GCE A2

Chemistry

January 2010

Mark Schemes

Issued: April 2010

MARK SCHEMES (2010)

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
January 2010

Chemistry

Assessment Unit A2 1

assessing

Module 4: Further Organic, Physical and Inorganic Chemistry

[A2C11]

THURSDAY 21 JANUARY, AFTERNOON

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, punctation and spelling are sufficiently intrusive to disrupt the understanding of the passage.

Section A

1 A

2 C

3 A

4 D

5 C

6 B

7 C

8 A

9 D

10 C

[2] for each correct answer [20] 20

Section A **20**

11 **(a)** $S + O_2 \rightarrow SO_2$ (1)

$2SO_2 + O_2 \rightarrow 2SO_3$ (1)

$H_2SO_3 + H_2O \rightarrow H_2SO_4$

$H_2SO_2 + SO_3 \rightarrow H_2S_2O_7$ } Any (1)

$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

Max [3]

pressure: 1–10atm
catalyst: V_20_5, vanadium pentoxide
temperature: 400–500ºC/450ºC
explanation of dissolving SO_3 Max [3] To Max of [5]

QWC [2]

(b) Acid rain/equivalent description [1]

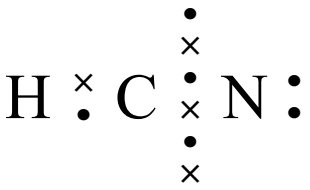
(c) e.g. Use in manufacture of "superphosphate" [1]
To dissolve phosphorus/make fertilisers [1] [2] 10

12 **(a)** $50mg = 50 \times 10^{-3}g = 5 \times 10^{-2}g$

$HCN = 1 + 12 + 14 = 27$

moles $= 5 \times 10^{-2}/27 = .05/27 = 0.00185$ mol [3]

(b)



[2]

(c) **(i)** (reaction endothermic) high temp → RHS [1]
speeds reaction up [1]

(ii) more molecules (etc) on RHS [1]
should not be used (conditional on first statement) [1]

(iii) $NH_3 + CH_4 \rightleftharpoons HCN + 3H_2$

0.2	0.2	–	–
		0.1	0.3
0.1	0.1		

$$K_c = \frac{0.1 \times 0.3^3}{0.1 \times 0.1} = \frac{0.0027}{0.01} = 0.27$$

Units = [ ]^4 / [ ]^2 = [ ]^2

= mol^2 dm^{-6} [3]

(d) **(i)** $NaOH + HCN \rightarrow NaCN + H_2O$ [1]

(ii) NaOH is a strong base
HCN is a weak acid

or explanation based on CN^- ion [2]

(iii) $CN^- + H^+ \rightleftharpoons HCN$ + explanation [1]

$HCN + OH^- \rightleftharpoons H_2O + CN^-$ + explanation [1]

(iv) [HCN] : mol HCN = $\frac{200}{1000} \times 0.5 = 0.1$

volume = 200 + 200 = $400cm^3$

0.1 mol in $400cm^3$

$\therefore$ 0.25 mol dm^{-3}

$[CN^-]$: mol NaCN = $\frac{200}{1000} \times 1.0 = 0.2$

volume = 200 + 200 = $400cm^3$

0.2 mol in $400cm^3$

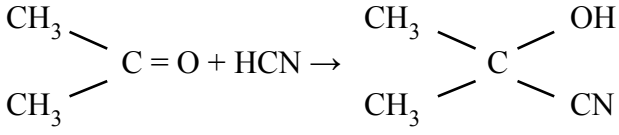
$\therefore$ 0.50 mol dm^{-3}

$k = 4.9 \times 10^{-10} = \frac{[H^+] \times 0.5}{0.25} = 2\,[H^+]$

$[H^+] = 2.45 \times 10^{-10}$

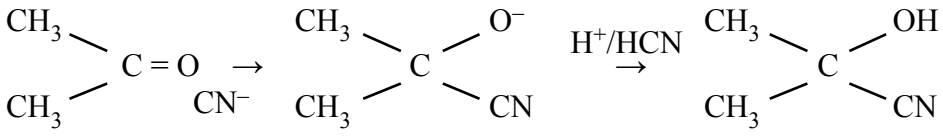
pH = 9.61

(e) **(i)**



[2]

(ii)



[3]

25

13 **(a)** **(i)** $Rb^+(g) + \frac{1}{2}Cl_2(g) + e^-$ on $Rb(g) + Cl(g)$

$Rb(g) + \frac{1}{2}Cl_2(g)$ on $Rb(g) + Cl(g)$ [2]

