

MARKSCHEME

May 2003

CHEMISTRY

Standard Level

Paper 3

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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 Options, mark only the required number in the order in which they are presented in the paper, **unless the candidate has indicated on the cover sheet the Options 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 3 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.

Option A – Higher Physical Organic Chemistry

- A1.** (a) replacement / substitution of atom/group by another (atom/group);
by species with **lone pair** of electrons / attracted to electron deficient part of molecule /
positive centre / δ^+ carbon atom; [2]
- (b) 1; [1]
- (c) 0;
rate not affected by change in $[\text{OH}^-]$ / *OWTTE*; [2]
- (d) rate = $k[\text{C}_4\text{H}_9\text{Br}]$ (*ECF from (b) and (c)*); [1]
- (e) $k \left(= \frac{\text{rate}}{[\text{C}_4\text{H}_9\text{Br}]} \right) = 0.2$;
 min^{-1} ; [2]
Allow ECF from (d).
- (f) $\text{C}_4\text{H}_9\text{Br} \rightarrow \text{C}_4\text{H}_9^+ + \text{Br}^-$ / in equation with curly arrows;
 $\text{C}_4\text{H}_9^+ + \text{OH}^- \rightarrow \text{C}_4\text{H}_9\text{OH}$ / in equation with curly arrows; [2]
No penalty if primary structure is shown. No credit for $\text{S}_\text{N}2$ mechanism, except by ECF from (d).
- (g) the slowest step in the reaction;
the first step (*however described*); [2]
- (h) the number of reactant molecules/species in the rate-determining step;
1 (*ECF from $\text{S}_\text{N}2$ mechanism in (f)*); [2]
- A2.** (a) $\text{CH}_3\text{CH}_2\text{COOH} \rightleftharpoons \text{CH}_3\text{CH}_2\text{COO}^- + \text{H}^+$ (*no penalty for \rightarrow*);
Accept equation with H_2O and H_3O^+ .
$$K_\text{a} = \frac{[\text{CH}_3\text{CH}_2\text{COO}^-][\text{H}^+]}{[\text{CH}_3\text{CH}_2\text{COOH}]};$$
 [2]
- (b) $1.35 \times 10^{-5} (\text{mol dm}^{-3})$; [1]
Units not needed. No penalty for too many sig figs.
- (c) $[\text{H}^+] = \sqrt{K_\text{a}[\text{CH}_3\text{CH}_2\text{COOH}]}$;
 $\left(= \sqrt{1.35 \times 10^{-5} \times 0.050} \right) = 8.21 \text{ or } 8.22 \times 10^{-4} (\text{mol dm}^{-3})$;
Units not needed, ECF from (b). No penalty for too many sig figs.
 $\text{pH} \left(= -\log[\text{H}^+] = -\log(8.22 \times 10^{-4}) \right) = 3.1 \text{ or } 3.09$ (*ECF*) *penalize more than 4 sig figs*; [3]
If expression for $[\text{H}^+]$ missing but both answers correct, award [3], if one answer correct, award [2].

Option B – Medicines and Drugs

- B1.** (a) rectally / by suppository, by inhalation, by injection (parenterally), by applying to skin / topically; [2]
[2] for three, [1] for two. Award [1 max] if intravenous, subcutaneous and intramuscular are given.
- (b) an effect produced as well as the one intended / unwanted or undesired effect; [1]
- (c) (i) magnesium / Mg, aluminium / Al, calcium / Ca; [1]
Any two for [1].
- (ii) $\text{NaHCO}_3 + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$ (*not* H_2CO_3); [1]
- (iii) acid from the stomach rises into the esophagus; [1]
- (iv) as an anti-foaming agent / to prevent problem in (iii) / to prevent flatulence; [1]
- B2.** (a) (i) a substance that reduces pain;
 mild analgesics intercept pain at the source / interfere with production of substances that cause pain;
 strong analgesics bond to receptor sites in the brain / prevent the transmission of pain impulses; [3]
- (ii) carboxylic (acid) / alkanoic (acid); [2]
 ester;
Accept only these names.
- (iii) *Any one of the following [1].*
beneficial effects
 used to treat mini-strokes;
 prevents heart attacks / reduces risk of heart attack / thins the blood / anti-coagulant;
 relieves symptoms of rheumatological diseases / anti-inflammatory;
 reduces fever;
Any one of the following [1].
side effects
 stomach bleeding;
 allergic reaction;
 Reye's syndrome;
 hearing loss;
 tinnitus (ringing in the ears);
 gastrointestinal irritation (*e.g.* heartburn, nausea); [2]
- (b) (i) 14 / 14.03 (*ignore units*); [1]
- (ii) increasing amounts needed to produce same effect;
 increasing amounts cause damage/death; [2]

- B3.** potassium dichromate(VI) (*oxidation number and presence of acid not essential*);
orange to green;
redox (*accept reduction / oxidation*);

[3]

