UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Ordinary Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

5070 CHEMISTRY

5070/22 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, which would have considered the acceptability of alternative answers.

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A1 NOTE: in **A1 (a)–(d)** the name takes precedence over the formula if both given

(a) sodium hydroxide / NaOH [1]

(b) copper(II) sulfate / $CuSO_4$ [1]
ALLOW: copper sulfate

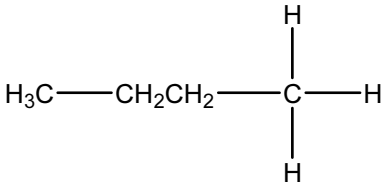
(c) ammonia / NH_3 [1]

(d) zinc carbonate / $ZnCO_3$ [1]

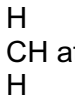
[Total:4]

A2 **(a)** C_nH_{2n+2} [1]
ALLOW: x in place of n

(b) $CH_3CH_2CH_2CH_3$ / displayed formula; [1]
ALLOW: mixture of displayed and structural formula e.g.

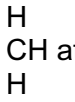


ALLOW: $(CH_2)_2$ in middle

REJECT: – 

REJECT: if one or more hydrogen atoms missing in displayed formula

$(CH_3)_2CHCH_3$ / displayed formula [1]
ALLOW: mixture of displayed and structural formula

REJECT: – 

REJECT: if one or more hydrogen atoms missing in displayed formula

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(c) (i) substitution [1]
ALLOW: if qualifying adjective to substitution e.g.
nucleophilic substitution/ chlorine substitution
IGNORE: chlorination / halogenation
APPLY: listing e.g. substitution + addition = 0

(ii) Any correct structure of a chloro substituted butane e.g. [1]

$CH_3CH_2CH_2CH_2Cl$ / $CH_3CH_2CHClCH_3$ /

$CH_3CH_2CHClCH_2Cl$

ALLOW: displayed formula /mixture of displayed and structural formula
APPLY same rules as in **(b)**

(d) fractional distillation [1]
ALLOW: fractionation
APPLY: listing

[Total:6]

A3 (a) (i) contains carbon–carbon double bonds; [1]

contains many / more than one (double bond); [1]
NOTE: 2nd mark dependent on double bonds being stated
REJECT: ideas of monomers e.g. chains of many monomers which contain C=C double bonds
REJECT: ideas of polymers

(ii) add aqueous bromine / add bromine water; [1]
ALLOW: add bromine / bromine liquid / bromine gas

with saturated hydrocarbon, bromine stays orange but unsaturated decolourised / with saturated hydrocarbon bromine does not change colour but unsaturated decolourise [1]

ALLOW: red-brown / brown / yellow for colour of bromine (but no other colours / not red)
IGNORE: unsaturated becomes clear / unsaturated becomes discoloured

ALLOW: (acidified) potassium mangante(VII) / potassium permanganate (1 mark)

with saturated hydrocarbon, potassium permanganate stays purple / pink but unsaturated decolourised / with saturated hydrocarbon potassium permanganate does not change colour but unsaturated decolourised (1 mark)

NOTE: it must be made clear which is the test for saturated and which is the test for the unsaturated compound

(b) hydrogenation / reaction with hydrogen / reaction with H_2 / bubbling hydrogen through the mixture / adding hydrogen [1]
APPLY: listing e.g. adding hydrogen and oxygen = 0
IGNORE: conditions

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(c) carbon dioxide / CO_2; [1]

water / H_2O / steam / hydrogen oxide [1]
ALLOW: carbon dioxide / CO_2 and water / H_2O etc as products from an equation
APPLY: listing

(d) 35% [2]
ALLOW: error carried forward from wrong M_r (for 1 mark)
ALLOW: 1 mark for M_r = 80 if answer is incorrect and no error carried forward

(e) **(i)** Any two from: [2]

- (increased) global warming / increased atmospheric temperature / Earth will be warmer / Earth will be hotter / environment is getting hotter
  NOT: it is getting hot
- climate change / example of climate change e.g. desertification / more heavy storms / more hurricanes / more tornados / more winds etc
  NOTE: there must be emphasis on increase in drastic weather conditions. Change in weather conditions is not enough.
- rise in sea level / polar ice melts / polar ice-cap melts / glaciers melt / flooding of low lying areas
  IGNORE: ice melts without qualification / flooding without qualification
  IGNORE: pollution / effect on humans / mention of ozone / acid rain

(ii) $NH_4NO_3 \rightarrow N_2O + 2H_2O$ [1]
ALLOW: multiples
IGNORE: state symbols

[Total: 12]

A4 **(a)** 7 [1]

