Location Entry Codes

UNIVERSITY of CAMBRIDGE
International Examinations

As part of CIE's continual commitment to maintaining best practice in assessment, CIE has begun to use different variants of some question papers for our most popular assessments with extremely large and widespread candidature, The question papers are closely related and the relationships between them have been thoroughly established using our assessment expertise. All versions of the paper give assessment of equal standard.

The content assessed by the examination papers and the type of questions are unchanged.

This change means that for this component there are now two variant Question Papers, Mark Schemes and Principal Examiner's Reports where previously there was only one. For any individual country, it is intended that only one variant is used. This document contains both variants which will give all Centres access to even more past examination material than is usually the case.

The diagram shows the relationship between the Question Papers, Mark Schemes and Principal Examiner's Reports.

Question Paper	Mark Scheme	Principal Examiner's Report
Introduction	Introduction	Introduction
First variant Question Paper	First variant Mark Scheme	First variant Principal Examiner's Report
Second variant Question Paper	Second variant Mark Scheme	Second variant Principal Examiner's Report

Who can I contact for further information on these changes?
Please direct any questions about this to CIE's Customer Services team at: international@cie.org.uk

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

International General Certificate of Secondary Education

MARK SCHEME for the May/June 2009 question paper

for the guidance of teachers

0620 CHEMISTRY

0620/31 Paper 3 (Extended Theory), maximum raw mark 80

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.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

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CIE is publishing the mark schemes for the May/June 2009 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

1 (a) (i) basic set up – container and chromatography paper [1]

sample clearly above level of solvent [1]
(original mark must be shown and not just the line)

indication that more than one "spot" either on diagram **or** as comment [1]

Allow MAX [2] for round filter paper with green spot at centre
two or more rings

(ii) run chromatogram of pure chlorophyll can be implied [1]
same position of green spot **or** same Rf [1]
NOT just a green spot

(b) catalyst
photosynthesis **or** chloroplasts
photochemical reaction **or** needs light
carbon dioxide + water form
glucose **or** starch **or** oxygen **NOT** sugar
Any **THREE** correct points ignore incorrect answers [3]

[Total: 8]

2 molten potassium iodide **NOT** aqueous [1]

hydrogen [1]
oxygen [1]
water used up **or** solution becomes more concentrated **or** sodium chloride remains
NOT no change [1]
If products are given as hydrogen, chlorine and sodium hydroxide then 2/3

copper [1]
oxygen (and water) [1]
sulfuric acid accept hydrogen sulfate [1]

aqueous **or** dilute **or** concentrated potassium bromide [1]
accept correct formulae

[Total: 8]

3 (a) (i) D [1]

(ii) E [1]

(iii) B or F [1]

(iv) B [1]

(v) A [1]

(b) (i) CF_2 **or** CaI_2 [1]
COND next two marks conditional on correct formula
C^{2+} and F^- **or** Ca^{2+} and I^- [1]
7× and 1o round F/I [1]
NOTE covalent = 0
Ignore electrons around Ca
accept arrow notation arrow from electron on calcium atom to iodine

(ii) high melting point **or** boiling point
conducts when molten **or** in solution
soluble in water
brittle
correct chemical properties
hard
Any **TWO** [2]
NOT crystalline solid **NOT** does not conduct as a solid

[Total: 10]

4 (i) Cu and Pd [2]

(ii) Ba and La [2]

(iii) +2 **or** 2+ **or** Ba^{2+} [1]

(iv) Ba **or** La [1]

(v) it is a transition metal **or** a d block element [1]

[Total: 7]

5 (a) (i) $Ca^{2+} + 2F^- \rightarrow CaF_2$ [2]
Not balanced **ONLY** [1]
Both species must be correct for first mark. Second mark is for correct balancing.

