UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/11 Paper 1 (Multiple Choice), maximum raw mark 40

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Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**C**
2	**A**	22	**A**
3	**C**	23	**B**
4	**C**	24	**B**
5	**D**	25	**B**
6	**A**	26	**D**
7	**B**	27	**D**
8	**D**	28	**B**
9	**C**	29	**B**
10	**C**	30	**D**
11	**C**	31	**D**
12	**B**	32	**B**
13	**C**	33	**D**
14	**D**	34	**B**
15	**B**	35	**A**
16	**D**	36	**D**
17	**C**	37	**B**
18	**C**	38	**C**
19	**C**	39	**A**
20	**C**	40	**A**

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9701 CHEMISTRY

9701/12 Paper 1 (Multiple Choice), maximum raw mark 40

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Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**D**
2	**C**	22	**C**
3	**B**	23	**B**
4	**C**	24	**A**
5	**B**	25	**C**
6	**B**	26	**D**
7	**C**	27	**C**
8	**C**	28	**C**
9	**A**	29	**D**
10	**C**	30	**A**
11	**C**	31	**D**
12	**B**	32	**D**
13	**D**	33	**D**
14	**B**	34	**C**
15	**A**	35	**A**
16	**B**	36	**A**
17	**D**	37	**A**
18	**B**	38	**D**
19	**A**	39	**A**
20	**B**	40	**D**

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9701 CHEMISTRY

9701/13 Paper 1 (Multiple Choice), maximum raw mark 40

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2	**D**	22	**C**
3	**C**	23	**B**
4	**A**	24	**D**
5	**B**	25	**B**
6	**A**	26	**B**
7	**C**	27	**D**
8	**C**	28	**D**
9	**D**	29	**D**
10	**C**	30	**B**
11	**B**	31	**B**
12	**C**	32	**D**
13	**C**	33	**D**
14	**D**	34	**B**
15	**C**	35	**D**
16	**B**	36	**B**
17	**D**	37	**C**
18	**C**	38	**A**
19	**C**	39	**A**
20	**A**	40	**A**

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9701 CHEMISTRY

9701/21 Paper 2 (AS Structured Questions), maximum raw mark 60

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1 (a) alkanes/paraffins
not hydrocarbon (1) [1]

(b) **2** $C_{14}H_{30}$ + **43** $O_2 \rightarrow$ **28** CO_2 + **30** H_2O **or**

$C_{14}H_{30} + {}^{43}/_{2}O_2 \rightarrow$ **14** CO_2 + **15** H_2O (1) [1]

(c) (i) mass of $C_{14}H_{30}$ burnt

$\frac{8195 \times 10.8}{1000} = 88.506 = 88.5$ t (1)

(ii) mass of CO_2 produced

M_r of $C_{14}H_{30} = (14 \times 12 + 30 \times 1) = 198$ (1)

2 x 198 t of $C_{14}H_{30} \rightarrow$ 28 x 44 t of CO_2

88.5 t of $C_{14}H_{30} \rightarrow \frac{28 \times 44 \times 88.5}{2 \times 198}$ (1)

= 275.3 t of CO_2 (1)

allow 275.4 t if candidate has used 88.506
allow ecf on wrong value for M_r of $C_{14}H_{30}$ [4]

(d) $n = \frac{PV}{RT} = \frac{6 \times 10^5 \times 710 \times 10^{-6}}{8.31 \times 293}$ (1)

= 0.175 (1) [2]

(e) $P = \frac{nRT}{V} = \frac{0.175 \times 8.31 \times 278}{710 \times 10^{-6}}$ (1)

= 569410.5634 Pa = 5.7×10^5 (1)

allow ecf on **(d)** [2]

[Total: 10]

2 (a) (i) break large hydrocarbons into smaller hydrocarbons **or**
break down large hydrocarbons (1)

smaller hydrocarbons are more useful **or**
smaller hydrocarbons are more in demand (1)

(ii) using high temperatures/thermal cracking **or**
using catalysts/catalytic cracking (1)

(iii) $C_{14}H_{30} \rightarrow C_7H_{16} + C_7H_{14}$ **or**
$C_{14}H_{30} \rightarrow C_7H_{16} + C_2H_4 + C_5H_{10}$ **or**
$C_{14}H_{30} \rightarrow C_7H_{16} + C_3H_6 + C_4H_8$ **or**
$C_{14}H_{30} \rightarrow C_7H_{16} + 2C_2H_4 + C_3H_6$ (1)

do not allow any equation with H_2 [4]

(b) ethanol has hydrogen bonding, ethanethiol does not (1) [1]

(c) (i) $C_2H_5SH + {}^{9}/_{2}\, O_2 \rightarrow \mathbf{2}CO_2 + SO_2 + \mathbf{3}H_2O$ **or**
$\mathbf{2}C_2H_5SH + \mathbf{9}O_2 \rightarrow \mathbf{4}CO_2 + \mathbf{2}SO_2 + \mathbf{6}H_2O$
correct products (1)
correct equation which is balanced (1)

(ii) **for CO_2**
enhanced greenhouse effect (1)
global warming (1)

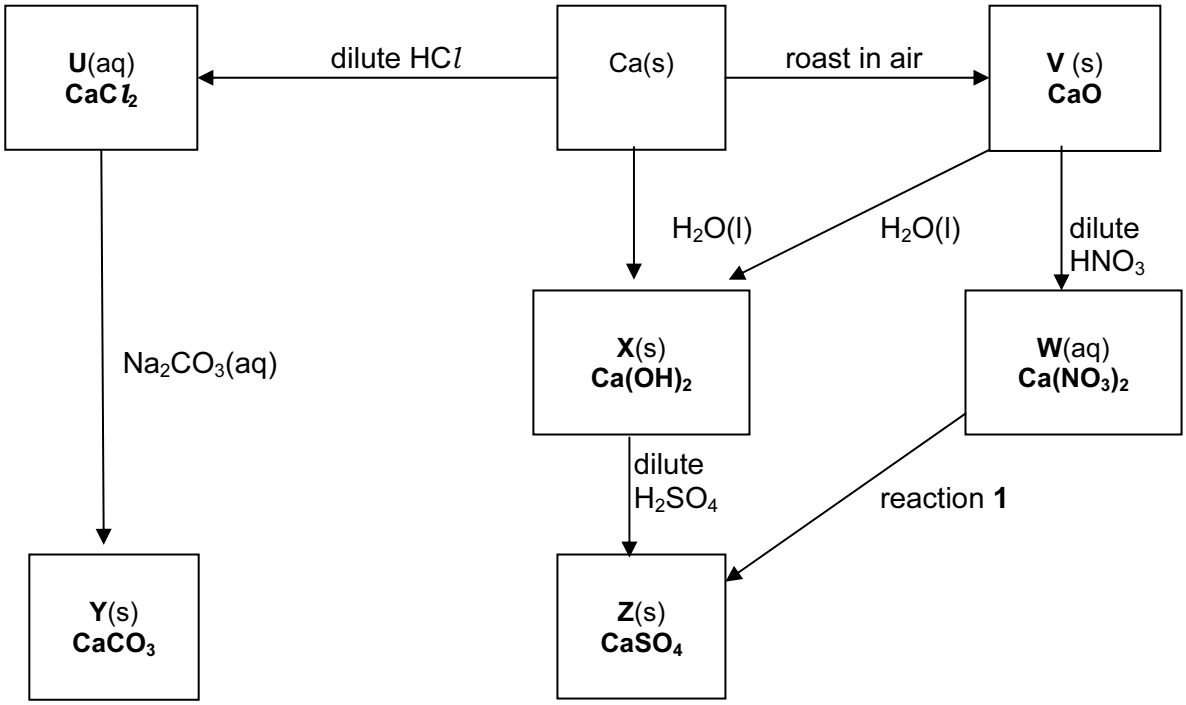
for SO_2
formation of acid rain (1)
damage to stonework of buildings/
dissolving of aluminium ions into rivers/
damage to watercourses or forests/
aquatic life destroyed/
corrosion of metals (1) [6]

(d) help detect leaks of gas (1) [1]

(e) temperature of 450°C (1)
pressure of 1 – 2 atm (1)
V_2O_5/vanadium(V) oxide/vanadium pentoxide catalyst (1) [3]

[Total: 15]

3



(a)

U	$CaCl_2$	(1)
V	CaO	(1)
W	$Ca(NO_3)_2$	(1)
X	$Ca(OH)_2$	(1)
Y	$CaCO_3$	(1) [5]

(b) heat strongly in a test-tube or a boiling tube
do not allow 'heat gently' or 'reflux' (1) [1]

(c) **(i)** Ca to **U**
$Ca + 2HCl \rightarrow CaCl_2 + H_2$ (1)

V to **W**
$CaO + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$ (1)

U to **Y**
$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$ (1)

(ii) $2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$ (1) [4]

(d) $Na_2SO_4(aq)/K_2SO_4(aq)$ **or** formula of any **soluble** sulfate (1) [1]

(e) (i) Ca to **X**
colourless gas formed/fizzing/effervescence/bubbles **or**
Ca dissolves **or**
white precipitate/suspension formed (1)

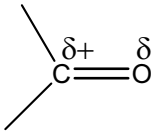
(ii) strongly exothermic/vigorous reaction **or**
steam formed/steamy fumes **or**
surface crumbles (1)
do not allow white ppt. [2]

[Total: 13]

4 (a) (i) nucleophilic addition (1)
both words are necessary

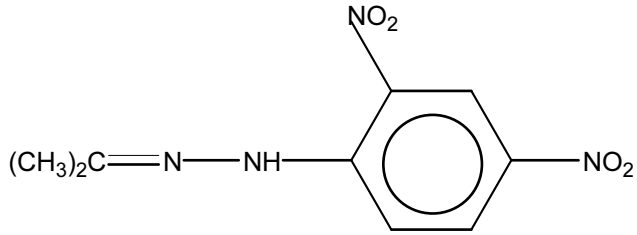
(ii) NaCN and H_2SO_4 **or**
HCN plus CN
do not allow HCN on its own (1)

(iii) correct δ+ **and** δ-, i.e.



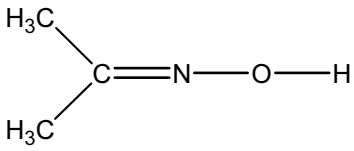
(1) [3]

(b) (i) correct organic product



C=N bond must be clearly shown (1)
H_2O formed/ equation balanced (1) [2]

(ii)



(1) [1]

[Total: 6]

5 **(a)** $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$ (1) [1]

(b) **(i)** step 1 electrophilic (1)
addition (1)
step 2 elimination **or** dehydrohalogenation (1)

(ii) reagent NaOH/KOH/OH (1)
conditions in alcohol/ethanol (1)
only allow conditions mark if reagent is correct [5]

(c) **(i)** **Q** is CH_3CHO (as minimum) (1)
R is CH_3CO_2H (as minimum) (1)

(ii) step 3 is addition (1)
step 4 is oxidation/redox (1) [4]

(d) **(i)** **combustion**
$C_2H_2(g) + {}^{5}/_{2}O_2(g) \rightarrow \mathbf{2}CO_2(g) + H_2O(l)$ **or**
equation must be for the combustion of one mole of C_2H_2
H_2O must be shown as liquid (1)
correct state symbols in this equation (1)

formation
$2C(s) + H_2(g) \rightarrow C_2H_2(g)$
no mark for state symbols here (1)

(ii) let **Z** be $\Delta H^{\ominus}_f$ of C_2H_2

	C_2H_2 +	${}^{5}/_{2}O_2 \rightarrow$	$2CO_2$ +	H_2O
$\Delta H^{\ominus}_f$	**Z**	0	2(-394)	-286

$\Delta H^{\ominus}_c = -1300 = 2(-394) + (-286) - \mathbf{Z}$ (1)

whence $\mathbf{Z} = 2(-394) + (-286) - (-1300)$

$= \mathbf{+}226$ kJ mol^{-1}
value (1)
sign (1)
allow ecf on wrong equation [6]

[Total: 16]

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1 **(a)** $K_c = \dfrac{[CH_3CH_2R][H_20]}{[CH_3CH_2H][ROH]}$ (1)

no units (1) [2]

(b) **(i)** $n(NaOH) = \dfrac{22.5 \times 2.00}{1000} = 0.045$ (1)

(ii) $n(NaOH) = n(HCl) = 0.005$ (1)

(iii) $CH_3CO_2H + NaOH \rightarrow CH_3CO_2Na + H_2O$ (1)

(iv) $n(NaOH) = 0.045 - 0.005 = 0.04$
allow ecf on **(i)** and/or **(ii)** (1) [4]

(c) **(i)** $n(NaOH)$ **and** $n(CH_3CO_2H) = 0.04$ (1)
$n(CH_3CO_2R)$ **and** $n(H_2O) = 0.06$ (1)

(ii) $K_c = \dfrac{0.06 \times 0.06}{0.04 \times 0.04} = 2.25$

allow ecf on wrong values in **(b)(i)**
allow ecf on wrong expression in **(a)** (1) [3]

(d) E_a for reaction with ester is high **or**
E_a for reaction with acid is low
or
reaction with ester is slow **or**
reaction with acid is fast (1) [1]

(e) equilibrium moves to RHS/more ester would be formed (1)
to maintain value of K_c **or**
to restore system to equilibrium (1) [2]

[Total: 12]

2 (a) $CH_2=CH_2 + HF \rightarrow CH_3CH_2F$

bonds broken /kJ mol^{-1}	4 C-H	1640	bonds made /kJ mol^{-1}	5 C-H	2050
	1 C=C	610		1 C-C	350
	1 H-F	562		1 C-F	*E*
		2812			(2400 + *E*)

breaking reactant bonds requires
4 x 410 + 610 + 562 = 2812 kJ mol^{-1} (1)

making product bonds gives

5 x 410 + 350 + *E* = (2400 + *E*) kJ mol^{-1} (1)

$\Delta H^{\ominus}_{reaction}$ = - (2400 + *E*) + 2812 = – 73 kJ mol^{-1} (1)

(2400 + *E*) = 2812 + 73 = 2885 kJ mol^{-1}

E = 2885 - 2400 = 485 kJ mol^{-1} (1)

allow ecf on wrong bond energy values and/or incorrect arithmetic [4]

(b) any **two** from
non-toxic
unreactive
volatile
non-flammable
easily liquefied (1 + 1) [2]

(c) in CCl_2F_2
C-C*l* bond energy is 340 kJ mol 1 and is weaker than C-F or C-H bonds (1)
C-C*l* bond is broken by uvl **or**
C*l* free radicals are formed (1) [2]

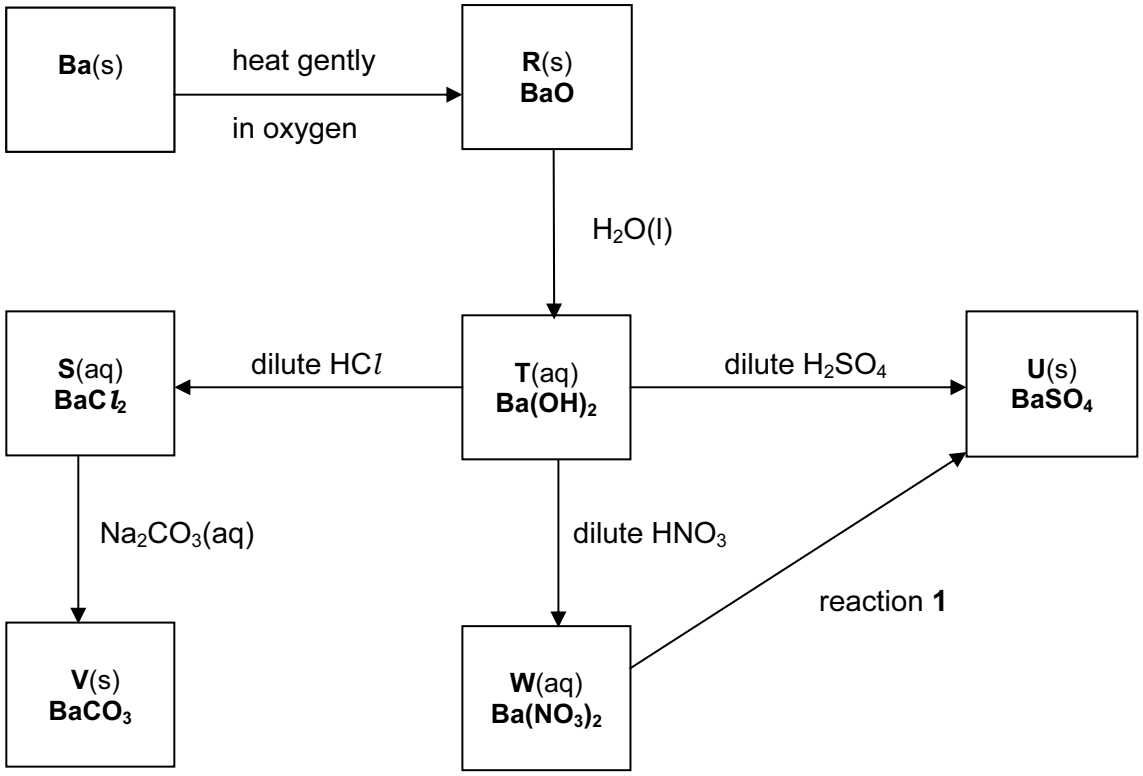
(d) (i) the trapping of reflected heat from the Earth in the lower atmosphere producing global warming

(ii) CO_2/carbon dioxide (1) [3]

(e) octahedral (1) [1]

[Total: 12]

3



(a) **R** BaO (1)
S $BaCl_2$ (1)
T $Ba(OH)_2$ (1)
U $BaSO_4$ (1)
V $BaCO_3$ (1)
W $Ba(NO_3)_2$ (1) [6]

(b) **(i)** **T** to **W**
$Ba(OH)_2 + 2HNO_3 \rightarrow Ba(NO_3)_2 + 2H_2O$ (1)

heat on **V**
$BaCO_3 \rightarrow BaO + CO_2$ (1)

(ii) **T** to **V**
CO_2 (1)
$Ba(OH)_2 + CO_2 \rightarrow BaCO_3 + H_2O$ (1) [4]

(c) $Na_2SO_4(aq)/K_2SO_4(aq)$ or any soluble sulfate (1) [1]

