N08/4/CHEMI/SP3/ENG/TZ0/XX/M+

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MARKSCHEME

November 2008

CHEMISTRY

Standard Level

Paper 3

17 pages

General Marking Instructions

Assistant Examiners (AEs) will be contacted by their team leader (TL) by e-mail (or telephone) – if by e-mail, please reply to confirm that you have downloaded the markscheme from EXAMNET. The purpose of this initial contact is to allow AEs to raise any queries they have regarding the mark scheme and its interpretation. AEs should contact their team leader by e-mail at any time if they have any problems/queries during the marking process.

Note:

The DHL courier service must be used to send assessment material to your team leader/senior moderator and to IB Cardiff. (However, this service is not available in every country.) The cost is met directly by the IBO. It is vitally important that the correct DHL account number is used.

If you have any queries on **administration** please contact:

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1. Follow the markscheme provided, award only whole marks and mark only in **RED**.

2. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded.**

3. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases write a brief annotation to explain your decision. You are encouraged to write comments where it helps clarity, especially for moderation and re-marking. It should be remembered that the script may be returned to the candidate.

4. Unexplained symbols or personal codes/notations are unacceptable.

5. Record marks in the right-hand margin against each mark allocation shown in square brackets *e.g.* ***[2]***. The total mark for a question must equal the number of ticks for the question.

6. Do **not** circle sub-totals. **Circle the total mark** for the question in the right-hand margin **at the end of the question.**

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

8. Where work is submitted on additional sheets the marks awarded should be shown as ticks and a note made to show that these marks have been transferred to the appropriate square bracket in the body of the script.

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

10. After entering the marks on the front cover 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. **All scripts are checked and a note of all clerical errors will be given in feedback to examiners.**

11. If an answer extends over more than one page and no marks have been awarded on a section draw a diagonal line through that section to indicate that it has been marked.

12. If a candidate has attempted more than the required number of questions within a paper or section of a paper, mark all the answers and use the marks of those answers that have the highest mark, **unless the candidate has indicated the question(s) to be marked on the front cover**.

13. A mark should not be awarded where there is contradiction within an answer. Make a comment to this effect in the left hand margin.

Subject Details: Chemistry SL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer questions from **TWO** of the options **[2 × 20 marks]**. Maximum total = **[40 marks]**

1. A markscheme often has more marking points than the total allows. This is intentional. Do not award more than the maximum marks allowed for part of a question.

2. Each marking point has a separate line and the end is signified by means of a semicolon (;).

3. An alternative answer or wording is indicated in the markscheme by a slash (/) - either wording can be accepted.

4. Words in brackets ( ) in the markscheme are not necessary to gain the mark.

5. Words that are <u>underlined</u> are essential for the mark.

6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by writing ***OWTTE*** (or words to that effect).

8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. Indicate this with **ECF** (error carried forward).

10. Only consider units at the end of a calculation. Unless directed otherwise in the mark scheme, unit errors should only be penalized once in the paper. Indicate this by writing **–1(U)** at the first point it occurs and **U** on the cover page.

11. Significant digits should only be considered in the final answer. Deduct **1 mark in the paper** for an **error of 2 or more digits** unless directed otherwise in the markscheme.

e.g. if the answer is 1.63:

2	*reject*
1.6	accept
1.63	accept
1.631	accept
1.6314	*reject*

Indicate the mark deduction by writing **–1(SD)** at the first point it occurs and **SD** on the cover page.

12. 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.

13. 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 directed otherwise in the markscheme.

14. Ignore missing or incorrect state symbols in an equation unless directed otherwise in the markscheme.

Option A – Higher physical organic chemistry

A1. (a) the increase in concentration of products per unit time / the decrease in concentration of reactants per unit time / change in concentration per unit time / change in amount of reactant or product per unit time; ***[1]***

(b) (i) first order / 1;
(ii) first order / 1;
(iii) second order / 2; ***[3]***

(c) rate $= k[BrO_3^-][I^-][H^+]^2$ / rate $\propto [BrO_3^-][I^-][H^+]^2$; ***[1]***
Allow for ECF from part (b).

