GCE A2

Chemistry

Summer 2009

Mark Schemes

Issued: October 2009

MARK SCHEMES (2009)

Foreword

Introduction

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16- and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

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Rewarding Learning

ADVANCED
General Certificate of Education
2009

Chemistry

Assessment Unit A2 1

assessing

Module 4: Further Organic, Physical and Inorganic Chemistry

[A2C11]

THURSDAY 21 MAY, MORNING

MARK SCHEME

Quality of Written Communication

2 marks The candidate expresses ideas clearly and fluently through well-linked sentences and paragraphs. Arguments are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.

1 mark The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.

0 marks The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.

Section A

1 D

2 D

3 C

4 C

5 A

6 C

7 C

8 D

9 C

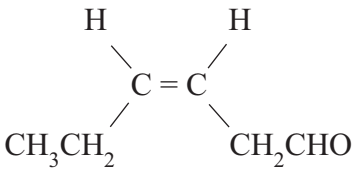
10 C

[2] for each correct answer [20] 20

Section A **20**

Section B

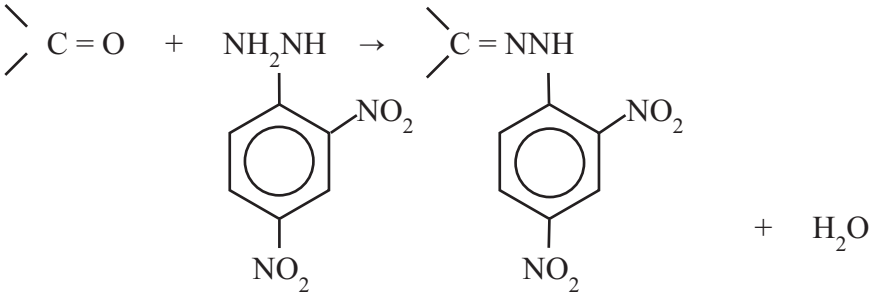
11 **(a)**



[2]

(b) red–(brown) [1]
precipitate [1]

(c)

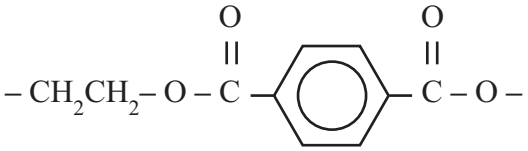


[3] 7

12 **(a)** **(i)** $HOCH_2CH_2OH$ [1]

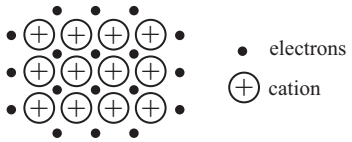
[1]

(ii)



[2]

(b) **(i)**



[2]

(ii) low density* [1]
strong/ductile/rigid [1]

(c) $4Al + 3O_2 \rightarrow 2Al_2O_3$ [1]

(d) **(i)** $Al_2O_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2O$ [2]

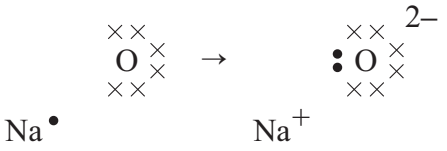
(ii) $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$ [2] 13

or $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

13 **(a)** **(i)** $2NaN_3 \rightarrow 2Na + 3N_2$ [1]

(ii)  [2]

(b) **(i)** $2KNO_3 + 10Na \rightarrow 5Na_2O + K_2O + N_2$ [1]

(ii)  [2]

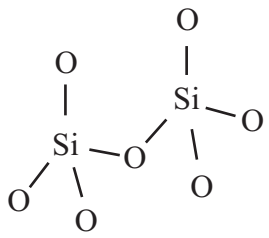
(c) $Na_2O + SiO_2 \rightarrow Na_2SiO_3$ [1]

(d) $NaN_3 = 23 + 3 \times 14 = 65$
$65\,g = 1.0\,mol$

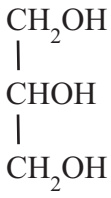
$KNO_3 = 39 + 14 + 3 \times 16 = 101$
$10\,g = 0.1\,mol$

$1.0\,mol\,NaN \rightarrow 1.5\,mol\,N_2$
$0.1\,mol\,KNO_3 \rightarrow 0.05\,mol\,N_2$

