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M03/420/S(2)M+

MARKSCHEME

May 2003

CHEMISTRY

Standard Level

Paper 2

10 pages

General Marking Instructions

After marking a sufficient number of scripts to become familiar with the markscheme and candidates' responses to all or the majority of questions, Assistant Examiners (AEs) will be contacted by their Team Leader (TL) by telephone. The purpose of this contact is to discuss the standard of marking, the interpretation of the markscheme and any difficulties with particular questions. It may be necessary to review your initial marking after contacting your TL. **DO NOT BEGIN THE FINAL MARKING OF YOUR SCRIPTS IN RED INK UNTIL YOU RECEIVE NOTIFICATION THAT THE MARKSCHEME IS FINALIZED.** *You will be informed by e-mail, fax or post of modifications to the markscheme and should receive these about one week after the date of the examination. If you have not received them within 10 days you should contact your Team Leader by telephone. Make an allowance for any difference in time zone before calling.* **AEs WHO DO NOT COMPLY WITH THESE INSTRUCTIONS MAY NOT BE INVITED TO MARK IN FUTURE SESSIONS.**

You should contact the TL whose name appears on your "Allocation of Schools listing" sheet.

Note:
Please use a personal courier service when sending sample materials to TLs unless postal services can be guaranteed. Record the costs on your examiner claim form.

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1. Follow the markscheme provided, do **not** use decimals or fractions and mark 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. Do **not** circle subtotals. **Circle the total mark for the question in the right-hand margin opposite the last line of the answer.**

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

7. For each Option: Add the totals for each question in the Option and write it in the Examiner column on the cover sheet.
Total: Add the marks awarded and enter this in the box marked TOTAL in the Examiner column on the cover sheet.

8. 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.**

9. 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.

10. If a candidate has attempted more than the required number of questions within the paper, mark only the required number in the order in which they are presented, **unless the candidate has indicated on the cover sheet the questions to be marked**.

11. A candidate can be penalized if s/he 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) 200 °C 600 atm. (*both for **[1]**, units not needed*); ***[1]***
allow the "highest pressure and the lowest temperature"

(b) (i) yield increases / equilibrium moves to the right / more ammonia;
4 (gas) molecules → 2 / decrease in volume / fewer molecules on right hand side; ***[2]***

(ii) yield decreases / equilibrium moves to the left / less ammonia;
exothermic reaction / *OWTTE*; ***[2]***

(c) high pressure expensive / greater cost of operating at high pressure / reinforced pipes *etc*. needed;
lower temperature – greater yield, but **lowers** rate; ***[2]***
Do not award a mark just for the word "compromise".

(d) $K_c = \dfrac{[NH_3]^2}{[N_2][H_2]^3}$ (*ignore units*); ***[1]***

2 (a) activation energy = **minimum** energy required for a reaction to occur; ***[1]***

(b) curve moved to the right;
peak lower; ***[2]***
*Deduct **[1]** if shaded area smaller at T_2 or if T_2 line touches the x-axis*

(c) rate increased;
as more molecules with energy ≥ E_a; ***[2]***

3. (a) Al $\dfrac{20.3}{26.98}$ Cl $\dfrac{79.70}{35.45}$ or similar working *(no penalty for use of 27 or 35.5)*;

empirical formula $AlCl_3$;

molecular formula: $n = \dfrac{267}{133.5} = 2$;

Al_2Cl_6; ***[4]***

*Full credit can be obtained if the calculations are carried out by another valid method. Two correct formulas but no valid method scores **[2 max]**.*

(b) moles of Na $= \dfrac{1.15}{23} = 0.05$;

moles of NaOH = 0.05;
Accept "same as moles of Na"

concentration $= \left(\dfrac{0.05}{0.25}\right) = 0.20\ (\text{mol dm}^{-3})$; ***[3]***

Allow ECF from moles of NaOH

4. (a) (i) Na has lower nuclear charge / number of protons;
electrons being removed are from same energy level / shell;
or Na has larger radius / electron further from nucleus; ***[2 max]***
Award this mark if both electron arrangements are given.

(ii) Na electron closer to nucleus / in lower energy level / Na has less shielding effect; ***[1]***
Allow counter arguments for Mg in (i) and K in (ii).

