude</u> oil/petroleum/fossil fuels which is a finite resource/ non-renewable/will run out; [1]
glucose obtained from plants so continuous supply/renewable resource/won't run out; [1]
ALLOW: reasonable named crop plants e.g. beet/wheat
ALLOW: glucose obtained by photosynthesis in place of plants
NOT: glucose made with the help of sunlight so renewable
NOT: because glucose is organic
(ethene from petroleum and glucose from plants = 1 mark)

(d) propanoic acid [1]
ALLOW: propionic acid/correct formula
ALLOW: propanal
NOT: propanic acid

[Total: 10]

B12 (a) correct structure of chloroethene showing all atoms and bonds



[1]

(b) (i) (bond formed) by sharing pair of electrons/two electrons (between the atoms) [1]
NOT: electrons shared between two non metal atoms

(ii) electrons can't move/no mobile electrons/electrons not free to move [1]
NOT: no free electrons/no sea of electrons
REJECT: there are no ions or electrons to conduct

(c) (i) fills up landfill sites quickly/stays a long time in the ground/needs a lot of landfill sites/takes up a lot of (valuable) land/blocks up drains [1]
ALLOW: can choke animals/fish/birds
[NOT: harms animals/fish/birds]
NOT: explanation of non-biodegradable e.g. does not rot
NOT: not produces harmful fumes when burnt
NOT: land pollution/fills up landfill sites (without qualification)

(ii) calcium chloride/$CaCl_2$ [1]
carbon dioxide/CO_2 [1]
water/H_2O [1]

(d) (i) correct dot and cross diagram including inner shells of carbon [2]
(paired electrons must be on the overlap areas of the orbits);
inner shells of carbon missing/incorrect number of inner shells = 1 mark maximum

(ii) 28 tonnes (unit required) [1]

[Total: 10]