Total number of $mol\,N_2 = 1.55\,mol$
Volume of $N_2 = 1.55 \times 24\,dm^3 = 37.2\,dm^3$ [3]

(e)  [2] 12

14 **(a)** **(i)**



[1]

(ii) $CH_3OCO(CH_2)_7CH=CHCH_2CH=CH(CH_2)_4CH_3$ [2]

(b) mass of fat [1]
dissolved in named (chlorinated) solvent [1]
mixed with Wij's solution } [1]
left in dark (for about 30 min) }
KI added [1]
titrated against standard sodium thiosulphate solution)
starch indicator blue\black to colourless [1]
blank titration [1]

to a maximum of [5] [5]

Quality of written communication [2]

(c) $CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOH + SOCl_2$
$\rightarrow CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COCl + SO_2 + HCl$ [2]

or $C_{17}H_{31}COOH + SOCl_2 \rightarrow C_{17}H_{31}COCl + SO_2 + HCl$

(d) 100 g = 100/280 mol = 0.36 mol of linoleic acid
there are 2 double bonds in 1 molecule of linoleic acid
hence 2×0.36 mol = 0.72 mol hydrogen = $0.72 \times 24\ dm^3$
$= 17.28\ dm^3$ [3] 15

15 (a) (i) PCl_4^+ tetrahedral [1]
PCl_6^- octahedral [1]

(ii) PCl_4^+ +5 PCl_6^- +5 [1]

(b) $PCl_5 + CH_3COOH \rightarrow CH_3COCl + HCl + POCl_3$ [2]

(c) (i) equilibrium moves to LHS to reduce pressure – essential [1]
more moles on RHS [1]

(ii) equilibrium moves to RHS to absorb heat – essential [1]
the reaction is endothermic [1]

(iii) total number of moles = 0.11 + 0.11 + 0.39 = 0.61
partial pressure of PCl_3 and Cl_2 = $0.11/0.61 \times 10^5$ Pa
$= 1.8 \times 10^4$ Pa
partial pressure of PCl_5 = $0.39/0.61 \times 10^5$ Pa
$= 6.4 \times 10^4$ Pa

$$K_p = \frac{P_{PCl_3} \times P_{Cl_2}}{P_{PCl_5}} = \frac{1.8 \times 10^4 \times 1.8 \times 10^4}{6.4 \times 10^4}$$

$= 5.1 \times 10^3$ Pa [3] 12

16 (a) (i) base = In^- [1]
acid = HIn [1]

(ii) OH^- reacts with H^+ equilibrium moves to RHS → blue [1]
Adding acid moves equilibrium to the LHS → yellow [1]

(b) (i) $$K_a = 1.7 \times 10^{-5} = \frac{[H^+]\,[CH_3CO_2^-]}{[CH_3CO_2^-]}$$

$1.7 \times 10^{-5} = [H^+]^2/0.1$

$[H^+] = 1.3 \times 10^{-3}$

pH = 2.89 [2]

(ii) yes, the vertical region of the titration curve is [1]
within the region 6.0–7.8 [1]

(iii) $NaOH + CH_3COOH \rightarrow CH_3CO_2Na + H_2O$ [1]

(iv) weak acid and strong base (form the salt) [1]

$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$ (1) [1] 11

Section B **70**

Total **90**

Rewarding Learning

ADVANCED
General Certificate of Education
2009

Chemistry

Assessment Unit A2 2

assessing

Module 5: Analytical, Transition Metals and Further Organic Chemistry

[A2C21]

WEDNESDAY 27 MAY, MORNING

MARK SCHEME

Quality of Written Communication

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Section A

1 A

2 C

3 C

4 B

5 C

6 D

7 C

8 D

9 C

10 B

[2] for each correct answer [20] 20

Section A **20**

Section B

11 (a) $[Cu(NH_3)_4(H_2O)_2]^{2+}$
$[CuCl_4]^{2-}$ $Cu(OH)_2$ [1] each [3]

(b) $CuSO_4 + Ba(NO_3)_2 \rightarrow Cu(NO_3)_2 + BaSO_4$ [1] 4

12 (a) (i) (Two) isotopes of chlorine [1]

(ii) $CH_3CH^{35}Cl^+$ [1]