(d) (i) Ba:O = $\frac{81.1}{137} : \frac{18.9}{16}$ (1)

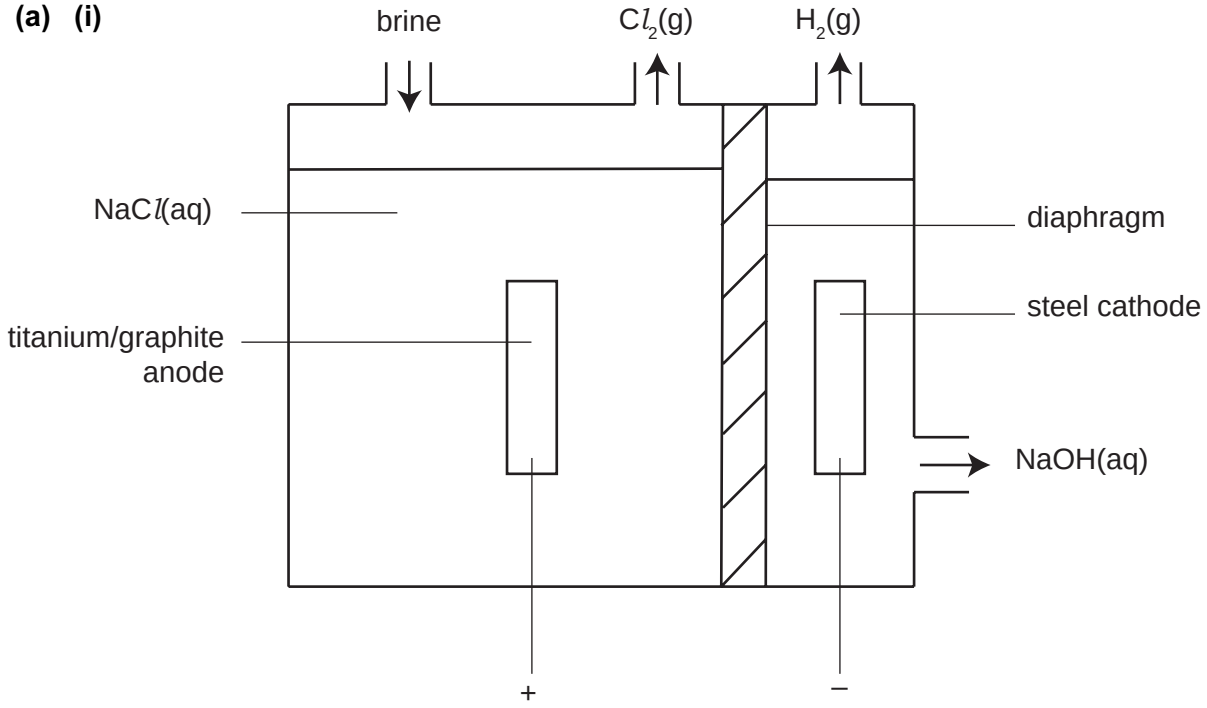
= 0.59 : 1.18
= 1 : 2
gives BaO_2 (1)

(ii) $BaSO_4$ (1)

(iii) $BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$ (1) [4]

[Total: 15]

4 (a) (i)



titanium/graphite anode identified correctly (1)
steel cathode identified correctly (1)
diaphragm identified correctly (1)
all three outlets correctly shown (1) [4]

(ii) **anode** $2Cl^-(aq) \rightarrow Cl_2(g) + 2e$ (1)

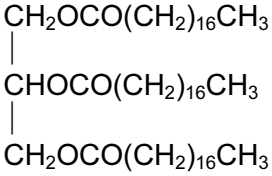
cathode $2H^+(aq) + 2e \rightarrow H_2(g)$

or $2H_2O(l) + 2e \rightarrow H_2(g) + 2OH^-(aq)$ (1) [2]

(iii) sodium hydroxide (1) [1]

[Total: 7]

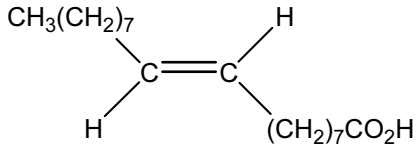
5 **(a)**



all three alcohol groups must be esterified (1) [1]

(b) dilute HC*l* **or** dilute H_2SO_4 **or** dilute mineral acid
or NaOH(aq) **followed by** dilute acid (1) [1]

(c)



(1) [1]

(d) **(i)** fatty acid that contains more than one C=C bond (1)

(ii) hydrogen (1)
nickel/Raney nickel/platinum/palladium (1) [3]

(e) **(i)** $CH_3(CH_2)_7CHO$ (1)
$OHC(CH_2)_7CX$ (1)

(ii) 2,4-dinitrophenylhydrazine (1)
yellow/orange/red precipitate (1)

(iii) Tollens' reagent **or** Fehling's/Benedict's solution (1)
silver mirror/ **or** brick red ppt.
grey precipitate (1) [6]

(f) **(i)** two (1)

(ii) ester (1) [2]

[Total: 14]

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1 Throughout this question, deduct **one mark only** for sig. fig. error.

(a) (i) the volume of solution **A** present in one 'typical ant' is
$7.5 \times 10^{6} \times 1000 = 7.5 \times 10^{3}$ cm^3 (1)

(ii) the volume of pure methanoic acid in one 'typical ant' is
$7.5 \times 10^{3} \times \frac{50}{100} = 3.75 \times 10^{3}$ gives 3.8×10^{3} cm^3

allow ecf on **(i)** (1)

(iii) no. of ants = $\frac{1000}{3.8 \times 10^{3}} = 263157.8947$ gives 2.6×10^{5}

use of 3.75×10^{3} gives $266666.6667 = 2.7 \times 10^{5}$ (1) [3]

(b) (i) the volume of solution **A**, in one ant bite is
$\frac{80}{100} \times 7.5 \times 10^{3} = 6.0 \times 10^{3}$ cm^3

allow ecf on **(a)(i)** (1)

the volume of pure methanoic acid in one bite is
$\frac{50}{100} \times 6.0 \times 10^{3} = 3.0 \times 10^{3}$ cm^3

allow ecf on first part of **(b)(i)** (1)

(ii) the mass of methanoic acid in one bite is
$3.0 \times 10^{3} \times 1.2 = 3.6 \times 10^{3}$ g

allow ecf on **(b)(i)** (1) [3]

(c) (i) $HCO_2H + NaHCO_3 \rightarrow HCO_2Na + H_2O + CO_2$ (1)

(ii) 46 g $HCO_2H \equiv$ 84 g $NaHCO_3$ (1)

5.4×10^{3} g $HCO_2H \equiv \frac{84 \times 5.4 \times 10^{3}}{46}$ g $NaHCO_3$
$= 9.860869565 \times 10^{3}$
$= 9.9 \times 10^{3}$ g $NaHCO_3$ (1) [3]

[Total: 9]

2 **(a)** there are no inter-molecular forces present between ideal gas molecules
ideal gas molecules have no volume
collisions between ideal gas molecules are perfectly elastic
ideal gas molecules behave as rigid spheres (any 2) [2]

(b) high temperature (1)
low pressure (1) [2]

(c) **most ideal** ..... neon..... nitrogen..... ammonia..... **least ideal** (1)
nitrogen has stronger van der Waals' forces than argon (1)
ammonia has hydrogen bonding as well as van der Waals' forces (1) [3]

(d) with increasing temperature,
average kinetic energy of molecules increases (1)
intermolecular forces are more easily broken (1) [2]

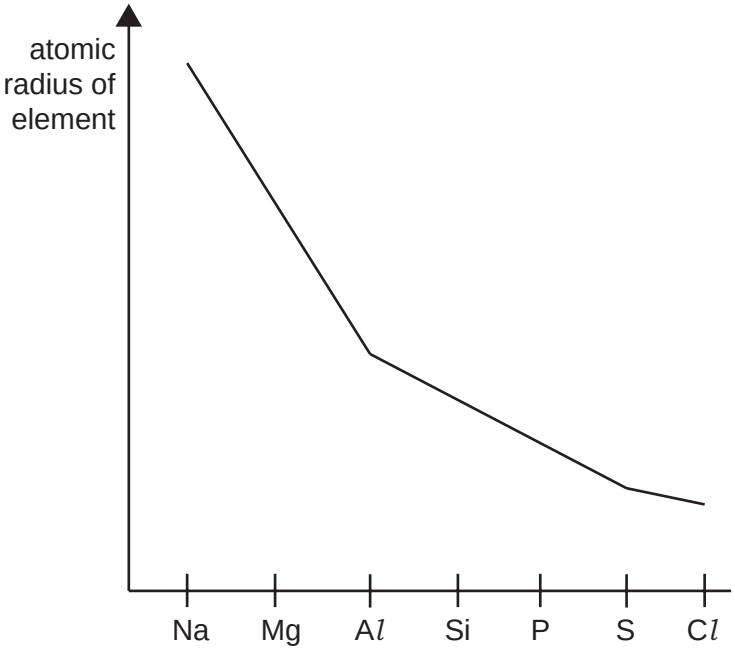
(e) 18 (1) [1]

(f) **(i)** both have very similar/same van der Waals' forces (1)

(ii) CH_3F has permanent dipole (1) [2]

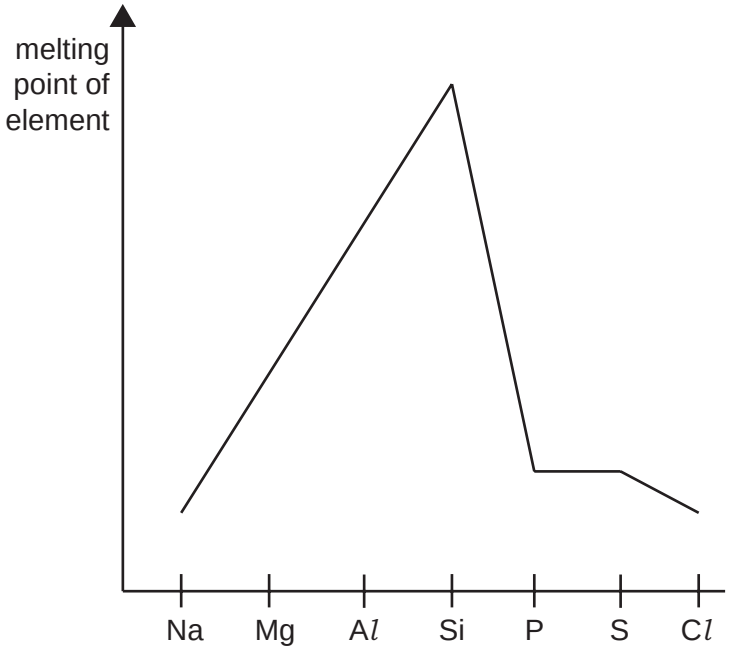
[Total: 12]

3 (a)



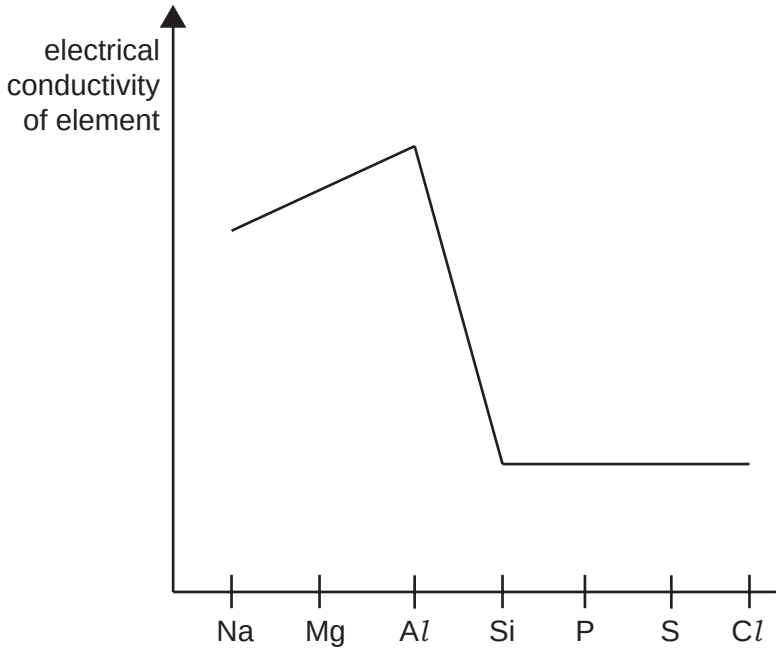
general shape of curve (1)
for Na → Ar
nuclear charge increases (1)
electrons are added to same shell (1) [3]

(b)



general shape of curve (1)
Na, Mg and Al have metallic bonding (1)
Si is giant molecular (1)
P, S, and Cl are simple molecular (1) [4]

(c)



general shape of curve	(1)	
Na, Mg and Al have increasing no. of outer shell electrons	(1)	
Si is a semi-conductor	(1)	
P, S and Cl are covalent/simple molecular	(1)	[4]

(d) **(i)**

Na_2O	ionic	(1)	
SiO_2	covalent	(1)	
P_4O_6	van der Waals' forces/induced dipoles	(1)	

(ii) Al_2O_3 **or** SiO_2 (1) [4]

[Total: 15]

4 **(a)** $C_9H_{16}O_2$ (1) [1]

(b) **(i)** aldehyde **not** carbonyl (1)
secondary (1)
alcohol (1)

(ii) Br_2/bromine **allow** $KMnO_4/H^+$ (1)
decolourised decolourised (1) [5]

(c) **(i)** $CH_3(CH_2)_4COCO_2H$ (1)
HO_2CCO_2H **or** CO_2 (1)

(ii) $CH_3(CH_2)_4CH(Cl)CH=CHCHO$ (1)

(iii) $CH_3(CH_2)_4CH(OH)CH=CHCH_2OH$ (1) [4]

[Total: 10]

5 (a) (i) $C_7H_{14}O_2$ (1)

(ii) one (1) [2]

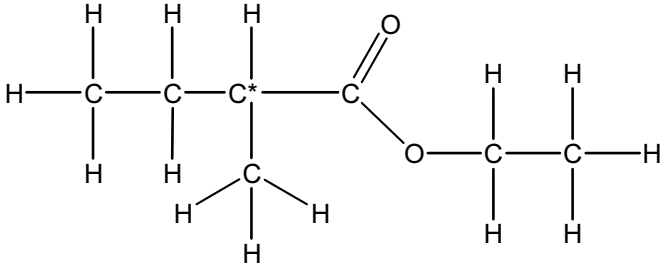
(b) (i) $Cr_2O_7^{2-}/H^+$ (1)
from orange (1)
to green (1)

(ii) 2-ethyl-3-methylbutanal/$(CH_3)_2CHCH(C_2H_5)CHO$/the corresponding aldehyde (1)
partial oxidation of alcohol will produce aldehyde (1)

(iii) reflux **because**
the alcohol must be fully oxidised (1) [6]

(c) none (1)
alcohol is tertiary (1)
cannot be oxidised (1) [3]

(d)



correct structure (1)
fully displayed $-CO_2C_2H_5$ group (allow ecf on wrong esters) (1)
correct chiral C atom (allow ecf on wrong esters) (1) [3]

[Total: 14]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/31 Paper 31 (Advanced Practical Skills 1), maximum raw mark 40

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UNIVERSITY of CAMBRIDGE
International Examinations

Question	Sections	Indicative material	Mark	
1 (a)	PDO Layout	**I** Volume given for rough titre **and** accurate titre details tabulated. *Minimum of 2 × 2 boxes.*	1	
	MMO Collection	**II** Initial and final burette readings recorded for rough titre **and** initial and final burette readings and volume of **FA 2** added recorded for each accurate titre. *Headings should match readings. Do **not** award this mark if: 50(.00) is used as an initial burette reading; more than one final burette reading is 50.(00); any burette reading is greater than 50.(00)*	1	
	PDO Recording	**III** All accurate burette readings (initial and final) recorded to nearest 0.05 (cm^3) *Assessed on burette readings only.*	1	
		IV Has two uncorrected, accurate titres within 0.1 cm^3 *Do **not** award this mark if having performed two titres within 0.1 cm^3 a further titration is performed which is more than 0.10 cm^3 from the closer of the initial **two** titres, unless a fourth titration, within 0.1 cm^3 of any of the previous titres has also been carried out.*	1	
Round any burette readings to the nearest 0.05 cm^3. Check and correct subtractions in the titre table. Examiner then selects the "best" titre using the hierarchy: two identical; titres within 0.05 cm^3; titres within 0.1 cm^3; etc				
	MMO Quality	**V**, **VI** and **VII** Award **V**, **VI** and **VII** for a difference from Supervisor within 0.20 cm^3 Award **V** and **VI** for a difference of > 0.20 – ≤ 0.40 cm^3 Award **V** for a difference of > 0.40 – ≤ 0.60 cm^3 *If the "best" titres are ≥ 0.60 cm^3 apart cancel one of the Q marks.*	3	[7]

(b)	ACE Interpretation	Calculates the mean, correct to 2 decimal places from any accurate titres within 0.20 cm^3. *The third decimal place may be rounded to the nearest 0.05 cm^3.* *A mean of exactly .x25 or .x75 is allowed but the candidate may round up or down to the nearest 0.05 cm^3.* *If **ALL** burette readings are given to 1 decimal place then the mean can be given to 1 decimal place* if numerically correct without rounding. *Mean of 24.3 and 24.4 = 24.35 **(✓)*** *Mean of 24.3 and 24.4 = 24.4 **(×)*** ***Titres to be used in calculating the mean must be clearly shown – in an expression or ticked in the titration table.***	1	[1]
(c)	ACE Interpretation	**I** Expression needed in step **(i)** (= mean titre $\times 0.15/1000$ mol) **and** step **(ii)** (= answer to step **(i)** / 2) *No irrelevant or incorrect working should be included.*	1	
		II Correctly evaluates step **(iii)** (= answer to step **(ii)** × 10) **and** step **(iv)** (= answer to step **(iii)** × 40)	1	
	PDO Display	**III** Some **relevant working** shown in a minimum of **three** parts in the calculation. (In **(ii)** could be × 2 or ÷ 2, in **(iii)** could × 10 or ÷ 10).	1	
		IV **All** answers given are quoted to 3 or 4 sig figs (must be a **minimum** of three steps)	1	[4]
				[Total: 12]