(b) (number of protons) 117; [1]

(number of neutrons) 163 [1]
ALLOW: error carried forward from number of protons i.e. 280 – number of protons)

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(c) Any 2 of: [2]

- poor electrical conductor / does not conduct electricity / poor conductor of heat / does not conduct heat
- solid / crystalline
- has (relatively) low melting point / (relatively) low boiling point / highest melting point of the Group / highest boiling point of the Group / higher melting point (or boiling point) than iodine
  NOT: higher melting point / boiling point alone
- black / grey / dark (no other colours e.g. dark brown)
  ALLOW: darker than iodine / astatine
  IGNORE: darker (without iodine/ astatine)
- insoluble in water / soluble in organic solvents
- radioactive
  IGNORE: low density / dull surface / soft / hazardous / poisonous / diatomic

(d) (i) $Mg + F_2 \rightarrow MgF_2$ [1]
IGNORE: state symbols

(ii) F^- is 2,8 ; [1]
(only 1 F^- need be shown)

Mg^{2+} is 2,8 [1]

ALLOW: information from diagram
ALLOW: 1 mark for Mg^{2+} and F^- (correct charges)
ALLOW: 1 mark for correct electronic structure for both ions i.e. 2,8 and 2,8
ALLOW: Fl^- for F^-
IF: charge in nucleus in two otherwise correct diagrams = 1 mark

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(e) (i) shared pair of electrons between carbon and each of the 4 halogen atoms; [1]
ALLOW: all dots / all crosses

rest of structure correct [1]
IGNORE: inner shells of electrons
IGNORE: type of halogen atoms e.g. CCl_4 / CF_4
REJECT: incorrect arrangement of atoms e.g. CF_3

(ii) Any one of: [1]

- poor conductor of heat / does not conduct heat
- has low melting point / has low boiling point / it is a gas
  allow: it is a liquid
- low density
- insoluble in water / soluble in organic solvents
  IGNORE: covalent / forms dimers

(iii) ozone depletion / destroys ozone layer / damages ozone layer / hole in the ozone layer / converts ozone to oxygen [1]
ALLOW: global warming / any of the results of global warming mentioned in **3e(i)**
REJECT: acid rain

[Total: 12]

A5 (a) many (strong) covalent bonds [1]
IGNORE: has a giant molecular structure

needs a lot of energy to break bonds / needs a lot of heat to break bonds / needs high temperature to break bonds [1]
ALLOW: hard to break the bonds / large amount of energy to overcome bonds / lot of energy needed to break strong forces between atoms
NOT: (just) lot of energy needed to break strong forces
REJECT: references to intermolecular or ionic forces = 0 for the question

(b) (i) no free electrons / no mobile electrons / electrons not free to move / <u>all</u> outer electrons fixed in position / no delocalised electrons / <u>all</u> electrons involved in covalent bonding / no sea of electrons [1]
ALLOW: the four electrons needed to form a covalent bond
IGNORE: no ions to move

(ii) (some) electrons free to move / it has delocalised electrons / blue diamond has delocalised electrons (some of the) electrons are delocalised / (some) free electrons / sea of electrons [1]
IGNORE: boron is metallic / boron is a metalloid / boron has sea of electrons / boron has delocalised electrons

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(c) Any two from: [2]

- conducts electricity / has free moving electrons
- high melting point
- (relatively) unreactive
  ALLOW: less reactive / doesn't react with solution
- doesn't dissolve in water / insoluble in water
  IGNORE: price / it is a solid

[Total: 6]

A6 (a) Nylon / Kevlar / Trogamid / Kermal / Nomex / Twaron / Technon / Teijinconex / Rilson / Ultramid [1]

(b) Marks can be obtained from written material or diagram

spot of mixture on (filter) paper above solvent level and paper dipping into solvent [1]
ALLOW: liquid (for solvent)

from diagram: paper dipping into a solvent (which needn't be labelled) and spot shown on either (i) just above solvent or (ii) further up the paper with base line shown or (iii) on base line and further up
NOTE: base line and /or spot must be above solvent level
ALLOW: liquid (for solvent)

spray with locating agent / use locating agent / spray with ninhydrin / use ninhydrin; [1]
ALLOW; spray with colouring agent
NOTE: the locating agent mark must be in context of the paper after running the amino acids not at another stage e.g. adding it to the solvent

The next 2 marks can be accessed in two ways:

EITHER
First way:
measure R_f value(s) / use R_f values / description of how to measure R_f e.g.

$$R_f = \frac{\text{distance moved by spot (from base line)}}{\text{distance moved by solvent front (from base line)}}$$ [1]

compare against standard R_f values / compare with known R_f values/ compare with R_f values in book [1]

