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

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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)** vanadium(V) (oxide) [1]
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) [1]
Cl^- 17 (protons), 20 (neutrons), 18 (electrons) [1]

[Total: 2]

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 [1]
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 $Na + ½\ At_2 \rightarrow NaAt$

[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]

[Total: 7]

A8 (a) displayed formula for ethanoic acid [1]
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; [1]
ALLOW: E_a
Z = enthalpy change (of reaction); [1]
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) $C_nH_{2n+1}OH$ [1]
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]

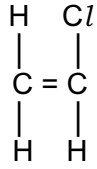
(ii) **either:**
M_r for glucose 180 and ethanol 46 ; [1]
180 g glucose → 92 g ethanol; [1]
36 × 92/180 = 18.4 tonnes (unit needed) [1]
or:
moles glucose = $36 \times 10^6/180 = 0.2 \times 10^6$ moles (1 mark)
0.2×10^6 moles glucose → 0.4×10^6 moles ethanol (1 mark)
$0.4 \times 10^6 \times 46 = 18.4$ 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 [1]
a lot of landfill sites/takes up a lot of (valuable) land/blocks up drains
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]