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N03/420/S(3)M+

MARKSCHEME

November 2003

CHEMISTRY

Standard Level

Paper 3

13 pages

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 within the paper, mark only the required number of Options in the order in which they are presented in the paper, **unless the candidate has indicated the Options s/he wants to be marked, on the cover sheet**.

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) (i) the increase in the concentration of a product / decrease in the concentration of a reactant per unit time *[1]*

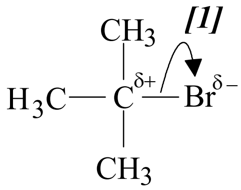
(ii) s^{-1} / min^{-1} *etc.* *[1]*

(iii) no effect (as $[OH^-]$ does not appear in the rate expression) *[1]*

(iv) first order / one *[1]*

(v) 8.0 seconds (since four half-lives elapse) *[1]*

(b) (i) S_N1 / substitution nucleophilic unimolecular;
mechanism



$\rightarrow (CH_3)_3C^+ + Br^-$

$HO^- + (CH_3)_3C^+ \rightarrow (CH_3)_3OH$; *[4]*

Mark is awarded for the curly arrow.
*slow step **[1]**;*

(ii) rate will increase / be faster;
C—I bond weaker than C—Br bond (so breaks more readily); *[2]*

(c) there will be two peaks (due to 2-methylpropan-2-ol (and one due to TMS));
ratio (or areas) of 9:1;
one will be at 0.9 ppm / 4.5 ppm;
0.9 ppm due to TMS; *[3]*

A2. (a) benzene undergoes substitution (rather than addition);
because of the extra stability of the ring (due to the resonance hybrids); *[2]*

(b) (the peak at) 60 (is) due to $C_3H_8O^+$ / the molecular ion;
(the peak at) 31 (is) due to / fragmentation /; $(M - C_2H_5)^+$ / CH_3O^+ *[2]*
Penalize missing charge(s) once only.

(c) the two isomers are methoxymethane / CH_3OCH_3 / dimethylether and ethanol / C_2H_5OH
names or structures, both isomers needed for mark;
ethanol is the isomer with the absorption at about 3300 cm^{-1} due to OH; *[2]*

Option B – Medicines and drugs

B1. (a) intramuscular / into muscles;
intravenous / into veins;
subcutaneous / into fat;
*(Award **[2]** for three correct **[1]** for two or one correct)* ;
intravenous; ***[4]***
the drug is circulated / transported quickly via the blood stream (to various parts of the body);
Accept parenteral (other than by mouth).

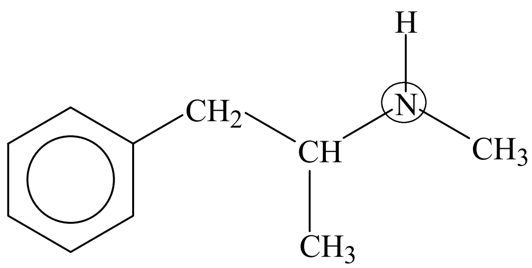
(b) more of the drug needs to be taken to achieve the original effect;
it may get close to / exceed the lethal dose; ***[2]***

B2. (a) the dichromate(VI) ion is reduced / forms the Cr^{3+} ion;
the ethanol is oxidized / forms ethanal / ethanoic acid; ***[2]***

(b) sample of breath passed into infrared spectrometer;
ethanol in breath absorbs because of OH group;
machine compares breath with air/reference sample with no breath; ***[3]***

(c) alcohol has a synergistic effect / *OWTTE* with other drugs;
alcohol depresses central nervous system which enhances the effect of other drugs which have a sedative effect on CNS / increased risk of stomach bleeding with aspirin;
alcohol can reduce the effectiveness of some drugs; ***[2 max]***

B3. (a) (i)



The ring must circle the N atom to gain the mark. ***[1]***

(ii) tertiary ***[1]***

(b) amide / N-methylamide *(accept peptide)* ***[1]***

(c) (i) they all contain the phenylethylamine structure / contain a benzene ring linked to two carbon atoms attached to an amine group ***[1]***

(ii) sympathomimetic drugs mimic the effect of adrenaline / stimulate the sympathetic nervous system;
speed up the heart / increase sweat production / increase rate of breathing; ***[2]***

(iii) weight loss / constipation / emotional instability ***[1]***

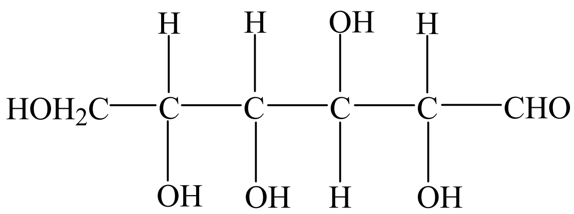
Option C – Human biochemistry

C1. (a) GM food contains a single gene / DNA that has been (artificially) incorporated from another organism / *OWTTE* ***[1]***