OR
Second way:
run known and unknown amino acid on the same piece of paper [1]
ALLOW: from diagram with labels of known and unknown

compare unknown (amino acid) with distance travelled by known (amino acids) on same piece of paper
ALLOW: from diagram showing spots of known and unknown run the same distance with some labelling explanation in words e.g. same (distance) / run equal distance [1]

[Total:5]

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B7 (a) reaction absorbs energy / reaction absorbs heat / it absorbs energy / it absorbs heat [1]
ALLOW: temperature of surroundings decreases / energy of products greater than energy of reactants / energy needed greater than energy released / it goes cold / bond energy of products is less than bond energy of reactants
IGNORE: energy needed to break the bonds (alone) / ΔH is positive
IGNORE: energy needed (on its own)
IGNORE: implications of activation energy e.g. heat needed to start the reaction

(b) product to the right and above reactants; [1]
ALLOW: NO / nitrogen oxide as product

E_a for forward reaction correctly labelled; [1]
IGNORE: double-headed arrow / arrow without any heads /
NOT: arrow pointing downwards
NOTE: arrow does not have to start exactly at reactant line and finish exactly at maximum of curve

ΔH labelled correctly with arrow pointing upwards (for endothermic reaction); [1]
ALLOW: + 66 (kJ mol^{-1}) in place of ΔH
ALLOW: *H2 – H1* with *H2* and *H1 shown* on vertical axis of diagram

NOTE: arrow does not have to start exactly at reactant level and finish exactly at product level
NOT: arrows with double heads / arrow pointing downwards

NOTE: Max 2 marks for error carried forward from a reaction that is exothermic and has products on right as long as the arrows for E_a and ΔH are appropriate

(c) moles N_2 = $\frac{100}{28}$ or 3.57 / 3.6 ; [1]

moles nitric oxide = 7.14 / indication of 2 x moles of N_2 [1]
ALLOW: error carried forward from incorrect moles N_2
IGNORE: 2 x mass in grams

mass of nitric oxide = (7.14 x 30) = 214 g [1]
ALLOW: 214.2 g / 214.3 / 214.28 / 214.29 g / answer to the number of significant figures the Candidate uses (minimum 2 SF's)
ALLOW: error carried forward from incorrect moles of nitric oxide

NOTE:
ALLOW: answer to two significant figures e.g. 210
IF: first marking point has been reduced to 2 significant figures i.e. 3.6 (1 mark) This gives 7.2 for the second marking point (1 mark) and an answer of 216 (3rd mark)

OR
28 g N_2 gives 60 g nitric oxide (1 mark)
100 g N_2 gives (100 x 60/28 g) nitric oxide = 214 g (1 mark)

mass of nitric oxide = (7.14 x 30) = 214 g

[NOTE: correct answer without working scores 3 marks]

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(d) rate increases / speed increases; [1]

more particles in given volume / more particles in same volume / more particles per cm^3 / particles more crowded / particles closer together / more concentrated particles [1]
IGNORE: more collisions unqualified / more particles in a given area
ALLOW: molecules / atoms / species for particles

more collisions per second / collision frequency increases/ increases collision rate / higher chance of collisions / collide more often / higher probability of collisions; [1]
IGNORE: more effective collisions / more energetic collisions unqualified / quicker collisions
IGNORE: equilibrium statements

[Total: 10]

B8 (a) H^+ / H_3O^+ [1]

(b) (i) carbon dioxide / CO_2 [1]

(ii) $Mg(C_2H_5CO_2)_2$ / $(C_2H_5CO_2)_2Mg$ / $Mg(C_2H_5COO)_2$ / $(C_2H_5COO)_2Mg$ [1]

(c) (i) moles hydrogen = $\frac{60}{24000}$ or 0.0025 ; [1]

moles magnesium = 0.0025 ; [1]
ALLOW: error carried forward from moles of hydrogen

mass magnesium (= 0.0025 x 24) = 0.06 g [1]
ALLOW: error carried forward from moles of magnesium / error carried forward from using 22 400 as molar gas volume

[correct answer without working = 3 marks)

(ii) same volume at the end of the experiment ; [1]
same general shape but initial gradient less and levels out after 120 s [1]

(d) $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
correct balanced equation ; [1]

correct state symbols (dependent on the correct species) [1]

[Total: 10]

