**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Ordinary Level**

# MARK SCHEME for the May/June 2010 question paper

# for the guidance of teachers

## 5070 CHEMISTRY

**5070/22** Paper 2 (Theory), maximum raw mark 75

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UNIVERSITY of CAMBRIDGE
International Examinations

**A1** **(a)** $CF_3Cl$ [1]

**(b)** $CH_4$ / $CO_2$ [1]

**(c)** $CaCO_3$ [1]

**(d)** $BaSO_4$ / $CaCO_3$ [1]

**(e)** $K_2Cr_2O_7$ [1]

**(f)** $C_2H_4$ [1]

**[Total: 6]**

**A2** **(a)** 1 / one [1]

**(b)** proton (atomic) number = 87
number of protons = 87
number of electrons = 87
number of neutrons = 136

All correct = 2 marks [2]
Any 3 correct = 1 mark

**(c)** Any two of:
- thermal conductor /
- electrical conductor /
- soft **or** cuts easily /
- low melting point **or** low boiling point /
- (relatively) low density **or** lightweight IGNORE: light
- malleable /
- ductile /
- shiny **or** silvery ALLOW: grey IGNORE: white / [2]

IGNORE: floats on water / sonorous.
IGNORE: chemical properties
IGNORE: comparisons e.g. heavier than lithium

**(d)** $2Fr + 2H_2O \rightarrow 2FrOH + H_2$ [1]
ALLOW: multiples
ALLOW: $Fr + H_2O \rightarrow FrOH + ½H_2$
IGNORE: state symbols

**[Total: 6]**

**A3 (a)** $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$ [2]
1 mark for correctly balanced equation ;
1 mark for correct state symbols (dependent on all formulae being correct)

**(b) (i)** gas escapes / hydrogen escapes / gas given off / hydrogen given off / gas released / hydrogen released / gas produced / gas evolved / hydrogen is a gas ; [1]
NOT: hydrogen produced without qualification. ALLOW: ecf from wrong gas in part **(a)**

**(ii)** downwards curve starting at the same point as the original curve but displayed to the left (at least at first) ; [1]

Line ends at the same mass as the original ; [1]
NOT: curve dipping markedly below the horizontal section and then going upwards to meet it

**(c)** (acid) particles in dilute acid are less crowded / there are fewer particles (of acid) in a given volume / the particles (of acid) are further apart ; [1]
ALLOW: concentration of $HCl$ particles is lower
ALLOW: molecules / ions in place of particles
ALLOW: reverse argument e.g. particles in concentrated acid are more crowded / there are more particles (of acid) in a given volume etc
IGNORE: there are fewer molecules unqualified / there is more water there are more moles in a given volume.

fewer collisions (in dilute acid) / less chance of collisions (in dilute acid) / frequency of collisions lower (in dilute acid) ; [1]
ALLOW: reverse argument e.g. more collisions (in concentrated acid) / more chance of collisions (in concentrated acid) ;
IGNORE: effective (collisions)

**(d)** more particles exposed / large(r) surface area ; [1]
ALLOW: atoms / ions in place of particles

more collisions / greater chance of collisions / particles collide more often / greater frequency of collisions ; [1]
IGNORE: effective (collisions)

**(e)** white precipitate / ppt **or** white solid ; [1]
IGNORE: bubbles / colourless ppt / incorrectly named ppt

precipitate redissolves (in excess) / precipitate goes to (colourless) solution (in excess) ; [1]
ALLOW: this mark if wrong colour precipitate
NOTE: second mark dependent on ppt or solid stated for first mark

**[Total: 11]**

**A4 (a)** graphite has electron(s) that can move / are mobile / are delocalised ; [1]
ALLOW: graphite has free electron(s) / graphite has a sea of electrons
REJECT: implications of layers moving / ions have free electrons

diamond has <u>all</u> its electrons involved in bonding / has electron(s) that cannot move / are not mobile / no delocalised electrons ; [1]
ALLOW: diamond has no free electron(s)
REJECT: mention of ions