(ii) $+ 81 + 403 + 242/2 - 348 = \triangle H + 685$

$+ 257 = \triangle H + 685$

$\triangle H = -428$ (KJ mol^{-1}) [2]

(b) ionisation energy of alkali metal decreases/cation size increases down group [1]

(c) **(i)** lithium/calcium/strontium [1]

(ii) add to concentrated HCl [1]
Pt/nichrome wire/silica rod [1]
blue flame – bunsen [1] 9

14 **(a)**

CH_2OH
|
CHOH
|
CH_2OH [1]

(b) reaction of an alcohol with an acid to form an ester [2]

(c) **(i)** mass of iodine in grams which reacts with 100g of oil/fat [2]

(ii) 46.0 – 6.0 cm^3 thoisulphate sol "used"

$= 40 \times 10^{-3} \times 0.1$ mol thoisulphate

$= 4 \times 10^{-3}$ mol

$2Na_2S_2O_3 + I_2 \rightarrow 2NaI + Na_2S_4O_6$

1 mol thio $\equiv$ 127g iodine

4×10^{-3} mol $\equiv 4 \times 10^{-3} \times 127$g

$\equiv 0.508$g

0.9g of oil react with 0.504g iodine

100g of oil react with $\frac{0.504}{0.90} \times 100$

$= 56/56.4$ [3]

(iii) stearic acid is saturated (less iodine reacts) [1]

(d) **(i)** carbon dioxide [1]
water/steam [1] [2]

(ii) carbon/carbon monoxide [1]

(iii) 2 from 3: carbon dioxide – global warming
carbon – smoke/soot
carbon monoxide – poisonous/toxic [2] 14

15 **(a)** **(i)** $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ [2]

(ii) NH_3 is a proton acceptor [1]

(b) **(i)** methyl orange [1]

(ii) the vertical section of the titration curve
is on the "acid side"/ammonium sulphate is acidic
methyl orange changes colour at low pH [1]

(c)

$$K_b = 1.8 \times 10^{-5} = \frac{[NH_4^+]\ [OH^-]}{[NH_3]} = \frac{[OH^-]^2}{0.2}$$

$[OH^-]^2 = 0.2 \times 1.8 \times 10^{-5} = 3.6 \times 10^{-6}$

$[OH^-] = 1.897 \times 10^{-3} = 1.9 \times 10^{-3}$

$[H^+]\ [OH^-] = 1 \times 10^{-14}$

$[H^+] \times 1.9 \times 10^{-3} = 10^{-14}$

$[H^+] = 0.526 \times 10^{-11} = 5.26 \times 10^{-12}$

pH = 11.28 [4]

(d) **(i)** $NH_3 + CH_3CO_2H \rightarrow CH_3CO_2NH_4$ [1]

(ii) 2 from 3: no vertical section on titration curve (1)
no definite colour change/no sharp end-point (1)
weak acid with weak base (1) [2] 12

Section B **70**

Total **90**

Rewarding Learning

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General Certificate of Education
2010

Chemistry

Assessment Unit A2 2

assessing

Module 5: Analytical, Transition Metals and Further Organic Chemistry

[A2C21]

WEDNESDAY 27 JANUARY, MORNING

MARK SCHEME

Section A

1 B

2 B

3 B

4 A

5 B

6 C

7 B

8 B

9 A

10 A

2 marks for each correct answer [20]

Section B

11 $Ni(OH)_2$ $Ni(NH_3)_6^{2+}$ $Ni(en)_3^{2+}$ [3] 3

12 **(a)** **(i)** add water [1] * essential
filter [1]
dry in oven/between filter paper [1] [3]

(ii) Mn +7 → +6 and +4
O –2 → 0

Mn +7 → +4 or +6 is reduction
O –2 → 0 is oxidiation } [3]

(iii) $KMnO_4 = 39 + 55 + 64 = 158$
2.0g = 2/158 = 0.013 mol
2 mol $KMnO_4$ → 1 mol O_2
∴ 0.013/2 mol O_2 obtained
= 0.0065 mol

Volume of $O_2 = 0.0065 \times 24\ dm^3 = 0.156\ dm^3$
$= 156\ cm^3$ [3]

(b) **(i)** $2MnO_4^- + 6H^+ + 5NO_2^- \rightarrow 2Mn^{2+} + 5NO_3^- + 3H_2O$ [2]

(ii) pink/purple → colourless [1]