2 (a)	MMO Collection	**I** Two pairs of temperature values recorded as instructed in **(a)**, with units for all readings in **(a)** and **(b)** – minimum of 3 readings. *Acceptable units are /ºC, (ºC), temperature in degrees Celsius, temperature in ºC.*	1	
	PDO Recording	**II** **All** thermometer readings recorded to 0.0 ^{o}C or 0.5 ^{o}C. (check readings in sections **2(a)** ***and*** **2(b)** – minimum of 4 readings).	1	
	ACE Interpretation	**III** Correct subtractions to give temperature rises **and** the correct mean value in **2(a)**. *Mean value may be rounded to 0.5 ^{o}C* **or** *to one d.p* **or** *to 0.05 ^{o}C and from 0.025 and 0.075 or these may be rounded up or down to nearest 0.1.*	1	
Supervisor script: check subtractions and calculate mean ΔT *Marks are awarded for comparing the "true" means: check working of candidate and Supervisor.* *Show Supervisor's mean (corrected* ***if*** *necessary) on the script in a ring.*				
	MMO Quality	Award **IV** and **V** if candidate's mean temp rise is within 2.0 ^{o}C of Supervisor's (incl) Award **IV** if the difference is between 2.0 ^{o}C and 3.0 ^{o}C.	1 1	[5]
	PDO Display	Heat produced (J) = 25 × 4.3 × temp rise *(method mark)*. *Unit is needed in the quoted answer (kJ if divided by 1000).* Correctly evaluates enthalpy change = $^{\text{heat produced}}/_{0.016}$. *Division by 1000 is not required if candidate did this in the previous step.* *Answer must be negative and to 3 sig figs.*	1 1	[2]

Examiner to calculate 20% and 40% of supervisor's ΔT and convert to nearest 0.5°C.				
(b)	ACE Interpretation MMO Quality	**I** Both temperature measurements clearly shown. Award **II** and **III** if candidate's temp rise is within 20% of Supervisor's. Award **II** if candidate's temp rise is within 40% of Supervisor's.	1 1 1	[3]
	ACE Interpretation PDO Display ACE Conclusions	**IV** Calculates 0.032 for moles in **(ii)** or 0.016 for moles in **(a)(ii)**. **V** Enthalpy change correctly calculated (= – $^{\text{heat change}}/_{0.032}$). *Answer **must** show negative sign (unless already penalised) and be given to 3 sig figs. (unless already penalised).* **VI** Correct calculation of enthalpy change $\Delta H_1 = \Delta H_2 - \Delta H_3 - 286$	1 1 1	[3]
(c)	ACE Improvements	Extra/thicker lagging ***or*** use a lid ***or*** use a vacuum flask	1	[1]
				[Total: 14]

		FA 7 is $Zn(NO_3)_2(s)$; **FA 8** is $CuSO_4(s)$		
3 (a) (i)	MMO Collection	No change (***or*** no precipitate **or** no reaction) both with barium chloride and silver nitrate.	1	
	MMO Collection	**Gentle** heat: solid melts **or** dissolves **or** gives a colourless liquid	1	
(ii)		Brown fumes/gas produced (allow 'qualified' brown e.g. red/brown, do not allow orange).	1	
		(Gas produced) that relights a glowing splint **or** yellow solid, goes white on cooling. (Allow precipitate).	1	
(iii)	ACE Conclusions	**FA 7** is a nitrate/nitrite (from some evidence)	1	
(iv)	MMO Decisions	(Heat) **FA 7** with A*l* foil and NaOH/ecf from anion given.	1	
	MMO Collection	Gas/vapour/NH3 produced ***and*** it turns red litmus to blue ***and*** confirms that **FA 7** contains nitrate/nitrite ions.	1	
(v)	MMO Decisions	Adds ammonia. *(This mark is **not** awarded if a second test is also used)*	1	
	ACE Conclusions	Zinc ions are present. (No ecf) *(Deduction **must** be consistent with observations recorded – white ppt soluble in excess)*.	1	[9]
(b) (i)	MMO Collection	With KI, goes yellow/orange/brown ***and*** gives a blue (blue-black ***or*** purple ***or*** black) colour with starch. *No reference to the state is required, just the colours.*	1	
		Brown/yellow/white/off- white precipitate forms.	1	
(ii)	ACE Conclusions	KI is the reducing agent (**or** it is oxidised) as iodine is formed **or** $2I^- - 2e \rightarrow I_2$ **or** $2Cu^{2+} + 2I^- \rightarrow I_2 + 2Cu^+$ *Ignore state symbols.*	1	
(iii)	MMO Collection	Blue (do not allow dark blue) precipitate obtained, which does not dissolve in excess NaOH	1	
	ACE Conclusions	$Cu^{2+} + 2OH^- \rightarrow Cu(OH)_2$	1	[5]
				[Total: 14]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/32 Paper 32 (Advanced Practical Skills 2), maximum raw mark 40

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UNIVERSITY of CAMBRIDGE
International Examinations

Question	Sections	Indicative material	Mark	
1 (a)	PDO Layout	**I** Volume given for Rough titre **and** accurate titre details tabulated. *Minimum of 2 × 2 boxes.*	1	
	MMO Collection	**II** Initial and final (burette) (readings) and volume of **FB 2** added/reading at start and finish recorded for each accurate titre (not 'difference'). **and** mass tube + **FB 1,** mass tube + residue/empty, mass **FB 1**. Ignore units. *Headings should match readings. Do not award this mark if: 50(.00) is used as an initial burette reading; More than one final burette reading is 50(.00); Any burette reading is greater than 50(.00).*	1	
	PDO Recording	**III** All accurate burette readings (initial and final) recorded to nearest 0.05 (cm^3). *Assessed on burette readings only (minimum of 2 readings).*	1	
	MMO Decisions	**IV** Has two uncorrected accurate titres within 0.1 cm^3. *Do not award this mark if, having performed two titres within 0.1 cm^3, a further titration is performed that is more than 0.10 cm^3 from the closer of the initial two titres, unless a fourth titre, within 0.1 cm^3 of any of the previous titres, has also been carried out.*	1	
Round any burette readings to the nearest 0.05 cm^3. Check and correct, if necessary, subtractions in the titre table and in the calculation of mass. Examiner then selects the 'best' titre using the hierarchy: two identical; titres within 0.05 cm^3, titres within 0.1 cm^3 etc. Calculate: candidate's titre × $\frac{\text{Supervisor mass}}{\text{candidate mass}}$ to 2 decimal places Calculate difference in Supervisor and candidate scaled values and award quality marks as below.				
	MMO Quality	**V**, **VI** and **VII** Award **V, VI** and **VII** if $\delta \leq 0.25\,cm^3$ Award **V** and **VI** if $0.25 < \delta \leq 0.50\,cm^3$ Award **V** if $0.50 < \delta \leq 0.80\,cm^3$ *If the 'best' titres are ≥ 0.60 cm^3 apart cancel one of the Q marks.*	3	[7]

(b)	ACE Interpretation	Calculates the mean, correct to 2 decimal places from any **accurate** titres within 0.2 cm^3. *The third decimal place may be rounded to the nearest 0.05 cm^3.* *A mean of exactly .×25 or .×75 is allowed but the candidate may round up to .×3 or .×8 or to the nearest 0.05 cm^3.* *If ALL burette readings are given to 1 decimal place then the mean can be given to 1 decimal place if numerically correct without rounding,* *Mean of 24.3 and 24.4 = 24.35 (✓)* *Mean of 24.3 and 24.4 = 24.4 (×)* **Titres to be used in calculating the mean must be clearly shown – in an expression or ticked in the titration table.** Allow ecf from subtraction error for titre.	1	[1]
(c)	ACE Interpretation PDO Display	**I** Correctly evaluates step **(i)** (= mean titre × 0.2 / 1000) **II**, **III** and **IV** are awarded for the correct expression or for the correct answer if no working shown. For all 'method' marks, no additional steps can be included. **II** Step **(ii)** (answer to **(i)** / 2) **and** step **(iii)** (answer to **(ii)** × 10) **III** In **(iv)** relative formula mass (= mass of washing soda / answer to **(iii)**) (ignore g) **IV** In **(v)** answer to **(iv)** – 106 / 18 **or** 106 + 18x = answer to **(iv)** (mark method even if M_r is < 106 or very large). **V** Some relevant working shown in a minimum of four parts in the calculation (in **(ii)** could be × 2 or ÷ 2, in **(iii)** could be × 10 or ÷ 10, in **(v)** could be use of 106). **VI** In steps **(i)** to **(iv)** all answers to 3 or 4 sig figs (minimum of 3 steps).	1 1 1 1 1 1	[6]
(d)	ACE Interpretation	0.1 × 100 / titre from **(b)** (only expression needed).	1	[1]
				[Total: 15]

2 (a)	PDO Layout	**I** Two balance readings, one mass, two thermometer readings and one change in temperature shown in suitable layout.	1	
	PDO Recording	**II** Masses and temperatures recorded with correct headings and units for all data shown. *Acceptable units for temperature are / °C, (°C), temperature in degrees Celsius, temperature in °C., units for mass are /g, (g), mass in grams.*	1	
	PDO Recording	**III** All thermometer readings recorded to 0.0 °C or 0.5 °C and all balance readings recorded to same degree of accuracy.	1	
Round all thermometer readings to nearest 0.5 °C.Check and correct, if necessary, subtractions in the temperature change and the mass used. Calculate to 1 decimal place: candidate temperature change × $\frac{\text{Supervisor mass}}{\text{candidate mass used}}$ Calculate difference in candidate and Supervisor scaled values and award quality marks as below.				
	MMO Quality	**IV** and **V** Award **IV** and **V** for changes within 0.8 °C of Supervisor Award **V** for changes > 0.8 but within 1.6 °C of Supervisor	2	[5]
(b) (i)	ACE Interpretation	**I** Expression for heat change in **(i)** = 25 × 4.3 × temperature change from **(a)** (answer given must correspond to units quoted).	1	
(ii)		**II** Expression for moles of washing soda from mass used and M_r from **(a)** or M_r = 259 or Mr = 286 in **(ii)**	1	
(iii)		**III** Correctly evaluates enthalpy change = heat change / (1000 × moles of washing soda) in **(iii)** (if 1000 not used, must say J).	1	
	ACE Conclusions	**IV** Enthalpy change shown as positive and to 3 sig figs. (Answer need not be arithmetically correct). Ignore sig figs (except if approximated to 1 sig fig in rest of question.)	1	[4]
(c)	ACE Improvements	Use a more precise thermometer/a thermometer with more accurate calibrations/a thermometer that reads to 0.1 °C or 0.2 °C (a more accurate thermometer/a digital thermometer/thermocouple is insufficient) **or** use a more precise method to measure the volume of acid **or** use a deeper plastic cup **or** scaling up apparatus and quantities of chemicals used (Do not accept 'add a lid')	1	[1]
				[Total: 10]

FB 5 is $MgSO_4(aq)$; **FB 6** is $Pb(NO_3)_2(aq)$ **FB 7** is $Al_2(SO_4)_3(aq)$; **FB 8** is $(NH_4)_2FeSO_4(aq)$				
3 (a) (i)	MMO Decisions	**I** Reagents chosen KI(aq) or HCl(aq) or K_2CrO_4 or $K_2Cr_2O_7$ or H_2SO_4 and NaOH (aq) (penalise additional reagents)	1	
	MMO Collection	**II** NaOH white precipitates for all	1	
		III Excess NaOH no effect **FB 5**, precipitate dissolves **FB 6** and **FB 7**	1	
		IV KI / HCl / K_2CrO_4 / $K_2Cr_2O_7$ / H_2SO_4 nothing/no visible reaction for (**FB 5** and **FB 7**), yellow precipitate/white precipitate for **FB 6.**	1	
		Ignore observations for additional reagents.		[4]
(ii)	ACE Conclusions	**I** **FB 5** contains Mg^{2+}, **FB 6** contains Pb^{2+} and **FB 7** contains Al^{3+} (no ecf and must follow observations in **(i)**)	1	
		II **FB 5** (white) precipitate with NaOH, insoluble in excess	1	
		III **FB 6** (yellow) precipitate with KI / (yellow) precipitate with K_2CrO_4 or $K_2Cr_2O_7$ / (white) precipitate with HCl or H_2SO_4.	1	
		FB 7 No precipitate with KI / HCl / H_2SO_4 **and** (white) precipitate with NaOH, soluble in excess. (Both observations needed unless **FB 6** already identified as Pb^{2+}).	1	
		Allow ecf, based on candidate's observations, for **II**, **III** and **IV**.		[4]

(b) (i)	MMO Collection	Effervescence/bubbles/hydrogen produced (ignore any test for ammonia but tests for other gases negate). (Do not accept gas produced) **or** Black/grey solid/coating on magnesium	1	
(ii)		Ammonia/gas turns litmus paper blue	1	
(iii)		Green precipitate (any qualified green including grey/green but do not allow green/brown.)	1	
		Turns brown (any qualified brown) on addition of hydrogen peroxide. Allow rusty or orange/brown precipitate but not orange alone. Ignore effervescence.	1	
		Fe^{2+} / iron (II).	1	[5]
	ACE Conclusions	(+)2 to 0 (ecf on chromium (+)3 to 0) or (+)3 to (+)2).	1	
		(+)2 to (+)3.	1	
		Conclusions are free standing but must be Fe^{2+}.		[2]
				[Total: 15]

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9701 CHEMISTRY

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Question	Sections	Indicative material	Mark	
1 (a)	PDO Layout	**I** Volume given for rough titre **and** accurate titre details tabulated. *Minimum of 2 × 2 "boxes".*	1	
	PDO Recording	**II** Appropriate headings and units for data given in weighing and accurate titration tables. *Acceptable headings:* *mass of tube + FA1;* *mass of tube + residue/mass of empty tube (mass of FA1 used);* *initial/final or 1st/2nd (burette) (reading)/(reading at) start/finish;* *volume added/used/ titre; or wtte [**not** "difference"]* *Acceptable units are solidus: /cm^3; brackets: (cm^3); in words: volume in cubic centimeters, volume in cm^3. Similarly for mass in g, etc* If units are not included in the heading every entry in the table must have the correct unit.	1	
	PDO Recording	**III** All accurate burette readings are given to the nearest 0.05 cm^3. *Do **not** award this mark if:* *50(.00) is used as an initial burette reading;* *more than one final burette reading is 50.(00);* *any burette reading is greater than 50.(00)*	1	
	MMO Decision	**IV** Two uncorrected titres within 0.10 cm^3 *Do not allow the Rough even if ticked.* *Do **not** award this mark if having performed two titres within 0.1 cm^3 a further titration is performed which is more than 0.10 cm^3 from the closer of the initial **two** titres, unless a fourth titration, within 0.1 cm^3 of any other has also been carried out.*	1	
Examiner rounds any burette readings to the nearest 0.05 cm^3, checks subtractions and then selects the "best" titre using the hierarchy: *two identical; titres within 0.05 cm^3; titres within 0.1 cm^3; etc* to calculate mean (ignore any labelled rough). Examiner compares [corrected mean titre/corrected mass of **FA 1**] with Supervisor result. Calculate the ratios to 2 dp.				
	MMO Quality	Award **V**, **VI** and **VII** if $\delta \leq 0.05$ (cm^{3}g ^{1}) Award **V** and **VI** if $0.05 < \delta \leq 0.10$ Award **V** only if $0.10 < \delta \leq 0.20$ *If the "best" **titres** are ≥ 0.60 cm^3 apart cancel one of the Q marks.*	1 1 1	[7]

(b)	MMO Decision	Selects **correctly subtracted accurate** titre values within 0.20 cm^3. Must use more than one value. If no calculation shown then titres must be indicated (*e.g.* with a tick) in the table	1	
	PDO Display	Correct mean from any values selected (may include rough) by candidate given to same decimal places as most precise burette reading recorded in the table. *The third decimal place may be rounded to the nearest 0.05 cm^3.* *A mean of exactly .x25 or .x75 is allowed but the candidate may round up or down to the nearest 0.05 cm^3.* *If **ALL** burette readings are given to 1 decimal place then the mean may be given to 1 decimal place* if numerically correct without rounding. *Mean of 24.3 and 24.4 = 24.35 (✓)* *Mean of 24.3 and 24.4 = 24.4 (×)* If no working shown allow mean if value identical to that used by Examiner.	1	[2]
(c)	ACE Interpretation	**I** In part **(i)** {titre from **(b)**/1000} × 0.01(0) *If no working shown then answer must be correct.*	1	
		II ans to **(i)** × 5 **and** ans to **(ii)** × 10 *with no additional steps*	1	
		III ans to **(iii)** × 55.8 *If* **(iii)** *incorrect allow correct* **(ii)** × 10 × 55.8	1	
		IV **correct** (ans to **(iii)** × 55.8/mass of **FA** 1) × 100 to sf shown (*ecf* allowed from **(iii)**) (sf shown may come from **(i)** with no previous rounding) *If* **(iii)** *incorrect allow correct* **(ii)** × 10 × 55.8 × 100/mass **FA 1** *(If choice of answer take the one in the answer space.)*	1	
	PDO Display	**V** 3 or 4 significant figures in final answers to all parts attempted (minimum three parts)	1	[5]
(d)	ACE Interpretation	**(i)** Uncertainty either 1 or .5 in final place. **If balance displays to 1 decimal place:** error in balance reading is ±0.05 g ***or*** ±0.1(0) g **If balance displays to 2 decimal places:** error in balance reading is ±0.005 g ***or*** ±0.01 g **If balance displays to 3 decimal places:** error in balance reading is ±0.0005 g ***or*** ±0.001g	1	
		(ii) {2 × **(i)**/mass used} × 100 answer to 2, 3 or 4 sf	1	[2]
				[Total: 16]

