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N03/420/S(2)M+

MARKSCHEME

November 2003

CHEMISTRY

Standard Level

Paper 2

14 pages

1. Follow the markscheme provided, do **not** use decimals or fractions and mark only in **RED**.

2. Where a mark is awarded, a tick (✓) should be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark.

3. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases write a brief annotation in the **left hand margin** to explain your decision. You are encouraged to write comments where it helps clarity, especially for moderation and re-marking.

4. Unexplained symbols or personal codes/notations on their own are unacceptable.

5. Record subtotals (where applicable) in the right-hand margin against the part of the answer to which they refer (next to the mark allocation for Section A). Do **not** circle sub-totals. **Circle the total mark for the question in the right-hand margin opposite the last line of the answer.**

6. For Section B, show a mark for each part question (a), (b), *etc.*

7. Where an answer to a part question is worth no marks, put a zero in the right-hand margin.

8. Section A: Add together the total for each question and write it in the Examiner column on the cover sheet.
Section B: Insert the total for each question in the Examiner column on the cover sheet.
Total: Add up the marks awarded and enter this in the box marked TOTAL in the Examiner column.

9. After entering the marks on the cover sheet, check your addition to ensure that you have not made an error. Check also that you have transferred the marks correctly to the cover sheet. **We have script checking and a note of all clerical errors may be given in feedback to examiners.**

10. Every page and every question must have an indication that you have marked it. Do this by **writing your initials** on each page where you have made no other mark.

11. If a candidate has attempted more than the prescribed number of questions, mark only the required number of answers in the order in which they are presented in the script, **unless the candidate has indicated the questions to be marked on the cover sheet**. Make a comment to this effect in the left hand margin.

12. A candidate can be penalized if he/she clearly contradicts him/herself within an answer. Make a comment to this effect in the left hand margin.

Subject Details: Chemistry SL Paper 2 Markscheme

General

- Each marking point is usually shown on a separate line or lines.
- Alternative answers are separated by a slash (/) – this means that either answer is acceptable.
- Words underlined are essential for the mark.
- Material in brackets (…) is not needed for the mark.
- The order in which candidates score marks does not matter (unless stated otherwise).
- The use of **OWTTE** in a markscheme (the abbreviation for "or words to that effect") means that if a candidate's answer contains words different to those in the markscheme, but which can be interpreted as having the same meaning, then the mark should be awarded.
- Please remember that many candidates are writing in a second language, and that effective communication is more important than grammatical accuracy.
- In some cases there may be more acceptable ways of scoring marks than the total mark for the question part. In these cases, tick each correct point, and if the total number of ticks is greater than the maximum possible total then write the maximum total followed by **MAX**.
- In some questions an answer to a question part has to be used in later parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in later parts then "follow through" marks can be scored. Show this by writing **ECF** (error carried forward). This situation often occurs in calculations but may do so in other questions.
- Units for quantities should always be given where appropriate. In some cases a mark is available in the markscheme for writing the correct unit. In other cases the markscheme may state that units are to be ignored. Where this is not the case, penalize the omission of units, or the use of incorrect units, once only in the paper, and show this by writing **–1(U)** at the first point at which it occurs.
- Do not penalize candidates for using too many significant figures in answers to calculations, unless the question specifically states the number of significant figures required. If a candidate gives an answer to fewer significant figures than the answer shown in the markscheme, penalize this once only in the paper, and show this by writing **–1(SF)** at the first point at which this occurs.
- If a question specifically asks for the name of a substance, do not award a mark for a correct formula; similarly, if the formula is specifically asked for, do not award a mark for a correct name.
- If a question asks for an equation for a reaction, a balanced symbol equation is usually expected. Do not award a mark for a word equation or an unbalanced equation unless the question specifically asks for this. In some cases, where more complicated equations are to be written, more than one mark may be available for an equation – in these cases follow the instructions in the mark scheme.
- Ignore missing or incorrect state symbols in an equation unless these are specifically asked for in the question.
- Mark positively. Give candidates credit for what they have got correct, rather than penalizing them for what they have got wrong.
- If candidates answer a question correctly, but by using a method different from that shown in the markscheme, then award marks; if in doubt consult your Team Leader.