(c) **(i)** $34.9\ cm^3$ of 0.02M $MnO_4^- = 34.9 \times 10^{-3} \times 0.02$
$= 6.98 \times 10^{-4}$ mol

mol $Fe^{2+} = 5 \times$ mol $MnO_4^- = 5 \times 6.98 \times 10^{-4}$

$= 3.49 \times 10^{-3}$

mol Fe^{2+}/mol Fe in $25cm^3$

mass of iron $= 56 \times 3.49 \times 10^{-3} = 0.19544 \times 10 = 1.9544$

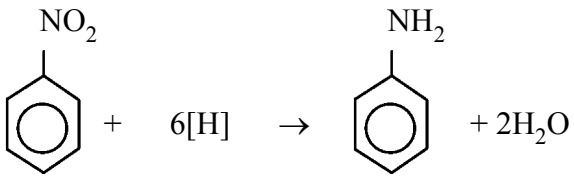
% iron $= 1.9544/2.00 \times 100 = 97.72\%$ [3]

(ii) $Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$
or $Fe_2(SO_4)_3 + 6NaOH \rightarrow 2Fe(OH)_3 + 3Na_2SO_4$

$Mn^{2+} + 2OH^- \rightarrow Mn(OH)_2$
or $MnSO_4 + 2NaOH \rightarrow Mn(OH)_2 + Na_2SO_4$

$H^+ + OH^- \rightarrow H_2O$
or $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$ [3] 18

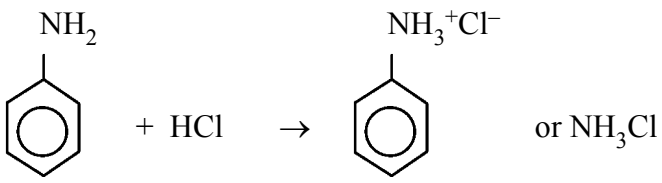
13 **(a)**



[2]

(b) **(i)** $C_6H_5CH_2CH_2NH_2$ > NH_3 > aniline [1]

(ii)



[1]

(iii) NH_2; attached to nitrogen atom with 2 hydrogens [1]

(c) phenylethylamine has H bonding
NH_2 lone pair readily available
lone pair delocalised on aniline
van der Waals with all
only van der Waals with propylbenzene
but propylbenzene b.pt. > aniline ∴ forces are greater [3]

(d) **(i)** $C_6H_5 - \overset{+}{N} \equiv N$ [2]

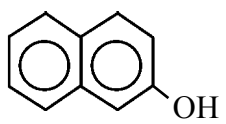
(ii) $NaNO_2$ / sodium nitrite [1]

HCl (aq) / hydrochloric acid [1]

(iii) $C_6H_5CH_2CH_2\overset{+}{N}_2$ is unstable [1]
the + charge cannot be delocalised [1] [2]

(iv) A HCl / H_2SO_4 or NaOH [1]
B $LiAlH_4$ [1]
C HNO_2 / $NaNO_2$ + HCl [1]
D PCl_5 / HCl [1] [4]

(e) **(i)**



[1]

(ii) alternating single and double bonds [2]/delocalisation [1] [2]

(iii) energy levels close together/high degree of conjugation [1]
hence electron easily excited by visible region radiation [1]
removes a colour from white light [1] [3]

24

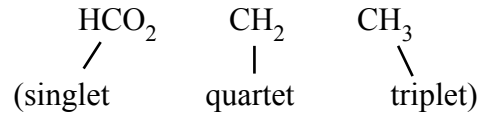
14 (a) (i) same molecular formula [1]
different structure [1] [2]

(ii) $HCOOH + C_2H_5OH \rightarrow HCO_2C_2H_5 + H_2O$ [2]

(iii) add conc H_2SO_4 / add excess methanoic acid / ethanol
removes water [2]

(b) (i) tetramethylsilane [1]
$Si(CH_3)_4$ [1] [2]

(ii) spin – spin



next to 0H next to 3H next to 2H
[2]

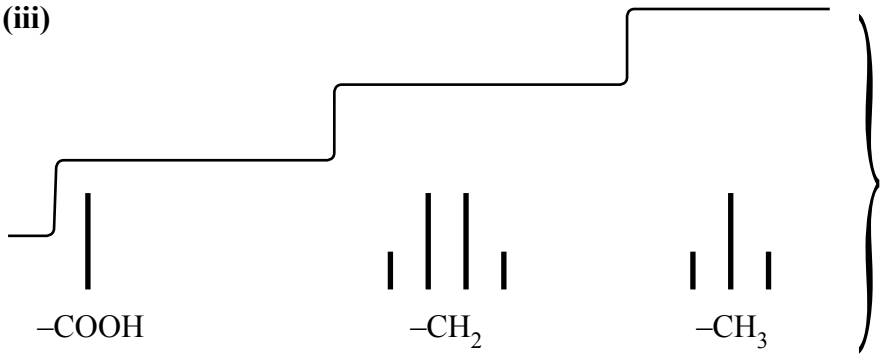
peak integration

from the left ratio 1 : 2 : 3 [1]
$HCO_2CH_2CH_3$ [1]

chemical shift

greatest deshielding [1]
hydrogens next to O [1] [6]