2 (a)	PDO Display	**I** Tabulates mass of (empty) crucible, mass of crucible + **FA 4**, mass of crucible + residue/**FA 4** after heating, mass of **FA 4**/**hydrated** magnesium sulfate, mass of water lost. *Do **not** award if mass of **FA 4** or mass of water incorrect*	1	
	PDO Recording	**II** Records **all** weighings consistently to at least 1 decimal place [minimum three weighings].	1	
	MMO Decision	**III** Final weighings after reheating are within 0.05 g or identical if masses recorded to 1 dp	1	
Examiner to calculate [lowest mass of residue/mass of **FA 4**] of Supervisor and candidate to 2 dp. If two experiments carried out then use sum of masses of residues and sum of masses of **FA 4** to calculate the ratio. *If the Supervisor's value is doubtful (higher than the majority of candidates) then check whether candidates are close to the expected value of 0.55 or use candidate average if majority in close agreement. (Contact team leader)*				
	MMO Quality	Award **IV** and **V** if $\delta \leq 0.05$ Award **IV** only if $0.05 < \delta \leq 0.10$	1 1	[5]
(b)	ACE Interpretation	Part **(i)** [mass of water lost/(7 × 18)] **or** [mass of water lost × 246.4/18] (allow m(H_2O) × 246.4/7) *M_r H_2O must be 18* *Allow ecf for mass of water lost* *If two experiments carried out then mass of water may be taken from either or the mean.* *Allow mark if answer calculated correctly but working not shown.*	1	
		Part **(i)** [mass of water lost × 246.4/7 × 18] correctly evaluated to 3 sf [= mass of water lost × 1.956] *(Ignore part **(ii)**)* There are other chemically correct methods – mark accordingly.	1	[2]
(c)	ACE Improvements	Use a lid (for the early gentle heating) **or** larger mass (for smaller percentage error) **or** use (cool in) desiccator	1	[1]
				[Total: 8]

FA 5 is $NaHCO_3(s)$; **FA 6** is $NH_4Br(s)$; **FA 7** is $H_2SO_4(aq)$					
3	**(a)**	MMO Collection	On heating, steam or condensation or water vapour, misty vapour is noted **or** solid becomes powdery	1	
		MMO Decisions	Tests for gas using limewater **or in 3(d)**	1	[2]
	(b)	PDO Layout	Presents results of tests in an unambiguous way *Minimum 4 × 2 boxes*	1	
		MMO Collection	(No reaction with cold NaOH and) gas/ammonia/fumes produced (on heating) that turn(s) red litmus blue *Do not award if ppt reported with NaOH (CON)*	1	
			No reaction with ammonia **and** no reaction with barium chloride/nitrate	1	
			Cream ppt with silver nitrate that partially dissolves/is insoluble in aqueous ammonia	1	
		ACE Conclusion	**FA 6** cation: ammonium/NH_4^+ *from some evidence and no CON obs*	1	
			FA 6 anion: bromide/Br *No ecf but can award Br from any mention of cream but ppt must be present **or** off-white ppt insoluble or partially soluble in NH_3.*	1	[6]
	(c)	MMO Collection	**Ignore any observations after water added.** Steamy/misty white/orange/red/red-brown (not brown) gas/vapour/ fumes/smoke produced **or** gas/vapour/fumes/smoke bleaches litmus (paper) **or** gas/vapour/fumes/smoke turns (potassium) dichromate (solution) from orange to green	1	
			(White) solid turns red/orange (not yellow, not brown, not solution, not ppt) Ignore "hot"	1	
		ACE Conclusion	**FA 6** is oxidised/redox reaction/oxidation because Br becomes Br_2/Br_2 is produced **or** redox/reduction because H_2SO_4 forms/becomes SO_2 (with positive dichromate observation) **or** exothermic because tube becomes hot/heat given out.	1	[3]
	(d)	MMO Collection	Fizzing/effervescence/bubbling (occurs) (*not gas is produced)* If limewater test used here give second mark in **(a)**.	1	
			White ppt with lead nitrate **and** no reaction with silver nitrate	1	[2]

(e)	MMO Decision	barium chloride/nitrate followed by hydrochloric/nitric acid (not $Ba^{2+}(aq)$, $BaNO_3$, …) (If H^+ already identified then "followed by hydrochloric/nitric acid" is not essential.)	1	
	ACE Conclusion	**FA 7** cation: protons/H^+ if there is a positive observation with blue litmus paper/K_2CrO_4/Mg/Na_2CO_3	1	
		FA 7 anion: sulfate/SO_4^{2} Allow from minimum evidence of white ppt with $Ba^{2+}(aq)$	1	[3]
				[Total: 16]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/34 Paper 32 (Advanced Practical Skills 2), maximum raw mark 40

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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UNIVERSITY of CAMBRIDGE
International Examinations

Question	Sections	Indicative material	Mark	
1 (a)	PDO Layout	**I** Volume given for Rough titre **and** accurate titre details tabulated. *Minimum of 2×2 "boxes".*	1	
	MMO Collection	**II** Follows instructions – dilutes 45.50–46.50 cm^3 **FB 1** **and** initial and final burette readings **and** volume of **FB 2** added recorded for each accurate **titre** (on page 3) *Headings should match readings. Ignore units. Acceptable headings: initial/final or 1st/2nd (burette) (reading)/(reading at) start/finish; volume added/used/ titre; or wtte [**not** "difference"] Do **not** award this mark if: 50(.00) is used as an initial burette reading; more than one final burette reading is 50.(00); any burette reading is greater than 50.(00)*	1	
	PDO Recording	**III** All accurate burette readings (initial and final) recorded to nearest 0.05 cm^3 (Accurate titration & dilution tables) *Assess this mark on burette readings only, ignore volumes of* **FB 1** *and* **FB 2** *added*	1	
	MMO Decisions	**IV** Has two uncorrected, accurate titres within 0.1 cm^3 *Do not consider the Rough even if ticked. Do **not** award this mark if having performed two titres within 0.1 cm^3 a further titration is performed which is more than 0.10 cm^3 from the closer of the initial **two** titres, unless a fourth titration, within 0.1 cm^3 of the third titration (or first two) has also been carried out.*	1	

Round any burette readings to the nearest 0.05 cm^3.
Check and correct, if necessary, subtractions in the titre table.
Examiner then selects the "best" titre using the hierarchy:
two identical; titres within 0.05 cm^3; titres within 0.1 cm^3; etc

$$\text{Calculate candidate titre} \times \frac{\text{candidate volume added}}{\text{Supervisor volume added}}$$

Calculate difference in Supervisor and candidate scaled values and award "quality" marks as below.
[If candidate has not recorded a volume diluted, use 46.00 cm^3]

Question	Sections	Indicative material	Mark	
	MMO Quality	**V**, **VI** and **VII** Award **V, VI** and **VII** for a difference from Supervisor within 0.20 cm^3 Award **V** and **VI** only for 0.20 < δ 0.40 cm^3 Award **V** only for 0.4 < δ 0.6 cm^3 *Apply spread penalty as follows:* *If titres selected (by Examiner) differ 0.60 cm^3* *cancel one of the Q marks*	1 1 1	[7]
(b)	ACE Interpretation	Calculates the mean, correct to 2 decimal places (third decimal place may be rounded up to the nearest 0.05 cm^3) from any **accurate** titres within 0.20 cm^3. *A mean of exactly .x25 or .x75 is allowed but the candidate may round up* to *.x3 or .x8 or to the nearest 0.05 cm^3.* *If **ALL** burette readings are given to 1 decimal place then the mean can be given to 1 decimal place* if numerically correct without rounding. *Mean of 24.3 and 24.4 = 24.35 (✓)* *Mean of 24.3 and 24.4 = 24.4 (✗)* ***Titres to be used in calculating the mean must be clearly shown – in an expression or ticked in the titration table.*** *Allow ecf from subtraction error for titre*	1	[1]
(c)	ACE Interpretation PDO Display	**I** correctly evaluates 1.25×10^4 **II**, **III**, **IV** are awarded for the correct expression but with no extra steps **or** for the correct answer if no working shown. **II** answer to **(i)** × 2.5 (3.125 or 3.13×10^4) **and** answer to **(ii)** × 2 (6.25×10^4) **III** Answer to **(iii)** × 250/mean titre in **(b)** **IV** Answer to **(iv)** × 1000/volume diluted **V** Working shown in a minimum of 4 steps *working must be in the right direction:* **(i)** *0.005 × 25* **(ii)** *indicate use of mole ratio (× 5/2 or 2/5)* *(If iodide used then × 5 or /5)* **(iii)** *use of × 2 or × 1/2* *(If iodide used then × 2/2 **not** × 1)* **(iv)** *answer to* **(iii)** × *250* ***or*** **(iii)***/mean titre* **(v)** *answer to* **(iv)** *and volume diluted used in denominator* **(vi)** All final answers to steps to 3 or 4 sf (minimum of 3 steps)	1 1 1 1 1 1	[6]
(d)	ACE Interpretation	(0.06/25) × 100 (= 0.24%) **and** (0.10/titre in **(b)**) × 100 *(only expressions needed)*	1	[1]
				[Total: 15]

Question	Sections	Indicative material	Mark	
2 (a)	PDO Recording	**I** Records volume of **FB 6**, *t* and 1/*t* unambiguously for the four experiments *Do **not** award if t is not to the nearest second*	1	
		II Correct headings and units: volume (cm^3) or $/cm^3$ or volume in cubic centimetres/cm^3; time (s) or /s or time in seconds/s; 1/time (s^{-1}) or $/s^{-1}$ or 1/time or rate in per second	1	
	MMO Decisions	**III** Selects two volumes of **FB 6** one between 25–30 cm^3 and one between 35–40 cm^3 **and** sufficient water to make the solutions up to 45 cm^3 before adding acid **or** between 30–35 and 10–15 with corresponding volumes of water.	1	
	Examiner corrects any fractional times to the nearest second for 45 cm^3 and 20 cm^3 of **FB 6** and calculates t_{20}/t_{45} to 2 dp			
	MMO Quality	Award **IV** only if 1.90 t_{20}/t_{45} 2.60 Award **IV** and **V** if 2.10 t_{20}/t_{45} 2.40	1 1	[5]
(b)	ACE Conclusions	Volume of **FB 6** is directly proportional to its concentration (if total volume is constant) **or** to keep the concentration of **FB 5** constant **or** to keep the depth constant	1	[1]
(c)	ACE Conclusions	Rate of reaction is proportional to concentration of **FB 6** (*allow directly proportional)* **or** increase in **concentration** increases **rate** or **1/*t***	1	[1]
(d)	ACE Interpretation	**Either** shortest time as greatest **percentage**/ **fractional** error **or** longest time as greatest uncertainty in judging when printing is obscured	1	[1]
(e)	ACE Improvements	Keep volume of thio/**FB 6** constant, change volume of acid/**FB 5** and (add water to) make total volume constant **or** use different concentrations of acid/**FB 5** and keep the volume of it and the thio/**FB 6** constant	1	[1]
				[Total: 9]

Question	Sections	Indicative material	Mark	
FB 7 is $Al_2(SO_4)_3$, **FB 8** is $Zn(NO_3)_2$, **FB 9** is $Pb(NO_3)_2$, **FB 10** is anhydrous $NaHCO_3$				
3 (a)		*Do not allow a dash for 'no reaction' except for* **FB 8** *with 2nd reagent provided NH_3 obs correct.*		
	PDO Layout	**I** Unambiguous layout of all (six minimum unless as above) observations with the two reagents *independent of reagents chosen*	1	
	MMO Decisions	**II** Chooses NH_3 **and** $KI/K_2CrO_4/H_2SO_4/HCl$ *(allow sodium/potassium dichromate)*	1	
	MMO Collection	**III** three white ppts with NH_3	1	
		IV Three correct obs **FB 7**: ppt insol in excess NH_3, **FB 8**: ppt soluble in excess NH_3, **FB 9**: ppt insol in excess NH_3	1	
		V three correct obs for a suitable reagent Expected obs: **FB 7** and **FB 8** no reaction, no change, no ppt, and **FB 9** white or yellow ppt depending on reagent *Allow obs mark if $BaCl_2$ used as 2nd reagent: white ppt with* **FB 7**, *no ppt with* **FB 8** *and white ppt or no ppt with* **FB 9**. *(If three reagents used mark obs for the two specified on 'reagent' line.)* *If any solutions appear to have been transposed, mark strictly as mark scheme.*	1	[5]
(b)	ACE Conclusions	**FB 7** contains Al^{3+}/aluminium (ions) as (white) ppt insoluble in excess NH_3 and no reaction with 2nd reagent	1	
		FB 8 contains Zn^{2+}/zinc (ions) as (white) ppt soluble in excess NH_3	1	
		FB 9 contains Pb^{2+}/lead (ions) as ppt with 2nd reagent *Only penalise missing charge once.* *If NaOH used as 2nd reagent allow* ***1st*** *mark if* ***both*** *Al^{3+} & Pb^{2+} specified for* **FB 7** ***and*** **FB 9**, *(***FB 8** *mark is still available)* *The evidence for* **FB 7** *and* **FB 9** *may come from a third reagent (if used)* *For 'transposed' solutions, if conclusions are valid for the obs given, a maximum of 2 marks may be awarded.* *If $BaCl_2$ used and* ***only*** *white ppt with* **FB 7** *then allow* **FB 7** *as Pb^{2+}. If* ***two*** *(white) ppts both unknowns should be Pb^{2+}* ***or*** *Al^{3+}/Pb^{2+}.*	1	[3]

Question	Sections	Indicative material	Mark	
(c)	MMO Collection	**(i)** Steam/water vapour/misty vapour/condensation/ droplets of liquid/water **or** lime water turns milky/cloudy white **(ii)** (pale) blue/green ppt/solid *(ignore effervescence)* **(iii)** effervescence/fizzing/bubbling *(ignore any reference to ppt)* **(iv)** white ppt **and** **either** effervescence (with acid) **or** (colourless) solution/ppt or solid dissolves **(v)** solid/ppt **turns** black/dark green/ darkens in 2nd box *Allow **is formed/changes to***	1 1 1 1 1	[5]
(d)	ACE Conclusions	**(i)** CO_3^{2} from limewater turning milky in **any** part of **(c)** **or** fizzing/effervescence with acid *Allow SO_3^{2} from correct obs in **(c)(iv)*** **(ii)** thermal decomposition **or** loss of water of crystallisation/dehydration (if CO_2 not tested for) **(iii)** effervescence suggests $Al^{3+}(aq)/Al_2(SO_4)_3$ is acidic **or FB 10** contains Ba^{2+} or Pb^{2+} (both needed) if white ppt recorded **or** CO_2 (produced) as limewater turns milky/cloudy white/forms white ppt **or** endothermic if cooling noted in **(c)(iii)**	1 1 1 	[3]
				[Total: 16]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/35 Paper 31 (Advanced Practical Skills 1), maximum raw mark 40

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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International Examinations

Question	Sections	Indicative material	Mark	
1 (a)	PDO layout	**I** Volume given for rough titre **and** accurate titre details tabulated *Minimum of 2×2 "boxes"*	1	
	MMO collection	**II** Follows instructions – dilutes 44.50–45.50 cm^3 **FA 2** **and** records unambiguous initial and final burette readings and volume of **FA 2** diluted and volume of **FA 3** added for each titration. *Headings should match readings.* *Do **not** award this mark if:* *50(.00) is used as an initial burette reading;* *more than one final burette reading is 50.(00);* *any burette reading is greater than 50.(00)*	1	
	MMO decisions	**III** All accurate burette readings (initial and final) recorded to nearest 0.05 cm^3 including dilution table *Assess this mark on burette readings only, ignore volume of **FA 3** added.*	1	
	PDO recording	**IV** has two titres within 0.10 cm^3 *Do **not** award this mark if having performed two titres within 0.1 cm^3 a further titration is performed which is more than 0.10 cm^3 from the closer of the initial **two** titres, unless a fourth titration, within 0.1 cm^3 of any other has also been carried out.*	1	
	Examiner to check and correct (if necessary) subtractions in the titre table. Examiner then selects the "best" titre using the hierarchy: two identical; titres within 0.05 cm^3, titres within 0.10 cm^3, etc., (ignore rough titre) For candidates and Supervisor scale titre for 45.00 cm^3 **FA 2** diluted. Calculate titre × $^{45.00}/_{\text{volume of FA 2 diluted}}$ to 2 dp Calculate difference in Supervisor and candidate scaled values and award "quality" marks as below.				
	MMO quality	Award **V**, **VI** and **VII** for a difference from Supervisor, δ 0.30 cm^3	1	
		Award **V** and **VI** for 0.30 < δ 0.60 cm^3	1	
		Award **V** only for 0.60 < δ 1.00 cm^3 *If "best" **titres** are 0.60 cm^3 apart cancel one of the Q marks*	1	[7]

(b)	ACE interpretation	Calculates the mean, correct to 2 decimal places from any accurate titres within 0.20 cm^3. *The third decimal place may be rounded to the nearest 0.05 cm^3.* *A mean of exactly .x25 or .x75 is allowed but the candidate may round up or down to the nearest 0.05 cm^3.* *If **ALL** burette readings are given to 1 decimal place then the mean can be given to 1 decimal place* if numerically correct without rounding. *Mean of 24.3 and 24.4 = 24.35 (✓)* *Mean of 24.3 and 24.4 = 24.4 (✗)* ***Titres to be used in calculating the mean must be clearly shown – in an expression or ticked in the titration table.***	1	[1]
(c)	ACE interpretation	**I** Expression correct in step **(i)** $^{\text{volume diluted}}/_{250}$ × 1.00	1	
		II Correctly uses $^{\text{titre from (b)}}/_{1000}$ × ans to **(i)** in **(ii)** **and** ½ × ans to **(ii)** in **(iii)**	1	
		III ans to **(iii)** × $^{1000}/_{25}$ × 201.2 in **(iv)**	1	
		IV Uses $^{(38.10 \quad \text{ans to (iv)})}/_{38.10}$ × 100 in **(v)**	1	
	PDO display	**V** Working shown in all steps attempted and a minimum of 3 steps. (use of 2 in **(iii)**, missing × 40 or M_r in **(iv)** gains the mark) *(Working should be a step in the right direction)*	1	
		VI 3 to 4 significant figures shown in final answer to all steps attempted – minimum of 3 steps	1	[6]
(d)	ACE interpretation	Correctly evaluates: $^{0.06}/_{25}$ × 100 or 0.24 % **and** $^{0.10}/_{\text{titre in (b)}}$ × 100 *Answers must be given to at least 2 significant figures and correctly rounded for the significant figures shown.*	1	[1]
				[Total: 15]