**(b)** solid sodium chloride has ions fixed in position / ions cannot move ; [1]
IGNORE: electrons cannot move / ions can't carry electricity / references to intermolecular forces
ALLOW: ions are not free
REJECT: no ions to move
aqueous sodium chloride has ions that can move / are mobile ; [1]
ALLOW: ions are free
REJECT: reference to moving electrons as well as ions
IGNORE: ions carry electric charge / ions dislocated / ions delocalised /

**(c)** 1st row: lead at cathode **and** bromine at anode ; [1]
ALLOW: Pb at cathode / $Br_2$ at anode
REJECT: lead(II) / $Pb^{2+}$ / $Br^-$ / bromide
IGNORE: Br
2nd row: oxygen / $O_2$ ; [1]
REJECT: $O^{2-}$
IGNORE: O
3rd row: hydrogen / $H_2$ ; [1]
REJECT: $H^+$
IGNORE: H

**(d)** commercial use e.g. extraction of aluminium or any other element which is definitely extracted by electrolysis / purification of copper / (electro)plating ; [1]
ALLOW: coating metals / hair removal / production of sodium hydroxide
NOT: electrolysis **of** named substance unqualified / reference to electrochemical cells

correct electrolyte / correct formula of electrolyte:
This mark is dependent on the correct use BUT allow if it is feasible e.g. zinc sulphate (given incorrect use of zinc in the first part).
e.g. molten aluminium oxide dissolved in <u>cryolite</u> / (aqueous) copper sulfate or
copper sulfate (solution) / for hair removal accept sweat or sodium chloride (solution). [1]

correct ionic equation: This mark is dependent on the electrolyte used; [1]
e.g. $Al^{3+} + 3e^- \rightarrow Al$ / $Cu^{2+} + 2e^- \rightarrow Cu$ / $2H^+ + 2e^- \rightarrow H_2$

**[Total: 10]**

**A5 (a)** cracking / thermal decomposition ; [1]

**(b) (i)** $C_2H_4 + H_2O \rightarrow C_2H_5OH$ [1]
ALLOW: $C_2H_6O$ for the product

**(ii)** propanol; [1]
ALLOW: propan-1-ol / propan-2-ol
IGNORE: formulae

**(c) (i)** any **two** from: [2]
- temperature between 25°C to 40°C /

REJECT: high temperature IGNORE: room temperature
- yeast / zymase / enzymes /

IGNORE: catalyst alone
- absence of oxygen / anaerobic (conditions) / not exposed to air
- water REJECT: moisture / damp
- pH neutral / near neutral / pH 7

IGNORE: pressure / presence of glucose

**(ii)** any one of: [1]
renewable raw materials used or renewable fuel made NOT: renewable process / conserves valuable resources / lower energy costs / lower temperature required / lower pressure required / consumes less energy / atmospheric pressure required / specialised equipment not required / simple apparatus required;
ALLOW: carbon neutral / carbon dioxide made (in this process) can be used for photosynthesis (to make more glucose) NOT: carbon dioxide can be used for photosynthesis alone
IGNORE: not as complicated / references to pollution / consumes energy without qualification
NOT: costs alone / faster / uses glucose without qualification

**(d)** (fractional) distillation / fractionation; [1]
ALLOW: description of distillation e.g. evaporating then condensing the alcohol (first)
IGNORE: using an anhydrous salt / named anhydrous salt

**(e)** <u>lime water</u> goes milky / cloudy / chalky / misty / white precipitate [1]

**[Total: 8]**

**A6 (a) (i)** addition ; [1]
ALLOW: additional
IGNORE: specific names

**(ii)** minimum required is $C_2H_5CH=CH_2$ [1]

**(iii)** no (carbon-carbon) double bonds / only has (carbon-carbon) single bonds [1]
ALLOW: no hydrogen can be added / no addition reactions / carbons fully occupied by (hydrogen atoms)
NOT: occupied by wrong atoms e.g. C*l* atoms
NOT: has carbon-carbon single bonds

**(b)** non-biodegradeable / can't be broken down by bacteria / insoluble in water / only soluble in organic solvents [1]
ALLOW: doesn't react with water / unreactive
IGNORE: it is a hydrocarbon / it is strongly bonded