(b) (i) Peak integration

1:6 ratio [1]
reference to hydrogens (in each environment) [1] [2]

(ii) Chemical shift

peak A shifted downfield due to (electronegative) chlorine [1]

(iii) Spin-spin splitting
Signal at a split (into 7) due to 6 (equivalent) neighbouring H [1]

(iv) Signal at b is a (doublet) due to 1 neighbouring H [1] 7

13 (a) $VO_2^+ = +5$ [1]
$VO^{2+} = +4$ [1]
reducing agent/provide electrons [1] [3]

(b) (i) (catalyst and reactants in) different phases [1]

(ii) gas molecules adsorb/bond to surface [1]
weakens bonds/lowers activation energy/d-orbitals/orientation [1] [2]

(c) (i) $V_2(SO_4)_3$ [1]

(ii) $[V(H_2O)_6]^{3+}$ [1]
Octahedral [1] [2] 9

14 **(a)** **(i)** K^+ [1]
$[Fe(CN)_6]^{4-}$ [1] [2]

(ii) Any soluble iron(III) salt, e.g. sulphate, chloride, nitrate [1]

(b) **(i)** colourless to pink/purple [1] [2]

(ii) moles of iron per litre = 7.84/56 = 0.14
moles of iron in 25 cm^3 = 0.14/40 = 3.5×10^{-3}
moles MnO_4^- = $3.5 \times 10^{-3}/5 = 7 \times 10^{-4}$
volume = $7 \times 10^{-4} \times 1000/0.1$ = 7 cm^3
[–1] for each error, carry error through [3]

(c) **(i)** use known mass of sample (and dissolve to make 250 cm^3 solution) [1]
known excess [1]
of NaOH [1]
titrate (25 cm^3) portions of above with (standard) hydrochloric acid [1][4]

(ii) iron(II) ions [1]
would form a precipitate (of iron(II) hydroxide)/react with NaOH [1] [2]

(iii) RFM $FeSO_4$ = 152
RFM $FeSO_4.(NH_4)_2SO_4.6H_2O$ = 392
moles double salt = 20/392 = 0.051
moles of iron(II) sulphate = 0.051
mass of iron(II) sulphate = 0.051 × 152 = 7.75 g
each error [–1], carry error through [3] 17

15 **(a)** petroleum [1]

(b) CH [1]

(c) single/sigma (covalent) bonds(carbon – carbon and carbon – hydrogen) [1]
delocalised electrons (above and below plane of ring [1],
form pi-bond/overlapping P orbitals [1]
bond order of 1.5 between carbon atoms/C–C bond
length all equal [1]
Any **three** from four [3]

(d) **(i)** catalyst [1]

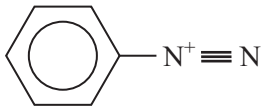
(ii) CH_3^+ [1]

(e) **(i)** concentrated sulphuric acid [1]
concentrated nitric acid [1] [2]

(ii) structure = [1]
name = [1]
1,2– or 1,3– or 1,4–dinitrobenzene [2]

(iii) tin [1]
concentrated hydrochloric acid [1] sodium hydroxide [1] } 2 from 3
reflux [1] [3]

(f) **(i)** $NaNO_2 + HCl \rightarrow HNO_2 + NaCl$ [1]

(ii) 

each error [–1], e.g. missing charge/double bond, etc. [2]

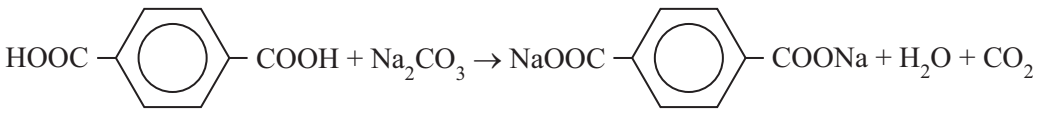
(iii) too unstable [1]

(iv) coupling [1]

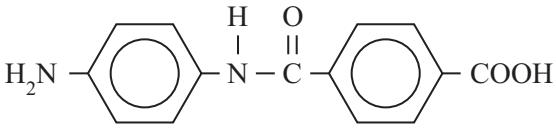
(v) $C_{16}H_{12}N_2O$ [1]