2 (a)	PDO layout	**I** All data presented clearly in all three sections. (6,6,7)	1	
	PDO recording	**II** Has correct headings and units on page 7.	1	
		III All thermometer readings recorded to nearest 0.5 ˚C in each of the experiments	1	
		IV Each pair of balance readings consistent and to at least 1 decimal place	1	[4]
(b)	Examiner to calculate (corrected) $\Delta T_1/m_1$ and $\Delta T_2/m_2$ for Supervisor and candidate. Compare candidate value with the same value from the Supervisor report. Award Q marks on the closer value.			
	MMO	Award **I** and **II** for δ 0.10 °Cg ^{1}	1	
	quality	Award **I** only for 0.10 < δ 0.30 °Cg ^{1}	1	[2]
(c)	MMO collection	**I** Follows instructions – weighs between 8.5 and 9.5 g of **FA 6** (mass bottle with **FA 6** – mass bottle)	1	
	PDO layout	**II** Check Δm and ΔT are correct in **(c)**	1	[2]
(d)	ACE interpretation	Examiner to check there is no obvious error in the evaluation of the expression, then award **one mark** for a mass of sodium carbonate between 2.5 and 3.5 g.	1	[1]
(e)	ACE improvements	Give **one mark** for: suggesting weighing, heating and weighing again, **or** weighing, heating and measuring gas volume **or** giving an outline for a titration method using 2 indicators.	1	[1]
				[Total: 10]

FA 8 is NaC*l*(aq); **FA 9** is $NaNO_2$(aq); **FA 10** is NaBr(aq); **FA 11** is $CuSO_4$(aq); **FA 12** is $MgSO_4$(aq)				
3 **(a)**	MMO decisions	Selects any named acid	1	
	MMO collection	Records brown gas with **FA 9** and no reaction with **FA 8** and **FA 10**	1	[2]
(b)	MMO decisions	**I** Selects: *(correct full name or formula)* silver nitrate as first reagent, aqueous ammonia as second reagent, aqueous ammonia added to tube with Ag^+, 1st box ticked (*do not allow if Pb^{2+} used as 2nd reagent)* **or** lead nitrate as first reagent, silver nitrate as second reagent, Ag^+(aq) added to fresh sample, 2nd box ticked	1	
	MMO collection	**II** <u>If Ag^+ used as 1st reagent</u> Give one mark for white ppt with **FA 8 and** cream ppt with **FA 10** <u>If Pb^{2+} used as 1st reagent</u> Give one mark for white ppt with **FA 8 and FA 10** *If* **FA 9** *not previously identified then no change/no reaction/no ppt* *(ignore any yellow colouration of solution with Pb^{2+})*	1	
		III <u>If Ag^+ used as 1st reagent (with NH_3 as 2nd)</u> Give one mark if white ppt with **FA 8** is soluble in aqueous ammonia **and** cream ppt with **FA 10** is insoluble or partially soluble in aqueous ammonia <u>If Ag^+ used as 1st reagent (with Pb^{2+} as 2nd)</u> Allow observations marks <u>If Pb^{2+} used as 1st reagent (with Ag^+ as 2nd)</u> Give one mark for white ppt with **FA 8** and Ag^+ **and** cream ppt with **FA 10** and Ag^+. *Ignore observations for* **FA 9**.	1	[3]
(c)	ACE conclusion	Mark consequentially on observations; Give **one mark** for appropriate anions identified for **FA 8**, **FA 9** and **FA 10**. (Allow from off-white or cream ppt for Br + Ag^+)	1	[1]

(d)	PDO recording	**I** Observations in a single table. All additions of NaOH(aq) and NH_3(aq) shown to excess where there is an initial ppt	1	
	MMO collection	**II** All observations correct for **FA 11** (Blue ppt in each, blue ppt insoluble in excess NaOH, soluble in excess NH_3 or forming/turning to a deep/dark blue solution)	1	
		III All observations correct for **FA 12** (White ppt insoluble in each)	1	[3]
(e)	ACE conclusion	**I** Mark consequentially to observations. Expected conclusion is Cu^{2+} in **FA 11** and Mg^{2+} in **FA 12** Allow Ca^{2+} from white ppt insoluble in excess NaOH and no ppt with NH_3.	1	
		II Gives appropriate evidence for each ion in the conclusion. Minimum evidence required for the expected ions: **Cu^{2+}** Records a blue ppt with either of the reagents **or** deep blue solution with excess NH_3. **Mg^{2+}** White ppt insoluble in excess NH_3 (or in each of the reagents)	1	[2]
(f)	MMO collection	**I** Blue, black, purple colour observed on adding starch in **(ii)**	1	
		II The brown (solution) or (brown) solution formed in **(i)** is decolourised/colour fades/paler **or** brown (solution) in **(i)** **and** white, off-white or light brown ppt recorded.	1	
	ACE conclusion	Award **III** and **IV** for **two** correct pairs	1	
		Award **III only** for **one** correct pair Expected results **(i)** I^- is oxidised, Cu^{2+} is reduced **(ii)** $S_2O_3^{2-}$ is oxidised, I_2 is reduced Mark horizontally or vertically.	1	[4]
				[Total: 15]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/41 Paper 4 (A2 Structured Questions), maximum raw mark 100

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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1 **(a)** N≡N triple bond is (very) strong
or the N_2 molecule has no polarity [1]

(b) $3Mg(s) \rightarrow 3Mg^{2+}(g)$ $\Delta H_1 = 3 \times 148 + 3 \times 2186 = 7002$
$N_2(g) \rightarrow 2N^{3}(g)$ $\Delta H_2 = 994 + 2 \times 2148 = 5290$

LE $= -\Delta H_1 - \Delta H_2 - 461 =$ **–12,753** (kJ mol ^{1}) (–[1] for each error) [3]

(c) **(i)** $Li_3N + 3H_2O \rightarrow NH_3 + 3LiOH$ (balanced equation) [1]

(ii) advantage: no high pressure/temperature/catalyst needed/standard conditions used [1]

disadvantage: Li is expensive
or Li would need to be recycled/removed
or LiOH by-product is corrosive/strongly basic
or this would be a batch, rather than continuous process [1]

(d) **(i)** Li_3N: 100 × 14/35 = 40% N [1]
urea: 100 × 28/60 = 47% N [1]

(ii) amide [1]

(iii) $NH_2CONH_2 + H_2O \rightarrow 2NH_3 + CO_2$
or $\rightarrow NH_2CO_2H + NH_3$
or $NH_2CONH_2 + 2H_2O \rightarrow 2NH_3 + H_2CO_3$ [1]

(iv) The LiOH would be strongly alkaline
or would increase the pH of the soil
or would 'burn' the crops/reduce plant growth/stunt plants
or would contaminate the environment [1]

[Total: 12]

2 **(a)** **(i)** One that can go in either direction. [1]

(ii) both forward & reverse reactions are going on at the same time, but the concentrations of all species do not change (owtte)
or rate of forward = rate of backward reaction [1]

(b) **(i)** $K_c = [H^+][OH^-]/[H_2O]$ [1]

(ii) $K_w = [H^+][OH^-]$ [1]
rearrangement of equation in **(i)** gives $K_c[H_2O] = [H^+][OH^-]$ & $K_w = K_c[H_2O]$ (owtte)
or the $[H_2O]$ is contained within K_w [1]

(iii) K_w will be higher in hot water **because** reaction is endothermic [1]

(c) **(i)** $[OH^-] = 5 \times 10^{-2}$; $[H^+] = (1 \times 10^{-14})/ 5 \times 10^{-2} =$ **2×10^{-13}** [1]
$pH = -\log_{10}[H^+] =$ **12.7** (correct ans = [2]) ecf [1]

(ii) $[NH_4^+] = [OH^-]$ $(= x)$ [1]
$x^2 = 1.8 \times 10^{-5} \times 0.05 \Rightarrow x\ (= [OH^-]) =$ **9.49×10^{-4}** (mol dm^{-3}) (correct ans = [2]) [1]

(iii) $[H^+] = K_w/[OH^-] = (1 \times 10^{-14})/ 9.49 \times 10^{-4} =$ **1.05×10^{-11}**(mol dm^{-3}) ecf [1]

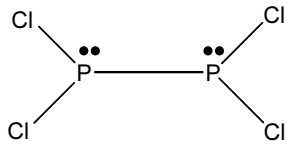
(iv) pH = **11.0** ecf [1]

[Total: 12 max 11]

3 **(a)** (+)1; (+)2; (+)3; (+)4 [1]
O.N. corresponds to the no. of electrons in outer/valence shell/lost [1]

(b) PCl_5 fizzes or white/misty fumes or heat evolved [1]
$PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$ *or* $PCl_5 + 3H_2O \rightarrow HPO_3 + 5HCl$
(allow partial hydrolysis: $PCl_5 + H_2O \rightarrow POCl_3 + 2HCl$) [1]

(c) **(i)** P = 30.4/31 = 0.98 Cl = 69.6/35.5 = 1.96 [1]
Thus E.F = **PCl_2** [1]
$M_r(PCl_2) = 102$, so $2 \times PCl_2 = 204 \approx 200$, so M.F. = **$P_2Cl_4$** [1]

(ii) 

(ignore lone pairs on Cl) [1]

(iii) O.N. = (+)2 [1]

(iv) $(HO)_2P\text{-}P(OH)_2$ *or* H(HO)P(=O)-P(=O)(OH)H ecf from structure in **(ii)** [1]
Allow HO-P-OH or HO-P=O
|
H

[Total: 10]

4 **(a)** $N_2 + 2O_2 \rightarrow 2NO_2$ (*or* via NO) *or* $2NO + O_2 \rightarrow 2NO_2$ [1]

(b) **(i)** catalytic converter **and** passing the exhaust gases over a catalyst/Pt/Rh [1]

(ii) $NO_2 + 2CO \rightarrow ½\ N_2 + 2CO_2$ ***or*** similar [1]
Allow $2NO_2 + CH_4 \rightarrow CO_2 + N_2 + 2H_2O$

(c) No, it wouldn't be reduced. Because the reaction in **(a)** does not presuppose a particular fuel (owtte) [1]
Allow formed from N_2 and O_2 in air during combustion

(d) **(i)** SO_3 produces acid rain [1]

(ii) $NO + ½\ O_2 \rightarrow NO_2$ [1]

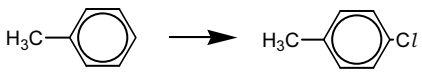
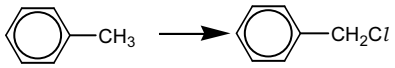
(iii) $K_p = (p_{NO}.p_{SO_3})/(p_{NO2}.p_{SO_2})$ [1]
units: dimensionless/none (don't accept just a blank!) [1]

(iv) $K_p = 99.8^2/0.2^2 =$ **2.5×10^5** [1]

(v) It will shift to the right (owtte) [1]
because the reaction is exothermic. NOT just Le Chatelier argument [1]

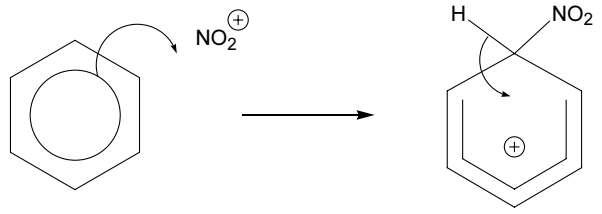
[Total: 11]

5 **(a)**

transformation	reagent + conditions
$C_2H_4 \rightarrow C_2H_5Cl$	**HCl, no light or catalyst**
$C_2H_5OH \rightarrow C_2H_5Cl$	**conc HCl + $ZnCl_2$ *or* $SOCl_2$ *or* PCl_5 *or* PCl_3 and heat**
$C_2H_6 \rightarrow C_2H_5Cl$	**Cl_2 + light**
$C_2H_4 \rightarrow C_2H_4Cl_2$	**Cl_2, no light or catalyst**
$CH_3CO_2H \rightarrow CH_3COCl$	**$SOCl_2$ *or* PCl_5 *or* PCl_3 and heat**
	**Cl_2 + $AlCl_3$**
	**Cl_2 + light or heat**

[6]

(b) (i) production of NO_2^+: $2H_2SO_4 + HNO_3 \rightarrow 2HSO_4 + H_3O^+ + NO_2^+$ [1]
(accept $H_2SO_4 + HNO_3 \rightarrow HSO_4 + H_2O + NO_2^+$)



curly arrow from ring to NO_2^+ **and** from C-H bond to ring [1]
correct intermediate, including charge in the right place
Note charge area must be more than half ring [1]

(ii) **C** is $C_6H_5CO_2H$ [1]

(iii) step 1: reagent is hot acidified or alkaline $KMnO_4$ [1]
step 2: reagent is Br_2 + $FeBr_3$/A*l*C*l*$_3$ etc. (H_2O or light negates) [1]

(If **C** is given as 3-bromotoluene, then allow the last [2] marks if steps 1 and 2 are reversed.)

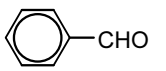
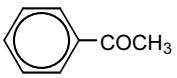
[Total: 12]

6 (a) (i) aqueous alkaline iodine ***or*** I_2 + OH (aq) allow NaC*l*O + KI [1]

(ii) CH_3CO- ***or*** $CH_3CH(OH)$- [1]

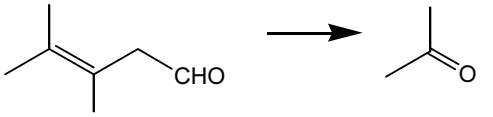
(iii) Pale yellow ppt. ***or*** antiseptic smell [1]

(iv)

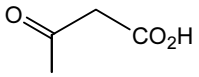
compound	result
CH_3OH	×
CH_3CH_2OH	✓
CH_3CHO	✓
CH_3CO_2H	×
	×
	✓

●✓●✓●✓ [3]

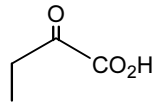
(b) (allow displayed, skeletal ***or*** structural formulae)



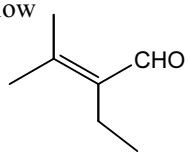
D **E**

\+ 

F

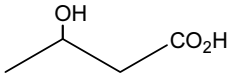
(**no mark** for 

)

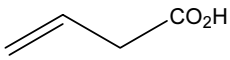
for **D** allow 

(**D** + **E** + **F**): 3 × [1]

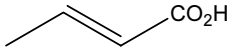
(c) (allow displayed, skeletal ***and*** structural formulae)
Must be consistent with **F**



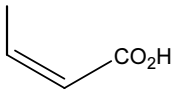
G



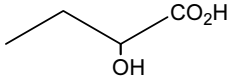
H
(only allow mark for **H** if **G** is the 3-OH acid)



J



K

allow for **G** 

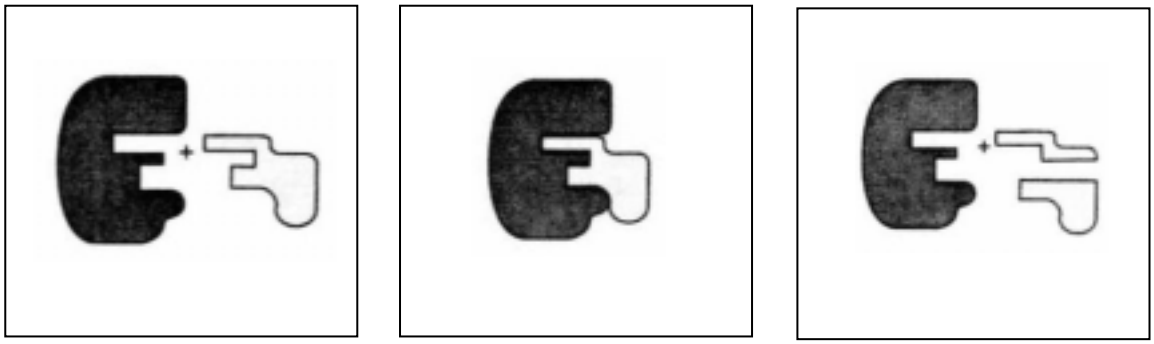
(N.B. letters **H**, **J**, **K** can be swapped around) (**G** + **H** + **J** + **K**): 4 × [1]

geometrical *or* cis-trans isomerism [1]

[Total: 14]

7 **(a)** The tertiary/3-dimensional structure/shape is held together by hydrogen/ionic/van der Waals bonds [1]
These break (relatively) easily/are weak/break at/above 45 °C [1]

(b) (*or* similar diagrams)



Enzyme + substrate Enzyme-substrate complex Enzyme + products 3 × [1]

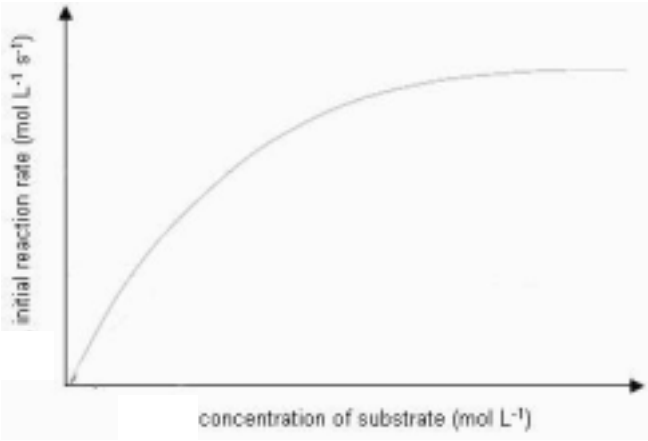
(c) a competitive inhibitor combines with the enzyme's active site (so preventing the substrate from binding) [1]

non-competitive inhibitor bonds with the enzyme away from the active site/at an allosteric site [1]

this changes the shape of the active site [1]

Also allow competitive inhibition can be overcome by increasing [substrate] ***or*** non-competitive inhibition cannot be removed by increasing [substrate] for the 3rd mark

(d) **(i)**



Line must be of similar shape to original but level out below original line [1]