Option C – Human Biochemistry

- C1.** (a) $\text{RCH}(\text{NH}_2)\text{COOH}$; [1]
- (b) $\text{H}_2\text{NCH}(\text{CH}_3)\text{CONHCH}_2\text{COOH}$ / $\text{H}_2\text{NCH}_2\text{CONHCH}(\text{CH}_3)\text{COOH}$; [2]
water / H_2O ;
- (c) structure / catalysis or enzymes / energy source / oxygen transport; [2]
Any two, [1] each. Accept specific structures, e.g. hair, muscle.
- (d) (i) acid / hydrochloric acid / HCl (accept H_2SO_4);
Accept base / NaOH .
concentrated / heat or high temperature or boil / time (any two, [1] each);
- $$\begin{array}{c} \text{O} \\ \parallel \\ \text{C}-\text{N} / \text{C}-\text{N} \\ | \\ \text{H} \end{array}$$
- / peptide / amide; [4]
- (ii) mixture / amino acids spotted on paper / gel;
apply voltage;
develop / ninhydrin / organic dye;
measure distances moved / compare with known samples / measure isoelectric points and compare with data; [4]
Marks may be given for a suitable diagram.
- C2.** (a) (i) $\text{CH}_2\text{OHCHOHCH}_2\text{OH}$; [1]
- (ii) 57; [1]
- (iii) (the one from) stearic acid;
saturated / no (C to C) double bonds;
chains pack close together / stronger intermolecular forces / van der Waals' forces *etc*; [3]
Ignore hydrogen bonding. If wrong choice made, only third mark can be scored.
- (b) $\frac{7.61}{253.8} = 0.03 \text{ (mol)}$; [2]
3 (double bonds) (ECF);
Correct answer scores [2]. If 6 is given, with no working, award [1].

Option D – Environmental Chemistry

- D1.** (a) (i) (osmosis) – movement of solvent / water from dilute to concentrated solution / *OWTTE*;
(partially permeable membrane) – allows solvent / water but not solute particles to pass through / *OWTTE*; [2]
- (ii) sea water is compressed / subjected to (high) pressure;
pressure must be greater than osmotic pressure;
drinking / pure water passes through (partially permeable) membrane;
salt / dissolved solids left behind; [3]
Any three for [1] each.
- (iii) *any reasonable suggestion*; [1]
- (b) (i) decreased; [1]
- (ii) plant life / algae **increases** (then dies);
decay consumes dissolved oxygen; [2]
- (c) *Advantages*
kills viruses / less needed or more effective / leaves no taste / products not toxic;
Any two, [1] each. Do not accept safer.
- Disadvantages*
more expensive / does not last as long or shorter retention time / must be made on site; [4]
Any two, [1] each.
- D2.** (a) amount of oxygen needed to decompose organic matter (in water sample);
in a specified time / five days / at a specified temperature / 20 °C; [2]
- (b) aeration / use of oxygen;
use of bacteria / micro-organisms;
organic matter;
broken down / oxidized;
sedimentation tank / settling process; [5]
All marks can be scored from a suitably labelled diagram.

Option E – Chemical Industries

- E1.** (a) boil / vaporize crude oil (*not just heat*);
(vapours) rise up column;
vapours condense / liquids form at different **heights**;
(heights depend on) boiling points / size of molecules; [4]
- (b) (i) alumina / silica *etc.* (*accept clay*);
 $C_{14}H_{30} \rightarrow C_7H_{14} + C_7H_{16}$; [2]
- (ii) hydrogen;
branched / cyclic / aromatic / saturated; [2]
- (c) $C_6H_{14} \rightarrow C_6H_6 + 4H_2$;
feedstock for Haber process / fuel / margarine production; [2]
- E2.** (a) (i) CH_2CHCH_3 ; [1]
- (ii)
- $$\begin{array}{cccccc}
 & H & & CH_3 & & H & & CH_3 & & H & & CH_3 \\
 & | & & | & & | & & | & & | & & | \\
 - & C & - & C & - & C & - & C & - & C & - & C & - \\
 & | & & | & & | & & | & & | & & | \\
 & H & & H & & H & & H & & H & & H
 \end{array}
 ;$$
- harder / more rigid / higher melting point / stronger / denser;
crystalline / chains closer together; [3]
- (b) polystyrene beads contain pentane / volatile hydrocarbon;
heating causes pentane to evaporate;
white / opaque / lower density / better insulator / (better) shock absorber; [4]
Any two properties, [1] each.
- (c) carbon dioxide is a greenhouse gas / CO_2 causes global warming, climate change *etc.*;
produces toxic chlorine compounds / causes acid rain due to HCl; [2]

Option F – Fuels and Energy

- F1.** (a) heat;
pressure;
millions of years;
absence of oxygen / air; [3 max]
Any three, [1] each.
- (b) CO/CO₂/SO₂/NO_x/ particulates or C / hydrocarbons; [2]
Three correct [2], two correct [1].
- (c) (i) carbon monoxide / CO;
hydrogen / H₂; [2]
- (ii) *Advantages, any two [1] each.*
production of sulfur dioxide / particulates or C is reduced;
solid products are useful / valuable / stated use, *e.g.* fertilizer production, road building;
product is easier to transport/store;
disadvantage – energy cost of process; [3]
- F2.** (a) (i) 1.49 V;
Units not needed.
$$\text{Zn} + 2\text{NH}_4^+ \rightarrow \text{Zn}^{2+} + 2\text{NH}_3 + \text{H}_2;$$
 [2]
- (ii) to oxidize / remove the hydrogen / to prevent polarization / to prevent build-up of gas; [1]
- (b) longer shelf life / more power / smaller voltage drop in use / no gas formed; [2]
Any two, [1] each.
- (c) (i) use more materials; [1]
- (ii) (join) four (together); [1]
- F3.** (a) $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-;$
 $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-;$ [2]
Accept e instead of e⁻ in equations.
- (b) less waste heat produced / more chemical energy converted to useful energy / less polluting / uses renewable energy source / more efficient; [1]
-