(vi) conjugated/delocalised electrons/chromophore [1]
absorb visible light/radiation [1]
to promote electrons (to higher energy level) [1]
mention of emission = [–1] [3]
Quality of written communication [2] 25

16 **(a)** look for N–H or C–N (stretch/bend) peaks [1]– benzene–1,4–diammine [1]
or C–O/C=O/O–H stretch/bend peaks [1]– benzene–1,4–dicarboxylic acid [1]
or one has N–H/peak and the other a C–O/C=O/O–H peak [1] [2]

(b) 

[2]

(c) **(i)**  [1]

(ii) peptide [1]

(iii) (strong) hydrogen bonds [1] between different chains [1] [2] 8

Section B **70**

Total **90**

Rewarding Learning

ADVANCED
General Certificate of Education
2009

Chemistry

Assessment Unit A2 3A

assessing

Module 6A: Synoptic Paper

[A2C31]

FRIDAY 29 MAY, MORNING

MARK SCHEME

Quality of Written Communication

2 marks The candidate expresses ideas clearly and fluently through well-linked sentences and paragraphs. Arguments are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.

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Section A

1 **(a)** $2Sb + 3Br_2 \rightarrow 2SbBr_3$ [2]

(b) 5g $SbBr_3$ at 75% = 6.67 g at 100%
moles $SbBr_3$ = 6.67/362 = 0.0184
3 moles Br_2 = 2 moles $SbBr_3$
moles Br_2 = 1.5 × 0.0184 = 0.0276
mass Br_2 = 0.0276 × 160 = 4.42 g
volume Br_2 = 4.42/3.1 = 1.43 cm^3
Award [4] directly for the correct answer
Each error [–1], carry error through [4]

(c) anti-bumping granules
reflux
vertical condenser
excess antimony
round bottomed/pear shaped flask
red/brown/orange to colourless/gloves/fume cupboard
distil
1, 1, 1–trichloroethane as solvent
red/brown/orange
to colourless/white solid
gloves
fume cupboard
No safety [6] max
No observations [7] max [8]

(d) separation – filter or distil
purify – redistill [1] at 280 °C [1]
or recrystallise [1] using 1, 1, 1 - trichloroethane [1]
purity - description of redistillation/narrow range [1]
or description of mpt/sharp/97 °C/small range [1] [4]

Quality of written communication [2] 20

Section A **20**

Section B

2 (a) (i) $S_8(l) + 24F_2(g) \rightarrow 8SF_6(g)$ [2]

(ii) oxidation state S in S_2F_{10} = +5
in SF_6 = +6
in SF_4 = +4
all three [2], two [1]
disproportionation – S is oxidised (+5 → +6) and reduced (+5 → +4) [1] [3]

(iii) $SF_4 + 6OH^- \rightarrow SO_3^{2-} + 4F^- + 3H_2O$ [2]

(iv) add barium nitrate/chloride (solution)/bariumions
white precipitate
soluble in (dilute) hydrochloric acid [3]

(b) (i) bend bonds [1]
stretch bonds [1]
(molecular) vibrations [1] to a max of [2] [2]

(ii) $SF_6 = 32 + 6 \times 19 = 32 + 114 = 146$
1 tonne = $1000 \times 10^3 = 1 \times 10^6$ g
1 tonne = $10^6/146 = 6.849 \times 10^3$ mol
volume of SF_6 = $6.849 \times 10^3 \times 24$ dm^3
= 1.64×10^5 dm^3
volume of CO_2 = $23\,900 \times 1.64 \times 10^5$ dm^3
= $2.39 \times 1.64 \times 10^9$ dm^3
= 3.92×10^9 dm^3
award [3] directly for correct answer
each error[–1], carry error through [3] 15

3 **(a)** **(i)** $NH_2CONH_2 + 2H_2O \rightarrow (NH_4)_2CO_3$ [1]

(ii) reactants and products labelled [1]
catalysed and uncatalysed [1] [2]

(b) pKa = 3.89 gives Ka = 1.288×10^{-4}

$$Ka = \frac{[H^+]^2}{[HX]}$$

$[H^+]^2 = 1.288 \times 10^{-4} \times 0.05$
$= 6.44 \times 10^{-6}$
$[H^+] = 2.54 \times 10^{-3}$
pH = 2.6 [3]