(ii) Mole ratio Ca^{2+}: F^- is 1:2 [1]
Answer must mention moles
accept argument based on charges or <u>number</u> of ions
accept 2 moles of NaF react with 1 mole of $CaCl_2$
NOT just "2" in equation
If fluorine must specify atoms or ions

(iii) to remove traces of solutions **or** to remove soluble impurities **or** to remove a named salt sodium chloride **or** sodium fluoride **or** calcium chloride [1]
To remove impurities is not enough

(iv) to dry (precipitate) **or** to remove water **or** to evaporate water [1]
NOT to evaporate some of water **NOT** to crystallise salt

(b) $T_3(PO_4)_2$ allow correct example [1]
explain why 8 cm^3 react fully [1]
comment about mole ratio [1]

[Total: 8]

6 **(a)** **(i)** air (liquid) [1]
petroleum **or** crude oil **or** alkanes **or** methane **or** water **or** steam **or** steam reforming **or** suitable aqueous solution e.g. brine or sea water [1]
NOTE: cannot crack methane

(ii) iron [1]

(iii) (as a) fertiliser **or** to make fertilisers **or** to make nitric acid [1]

(b) **(i)** concentrations/macroscopic properties do not change [1]
accept amounts stay the same
NOT no change

rate of forward and back reactions equal [1]

(ii) it decreases with increase temperature [1]
or it increases with decrease temperature

(c) **(i)** shows an increase either a line **or** curve [1]
(any decrease = 0)

(ii) increase pressure favours the side with lower volume or molecules or moles [1]
that is RHS **or** products side [1]
ignore any mention of rates

[Total: 10]

7 **(a)** (total endothermic change = 436 + 242 = +)678 kJ [1]
(total exothermic change = 2 × 431 = –)862 kJ [1]
accept correct sign/supplied/absorbed for endo etc.
accept correct sign/evolved/produced for exo etc.
change for reaction = –184 kJ [1]

not necessary to calculate –184, just show that exo change > than endo
ecf allowed provided negative
–184 kJ scores all 3 marks

(b) **(i)** because it accepts a proton [2]
accepts hydrogen ion **or** H^+ **ONLY** [1]
proton and H^+ [2]

(ii) hydrogen chloride is a strong acid [1]
hydrogen fluoride is a weak acid [1]
weaker **or** stronger correctly applied for [2]

(iii) hydrogen chloride (aqueous) would have lower pH [1]
OR hydrogen fluoride (aqueous) would have higher pH
If values suggested, not over 7

[Total: 8]

8 **(a)** biodegradable or breaks down naturally
made from a renewable source **or** does not use up petroleum

reduce visual pollution **or** reduces need for landfill sites **or** less danger to wildlife
any **TWO** [2]
ignore mention of toxic gases

(b) **(i)** ester [1]
accept polyester **or** fat **or** lipid **or** vegetable oil **or** carboxylic acid

(ii) acid **or** carboxylic acid **or** alkanoic acid [1]
alcohol **or** hydroxyl **or** alkanol [1]
NOT formulae **NOT** hydroxide

(iii) condensation [1]
COND because water is formed in reaction
or monomer does not have C=C bond [1]

(c) **(i)** lactic acid $\rightarrow$ acrylic acid + water [1]

(ii) add bromine (water) or bromine in an organic solvent [1]
remains brown/orange/yellow [1]
goes colourless **NOT** clear [1]
If mark 1 near miss e.g. bromide allow marks 2 and 3
Colour of reagent must be shown somewhere for [3] otherwise max [2]

OR acidified potassium manganate(VII)
purple/pink to colourless

OR alkaline potassium manganate(VII)
purple/pink to green
or purple/pink to brown precipitate

(iii) reagent [1]
observable result [1]

suitable named metal (**NOT** sodium, lead, any metal below magnesium etc.)
if un-named metal [0] result can score [1]
hydrogen evolved or bubbles/effervescence/fizzing

insoluble metal oxide
colour change or dissolves

any carbonate or bicarbonate
gas/carbon dioxide/bubbles/effervescence/fizzing

sodium hydroxide or alkali
temperature increase **or** accept indicator to show neutralisation
unspecified base scores [1] only
NOT alcohol

