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MARKSCHEME

November 2002

CHEMISTRY

Standard Level

Paper 3

11 pages

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 penalised. 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, penalise 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 penalise 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, penalise 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 penalising 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 organic chemistry

A1. (a) non-polar bonds / bonds of low polarity;
strong bonds / high bond energies; ***[2]***

(b) (species with) unpaired / lone / single / odd electron;
homolytic; ***[2]***

(c) (i) $(CH_3)_3CCH_2CH(CH_3)_2$ / more detailed structure; ***[2]***
[1] *for correct carbon skeleton,* ***[2]*** *if correct bonding and correct number of hydrogen atoms as well.*

(ii) short(er) (carbon) chains / smaller molecules / lower M_r;
(more) branching; ***[2]***

(d) (i) (H – C – H) 109.5° *(accept* 109 – 110° *)*;
(C – O – H) 104.5° *(accept* 104 – 105° *)*;
H – C – H angle due to (equal) repulsion by 4 bonding pairs (of electrons);
C – O – H angle due to presence of 2 bonding and 2 non-bonding pairs (of electrons);
repulsion greater for non-bonding pairs / less for bonding pairs; ***[5]***
Accept references to negative charge centres.

(ii) (methanol) 2;
(MTBE) 2; ***[2]***

Option B – Higher physical chemistry

B1. (a) 1; ***[1]***

(b) the slow(est) step in the reaction;
step 1 *(however identified)*;
only $(CH_3)_3CBr$ appears / OH^- does not appear in the rate expression / it involves bond breaking; ***[3]***

(c) A, D ***[2]***
Two correct = ***[2]****, any one correct =* ***[1]****, three or more answers =* ***[0]****.*

(d) increases ***[1]***

B2. (a) (i) a solution whose pH does not change / changes slightly;
when a **small amount** of acid / alkali is added; ***[2]***

(ii) $K_a = \dfrac{[CH_3COO^-][H^+]}{[CH_3COOH]}$ / correct rearrangement;

$[H^+] = \dfrac{1.74\times10^{-5}\times0.200}{0.100}$ / 3.48×10^{-5} (mol dm^{-3}); ***[3]***

pH = 4.46 *(accept* 4.4 – 4.5);
Ignore units, no penalty for too many significant figures, ECF from $[H^+]$ *to pH, correct final answer scores* ***[3]****.*

(iii) (most of) the OH^- ions are removed;
$CH_3COOH + OH^- \rightarrow CH_3COO^- + H_2O$; ***[2]***
Accept $H^+ + OH^- \rightarrow H_2O$ *only if there is reference to* H^+ *ions coming from dissociation of the acid. Accept molecular equation.*

(b) any named ammonium salt of strong acid / hydrochloric acid / HCl / any other strong acid; ***[1]***

Option C – Human biochemistry

C1. (a) hypothalamus;
pituitary gland; ***[2]***

(b) (insulin) pancreas *(accept islets of Langerhans)*;
decreases glucose / sugar concentration in blood / helps conversion of glucose to glycogen;

(thyroxine) thyroid gland;
regulates metabolism / involved in control of heart rate / involved in temp regulation / role in calcium metabolism; ***[4]***

C2. (a) propane-1,2,3-triol / glycerol *(accept formula)*; ***[1]***

(b) (i) presence of one (or more) C═C bond, *(no mark for just "double bond")*; ***[1]***

(ii) $C_{17}H_{35}COOH > C_{15}H_{31}COOH > C_{17}H_{31}COOH$; ***[1]***

(iii) van der Waals' forces;
(*do not accept H-bonding because in this case the main attractive forces are vdWs'*). ***[1]***

(iv) (first pair) difference in M_r / chain length / area of contact;
(second pair) difference in bond angle / closeness of packing / area of contact; ***[2]***
Credit area of contact only once.

(c) $M_r(I_2) = 253.8 / 254$;
$I_2\ n = \left(\frac{0.254}{253.8}\right) = 0.001\,(\text{mol})$;
oil is monounsaturated / has 1 (C ═ C) double bond per molecule; ***[3]***
2 double bonds, based on use of $A_r = 126.9 / 127$ *scores* ***[2]***.

Option D – Environmental chemistry

D1. (a) (formation) $O_2 \rightarrow 2O\bullet$;
$O\bullet + O_2 \rightarrow O_3$;
(depletion) $O_3 \rightarrow O_2 + O\bullet$;
$O_3 + O\bullet \rightarrow 2O_2$; ***[4]***
• *symbol not essential, ignore state symbols.*

(b) (i) chlorofluorocarbon *(ignore minor spelling errors)*;

spray cans / aerosols / propellants;
refrigerators / air conditioning;
solvents;
blowing agents;
fire extinguishers; ***[3 max]***
*Any two uses for **[1]** each.*

(ii) skin cancer;
(eye) cataracts;
genetic mutation; ***[2 max]***
*Any two for **[1]** each.*

(iii) flammable;
greenhouse gas / causes global warming; ***[2]***

D2. activated sludge process;
sedimentation tank / settling tank / trickle bed;
aeration / bubble air or oxygen through;
organic matter removed / oxidized / decomposed aerobically;
with the help of bacteria;
(some) sludge recycled / used as fertilizer; ***[4 max]***
*Any four for **[1]** each.*

Option E – Chemical industries

E1. (a) dried / water vapour removed / purified / carbon dioxide removed;
compressed / pressurized;
cooled; ***[3]***

(b) nitrogen / N_2 *(accept* N*)*; ***[1]***

(c) (nitrogen) freezing food / filling snack food packets / providing inert atmosphere in welding / flushing out oil tanks / other feasible use *(accept Haber process)*;

(oxygen) steel making / rocket propulsion / specified medical use / other feasible use; ***[2]***

E2. (a) (i) $C_{12}H_{26} \rightarrow C_8H_{18} + C_4H_8$ / $C_{12}H_{26} \rightarrow C_8H_{16} + C_4H_{10}$; ***[1]***

(ii) alumina / Al_2O_3 / silica / SiO_2 / zeolite; ***[1]***

(iii) alkene;
presence of hydrogen;
would add to $(C = C)$ double bonds (in alkenes); ***[3]***

(b) benzene and hydrogen *(both needed for mark)*;
$C_6H_{14} \rightarrow C_6H_6 + 4H_2$; ***[2]***

(c) isomerization;
cyclization; ***[2]***

Option F – Fuels and energy

F1. (a) plants / trees / vegetation;
buried under sediment / layers of rock;
compressed / pressurized;
heated;
for millions of years;
in the absence of oxygen / anaerobic conditions; ***[4 max]***
*Any four for **[1]** each.*

(b)

	Coal	Oil
advantages:	reserves greater; cheaper if mined near surface;	less polluting if sulfur removed;
disadvantages:	more pollution by acid rain / particulates; scars environment / *OWTTE*;	reserves less; greater cost of deep drilling / drilling under water / in hostile environments; pollution risk from oil spills at sea;

[5 max]

*Any five for **[1]** each, provided that at least two points refer to coal and two to oil.*
The point about reserves can be scored for only coal or oil.

F2. (a) photosynthesis;
$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$; ***[3]***
*All formulas correct = **[1]**, correctly balanced = **[2]**.*

(b) fermentation;
$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$; ***[3]***
*All formulas correct = **[1]**, correctly balanced = **[2]**.*