(iii)



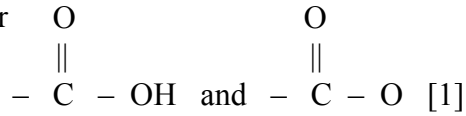
need labels [3]

(c) 28 $C_2H_4^+$ or CO^+ [1]

45 $HCOO^+$ / HCO_2^+ / $C_2H_5O^+$ [1] [2]

(d) the bonds in the molecules vibrate [1]
they absorb energy corresponding to a certain frequency [1]
dependent on the atoms mass in the bond [1]

at different positions for



[1]

–OH absorption for acid [1]

(at high wave number/frequency)

to max of [4] [4]

QWC [2] 25

Total **90**

Rewarding Learning

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January 2010

Chemistry

Assessment Unit A2 3A

assessing

Module 6A: Synoptic Paper

[A2C31]

MONDAY 1 FEBRUARY, MORNING

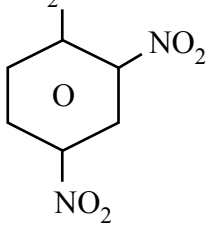
MARK SCHEME

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, punctation and spelling are sufficiently intrusive to disrupt the understanding of the passage.

1 **(a)** $CH_3CH_2CHO + NH_2NH \rightarrow CH_3CH_2CH=N–NH$ +  + H_2O

[3]

(b) 2, 4 – dinitrophenylhydrazine $= C_6H_3(NO_2)_2NHNH_2 = C_6H_6N_4O_4$

$= 72 + 6 + 56 + 64$

$= 198$

$1g = \frac{1}{198} = 5 \times 10^{-3}$ mol $\equiv 32$ cm^3 solution

2, 4 – dinitrophenylhydrazone $= C_9H_{10}N_4O_4 = 108 + 10 + 56 + 64 = 238$

$= 0.2g = \frac{0.2}{238}$ 8.4×10^{-4} mol

Volume of solution needed $= \frac{8.4 \times 10^{-4}}{5 \times 10^{-3}} \times 32$ cm^3

$= 5.376$ cm^3 $= 5.4$ cm^3

Assuming 75% yield $\frac{4}{3} \times 5.4 = 7.2$ cm^3 [5]

(c) ethanol flammable + water bath [2]
minimum vol of hot ethanol [1]
filter [1]
dry with filter paper/oven [1]

(d) heat until starts to melt and note finish [2]
melting point apparatus description [2]
max of 3

(e) sharp melting point/not lower than literature [1]
compare with mpt in data book [1]

QWC [2] 20

2 **(a)** 12.4g of P = $\frac{12.4}{31}$ = 0.4 mol

$4P + 5O_2 \rightarrow 2P_2O_5$

4 mol P → 5 × 24 dm^3 = 120 dm^3

1 mol P → 30 dm^3

0.4 mol → 12 dm^3

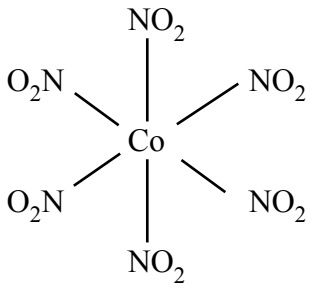
Air 5 × → = 60 dm^3 [4]

(b) Na_3PO_4 Na_2HPO_4 NaH_2PO_4 [2]

(c) $2HNO_3 \rightarrow N_2O_5 + H_2O$ [1] 7

3 **(a)** **(i)** $Co^{2+} + NO_2^- + 2H^+ \rightarrow Co^{3+} + H_2O + NO$ [1]

(ii)



[1]

(b) **(i)** $NH_4Co(SO_4)_2\ 12H_2O$ = 18 + 59 + 92 + 216

= 485

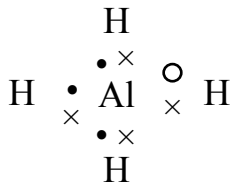
% Co = $\frac{59}{485}$ × 100 = 12.16% [3]

(ii) NH^+_4, Co^{3+}, SO_4^{2} (any 2) [2]

(iii) white ppt, sinks, blue solution [2] 9

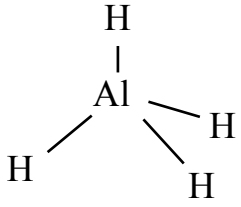
4 **(a)** **(i)** $4LiH + AlCl_3 \rightarrow LiA1H_4 + 3LiCl$ [2]