(b) *Any two benefits from:*
improve flavour / improve texture / improve nutritional value / increase shelf-life / make plants more resistant to disease / more resistant to insect attack / more resistant to herbicides / increases (crop) yield *etc*.;

Any two concerns from:
outcome of alterations uncertain / may cause disease / may escape to contaminate normal crops / may alter ecosystem *etc*.; ***[4]***

C2. (a)



[1]

No penalty for "sticks" or for OH groups written back-to-fron, eg. OH- instead of HO-. t

(b) the –OH group on the first carbon atom is inverted in β-glucose ***[1]***

(c) one (amylose) is a straight chain polymer whereas the other (amylopectin) is branched;
one (amylose) has only 1,4 bonds (between the monomers) whereas the other (amylopectin) has 1,4 and 1,6 bonds; ***[2]***

(d) M_r for sucrose $= 342$;
heat evolved $= 0.631\text{ (kg)} \times 4.18\text{ (kJ kg}^{-1}\text{ K}^{-1}) \times 6.22\text{(K)} = 16.4\text{ kJ}$;
calorific value $= \dfrac{16.4 \times 342}{1.00} = 5.61 \times 10^3\text{ kJ mol}^{-1}$; ***[3]***

Allow answers in range 5610 to 5620.
Penalize for more than 5 sig. Figs.
ECF from incorrect M_r.

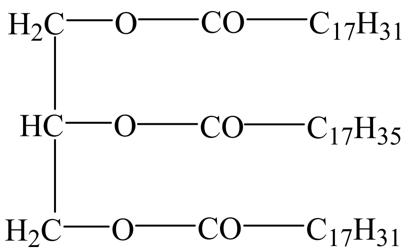
C3. (a) stearic acid is saturated, linoleic acid is unsaturated / contains C=C double bonds;
contains stearic acid they can pack closer together than linoleic acid molecules / *OWTTE*;
van der Waals' forces are weaker / *OWTTE*;

[3]

(b) (i) zero (it is saturated so iodine cannot add) ***[1]***

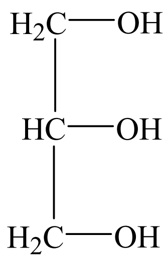
(ii) amount $= \frac{100}{280} = 0.357$ mol;
mass of $I_2 = 2 \times 0.357 \times 254 = 181$ g; ***[2]***

(c) (i)



Accept acid residues in a different order. ***[1]***

(ii)



$C_{17}H_{31}COONa$ $C_{17}H_{35}COONa$

*Allow for ECF if structure in (c) is incorrect. Accept any two correct formulas for **[1]**.* ***[1]***

Option D – Environmental chemistry

D1. (a) catalytic converter / lean burn engine / thermal exhaust reactor;
$2CO + O_2 \rightarrow 2CO_2$;
For catalytic converter also accept $2CO + 2NO \rightarrow 2CO_2 + N_2$. ***[2]***

(b) catalytic converter;
$2CO + 2NO \rightarrow 2CO_2 + N_2$; ***[2]***

(c) (alkaline) scrubbing / fluidised bed combustion;
$CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$ / $CaO + SO_2 \rightarrow CaSO_3$; ***[2]***

(d) catalytic converter;
$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$; ***[2]***
Accept thermal exhaust reactor but not lean burn.

D2. (a) *Any two from:*
low boiling point / volatile / non reactive / non toxic / non flammable / inflammable / does not act as a greenhouse gas ; ***[2]***

(b) C_4H_{10} more flammable than CHF_2Cl;
CHF_2Cl still contains a C—Cl bond (so can form radicals with UV radiation);
C_4H_{10} and CHF_2Cl can both absorb IR radiation / cause global warming / are greenhouse gases; ***[3]***
Award marks for any other correct advantages / disadvantages.
Award [1] for "2-methylpropane flammable".

D3. (a) it contains dissolved carbon dioxide / carbonic acid
$CO_2 + H_2O \rightarrow H_2CO_3$ / $CO_2 + H_2O \rightarrow H^+ + HCO_3^-$ ***[2]***

(b) coal contains sulfur (which burns to form SO_2);
$S + O_2 \rightarrow SO_2$; ***[2]***
Accept equation for formation of H_2SO_3 *or* H_2SO_4.