SECTION A

1. (a) $C(s)+2F_2(g)\rightarrow CF_4(g)$ $\Delta H_1=-680\text{ kJ}$;

$4F(g)\rightarrow 2F_2(g)$ $\Delta H_2=2(-158)\text{ kJ}$;

$C(g)\rightarrow C(s)$ $\Delta H_3=-715\text{ kJ}$;

Accept reverse equations with $+\Delta H$ *values.*

$C(g)+4F(g)\rightarrow CF_4(g)$ $\Delta H=-1711\text{ kJ}$, so average bond enthalpy $=\dfrac{-1711}{4}$ ***[4]***

$=-428\text{ kJ mol}^{-1}$;

Accept + or – sign.

*Lots of ways to do this! The correct answer is very different from the value in the Data Booklet, so award **[4]** for final answer with/without sign units not needed, but deduct **[1]** if incorrect units. Accept answer in range of 427 to 428 without penalty for sig figs.*

If final answer is not correct use following;
*Award **[1]** for evidence of cycle or enthalpy diagram or adding of equations.*
*Award **[1]** for or* $2F_2(g)\rightarrow 4F(g)$ *2 x 158 seen.*
*Award **[1]** for dividing 1711 or other value by 4.*

(b) $(\Delta G^{\ominus}=\Delta H^{\ominus}-T\Delta S^{\ominus})$

as T increases, $-T\Delta S^{\ominus}$ becomes larger / more positive;
ΔG increases / becomes more positive / less negative;
process becomes less spontaneous / reverse reaction favoured; ***[3]***

2. (a) $3Ag^{+}(aq)+XO_4^{3-}(aq)\rightarrow Ag_3XO_4(s)$;
states; ***[2]***
***[1]** for balanced equation and **[1]** for states.*

(b) (i) $n_{Ag+}=cV=0.2040\text{ mol dm}^{-3}\times 0.04118\text{ dm}^3$

$=0.008401\,/\,8.401\times10^{-3}\text{ mol}$ *(–1 SF)* ***[1]***

Ignore units even if wrong, do not award mark unless 4 sig fig.

(ii) $n_{Ag_3XO_4}=\frac{1}{3}n_{Ag+}=\frac{1}{3}\times 0.008401\text{ mol}$

$=0.002800\,/\,2.800\times10^{-3}\text{ mol}$ ***[1]***

ECF from (a) and (b) (i)

(iii) 0.002800 mol weighs 1.172 g

1 mol weighs $\dfrac{1.172\text{ g}}{0.002800\text{ mol}}=418.6\text{ g mol}^{-1}$

[2]

418.6;
Accept answer in range 418 to 419.
No penalty for too many sig figs.
ECF from (b)(ii)
g mol^{-1}
Do not accept g.

(iv) $(3 \times 107.87) + x + 4\,(16.0) = 418.6$
therefore, $x = 30.99$ *(accept 31.0 / 31)*;
P / phosphorous; ***[2]***

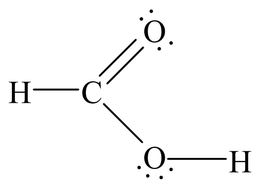
3. (a) mass / density / for gases: rate of effusion or diffusion / melting point / boiling point ***[1]***

Do not accept mass number.

(b) if $^{35}Cl = x$, then $(x \times 35.00) + (1 - x)\,37.00 = 35.45$;
*Award **[1]** for set up.*

therefore, $x = 0.775$
$^{35}Cl = 77.5\ \%$ and $^{37}Cl = 22.5\ \%$; ***[2]***
(need both for mark);

4. (a)



[1]

No mark without lone electron pairs.

Correct shape not necessary.
Do not award mark if dots / crosses and bond liens are shown.
Accept lone pairs represented as straight lines.

(b) $O-C-O = 120^{\circ}$ / $H-C-O = 120^{\circ}$;
$C-O-H \approx 109^{\circ}$ / $< 109^{\circ}$;
No mark for 109.5^{o}.
Accept answer in range 100-109°

[2]

(c) length: $C=O < C-O$;
strength: $C=O > C-O$;
greater number of electrons between nuclei pull atoms together and require greater energy to break;

[3]

Or

double bonds are shorter / sing bonds are longer;
double bonds are stronger / single bonds are weaker;
Accept stonger attraction between nuclei and (bonding) electrons.