**[Total: 4]**

**B7 (a)** non-polluting gases formed / harmless gases formed / nitrogen and water are harmless / nitrogen and water are non-polluting / the products are non-polluting/the products are harmless ; [1]
ALLOW: nitrogen and water don't affect ozone / don't contribute (as much) to greenhouse effect / don't contribute to acid rain
NOT: nitrogen and water less harmful / nitrogen and water are formed (without qualification) / environmentally friendly products

**(b)** bond breaking endothermic / requires energy / absorbs energy
**AND** bond making exothermic / releases energy / gives out energy ; [1]

more energy is released than absorbed (or similar wording) ; [1]
REJECT: implication that energy needed in bond formation
NOTE: energy released on forming bonds is greater than energy taken in to break bonds (or similar wording) = 2 marks

**(c) (i)** moles $N_2H_4$ = 1 000 000 / 32 = 31 250 ; [1]

moles $O_2$ = moles $N_2H_4$ or implication of this in working ; [1]
ALLOW: ecf from wrong moles of $N_2H_4$

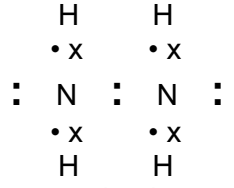
Volume of $O_2$ (31 250 × 24) = 750 000 $dm^3$ / 7.5 × $10^5$ $dm^3$ ; [1]
ALLOW: ecf from second mark.

Alternative for 1st two stages:
32 g $N_2H_4 \rightarrow$ 32g $O_2$ (1 mark)
moles $O_2$ = 1 000 000 / 32 = 31 250 (allow ecf) (1 mark)

**(ii)** it / liquid oxygen takes up less space / room ; [1]
ALLOW: able to store more in liquid form / gaseous volume too high / maximum storage capacity.
IGNORE: less easily spread out/no gas can escape / less possibility of an explosion / to prevent reaction with other substances

**(d) (i)** $N_2H_5Cl$ / $N_2H_6Cl_2$ [1]
ALLOW: any order of atoms
ALLOW: correct displayed formulae or mixtures of displayed and molecular
REJECT: $N_2H_5Cl$ in equation if more than one product given

**(ii)** [2]



Structure completely correct = 2 marks
NOTE: (i) only outer shells need be shown
(ii) no distinction need be made between dots and crosses
IF: inner shells incorrect = 1 mark maximum.
IF: structure with a triple bond and no lone pairs = 1 mark
NOT: structures with separate nitrogen atoms / double bonds (= 0)

**B8 (a) (i)** butanoic acid / methylpropanoic acid ; [1]

**(ii)** minimum is $CH_3CH_2CH_2COOH$ / $(CH_3)_2CHCOOH$ [1]
ALLOW: correct displayed formulae or mixture of structural and displayed

**(iii)** $C_2H_4O$ [1]

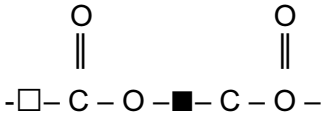
**(b)** molar ratio correct C = 4.35, H = 13.0, O = 2.18 ; [1]

$C_2H_6O$ [1]
ALLOW: correct error carried forward as long as there is not too much rounding up or down from the first stage
ALLOW: $C_2H_5OH$

**(c) (i)** ethyl ethanoate ; [1]

**(ii)** solvent / flavouring / perfume / aroma /
ALLOW: to make the taste in sweets / deodorants
IGNORE: food additive

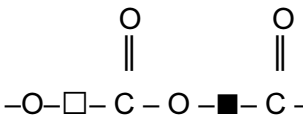
**(d) (i)**




[2]

correct structure of ester linkage showing ALL atoms and bonds (including bonds to the boxes) = 1 mark

at least 2 units shown with continuation bonds = 1 mark
ALLOW: ester linkages reversed
ALLOW: boxes or part formulae between ester linkages the same
NOT: more than three type of 'boxes'
ALLOW:




ALLOW: single unit shown bracketed and continuation bonds
2nd mark dependent on ester linkage being shown correctly, or as –COO- or –CO2- etc

**(ii)** fat / lipid / (tri)glyceride; [1]

**B9 (a)** reaction in which there is electron transfer / one reactant loses electrons and the other gains electrons / both oxidation and reduction occur ; [1]
ALLOW: a reaction involving changes in oxidation state
IGNORE: gaining and losing oxygen / gaining and losing hydrogen