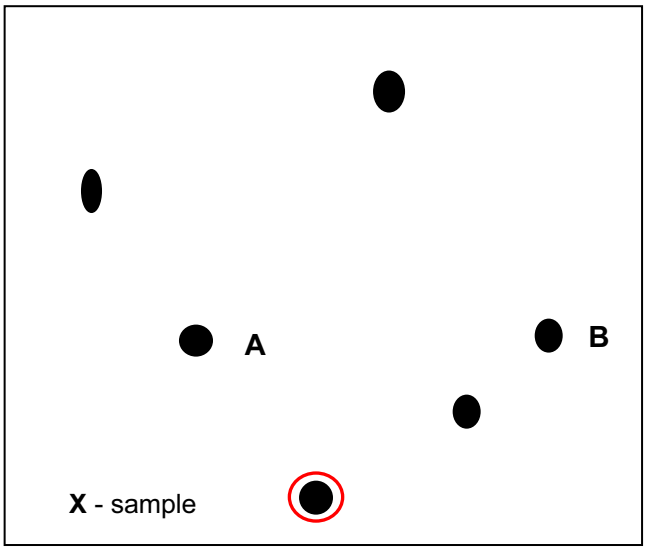
(ii) Inhibitor reduces the number of enzymes with 'working' active sites (owtte) [1]

[Total: 10]

8 (a) **partition** – separation due to the different solubilities of compounds in two solvents/phases [1]

adsorption – separation due to the different attractions between the compounds and the stationary phase, relative to their solubility in the solvent [1]
Note, if candidates do not refer to different solubilities and different attractions max 1

(b)



Ring: [1]
A + **B**: [1]

(c) (i) **X** is bromine – M and (M+2) peaks almost same height [1]

(ii) $\frac{M}{M+1}$ $\frac{100}{1.1} \times \frac{9}{n}$ $\frac{100}{0.3}$ $1.1 \times n$

Hence n $\frac{100 \times 0.3}{1.1 \times 9}$ 3.03 p = 3

(answer + working) [1]

(If the mass peak is at 122 and the compound contains Br and 3 C atoms then Q = (122 – 79 – 36)) thus **Q = 7** ecf from **(ii)** [1]

(The compound is C_3H_7Br)

(iii) *(R is at m/e 43),* hence $\mathbf{C_3H_7^+}$ [1]

(d) Any **two** from H_2, H_2O, CO, C_2H_4, C_2H_2, CH_4 2 × [1]

[Total: 10]

9 **(a)** **(i)** One [1]

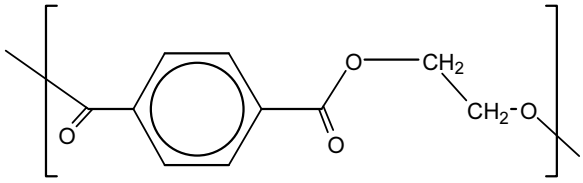
(ii) Any alkene (***or*** allow a cyclic amide, as in caprolactam) [1]

(b) Any TWO from: addition needs unsaturated/double bonds/alkene
condensation eliminates a small molecule
condensation needs a molecule other than a hydrocarbon
empirical formula of addition polymer is the same as that of its monomer
condensation needs two different functional groups

(**NOT** – "condensation needs two different monomers") 2 × [1]

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

(ii)



Correct 'ester' bond [1]
'sticks' to rest of molecule [1]
Note : candidates need only show 'brackets' if more than one repeat unit shown

(iii) Polyesters [1]

(d) Monomers in *Terylene* have to alternate in order to condense out water (owtte) [1]

Alkenes can link in any order (and still form a polyalkene) (***or*** diagram showing this) [1]

[Total: 10]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/42 Paper 4 (A2 Structured Questions), maximum raw mark 100

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.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

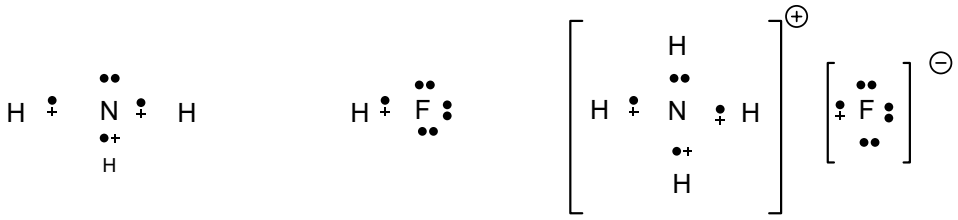
Cambridge is publishing the mark schemes for the May/June 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

1 **(a)** $[H^+] = \sqrt{(0.05 \times 5.6 \times 10^{-4})} = 5.29 \times 10^{-3}$ mol dm^{-3} [1]
pH $= -\log_{10}(5.29 \times 10^{-3}) = 2.3$ [1]
[2]

(b) **(i)** (Brønsted-Lowry) acid-base/proton transfer/neutralisation/exothermic/reversible/equilibrium [1]

(ii)



[1] [1] [1] 3 x [1]

(iii) *(in NH_4F):*
covalent: between N & H [1]
dative: between N & H [1]
ionic: between NH_4^+ & F *or* N^+ & F *or* ammonium and fluor**ide** (i.e. in words) *or* between (oppositely charge) ions [1]

(iv) (***reverse*** *reaction, remember*)
high temperature, because reverse reaction is endothermic [1]
low pressure, because reverse reaction causes an increase in no. of gaseous molecules *or* an increase in partial pressure/volume. [1]
[9]

(c) **(i)** $4NH_3 + CuS + 2O_2 \rightarrow [Cu(NH_3)_4]SO_4$ [1]

(ii) deep/dark/royal blue *or* purple [NOT violet] [1]

(iii) deep blue colour would change to light blue [NOT intensity of colour decreases] [1]
$\Rightarrow$ hexaquocopper(II) ion *or* $[Cu(H_2O)_6]^{2+}$ *or* $[Cu(H_2O)_n(NH_3)_{a-n}]^{2+}$, where a = 4 or 6 *or* ligand exchange (of NH_3) by H_2O [1]
[4]

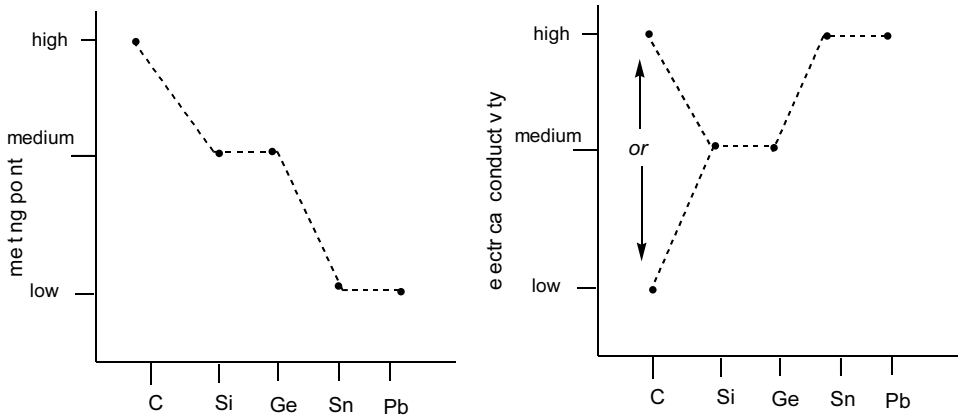
(d) ligand exchange/substitution/displacement/replacement [IN WORDS] [1]
(use of named ligands are OK instead of 'ligand'. e.g. "water is displaced by chloride")

formula of anion (see below for possibilities) [1]
balanced equation. e.g. $[Cu(H_2O)_6]^{2+} + nCl \rightarrow [Cu(H_2O)_{6-n}Cl_n]^{2-n} + nH_2O$ [1]

(Allow n=1 up to n=6. Also allow $[CuCl_n]^{2-n}$ as product. Examples from many possible are:
$[Cu(H_2O)_6]^{2+} + 2Cl \rightarrow [Cu(H_2O)_4Cl_2] + 2H_2O$
$[Cu(H_2O)_6]^{2+} + 4Cl \rightarrow [CuCl_4]^{2-} + 6H_2O$
equation could include HCl on the LHS, for example:
$[Cu(H_2O)_6]^{2+} + 4HCl \rightarrow H_2CuCl_4 + 2H^+ + 6H_2O$ *or* $\rightarrow CuCl_4^{2-} + 4H^+ + 6H_2O$ **[3]**

[Total: 18 max 17]

2 (a) (i)



[2] + [2]

(ii) m. pt. trend: (from) giant/macro molecular/covalent to metallic bonding
(or implied from at least two specific examples, e.g. diamond and tin) [1]
(mention of *simple* covalent anywhere negates this mark)

conductivity trend: increasing delocalisation of electrons (down the group) [1]
or e are more free-moving
(or implied from at least two examples, e.g. Si is semiconductor, lead has delocalised e)
[6]

(b) (i) heat PbO_2, or T > 200°C *or* Δ on arrow: $PbO_2 \rightarrow PbO + ½O_2$ (N.B. $½O_2$ NOT [O]) [1]

(ii) (burning CO in air produces CO_2):$CO + ½O_2 \rightarrow CO_2$ [1]
blue flame (ignore ref to limewater test) [1]

(iii) e.g. $SnCl_2$(aq) will turn $KMnO_4$ from purple to colourless [1]
$5Sn^{2+} + 2MnO_4^- + 16H^+ \rightarrow 5Sn^{4+} + 2Mn^{2+} + 8H_2O$ [1]

or $SnCl_2$(aq) will turn $K_2Cr_2O_7$ from orange to green [1]
$3Sn^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 3Sn^{4+} + 2Cr^{3+} + 7H_2O$ [1]

or $SnCl_2$(aq) will turn Fe^{3+} from orange/brown/yellow to green/colourless [1]
$Sn^{2+} + 2Fe^{3+} \rightarrow Sn^{4+} + 2Fe^{2+}$ [1]

or $SnCl_2$(aq) will turn Cu^{2+}(aq) from blue to colourless *or* give a pink/brown/copper-coloured ppt. [1]
$Sn^{2+} + Cu^{2+} \rightarrow Sn^{4+} + Cu$ [1]

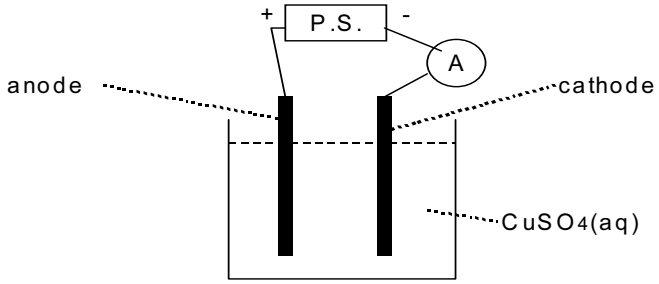
Other possible oxidants ($E^\ominus$ must be > +0.2V) include: $S_2O_8^{2-}$, H_2O_2, Cl_2, Br_2, I_2 and Ag^+.
No observations with the first three of these, but this should be stated explicitly, e.g. "no colour change".

[5]

[Total: 11 max 10]

3 **(a)** L = F/e *or* F = Le [1]
[1]

(b) **(i)**



[allow the conventional symbol ⊣⊢ to represent + ▭ – (the "P.S." is not required)]

correct cell (2 electrodes + PS circuit) [1]
ammeter in series [1]
anode and cathode of the right polarity [IN WORDS] [1]
$CuSO_4(aq)$ *or* $CuCl_2(aq)$ *or* $Cu^{2+}(aq)$ *or* soln *or* 1 mol dm^{-3} [1]

(ii) n(Cu) = (52.542–52.243)/63.5 = 4.71×10^{-3} mol (4.67×10^{-3}) [1]
n(e) required = $4.71 \times 10^{-3} \times 2$ = **9.42×10^{-3}** mol (9.34×10^{-3}) ecf [1]

amount of electricity passed = $0.5 \times 30 \times 60$ = 900 C [1]
no. of electrons passed = $900/1.6 \times 10^{-19}$ = **5.625×10^{21}** ecf [1]

no of electrons/n(e) = L = $5.625 \times 10^{21}/9.42 \times 10^{-3}$ = **5.97×10^{23}** mol^{-1} (6.02×10^{23}) ecf [1]

(values in italics are if candidate has used A_r = 64, not 63.5. No last mark if not 3 s.f.: correct ans = [5]) **[9]**

(c)

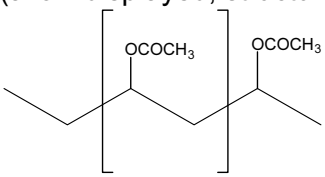
compound	product at anode	product at cathode
AgF	O_2	Ag
$FeSO_4$	O_2	H_2
$MgBr_2$	Br_2	H_2

6 correct ⇒ [5]
5 correct⇒ [4] etc.

Names can be used instead of symbols. If the atomic symbol (e.g. Br or H or O) is used instead of the molecular formula (e.g. Br_2 etc.) then deduct [1] mark only for the whole table.
[5]

[Total: 15]

4 (a) (i) (allow displayed, structural or skeletal formula)



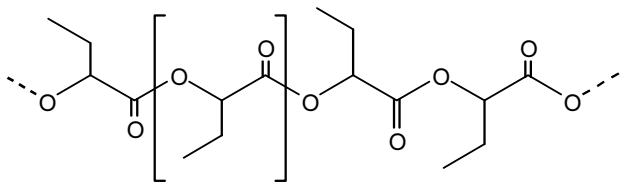
chain [1]
repeat unit [1]

(ii) **C** should be CH_2=CHOH (*or* skeletal formula) [1]

(iii) **C** is CH_3CH=O (*or* skeletal formula) [1]

(iv) e.g. add (2,4-)DNPH *or* DNP *or* Brady's reagent ecf [1]
orange *or* red ppt forms (NOT yellow) ecf [1]
(*or* could use Fehling's or Tollens',
or $H^+ + Cr_2O_7^{2-}$: orange to green, *or* $H^+ + MnO_4$: purple to colourless)
[6]

(b) (i) (allow displayed, structural or skeletal formula)



D

correct repeat unit bracketed (any 3 atoms in chain) [1]

(ii) ester [1]

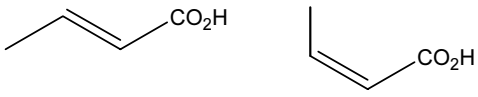
(iii) **E** is $CH_3CH_2CH(OH)CO_2H$ (*or* skeletal structure etc.)(2-hydroxybutanoic acid) [1]
allow ecf here from the formula of the repeat unit shown in **(b)(i)**

(iv) <u>condensation</u> (polymerisation) [1]

(v) they have the same "molecular" formula *or* $C_4H_6O_2$ (do **NOT** allow empirical formula) *or* same no. and type of atoms *or* same functional group *or* both are esters *or* they are isomers [1]
[5]

(c) (i) optical isomerism (*or* chiral) [1]

(ii)



F **G**

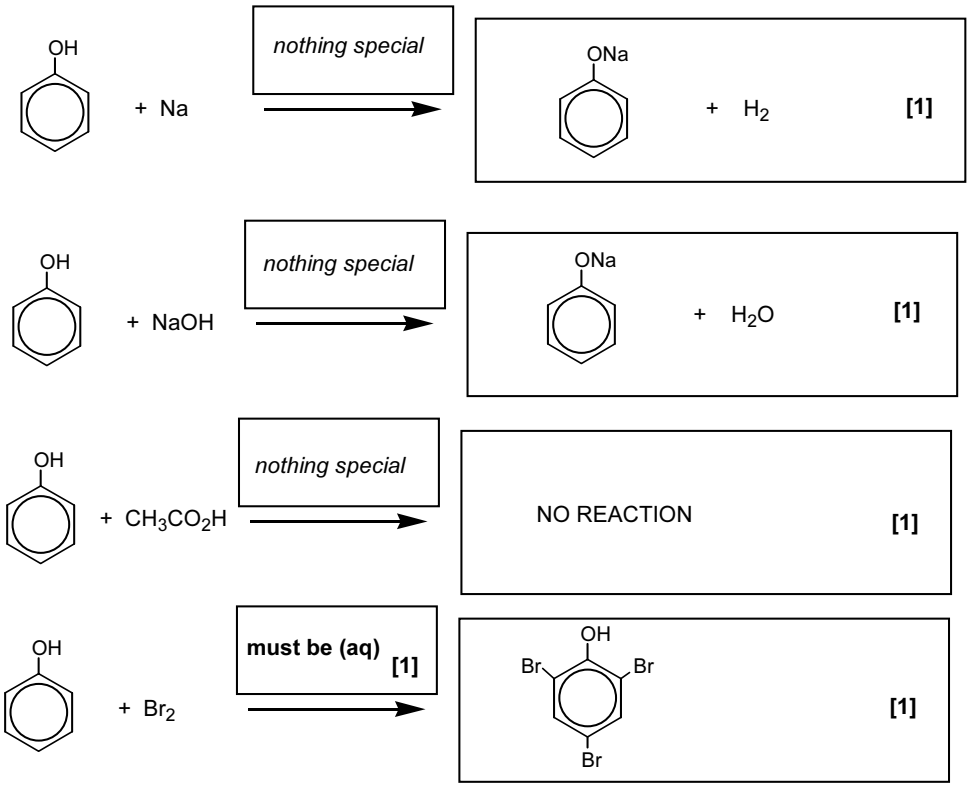
(letters may be reversed)(allow ecf from **E**, also allow ecf for **G** from **F**) [1] + [1]

cis-trans *or* geometrical isomerism [1]
[4]

[Total: 15]

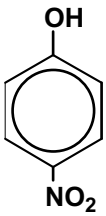
5 **(a)** acidity: ethanol < water [1]
due to +ve inductive effect of C_2H_5 group *or* C_2H_5 gives e to oxygen *or* intensifies e (in O-H bond) [1]
acidity: phenol > water [1]
due to stabilisation of the anion/anionic charge *or* makes the anion less basic [1]
[4]

(b)



[5]

(c) **H** is



[1]

reagents & conditions:
step 1 **dilute** HNO_3 (dilute, not just 'aq'. H_2SO_4 negates) [1]

step 2 Sn/$SnCl_2$/Fe + HC*l* *or* H_2 + Ni/Pd (NOT H_2 + Pt. NOT $LiAlH_4$ or $NaBH_4$) [1]

step 3 CH_3COCl *or* $(CH_3CO)_2O$ ('aq.' negates) [1]
[4]

[Total: 13]

6 **(a)** They are polar/ionic *or* can hydrogen-bond *or* are hydrophilic. [1]
(NOT 'contain the –OH group', on its own)

[1]