(c) **(i)** $C_9H_9O_3N$ [1]

(ii) hydrogen bonding [1]
NH/CO/OH groups [1] [2]

(iii) two hydrogens on central carbon/only 3 different atoms or groups on the central carbon [1]

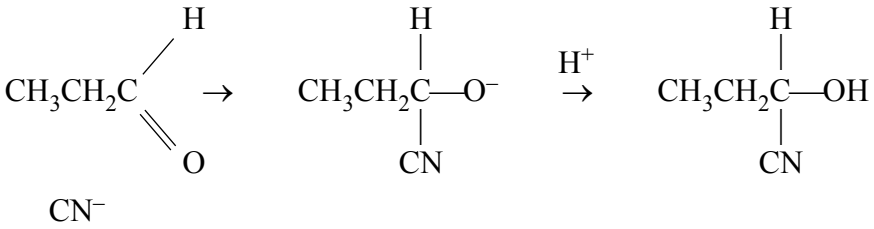
(d) **(i)** Eriochrome Black T [1]
red to blue [1] [2]

(ii) moles Mg^{2+} in 100 cm^3 = $0.01/24 = 4.166 \times 10^{-4}$
1 mole Mg^{2+} = 1 mole edta
moles edta = 4.166×10^{-4}
volume edta = $4.166 \times 10^{-4} \times 1000/0.02 = 20.83$ cm^3
award [3] directly for correct answer
each error [–1], carry error through [3] 15

4 **(a)** **(i)** Fehling's solution [1]
red precipitate [1]
or
Tollen's reagent [1]
silver mirror [1]
for the propanal/aldehyde [1] [3]

(ii) propanal has three peaks [1]
propanone has one peak [1] [2]

(b) **(i)**



each error [–1] [3]

(ii) named mineral acid [1]

(iii) 2-hydroxybutanoic acid [1]

(c) **(i)** $CH_3CH{=}NOH$ [1]

(ii)

	C	H	N	O
	45.38	4.20	23.53	26.89
divide by each RAM				
	3.78	4.2	1.68	1.68
divide by 1.68				
	2.25	2.5	1	1

$C_9H_{10}N_4O_4$
Each error [–1], carry error through [3] 14

5 **(a)** **(i)** solid copper dissolves
blue solution (formed)
fizzing/effervescence
heat evolved
brown gas
any **two** [2]

(ii) add sodium hydroxide solution/ammonia solution [1]
blue precipitate (dissolves with excess ammonia solution) [1] [2]

(iii) Rate $= k[X]^3$
$= 1.7 \times 10^{-5} \times 0.1^3$
$= 1.7 \times 10^{-8}$ mol dm^{-3} s^{-1} [2]

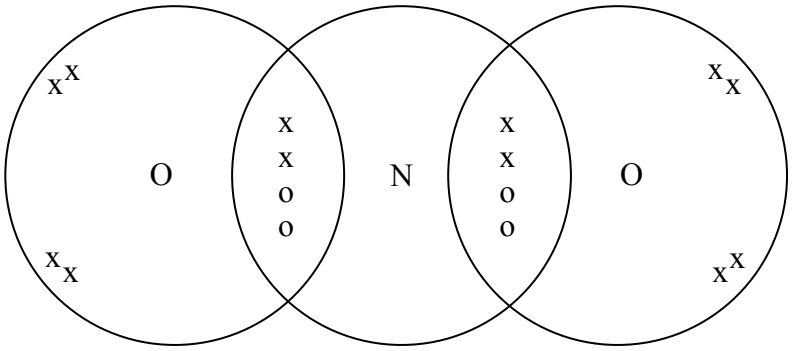
(iv) $NO + O_3 \rightarrow NO_2 + O_2$ [1]

(b) **(i)** lowers it
equilibrium moves to right [1]
exothermic reaction [1] [2]

(ii) moves to right [1]

(c) **(i)** nitronium/nitryl (cat)ion [1]

(ii)



each error [–1] [2]

(iii) electrophilic [1]
substitution [1]
methyl-2,4,6-trinitrobenzene [1]/2, 4, 6 – trinitrotoluene
1 – methyl – 2, 4, 6-trinitrobenzene
2 – methyl – 1, 3, 5-trinitrobenzene [3] 16

Section B **60**

Total **80**