5. (a) resists change in pH;
when **small** amounts of strong acid or base added to it;

[2]

(b) (i) not a buffer;
after reaction, contains $0.10 \text{ mol } NH_4Cl + 0.10 \text{ mol } HCl$ / weak acid + strong acid / a strongly acidic solution / not a weak acid-conjugate base combination;

[2]

Do not award any marks if stated "a buffer solution".

(ii) a buffer;
after reaction, contains $0.10 \text{ mol } NH_3 + 0.10 \text{ mol } NH_4Cl$ / a weak acid and conjugate base;

[2]

Do not award marks if stated "not buffer solution".

SECTION B

6. (a) oxides of: Na, Mg: basic;
Al: amphotoric;
Si to Cl: acidic;
Ar: no oxide;
*All four correct **[2]**, two or three correct **[1]**.*

$Na_2O + H_2O \rightarrow 2NaOH$;
$SO_3 + H_2O \rightarrow H_2SO_4$;
Must be balanced for marks. ***[4]***
Award makrs for alternative correct equations such as SO_3 with NaOH.

(b) *alkali metals:*
metallic bonding / a bed of cations in a sea of electrons;
as radius increases down the group, valence electrons are further away from nucleus (and strength of metallic bonding decreases);

halogens:
non-polar / van der Waal's forces between molecules;
as size increases van der Waal's forces increase (and melting point increases);

period 3 elements:
increase in melting points of metals (Na, Mg, Al) due to increase in number of valence electrons **and** decrease in size / the way atoms are packed as solids;
Award mark just for "increased number of delocalized or valence electrons".

silicon:
network covalent solid (with very high melting point);
Award mark also for "many or strong covalent bonds". ***[8]***

$P \rightarrow Ar$:
simple molecular (atomic in case of Ar) substances with weak van der Waal's forces (and lower melting points);
trend in P_4, S_8, Cl_2, Ar due to size / mass of particles;
Award mark for "decreasing mass or size".
Molecular formulae not necessary.

(c) *(i) and (ii) marked together.*

K less than Na because
electron removed (from K) is from higher energy level / further from nucleus / in n=4 compared to n= 3;
this is more important than the extra 8 protons in K / OWTTE;
increase repulsion by extra shell of electrons / greater shielding effect;
so less strongly attracted by nucleus;

K less than Ar because
electron removed (from K) is from higher energy level / further from nucleus / in n=4 compare to n = 3;
and has only one more proton;
increase repulsion by extra shell of electrons / greater shielding effect;
so less strongly attracted by nucleus;

Mg greater than Na because
(Mg has) greater nuclear charge / one more proton / 12 protons compare to 11;
electron removed is in same (main) higher energy level / shell;
smaller (atomic) radius;
so more strongly attracted by nucleus; ***[7]***

Accept opposite worded arguments, i.e. why Na is greater than K.
*Award **[7]** for any seven correct but accept less/more strongly attracted to nucleus once only.*

(iii) second electron in Na removed from n = 2, whereas second electron in Mg removed from n = 3 ***[1]***

7. (a) (i) one general formula / same general formula;
differ by CH_2;
similar chemical properties;
gradual change in physical properties;
*Award **[1]** for any two from last three*

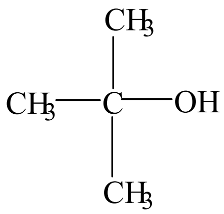
functional group: atom or group of atoms responsible for the characteristic reactions of the molecule / homologous series; ***[3]***

(ii) ethanol lower / ethanoic acid higher;
due to larger mass of ethanoic acid / stronger intermolecular forces / stronger van der Waals' forces / stronger hydrogen bonding; ***[2]***
No mark for H–bonding.

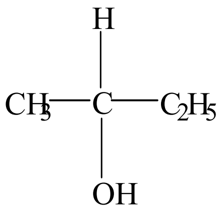
(iii)

$CH_3—CH_2—CH_2—CH_2—OH$

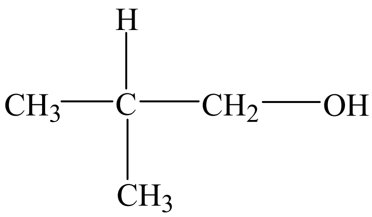
I



II



III



IV

No penalty for condenses formulas such as CH3CH2 CH2 CH2OH.