[Total: 13]

9 **(a)** 72/24 = 3 and 28/14 = 2 [1]
Mg_3N_2 [1]
accept just formula for [2] even with incorrect or no working
NOT ecf

(b) $Al_4C_3 + 12H_2O = 4Al(OH)_3 + 3CH_4$ [2]
For Al_4C_3 ONLY [1]

(c) **(i)** silicon is limiting reagent [1]
0.07 moles of Si and 25/160 = 0.156 moles of Br_2 [1]
because 0.14 (2 × 0.07) < 0.156 [1]
If 80 used to find moles of Br_2 the mark 1 and 3 still available
arguments based on masses can be used

(ii) 0.07 [1]
NOT ecf

[Total: 8]

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Allow MAX [2] for round filter paper with green spot at centre
two or more rings

(ii) run chromatogram of pure chlorophyll can be implied [1]
same position of green spot **or** same Rf [1]
NOT just a green spot

(b) catalyst
photosynthesis **or** chloroplasts
photochemical reaction **or** needs light
carbon dioxide + water form
glucose **or** starch **or** oxygen **NOT** sugar
Any **THREE** correct points ignore incorrect answers [3]

[Total: 8]

2 molten lithium chloride **NOT** aqueous [1]

hydrogen [1]
oxygen [1]
water used up **or** solution becomes more concentrated **or** sodium chloride remains
NOT no change [1]
If products are given as hydrogen, chlorine and sodium hydroxide then 2/3

copper [1]
oxygen (and water) [1]
sulfuric acid accept hydrogen sulfate [1]

aqueous **or** dilute **or** concentrated potassium bromide [1]
accept correct formulae

[Total: 8]

3 (a) (i) D [1]

(ii) E [1]

(iii) B or F [1]

(iv) B [1]

(v) A [1]

(b) (i) CA **or** CaO [1]
COND C^{2+} and A^{2-} **or** Ca^{2+} and O^{2-} [1]
6× and 2o round anion [1]
NOTE covalent = 0
Ignore electrons around Ca
accept arrow notation arrow from electron on calcium atom to oxygen

(ii) high melting point **or** boiling point
conducts when molten **or** in solution
soluble in water
brittle
basic(oxide) or basic property
hard
Any **TWO** [2]
NOT crystalline solid **NOT** does not conduct as a solid

[Total: 10]

4 (i) Cu and Pd [2]

(ii) Ba and La [2]

(iii) +2 **or** 2+ **or** Ba^{2+} [1]

(iv) Ba **or** La [1]

(v) it is a transition metal **or** a d block element [1]

[Total: 7]

5 (a) (i) $Fe^{3+} + 3F^- \rightarrow FeF_3$ [2]
Not balanced **ONLY** [1]
Both species must be correct for first mark. Second mark is for correct balancing.

(ii) Mole ratio Fe^{3+}: F^- is 1:3 [1]
Answer must mention moles
accept argument based on charges or <u>number</u> of ions
accept 1mole of FeF_3 reacts with 3 moles of NaF
NOT just "3" in equation
If fluorine must specify atoms or ions

(iii) to remove traces of solutions **or** to remove soluble impurities **or** to remove a named salt sodium chloride **or** sodium fluoride **or** iron(III) chloride [1]
To remove impurities is not enough

(iv) to dry (precipitate) **or** to remove water **or** to evaporate water [1]
NOT to evaporate some of water

(b) T_3PO_4 allow correct example [1]
explain why 6 cm^3 react fully [1]
comment about mole ratio [1]

[Total: 8]

6 (a) (i) air (liquid) [1]
petroleum **or** crude oil **or** alkanes **or** methane **or** water **or** steam **or** steam reforming **or** suitable aqueous solution e.g. brine or sea water [1]
NOTE: cannot crack methane