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B9 (a) closely packed positive ions regularly arranged; [1]
REJECT: closely packed atoms

sea of electrons / delocalised electrons / free electrons; [1]
NOTE: electrons can be shown in diagram as e^- / e or – or dots labelled electron

attraction between electrons and positive ions [1]
IGNORE: attraction between electrons and protons
NOTE: marks can be obtained from either written description or a diagram but take account of any contradictory statements

(b) (i) electrons can move / has delocalised electrons / electrons are free / has sea of electrons / has mobile electrons [1]

(ii) impure copper anode and pure copper cathode ; [1]

electrolysis of (aqueous) copper(II) sulfate / copper(II) nitrate [1]
ALLOW: electrolysis of copper sulfate / copper nitrate
NOT: electrolysis of copper chloride
ALLOW: description of electrolysis e.g. cells connected to electrodes dipping in electrolyte / pass electric current through solution of copper sulfate
ALLOW: relevant information from a diagram
IGNORE: copper being deposited at the wrong electrode

(c) brass / bronze / gilding metal / Muntz metal / yellow metal / bell metal / cupro-nickel / gunmetal / speculum metal / (cupro) nickel-silver / duralumin [1]
ALLOW: smart alloy / gold alloy
IGNORE: steel alloys

(d) Any three of: [3]

- copper ores are in limited supply / are becoming worked out / are finite (resource) / saves resources / less copper extracted from the soil
  IGNORE: no waste of copper
- less energy used (in recycling than in extracting from the ore)
- reduces pollution / reduces waste / reduces trash / less eyesore / not an eyesore / less landfill / no landfill
  IGNORE: does not cause pollution
- (need to) sort out recycled metals / (need to) collect scrap / collecting scrap (costs money) / collecting scrap requires energy
- need to purify the recycled copper
- (less mining) saves more land for other uses / (less mining) saves land for more agriculture
  IGNORE: costs / time consuming

[Total: 10]

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B10 (a) CH_2O [1]

(b) (i) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ [1]
ALLOW: $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$
IGNORE: word equation

(ii) Any two of: [2]

- needs sunlight (NOT: light alone)
- needs chlorophyll
- needs enzyme(s)
- temperature values quoted from 20 and 40 °C (if range given, both values should be within the range)
  ALLOW: 'body' temperature
  IGNORE: temperature more than a specified temperature / temperature less than a specified temperature / room temperature
  APPLY: listing but ignore CO_2 and H_2O in listing

(c) (i) Any two of: [2]

- temperature values quoted from 20 and 40 °C (if range given, both values should be within the range)
  ALLOW: 'body' temperature
  IGNORE: temperature more than a specified temperature / temperature less than a specified temperature / room temperature
- water / moisture / damp
  IGNORE: humid
- needs yeast / enzymes / zymase
- pH 7 / pH near 7 / neutral
- absence of oxygen / anaerobic
  IGNORE: minerals / salts
  APPLY: listing

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(ii) Method 1:
moles of glucose = $\frac{1000000}{180}$ / 5 556 / 5 555.5 ; [1]

moles ethanol = 2 x moles glucose / 11 111 / 11 112 ; [1]
ALLOW: error carried forward from wrong moles of glucose

mass of ethanol = (46 x moles ethanol) = 511 106 g / 511 111 g/ 511 152 g / 0.511 106 to 0.511 152 tonnes [1]
ALLOW: 0.51(1) tonnes / 511 000 g / 510 000 g
ALLOW: error carried forward from incorrect moles of ethanol

[correct answer without working = 3 marks]

ALLOW: 0.5 as final answer depending on working being correct i.e. not 1 tonne ÷ 2
IF: no other marks scored allow correct molar masses of glucose and ethanol i.e. 180 and 46
NOTE: if working is in tonnes but answer incorrect candidates can get a mark for 1/180 and a mark for 2 x moles glucose

ALLOW: credit for answers derived from particular part rounded to 1 significant figure e.g. 5.5 x 10^3 x 2 = 1 x 10^4 gets the first 2 marks.

Alternative: Method 2
180 g glucose → 46 g ethanol (1 mark)
indication of correct molar ratio e.g. 2 x 46 / 92 (1 mark for either)
ALLOW: error carried forward
1 000 000 g glucose → 1 000 000 x 92/ 180 = 511 111 g (1 mark)
ALLOW: error carried forward from incorrect moles of ethanol

(iii) produces a greenhouse gas / carbon dioxide is a greenhouse gas / need to separate ethanol from fermentation mixture (or words to that effect) [1]
ALLOW: fermentation is a slow process
IGNORE: fermentation is a long process / takes a long time
ALLOW: fewer food crops / fewer plants grown for food / food crop used for biofuels instead of food
IGNORE: global warming / carbon dioxide given off / high activation energy

[Total:10]

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