(b) chlorine has a higher nuclear charge;
attracts the electron **pair** / electrons in bond more strongly; ***[2]***

5. (a) atom of same element / same number of protons but with different mass number / number of neutrons; ***[1]***

(b) protons 23
electrons 23
neutrons 27
*Three correct **[2]**, two correct **[1]**.* ***[2]***

(c) $^{51}_{23}V$ / 51 nearer to A_r value of 50.94; ***[1]***

(d) carbon, 12 / ^{12}C; ***[1]***

SECTION B

6. (a) (i) as molecules become larger / heavier / have higher M_r values / number of electrons increases;
van der Waals' / London / dispersion forces increase; ***[2]***

(ii) hydrogen bonding **between molecules** in H_2O;
this bonding is stronger (than van der Waals' forces); ***[2]***
Must be an implied comparison with 6 (a) (i)

(b) (i) tetrahedral (*accept correct 3-D diagram*);
bent / V-shape / angular (*accept suitable diagram*); ***[2]***

(ii) 105° (*accept 103 – 106°*);
lone pairs **repel** each other more than bonding pairs; ***[2]***
Do not accept repulsion of atoms.

(c) bonds are polar as Cl more electronegative than Si;
Allow "electronegativities are different"
molecule is symmetrical, hence polar effects cancel out / *OWTTE*; ***[2]***

(d) (i) A – sodium iodide, B – sodium, C – iodine (*three correct **[1]***); ***[1]***
Accept correct formulas.

(ii) A – ionic bonding;
B – metallic bonding;
C – van der Waals' forces (and covalent bonding); ***[3]***

(e) (i) (for Na) (lattice of) positive ions / atoms;
delocalized / free electrons / sea of electrons;

(for NaI) oppositely charged ions / positive and negative ions;
free to move (only) in molten state; ***[4]***

(ii) forces between I_2 molecules are weak;
ionic / metallic bonding strong(er); ***[2]***

7. (a) strong acid completely dissociated / ionized;
weak acid only partially dissociated / ionized;

$HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$;
$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$; ***[4]***
Insist on both arrows as shown, state symbols not needed.
Also accept $H_2O(l)$ *and* $H_3O^+(aq)$ *in equations.*

(b) (i) bubbling / effervescence / dissolving of $CaCO_3$ / gas given off (*do not accept* CO_2 *produced*); ***[2]***
more vigorous reaction with HCl / *OWTTE*;

(ii) $2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$; ***[2]***
[1] *for correct formulas,* ***[1]*** *for balanced, state symbols not essential.*

(iii) amount of $CaCO_3 = \frac{1.25}{100.09} = 0.0125$ mol (*no penalty for use of 100*);

amount of $HCl = 2 \times 0.0125 = 0.0250$ mol (*allow ECF*);

volume of $HCl = 0.0167$ dm^3 / 16.7 cm^3 (*allow ECF*); ***[3]***

(iv) 1:1 ratio of $CaCO_3$ to CO_2 / use 0.0125 moles CO_2 (*allow ECF*);
$(0.0125 \times 22.4) = 0.28$ dm^3 / 280 cm^3 / 2.8×10^{-4} m^3 (*allow ECF*); ***[2]***
Accept calculation using $pV = nRT$.

(c) (i) 0.1 (mol dm^{-3}) *(units not needed but penalize if incorrect)*; ***[1]***

(ii) to 0.01 / decreases by factor of 10 / goes down by 0.09; ***[1]***

(iii) 25 cm^3 ; ***[1]***

(d) (i) a solution that resists pH change / maintains a (nearly) constant pH;
when **small** amounts of acid or alkali are added; ***[2]***

(ii) *Any suitable example,* ***[1]*** *for each correct component.*
e.g. ammonia solution and ammonium chloride;
ethanoic acid and sodium ethanoate; ***[2]***
weak acid + salt of weak acid / weak base + salt of weak base ***[1 max]***
blood ***[1 max]***

8. (a) (i) butane;
$C_4H_{10}(g) + \frac{13}{2}O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$;
(ignore state symbols, accept balancing using $13O_2$)
***[1]** for all formulas and **[1]** for balancing equation.*

CO produced;
CO is poisonous / combines with hemoglobin / *OWTTE*;
or
C;
which causes respiratory problems; ***[5]***

(ii) add Br_2 (water);
valid test needed to score further marks

A – no effect;
B – would decolorise Br_2 (*do not accept discolour*); ***[3]***

(iii) $CH_3CH{=}CHCH_3 + HBr \rightarrow CH_3CHBrCH_2CH_3$;
***[1]** for HBr in balanced equation, **[1]** for structure of product.*

addition; ***[3]***

(b) (i) $CH_3OH + HCOOH \rightarrow HCOOCH_3 + H_2O$;
***[1]** for both reactants and **[1]** for both products (accept $C_2H_4O_2$)*
methyl methanoate; ***[3]***

(ii) ethanoic acid; ***[1]***

(c) (i) $CH_2OH\ COOH$;
alcohol (*accept hydroxy(l)*);
carboxylic acid; ***[3]***
Last two marks dependent on correct monomer or reasonable attempt at identifying the monomer.

(ii) condensation;
eliminates H_2O / a small molecule is eliminated; ***[2]***