(ii)



[2]

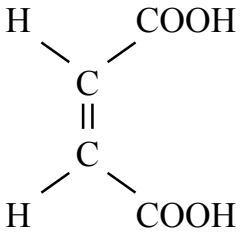
(iii)



[1]

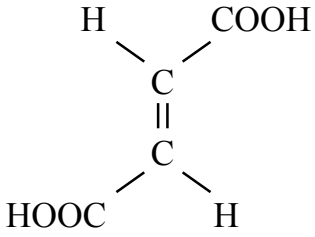
tetrahedral [1]

(b) **(i)**



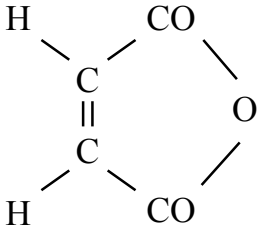
[1]

(ii)



[1]

(iii)

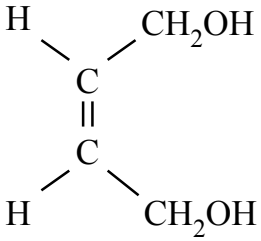


[1]

or the dimer structure

(iv) – COOH groups too far away [1]

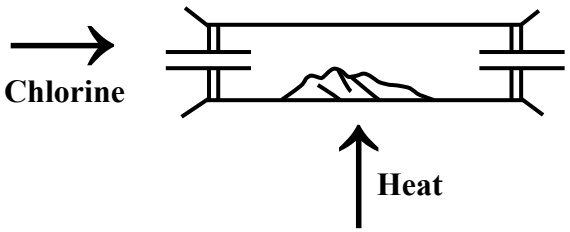
(v)



[2]

12

5 (a)



[2]

chlorine poisonous
use fume cupboard [2] [4]

(b) strong acid weak(er) base
or equation explanation [2]

(c) $20 \times 10^{-3} \times 10^{-1}$ mol edta $= 2 \times 10^{-3}$ mol edta

$= 2 \times 10^{-3}$ mol Mg^{2+}

mol Mg^{2+} in 1 dm^3 $= 40 \times 2 \times 10^{-3}$ mol

$= 8 \times 10^{-2}$ mol

mass $MgCl_2$ $= (24 + 71) \times 8 \times 10^{-2} = 7.6$g

mass H_2O $= 13.4 - 7.6 = 5.8$g

mol $MgCl_2$ $= 0.08$

mol H_2O $= \frac{5.8}{18} = 0.32$ $\therefore$ $MgCl_2.4H_2O$ [4]

(d) conc H_2SO_4 with water produces heat
steamy fumes of HCl when HCl meets air
forming droplets of HCl (aq) [3]

(e) $AgNO_3$/silver nitrate
solution/acidified/dissolve carnallite
white ppt [3]
$Ag^+ + Cl^- \rightarrow AgCl$ [1] 17

6 **(a)** **(i)** second [1]

(ii) $[\ ]\ s^{-1} = k\ [\ ]^2$

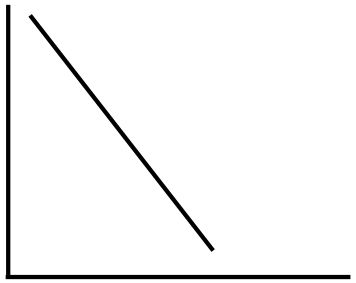
$k = S^{-1}\ [\ ]^{-1} = mol^{-1}\ dm^3\ S^{-1}$ [2]

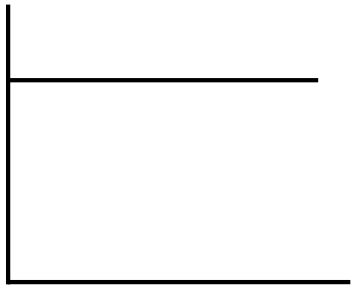
(b) **(i)** prepare solutions of known conc of iodine
choose an appropriate colour of light
test unknown iodine solutions absorbance
compare with calibration chart [4]

(ii) $2S_2O_3^{2-} + I_2 \rightarrow 2I^- + S_4O_6^{2-}$ [1]

add thiosulphate sol to iodine
until iodine colour fades/straw yellow
add starch
titrate until blue/black → colourless [3]

(c)





[2]

(d) rate determining step (slowest step)
involves reaction of H^+ with CH_3COCH_3
H^+ reacts with O
or H^+ reacts with lone pairs on O [2] 15

Total **80**