**(b) (i)** less iodine present / lower concentration of iodine ; [1]
NOT: less reactants present / diluted in colour because more colourless HI present

(position of) equilibrium moves to the right / increased yield / reaction moves to the right ; [1]
ALLOW: more hydrogen and iodine react to form hydrogen iodide
ALLOW: more hydrogen iodide formed / more product formed / rate of forward reaction increases (to achieve new equilibrium)

The reaction is endothermic / the reaction absorbs heat (or energy) / $\Delta H$ is positive; [1]

**(c)** moles of hydrogen = 45.3 / 2 = 22.65 [1]
answer only scores mark
ALLOW: 22.7

moles of HI = 45.3; [1]
ALLOW: ecf / indication that moles HI 2× moles of hydrogen i.e. use of 1:2 ratio

mass = (45.3 × 128) = 5798 g / 5798.4 g; [1]
ALLOW: ecf moles HI / 5800 g

Alternative method:
2 g hydrogen $\rightarrow$ 2 × 128 = 256 g HI (1 mark)
so 1 g hydrogen $\rightarrow$ 128 g HI (1 mark)
45.3 g hydrogen $\rightarrow$ 45.3 × 256 / 2 = 5798(.4) g (1 mark)

**(d) (i)** $Pb^{2+}(aq) + 2I^{-}(aq) \rightarrow PbI_2(s)$ [2]

balanced equation = 1 mark
correct state symbols = 1 mark (dependent on correct formulae above)
ALLOW: full ionic equation
NOT: $X^{-}$ in place $I^{-}$ and $PbX_2$ in place of $PbI_2$

**(ii)** it or X is a reducing agent / HI is a reducing agent / it or X can be oxidised / HI can be oxidised ; [1]

**B10 (a) (i)** $KOH + HCl \rightarrow KCl + H_2O$ [1]
ALLOW: $K_2CO_3 + 2HCl \rightarrow 2KCl + H_2O + CO_2$
ALLOW: $KHCO_3 + HCl \rightarrow KCl + H_2O + CO_2$
IGNORE: state symbols
NOT: word equation

**(ii)** titrate (acid against alkali) / titration / description of titration e.g. add one solution to the other until neutralised / add one solution to another until (acid-base) indicator changes colour ; [1]
IGNORE: lack of repeating the titration without indicator

Evaporate the solution (from the titration flask to dryness) ; [1]
ALLOW: evaporate / heat / boil
ALLOW: ecf from wrongly named solution in first marking point
ALLOW: evaporation etc from potassium chloride / salt solution without reference to titration
REJECT: if method incorrect e.g. precipitation the mark for part **(ii)** is zero in total.

**(b) (i)** $(NH_4)_3PO_4$ [1]
ALLOW: $PO_4(NH_4)_3$

**(ii)** molar mass $(NH_4)_3PO_4 = 149$; [1]
ALLOW: ecf from wrong formula in part **(i)**

% by mass = 28.2 [1]
ALLOW: 28.19 / 28
ALLOW: ecf from wrong molar mass

**(c) (i)** $Ca(OH)_2 + 2H^+ \rightarrow Ca^{2+} + 2H_2O$ [1]
ALLOW: $Ca^{2+} + 2OH^- + 2H^+ \rightarrow Ca^{2+} + 2OH^- + 2H_2O$
ALLOW: $OH^- + H^+ \rightarrow H_2O$ (or multiples)

**(ii)** ammonium phosphate (reacts with calcium hydroxide to) give ammonia / there is loss of nitrogen (content) with ammonium phosphate [1]
ALLOW: reverse arguments
IGNORE: ammonia poisonous / potassium nitrate is more soluble
REJECT: loses nitrogen gas / potassium nitrate has a greater % of nitrogen

**(d)** add (excess) sodium hydroxide **and** aluminium (powder / foil and warm) ; [1]
ALLOW: add sodium hydroxide **and** Devarda's alloy

ammonia given off / gas (given off) turns red litmus blue; [1]
NOTE: this mark is dependent on correct reagents $Al$ + NaOH

Alternative:
add iron(II) sulfate then concentrated sulfuric acid (1 mark)
brown ring forms at the interface (1 mark)