(c) (i) it leaches nutrients (Ca^{2+}, Mg^{2+}, K^+) from the soil;
OR it lowers the concentration of Mg^{2+} so reduces the amount of chlorophyll / photosynthesis;
OR it increases the concentration of Al^{+3} (from rocks) which damages roots; ***[1 max]***

(ii) $CaCO_3 + 2H^+ \rightarrow Ca^{2+} + CO_2 + H_2O$ ***[1]***
Accept full equations with HNO_3, H_2SO_3 *or* H_2SO_4.

(d) CaO is a basic oxide / CaO neutralizes the acid in the lake / equation to represent this ***[1]***

Option E – Chemical industries

E1. (a) the method of reduction depends on the metal's position in the reactivity / electrochemical series;
the method of reduction (*e.g.* with zinc) can be influenced by the availability or otherwise of electrical energy / coal;
Ag is low in series so can occur uncombined / the ore can be heated;
Pb is higher in the series so the ore is reduced by chemical means / C / CO;
Na is high in the series so the molten ore is reduced by electrons / electrolysis;
degree of purity required; ***[5 max]***
*Award **[1]** each for any 5.*

E2. (a) (i) *Award **[1]** each for any three of the following.*
availability of investment and or incentives / ready market for product / available labour / suitably skilled workforce / minimal pollution to local area; ***[3 max]***

(ii) intermediate product: used to make another chemical *e.g.* H_2SO_4, NH_3 *etc*.;
consumer product: end product *e.g.* pharmaceuticals / silicon chips / dyes *etc*.; ***[2]***
Both definition and a suitable example must be given to gain mark.

(b) enzymes to make ethanol / fructose syrup / proteases in biological detergents / insulin production / vitamin synthesis / other suitable example ***[1]***

E3. (a) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ ***[1]***

(b) $Fe_3O_4 + 4H_2 \rightarrow 3Fe + 4H_2O$ ***[1]***

(c) oxygen passed in;
at high temperature / pressure / with high degree of purity;
impurities / one named impurity oxidized;
one equation from those listed, but including 2C + 02 -> 2CO;
lime / limestone / CaO / CaO3 added;
which reacts with/removes some oxides;
one equation such as CaO + SiO2 - CaSIO3; ***[6 max]***
scrap iron/steel added;
to lower temperature / because other reactions are exothermic

*Award **[1]** each for any 6.*

(d) chromium / nickel ***[1]***

Option F – Fuels and energy

F1. (a) *Any two from:*
fission involves the breakdown of the nucleus, chemical bond breaking involves the rearrangement of electrons;
no new elements are formed in chemical fission, they are in nuclear fission;
mass is lost in nuclear fission and retained in chemical fission;
a large change in energy for nuclear fission compared to chemical bond breaking;
chemical bond breaking is endothermic, nuclear fission may be exothermic or endothermic; ***[2 max]***

(b) (i) neutron / ${}^{1}_{0}n$ ***[1]***

(ii) the mass of the products is less than the mass of the reactants / the mass defect is converted into energy / $E = mc^2$ ***[1]***

(c) 1.35×10^{10} years ***[1]***

(d) (i) control rods: absorb (excess) neutrons;
moderators: slow down neutrons (making them more likely to collide with fissionable nuclei); ***[2]***

(ii) cadmium / boron ***[1]***

(e) to avoid the transfer of radioactivity to the water / escape of radioactivity ***[1]***

F2. (a) the mixture burns as efficiently as a mixture of 2 % heptane and 98 % 2,2,4-trimethylpentane / an isomer of octane / 98 indicates efficiency on a scale where heptane = 0 and isooctane = 100; ***[1]***

(b) $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ (*accept* $C_8H_{18} + 12.5O_2$ *etc.*) ***[1]***

(c) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ ***[1]***

(d) (i) $\frac{1000}{114} \times 5512 = 4.83 \times 10^4$ kJ ***[1]***
Accept answer in range 48350 to 48400 kJ. No penalty for sig figs.

(ii) $\left(\frac{800}{114} \times 5512\right) + \left(\frac{200}{46} \times 1371\right)$;
$= 4.46 \times 10^4$ kJ ; ***[2]***
Accept answer in range 4460 to 44642 kJ.

F3. (a) photoelectric effect ***[1]***

(b) a photovoltaic cell is used;
which is made of a semiconductor / silicon / germanium;
sunlight causes the release/flow of electrons; ***[2 max]***
*Award **[1]** each for any 2.*

(c) *Any two of the following, **[1]** each.*
they have no moving parts;
electricity can be generated indefinitely / uses a renewable source of energy (the sun);
low maintenance;
no pollution is produced; ***[2 max]***