*Four correct **[2]**, two or three correct **[1]**.*

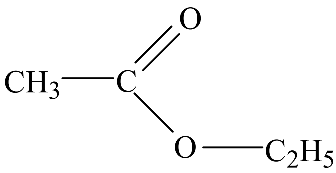
structure III;
chiral centre / asymmetric carbon atom / four different groups around one carbon (atom) ***[4]***

(b) (i) esterification / condensation;

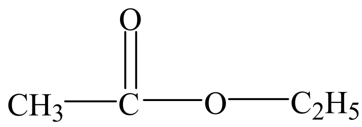
$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COO\,C_2H_5 + H_2O$;

Accept product: ethyl ethanoate / ethyl acetate;

structure:



accept ;



Do not accept $CH_3COOC_2H_4$. ***[4]***

(ii) catalyst;

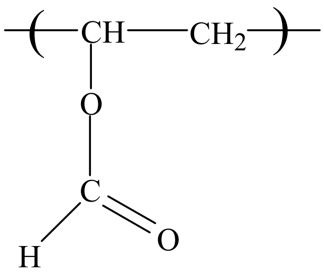
lowers E_a (by providing an alternate pathway); ***[2]***

(iii) flavouring agents / in plasticisers / in solvents / in perfumes / making aspirin ***[1]***

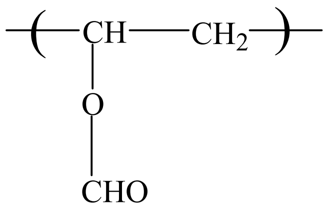
(c) (i) II reacts with Br_2;

II is an alkene / has unsaturated R group / C=C present, I contains only saturated R groups; ***[2]***

(ii) addition polymerization;



accept



[2]

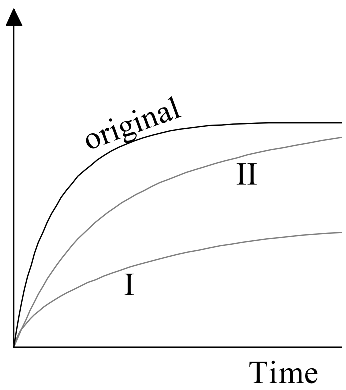
;

8. (a) (i) $CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$ ***[1]***

States not required, accept molecular equation.

(ii) rate decreases with time;
as concentration decreases so fewer (successful) collisions;
draw tangent to the curve at time *t*;
rate = slope or gradient; ***[4]***

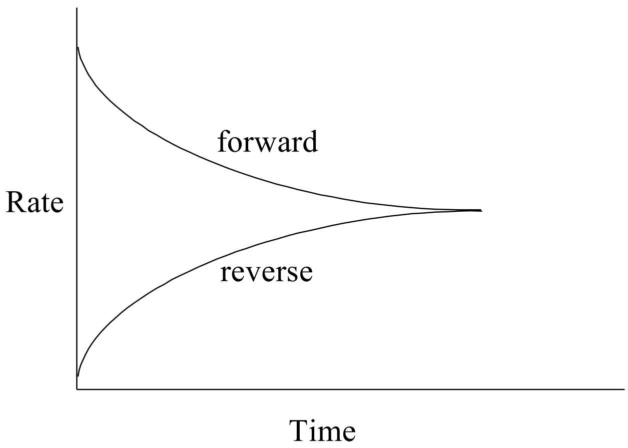
(iii) Volume of
CO_2 produced



I. (less Co2 because) amount of HCl is limiting and half the orginal / OWTTE;

II. (same amount of Co2 because) amount of HCl is the same;
curve less steep because less frequent *(accept fewer)* collisions

Awared last mark if in either I or II. ***[5]***



(b)

two curves - one labled "forward" starting up high up y-axis and one labeled "reverse" starting from zero;
curves merge and become horizontal;
No penalty for failing to label axes.

forward reaction:
highest concentration, thus rate high to begin with;
as reaction proceeds, concentrations decrease, so does rate;

reverse reaction:
zero rate initially / at t = 0 (since no products present);
rate increases as concentration of products increases;

equilibrium established when rate of forward reaction = rate of reverse reaction; ***[7]***

(c) reaction is) endothermic;
K_c increases with (increasing) temperature;
forward reaction favoured / heat used up / OWTTE; ***[3]***