(ii) iron [1]

(iii) (as a) fertiliser **or** to make fertilisers **or** to make nitric acid [1]

(b) (i) concentrations/macroscopic properties do not change [1]
accept amounts stay the same
NOT no change

rate of forward and back reactions equal [1]

(ii) it increases with increase pressure [1]
or it decreases with decrease pressure

(c) (i) shows a decrease either a line **or** curve [1]
(any increase = 0)

(ii) increase temperature favours the endothermic change [1]
that is LHS **or** reactants side **or** so less ammonia at equilibrium [1]
accept corresponding exothermic argument

[Total: 10]

7 (a) (total endothermic change = 436 + 158 = +)594 kJ [1]
(total exothermic change = 2 × 562 = –)1124 kJ [1]
accept correct sign/supplied/absorbed for endo etc.
accept correct sign/evolved/produced for exo etc.
change for reaction = –530 kJ [1]

not necessary to calculate –530, just show that exo change > than endo
ecf allowed provided negative
–530 kJ scores all 3 marks

(b) (i) because it accepts a proton [2]
accepts hydrogen ion **or** H^+ **ONLY** [1]
proton and H^+ [2]

(ii) hydrogen chloride is a strong acid [1]
hydrogen fluoride is a weak acid [1]
weaker **or** stronger correctly applied for [2]

(iii) hydrogen chloride (aqueous) would have lower pH [1]
OR hydrogen fluoride (aqueous) would have higher pH
If values suggested, not over 7

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made from a renewable source **or** does not use up petroleum

reduce visual pollution **or** reduces need for landfill sites **or** less danger to wildlife
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(b) **(i)** ester [1]
accept polyester **or** fat **or** lipid **or** vegetable oil **or** carboxylic acid

(ii) acid **or** carboxylic acid **or** alkanoic acid [1]
alcohol **or** hydroxyl **or** alkanol [1]
NOT formulae **NOT** hydroxide

(iii) condensation [1]
COND because water is formed in reaction
or monomer does not have C=C bond [1]

(c) **(i)** lactic acid $\rightarrow$ acrylic acid + water [1]

(ii) add bromine (water) or bromine in an organic solvent [1]
remains brown/orange/yellow [1]
goes colourless **NOT** clear [1]
If mark 1 near miss e.g. bromide allow marks 2 and 3
Colour of reagent must be shown somewhere for [3] otherwise max [2]

OR acidified potassium manganate(VII)
purple/pink to colourless

OR alkaline potassium manganate(VII)
purple/pink to green
or purple/pink to brown precipitate

(iii) reagent [1]
observable result [1]

suitable named metal (**NOT** sodium, lead etc.)
gas/hydrogen/bubbles/effervescence/fizzing
if un-named metal [0] result can score [1]

insoluble metal oxide
colour change or dissolves

any carbonate
gas/carbon dioxide/bubbles/effervescence/fizzing
accept bicarbonate

sodium hydroxide or alkali
(temperature increase **or** accept indicator to show neutralisation)
unspecified base scores [1] only
NOT alcohol

[Total: 13]

9 **(a)** 72/24 = 3 and 28/14 = 2 [1]
Mg_3N_2 [1]
accept just formula for [2] even with incorrect or no working
NOT ecf

(b) $Al_4C_3 + 12H_2O = 4Al(OH)_3 + 3CH_4$ [2]
For Al_4C_3 ONLY [1]

(c) **(i)** silicon is limiting reagent [1]
0.08 moles of Si and 7.2/38 = 0.189 moles of F_2 [1]
because 0.16 (2 × 0.08) < 0.189 [1]
If 19 used to find moles of F_2 marks 1 and 3 still available
arguments based on masses can be used

(ii) 0.08 [1]
NOT ecf

[Total: 8]