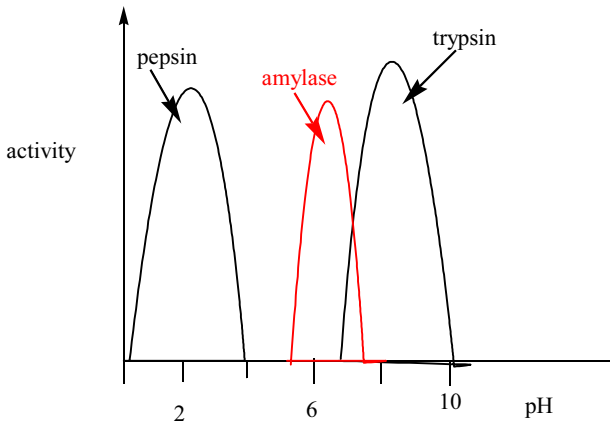
(b) **(i)** Primary structure is the sequence/order of amino acids [1]
Secondary structure is the H-bonding between C=O & N-H *or* peptide group/bonds [1]
Tertiary structure gives the (overall) 3D structure/shape/folding/globularity
(not 'coiling' on its own)
or mention of at least one method of forming the 3° structure, e.g.; hydrogen bonding **between R-groups/side chains**; –S-S- bridges; van der Waals forces; ionic interactions [1]

(ii) The 3° structure provides a complementary shape to that of the substrate
or it provides the right/specifically shaped cavity for the substrate. (NOT just 'a cleft')
or provides nearby groups to aid the reactions of the substrate (owtte) [1]

(iii) Two conditions out of the following:
(a) Increased temperature
(b) Decreased temperature
(c) Change in pH
(d) Addition of heavy metals (*or* specified, e.g. Hg/Ag)
(e) Addition of inhibitors (competitive or non-competitive)
Suitable reasons:
(i) 3D structure changes shape/is deformed/is broken *or* R-R interactions (or a specific example, e.g. H-bonding) are broken
(ii) inhibitor occupies active site.
(iii) *either* fewer substrate molecules with E > E_a *or* fewer successful collisions [2]

[6]

(c) **(i)**



left hand peak labelled as pepsin [1]
right hand peak labelled as trypsin [1]
(Correct enzymes, but wrong way round, scores [1] only)

(ii) Peak between pH 6 and pH 8, **and** correct name (amylase) [1]

[3]

[Total: 10]

7 (a)

Number	Process	Correct sequence (numbers)
A	Place samples on agarose gel	4
B	Use polymerase chain reaction	3
C	Label with radioactive isotope	6
D	Extract DNA	1
E	Use restriction enzyme	2
F	Carry out electrophoresis	5

mark as follows: if **A** is **just** before **F** (i.e. **A** = 4, **F** = 5 *or* **A** = 5, **F** = 6) [1] mark
if **D** = 1 and **E** = 2 [1] mark
if **C** = 6 [1] mark
[3]

(b) (i) P *or* phosphorus (NOT phosphate) [1]

(ii) Phosphate groups are present in DNA *or* it makes the DNA fragments/bands etc. visible *or* locates their position *or* identifies them on a photographic plate etc. [1]
(NOT because it's radioactive *or* makes the bands coloured)
[2]

(c) (i) Yes, all 4 children share one/some band (*or* match/gene/fragment/part/DNA/ amino acid) with the mother's (DNA) (NOT the general statement "matches the mother's DNA") [1]

(ii) Child **2**, since he/she shares none of the bands of father's DNA/fingerprint *or* their fingerprint/DNA does not match the father's DNA (the general "match" is OK here) [1]
[2]

(d) (i) Compare DNA fingerprint for **each** fragment (can be read into use of the word 'same' below) [1]
Match the DNA patterns to determine which came from which skin [1]

(ii) A named example of biological origin (N.B. a material, not a whole organism) [1]
e.g. leather (= bull skin), pollen, fish scales, leaves, seeds, feathers, hair, blood, textiles (or a named one like wool or silk or cotton or linen/flax), wood.

(N.B. NOT human or goat skin, also not metal, pottery or stone. If more than one material is given, mark the first one)
[3]

[Total: 10]

8 **(a)** Range should be from 10^{-6}–10^{-7} (the left hand arrow) [1]
to 10^{-8}–10^{-9} (the right hand arrow) [1]
[2]

(b) Forms of the **same element** (*or* of **carbon**, since carbon is the context of the question) [1]
with different structures/arrangements of atoms [1]
allow 'different molecular structure', but not structural formula. Any mention of 'compound' negates the mark.
[2]

(c) Nanoparticles are smaller than (animal) cells *or* they can pass through the cell membrane *or* pass into/between cells [1]
Drugs can be bound to/enclosed by the nanoparticle [1]
[2]

(d) **(i)** Reduction/redox [1]

(ii) M_r of chalcopyrite is 63.5 + 56 + 64 = 183.5
Mass of copper present is 63.5

Hence percentage of copper present = $\frac{63.5 \times 100}{183.5}$ = 34.6% [1]
(if A_r(Cu) = 64 is used, ans = **34.8**%. allow **34–35**%)

(iii) *If the ore contains 2% of chalcopyrite by mass, calculate how much copper is produced from each tonne of ore.*

1 tonne = 1000 kg
1 tonne of chalcopyrite would produce 346 kg of copper
1 tonne of 2 % ore would produce 346 × 0.02 or **6.9** kg of copper ecf from **(d)(ii)** [1]
(accept **7.0** or 7 kg)
answer may be given as 7000 g or 7×10^{3} tonnes. If no units are given, assume they are tonnes, and mark accordingly)

(iv) By displacement with a metal (the following specified metals higher than Cu in the ECS may be used: Fe, Zn, Sn, Pb, A*l*, Mg. (NOT Ca, Li, Na. K etc.) *or* with a suitable non-metallic reducing agent, e.g. SO_2 or Sn^{2+}, but not something that wouldn't react, like H_2
or By electrolysis (with carefully controlled voltage) [1]
[4]

[Total: 10]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/43 Paper 4 (A2 Structured Questions), maximum raw mark 100

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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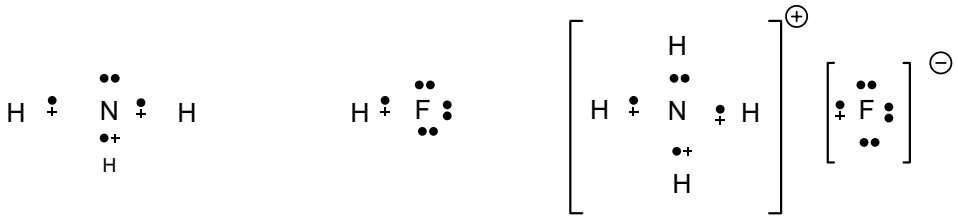
UNIVERSITY of CAMBRIDGE
International Examinations

1 **(a)** $[H^+] = \sqrt{(0.05 \times 5.6 \times 10^{-4})} = 5.29 \times 10^{-3}$ mol dm^{-3} [1]
pH $= -\log_{10}(5.29 \times 10^{-3}) = 2.3$ [1]
[2]

(b) **(i)** (Brønsted-Lowry) acid-base/proton transfer/neutralisation/exothermic/reversible/equilibrium [1]

(ii)



[1] [1] [1] 3 x [1]

(iii) *(in NH_4F):*
covalent: between N & H [1]
dative: between N & H [1]
ionic: between NH_4^+ & F *or* N^+ & F *or* ammonium and fluor**ide** (i.e. in words) *or* between (oppositely charge) ions [1]

(iv) (***reverse*** *reaction, remember*)
high temperature, because reverse reaction is endothermic [1]
low pressure, because reverse reaction causes an increase in no. of gaseous molecules *or* an increase in partial pressure/volume. [1]
[9]

(c) **(i)** $4NH_3 + CuS + 2O_2 \rightarrow [Cu(NH_3)_4]SO_4$ [1]

(ii) deep/dark/royal blue *or* purple [NOT violet] [1]

(iii) deep blue colour would change to light blue [NOT intensity of colour decreases] [1]
$\Rightarrow$ hexaquocopper(II) ion *or* $[Cu(H_2O)_6]^{2+}$ *or* $[Cu(H_2O)_n(NH_3)_{a-n}]^{2+}$, where a = 4 or 6 *or* ligand exchange (of NH_3) by H_2O [1]
[4]

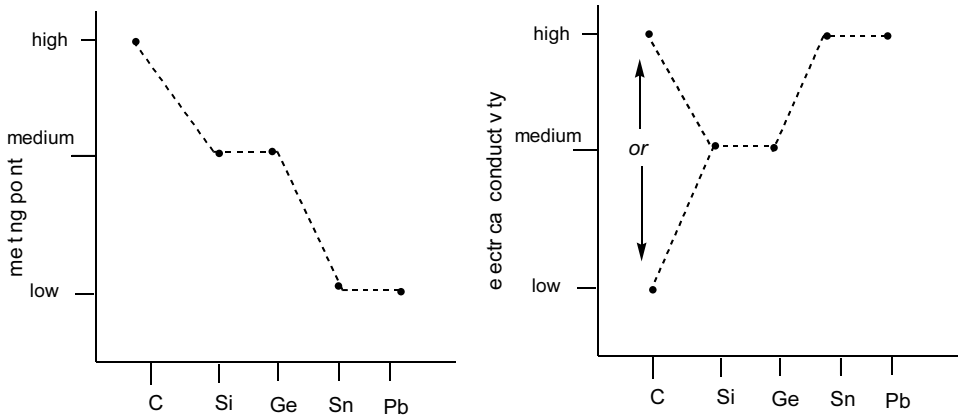
(d) ligand exchange/substitution/displacement/replacement [IN WORDS] [1]
(use of named ligands are OK instead of 'ligand'. e.g. "water is displaced by chloride")

formula of anion (see below for possibilities) [1]
balanced equation. e.g. $[Cu(H_2O)_6]^{2+} + nCl \rightarrow [Cu(H_2O)_{6-n}Cl_n]^{2-n} + nH_2O$ [1]

(Allow n=1 up to n=6. Also allow $[CuCl_n]^{2-n}$ as product. Examples from many possible are:
$[Cu(H_2O)_6]^{2+} + 2Cl \rightarrow [Cu(H_2O)_4Cl_2] + 2H_2O$
$[Cu(H_2O)_6]^{2+} + 4Cl \rightarrow [CuCl_4]^{2-} + 6H_2O$
equation could include HCl on the LHS, for example:
$[Cu(H_2O)_6]^{2+} + 4HCl \rightarrow H_2CuCl_4 + 2H^+ + 6H_2O$ *or* $\rightarrow CuCl_4^{2-} + 4H^+ + 6H_2O$ **[3]**

[Total: 18 max 17]

2 (a) (i)



[2] + [2]

(ii) m. pt. trend: (from) giant/macro molecular/covalent to metallic bonding
(or implied from at least two specific examples, e.g. diamond and tin) [1]
(mention of *simple* covalent anywhere negates this mark)

conductivity trend: increasing delocalisation of electrons (down the group) [1]
or e are more free-moving
(or implied from at least two examples, e.g. Si is semiconductor, lead has delocalised e)
[6]

(b) (i) heat PbO_2, or T > 200°C *or* Δ on arrow: $PbO_2 \rightarrow PbO + ½O_2$ (N.B. $½O_2$ NOT [O]) [1]

(ii) (burning CO in air produces CO_2):$CO + ½O_2 \rightarrow CO_2$ [1]
blue flame (ignore ref to limewater test) [1]

(iii) e.g. $SnCl_2$(aq) will turn $KMnO_4$ from purple to colourless [1]
$5Sn^{2+} + 2MnO_4^- + 16H^+ \rightarrow 5Sn^{4+} + 2Mn^{2+} + 8H_2O$ [1]

or $SnCl_2$(aq) will turn $K_2Cr_2O_7$ from orange to green [1]
$3Sn^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 3Sn^{4+} + 2Cr^{3+} + 7H_2O$ [1]

or $SnCl_2$(aq) will turn Fe^{3+} from orange/brown/yellow to green/colourless [1]
$Sn^{2+} + 2Fe^{3+} \rightarrow Sn^{4+} + 2Fe^{2+}$ [1]

or $SnCl_2$(aq) will turn Cu^{2+}(aq) from blue to colourless *or* give a pink/brown/copper-coloured ppt. [1]
$Sn^{2+} + Cu^{2+} \rightarrow Sn^{4+} + Cu$ [1]

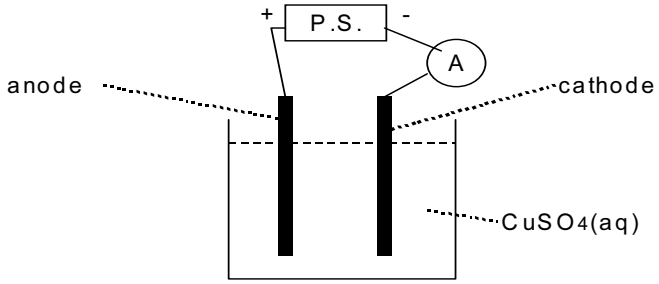
Other possible oxidants ($E^\ominus$ must be > +0.2V) include: $S_2O_8^{2-}$, H_2O_2, Cl_2, Br_2, I_2 and Ag^+. No observations with the first three of these, but this should be stated explicitly, e.g. "no colour change".

[5]

[Total: 11 max 10]

3 **(a)** L = F/e *or* F = Le [1]
[1]

(b) **(i)**



[allow the conventional symbol ⊣⊢ to represent + ▭ – (the "P.S." is not required)]

correct cell (2 electrodes + PS circuit) [1]
ammeter in series [1]
anode and cathode of the right polarity [IN WORDS] [1]
$CuSO_4(aq)$ *or* $CuCl_2(aq)$ *or* $Cu^{2+}(aq)$ *or* soln *or* 1 mol dm^{-3} [1]

(ii) n(Cu) = (52.542–52.243)/63.5 = 4.71×10^{-3} mol (4.67×10^{-3}) [1]
n(e) required = $4.71 \times 10^{-3} \times 2$ = **9.42×10^{-3}** mol (9.34×10^{-3}) ecf [1]

amount of electricity passed = $0.5 \times 30 \times 60$ = 900 C [1]
no. of electrons passed = $900/1.6 \times 10^{-19}$ = **5.625×10^{21}** ecf [1]

no of electrons/n(e) = L = $5.625 \times 10^{21}/9.42 \times 10^{-3}$ = **5.97×10^{23}** mol^{-1} (6.02×10^{23})
ecf [1]

(values in italics are if candidate has used A_r = 64, not 63.5. No last mark if not 3 s.f.: correct ans = [5]) **[9]**

(c)

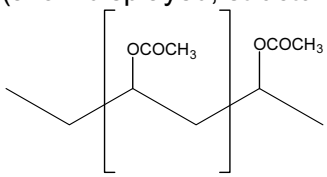
compound	product at anode	product at cathode
AgF	O_2	Ag
$FeSO_4$	O_2	H_2
$MgBr_2$	Br_2	H_2

6 correct ⇒ [5]
5 correct⇒ [4] etc.

Names can be used instead of symbols. If the atomic symbol (e.g. Br or H or O) is used instead of the molecular formula (e.g. Br_2 etc.) then deduct [1] mark only for the whole table.
[5]

[Total: 15]

4 (a) (i) (allow displayed, structural or skeletal formula)



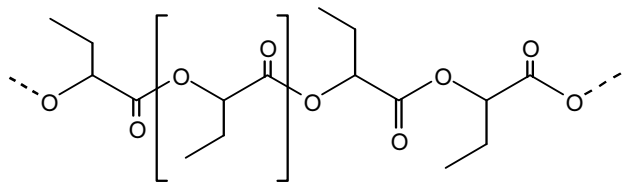
chain [1]
repeat unit [1]

(ii) **C** should be CH_2=CHOH (*or* skeletal formula) [1]

(iii) **C** is CH_3CH=O (*or* skeletal formula) [1]

(iv) e.g. add (2,4-)DNPH *or* DNP *or* Brady's reagent ecf [1]
orange *or* red ppt forms (NOT yellow) ecf [1]
(*or* could use Fehling's or Tollens',
or $H^+ + Cr_2O_7^{2-}$: orange to green, *or* $H^+ + MnO_4$: purple to colourless)
[6]

(b) (i) (allow displayed, structural or skeletal formula)



D

correct repeat unit bracketed (any 3 atoms in chain) [1]

(ii) ester [1]

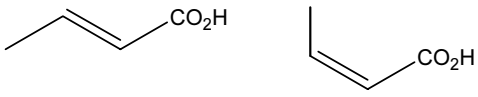
(iii) **E** is $CH_3CH_2CH(OH)CO_2H$ (*or* skeletal structure etc.)(2-hydroxybutanoic acid) [1]
allow ecf here from the formula of the repeat unit shown in **(b)(i)**

(iv) <u>condensation</u> (polymerisation) [1]

(v) they have the same "molecular" formula *or* $C_4H_6O_2$ (do **NOT** allow empirical formula) *or* same no. and type of atoms *or* same functional group *or* both are esters *or* they are isomers [1]
[5]

(c) (i) optical isomerism (*or* chiral) [1]

(ii)



F **G**

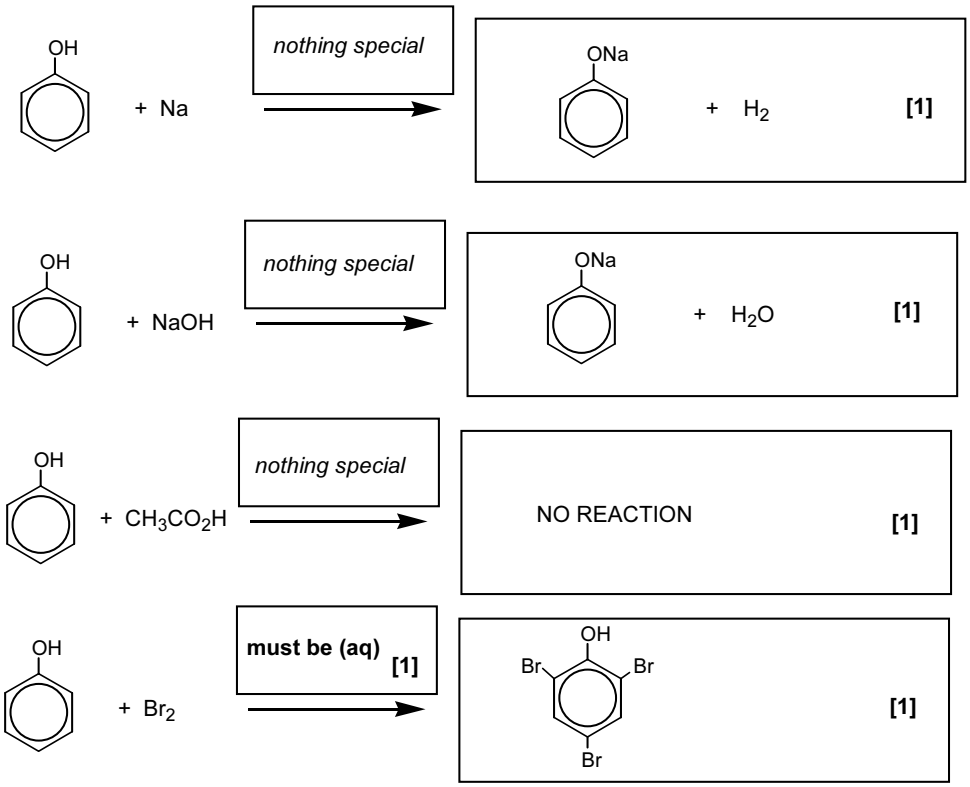
(letters may be reversed)(allow ecf from **E**, also allow ecf for **G** from **F**) [1] + [1]

cis-trans *or* geometrical isomerism [1]
[4]

[Total: 15]

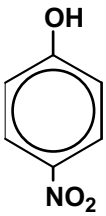
5 **(a)** acidity: ethanol < water [1]
due to +ve inductive effect of C_2H_5 group *or* C_2H_5 gives e to oxygen *or* intensifies e (in O-H bond) [1]
acidity: phenol > water [1]
due to stabilisation of the anion/anionic charge *or* makes the anion less basic [1]
[4]

(b)



[5]

(c) **H** is



[1]

reagents & conditions:
step 1 **dilute** HNO_3 (dilute, not just 'aq'. H_2SO_4 negates) [1]

step 2 Sn/$SnCl_2$/Fe + HC*l* *or* H_2 + Ni/Pd (NOT H_2 + Pt. NOT $LiAlH_4$ or $NaBH_4$) [1]

step 3 CH_3COCl *or* $(CH_3CO)_2O$ ('aq.' negates) [1]
[4]

[Total: 13]

6 **(a)** They are polar/ionic *or* can hydrogen-bond *or* are hydrophilic. [1]
(NOT 'contain the –OH group', on its own)

[1]

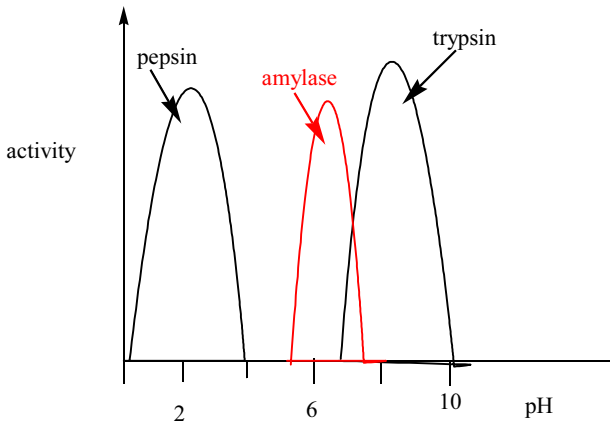
(b) **(i)** Primary structure is the sequence/order of amino acids [1]
Secondary structure is the H-bonding between C=O & N-H *or* peptide group/bonds [1]
Tertiary structure gives the (overall) 3D structure/shape/folding/globularity
(not 'coiling' on its own)
or mention of at least one method of forming the 3° structure, e.g.; hydrogen bonding **between R-groups/side chains**; –S-S- bridges; van der Waals forces; ionic interactions [1]

(ii) The 3° structure provides a complementary shape to that of the substrate
or it provides the right/specifically shaped cavity for the substrate. (NOT just 'a cleft')
or provides nearby groups to aid the reactions of the substrate (owtte) [1]

(iii) Two conditions out of the following:
(a) Increased temperature
(b) Decreased temperature
(c) Change in pH
(d) Addition of heavy metals (*or* specified, e.g. Hg/Ag)
(e) Addition of inhibitors (competitive or non-competitive)
Suitable reasons:
(i) 3D structure changes shape/is deformed/is broken *or* R-R interactions (or a specific example, e.g. H-bonding) are broken
(ii) inhibitor occupies active site.
(iii) *either* fewer substrate molecules with E > E_a *or* fewer successful collisions [2]

[6]

(c) **(i)**



left hand peak labelled as pepsin [1]
right hand peak labelled as trypsin [1]
(Correct enzymes, but wrong way round, scores [1] only)

(ii) Peak between pH 6 and pH 8, **and** correct name (amylase) [1]

[3]

[Total: 10]

7 (a)

Number	Process	Correct sequence (numbers)
A	Place samples on agarose gel	4
B	Use polymerase chain reaction	3
C	Label with radioactive isotope	6
D	Extract DNA	1
E	Use restriction enzyme	2
F	Carry out electrophoresis	5

mark as follows: if **A** is **just** before **F** (i.e. **A** = 4, **F** = 5 *or* **A** = 5, **F** = 6) [1] mark
if **D** = 1 and **E** = 2 [1] mark
if **C** = 6 [1] mark
[3]

(b) (i) P *or* phosphorus (NOT phosphate) [1]

(ii) Phosphate groups are present in DNA *or* it makes the DNA fragments/bands etc. visible *or* locates their position *or* identifies them on a photographic plate etc. [1]
(NOT because it's radioactive *or* makes the bands coloured)
[2]

(c) (i) Yes, all 4 children share one/some band (*or* match/gene/fragment/part/DNA/ amino acid) with the mother's (DNA) (NOT the general statement "matches the mother's DNA") [1]

(ii) Child **2**, since he/she shares none of the bands of father's DNA/fingerprint *or* their fingerprint/DNA does not match the father's DNA (the general "match" is OK here) [1]
[2]

(d) (i) Compare DNA fingerprint for **each** fragment (can be read into use of the word 'same' below) [1]
Match the DNA patterns to determine which came from which skin [1]

(ii) A named example of biological origin (N.B. a material, not a whole organism) [1]
e.g. leather (= bull skin), pollen, fish scales, leaves, seeds, feathers, hair, blood, textiles (or a named one like wool or silk or cotton or linen/flax), wood.

(N.B. NOT human or goat skin, also not metal, pottery or stone. If more than one material is given, mark the first one)
[3]

[Total: 10]

8 **(a)** Range should be from 10^{6}–10^{7} (the left hand arrow) [1]
to 10^{8}–10^{9} (the right hand arrow) [1]
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(b) Forms of the **same element** (*or* of **carbon**, since carbon is the context of the question) [1]
with different structures/arrangements of atoms [1]
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Drugs can be bound to/enclosed by the nanoparticle [1]
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Mass of copper present is 63.5

Hence percentage of copper present = $\frac{63.5 \times 100}{183.5}$ = 34.6% [1]
(if A_r(Cu) = 64 is used, ans = **34.8**%. allow **34–35**%)

(iii) *If the ore contains 2% of chalcopyrite by mass, calculate how much copper is produced from each tonne of ore.*

1 tonne = 1000 kg
1 tonne of chalcopyrite would produce 346 kg of copper
1 tonne of 2 % ore would produce 346 × 0.02 or **6.9** kg of copper ecf from **(d)(ii)** [1]
(accept **7.0** or 7 kg)
answer may be given as 7000 g or 7×10^{3} tonnes. If no units are given, assume they are tonnes, and mark accordingly)

(iv) By displacement with a metal (the following specified metals higher than Cu in the ECS may be used: Fe, Zn, Sn, Pb, A*l*, Mg. (NOT Ca, Li, Na. K etc.) *or* with a suitable non-metallic reducing agent, e.g. SO_2 or Sn^{2+}, but not something that wouldn't react, like H_2
or By electrolysis (with carefully controlled voltage) [1]
[4]

[Total: 10]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/51 Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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UNIVERSITY of CAMBRIDGE
International Examinations

Question	Sections	Indicative material	Mark
1 (a)	PLAN Problem	Predicts that the higher A_r elements/M_r compounds decompose less easily. Distortion/polarisation decreases. Accept reverse argument if related to correct group/M_r/A_r trend. Any graph showing a decreasing rate (not time) with M_r (bar chart or any line). Axes must be labelled (accept group II carbonate). Ignore units. Allow consequential graph answer from incorrect prediction.	[1] [1] [1]
(b)	PLAN Problem	**(i)** Element/carbonate as the independent variable. Mass negates. **(ii)** Time identified as dependent variable/ rate (of reaction) or equivalent.	[1] [1]
(c)	PLAN Methods	Diagram to show only experimental setup **(i)** Any suitable closed container and heat (no baths). **(ii)** Syringe labelled with the volume (10 cm^3 to 1000 cm^3). Or inverted measuring cylinder/burette (10 cm^3 to 1000 cm^3). Must be calibrated.	 [1] [1]
(d)	PLAN Methods	**(i)** Statement of the gas volume. Minimum 10 cm^3. Exceeding capacity negates. If the diagram has a syringe/cylinder < 10 cm^3 which loses the mark in **(c)**, then allow a reasonable measured volume in **(d)** including up to the syringe/cylinder volume. **(ii)** An indication that the mass of each carbonate used must contain the same number of moles. A generalised mole calculation is acceptable. **(iii)** Having the same settings on the Bunsen (strength). Bunsen at the same distance from the reaction vessel.	[1] [1] [1] [1]
(e)	PLAN Methods	Reference to 'hot' apparatus not any heating equipment. Heat proof gloves/handling devices/cool before handling. Accept sucking back and removing delivery tube.	[1] [1]

(f)	PLAN Methods	1. element/carbonate and 4 rows 2. time to chosen point and rate /1/t/1/time 3. Units (/s, /seconds), (/s ^{1}), (/1/s) All correct 2 marks; One error 1 mark; Two or more errors, zero. If 1 column missing but all rest correct award 1 mark.	[2]
(g)	ACE Evaluation	Has to have a change to the apparatus. Regulated heating device/electrical hotplate/time to complete decomposition (syringe stops moving/or equivalent)/gravimetric mass loss in a set time. Change to a smaller reaction vessel e.g. conical to boiling tube/collecting in a syringe rather than over water to combat solubility not suck back. A larger syringe/cylinder to collect a larger volume (less proportion of displaced air).	[1]
	Total		**[16]**

Question	Sections	Indicative material	Mark
2 (a)	ACE Data	Both M_rs calculated correctly 85, 69, ignore units. May be seen in table.	[1]
(b)	ACE Data	Moles of $NaNO_3$, B-A/M_r, and full columns. Ignore units and moles of $NaNO_2$, C-A/M_r and full columns. Ignore units. All data correct and to 2 sig figs ECF incorrect M_r. Allow 2 arithmetic or sig fig errors. No ECF of incorrect formula. If no score, allow 1 for 1 full heading and 1 column correct in any combination.	[1] [1]
(c)	ACE Data	Labelled axes (name and moles needed somewhere, nitrate to be the *x*-axis). Accept column label if its heading fully correct. Appropriate scaling (origin not necessary). Correctly plotted points. All 10 points need plotting. (Check points 1, 4, 7 & 10 and any that appear incorrect). Line of best fit which must go through 0,0.	[1] [1] [1]
(d)	ACE Evaluation	Give one mark if the two anomalous points furthest from the line (one on each side) are identified. Allow only one anomaly if there is only one or all the anomalies are on the same side. Allow extra anomalies due to misplotting. For credit, the anomalies must include the most anomalous. In plotting the points, it is possible that some points will be a little way from the correctly drawn line. These in many cases are likely not to be 'ringed'. Examiner judgement will be required in determining whether or not a point should be 'ringed'. If 5 or more points are 'ringed' do not award this mark but allow any subsequent correct discussion. Point 4 incomplete decomposition/not heated for long enough/ not hot enough. Point 7 solid loss during heating/damp sample/nitrite may decompose. One mark for two correct reasons not related to the points.	[1] [1] [1]
(e)	ACE Data ACE Conclusions	Construction lines on graph. If line into origin and 0,0 used only 1 line necessary. Takes intercept readings from the graph. Calculates the slope (independent mark). Do not accept calculations that give negative differences in *x* or *y* values.	[1] [1] [1]
(f)	ACE Conclusions	For stating that the slope supports the equation. ECF applies from incorrect gradient. For using the slope (1) and deducing a ratio (1:1). The mole relationship must be present. ECF incorrect ratio provided related to the above gradient.	[1] [1]
	Total		**[14]**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/52 Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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UNIVERSITY of CAMBRIDGE
International Examinations

Question	Sections	Indicative material	Mark
1 (a)	PLAN Problem	Predicts that rate of reaction will be proportional to the temperature/ increasing temperature increases rate Greater frequency/greater chance/greater/energy of collision/more particles have energy greater than the activation energy/more effective collisions/more often. Any graph showing an increasing rate with temperature (curve or straight line) Line may start anywhere. Ignore units but axes must be labelled and can be 'either way round'. Use of 'time' negates (If time is mentioned in the prediction the graph might be worth a mark as an ECF, the prediction of course would be worth zero) Allow a consequential answer from an incorrect prediction.	[1] [1] [1]
(b)	PLAN Problem	**(i)** Temperature as the independent variable **(ii)** Time identified as dependent variable/rate (of reaction). Other incorrect suggestions negate in either part.	[1] [1]
(c)	PLAN Methods	**(i)** A 'container' with liquid and an immersed thermometer being heated. No mark if sealed. (If the candidate chooses at this stage to set up an experiment using a water-bath [which is of course the way many of us would carry out this exercise] with the thermometer immersed in the bath and reaction vessel(s) shown we should give this mark here. However, in **(d)** in order to access the 'temperature' mark using such a water-bath 'equilibration' must be stated or clearly implied.) **(ii)** Volume of 'container' (any conical flask or beaker must have a volume of at least 20 cm^3) and thermometer range (to cover the candidate's expts.) (Upper and lower temps on the thermometer to be given). Allow a boiling/test tube without a volume.	[1] [1]
(d)	PLAN Methods	**(i)** At least 5 experiments (not repeats of the same expt.) To cover at least a 25 ^{o}C range **(no greater than 100 ^{o}C)** **(ii)** Maintaining the volumes of both reagents **(not total vol.)** If a candidate states that the experiment should be repeated, (even if it is the same experiment) in the absence of any contrary detail, give this mark. **(iii)** Temperature(s) of both reagents taken/or temperature taken immediately after mixing. (see note above)	[1] [1] [1] [1]

		(iv) Statement of timing to (first) opacity/determination of the point of opacity (e.g. the disappearing cross). [If it is clear that the timing starts after mixing and heating has taken place do not award this mark]. Some of these points (**(i)**, **(ii)** and **(iii)**)may be available from the table. These first three marks can also be awarded even if the candidate is clearly bent on carrying out a different experiment. E.g. an experiment which involves an apparent rise of temperature during the experiment or one which seems to be measuring the time between the first opacity and a 'final' opacity.	[1]
(e)	PLAN Methods	Reference to 'hot' apparatus/sulfur dioxide evolved/hydrochloric acid (ignore any reference to possible effects) **with** 'use of heat proof gloves/use of tongs'/use of fume cupboard/gloves and goggles. Ignore spillages	[1]
(f)	PLAN Methods	There are four items to be covered here table to include; Temperature; (If candidates record two temperatures per experiment and this is as a result of a 'flawed experimental design' allow the temperature mark even if a Δt is also given. However Δt alone does not gain the mark.) Time to opacity (ignore start times); Rate (allow 1/t or 1/time); All with correct units. Allow /s or seconds, (s or seconds). Allow /s ^{1} or seconds ^{1}, (1/s or 1/seconds) Ignore all other columns All four correct 2 marks; Any error 1 mark; Two or more errors zero. If one column missing but others fully correct allow one mark	[2]
	Total		**[15]**

Question	Sections	Indicative material	Mark
2 (a)	ACE Data	Focus on the solubility column initially then: Correct heading and formula, Correct units,(allow g/100g without the solidus) All calculations correct (allow one calculation or sf error). (No ecf from earlier errors) (no ecf in solubility calc) Give one mark for; two fully correct headings including units/two correct columns/one heading with units and one column correctly calculated (any combination) (allow one error)	[1] [1] [1]
(b)	ACE Data	Unambiguously labelled axes (ignore units) (Solubility must be on the *y*-axis) If either mass is plotted against temperature all the three subsequent marks are available but not this first mark. But, see below. Appropriate scaling (axes to allow points to cover at least half of the grid in each direction). Check points 1,5, 7 and 12. Points need to be plotted in the correct small square unless the points should be on a line or at a corner (then it has to be there).If the point is on a grid line and should not be it is incorrect. Line of best fit (the correct graph is a curve, hence straight lines gain zero. If however a wrong set of results genuinely produces a straight-line, award the mark for a straight-line) (ignore extrapolation at temperatures lower than 20 ^{o}C) Examiner judgement for best-fit curves.	[1] [1] [1] [1]
(c)	ACE Evaluation	One identified anomaly At least one more anomaly identified (max 6 anomalies) (must include the most anomalous)(any anomaly on the line negates) Correct explanation for the anomaly. If either or both of the anomalies are mentioned here but not 'ringed' on the graph allow the marks. Correct explanation for the second anomaly Anomalies above the line: temperature read too late/super cooling Below the line: water lost (due to evaporation) (so crystals form at a higher temp.)/temperature read before crystallisation. ONE mark for two correct reasons which are not tied to a particular point. Ignore any reference that might be 'human error' e.g. reference to spillage, mass loss, misreading of the balance or thermometer etc. These last two marks are not available if the graph includes a mass and no further marks are available in (d) or (e)	[1] [1] [1] [1]

(d)	ACE Data ACE Conclusions	Takes readings from the graph at 85 ^{o}C and 35 ^{o}C Calculates the mass of solid (divides by 2 and subtracts or the reverse). Correct answer alone gets both marks.	[1] [1]
(e)	ACE Conclusions	For stating 'endothermic'. For the statement 'solubility increases with temperature' (Allow alternatives for both marks if the graph supports e.g. exothermic if the graph slopes the other way and solubility decreasing with temperature etc.)	[1] [1]
	Total		**[15]**

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