(d) rate $= k[NO_2]^2$ / rate $\propto [NO_2]^2$; ***[1]***

A2. (a) they will have different fingerprint regions / 1500 – 500 cm^{-1}; ***[1]***

(b)

Compound	Total number of peaks	Ratio of relative areas under each peak
butan-1-ol	5;	3:2:2:2:1;
2-methylpropan-2-ol	2;	9:1;

[4]

(c) *m/z* =74
both compounds have a peak at 74 due to M^+/molecular ion / both have the same relative molar mass;

m/z =29
butan-1-ol can form the $C_2H_5^+$ (fragment) / $(M - CH_2CH_2OH)^+$;
2-methylpropanol can form the COH^+ (fragment) / $(M - (CH_3)_3)^+$; ***[3]***
Penalize missing + charge once only.

A3. (a) $C_2H_5COOH + H_2O \rightleftharpoons C_2H_5COO^- + H_3O^+$ / $C_2H_5COOH \xrightleftharpoons{H_2O} C_2H_5COO^- + H^+$; ***[1]***

Ignore state symbols and do not penalize use of $\rightarrow$ *instead of* $\rightleftharpoons$.

(b) $K_a = \dfrac{[C_2H_5COO^-][H^+]}{[C_2H_5COOH]}$ / $K_a = \dfrac{[C_2H_5COO^-][H_3O^+]}{[C_2H_5COOH]}$; ***[1]***

(c) $K_a = 10^{-4.87}$ / 1.35×10^{-5} / 1.4×10^{-5};

$K_a = \dfrac{[H^+]^2}{1.00 \times 10^{-2}}$;

$[H^+] = 3.67 \times 10^{-4}$ (mol dm^{-3}) / 3.7×10^{-4} (mol dm^{-3});

pH = 3.43 / 3.44; ***[4]***

Correct final answer scores ***[4]***.

Option B – Medicines and drugs

B1. (a) they both contain (at least one) $-\overset{\overset{\displaystyle O}{\|}}{C}-O-CH_3$ / $-\overset{\overset{\displaystyle O}{\|}}{C}-O-R$ group; ***[1]***

Do not accept –COO without the carbon attached or RCOO.

(b) *aspirin*:
prevents the formation of prostaglandin synthase/other pain producing substances at source;
stops transmission of pain from source to brain;

heroin:
interacts with receptor sites within brain/spinal cord;
blocks pain signals within brain/spinal cord; ***[4]***

(c) causes bleeding/ulcers in stomach / Reye's disease / asthma / deafness; ***[1]***

(d) larger and larger doses needed to achieve original effect / *OWTTE*;
danger of exceeding the lethal dose / *OWTTE*; ***[2]***

B2. (a) $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$;
$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$ / $NaCl + H_2CO_3$; ***[2]***

(b) *alginates:*
produce neutralizing layer/coating (over stomach contents) / prevent heartburn / prevent stomach contents/acid rising up oesophagus / prevents acid reflux;

anti-foaming agents:
prevent bloating/flatulence; ***[2]***

B3. (a) overcame the problems associated with isolating/concentrating penicillin;
showed that penicillin is harmless and effective on mice;
developed techniques to purify penicillin (to eliminate many side effects) / prepared it in crystal form / *OWTTE*;
first to use penicillin on a policeman/human (dying of septicaemia);
grew penicillin in bulk;
grew strains of penicillin in corn-steep liquor; ***[3 max]***

(b) *A:*
carboxylic acid;

B:
amide / peptide; ***[2]***

(c) bacteria were able to build up a resistance;
the enzyme penicillinase deactivates/destroys (the original) penicillin; ***[2]***

(d) (the active part is retained but) the side chain is altered / *OWTTE*; ***[1]***

Option C – Human biochemistry

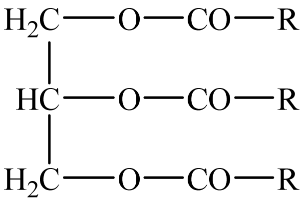
C1. (a) (i) heat produced by $2.19\,\text{g} = 600 \times 4.18 \times 11.2 = 2.81 \times 10^4$ (J) / 28.1(kJ) ;

heat produced by $45.0\,\text{g} = \dfrac{45.0 \times 28.1}{2.19} = 577\,\text{kJ}$; ***[2]***

*Correct final answer scores **[2]**.*

(ii) not all the heat was transferred to the water;
food was not completely combusted;
heat capacity of stirrer/thermometer/calorimeter was not taken into account;
heat was lost to the surroundings; ***[2 max]***
*Any two for **[1]** each.*

(b) (i)



; ***[1]***

(ii) unsaturated fats contain a <u>carbon to carbon</u> double bond, in saturated fats all the carbon to carbon bonds are single; ***[1]***

(iii) 7.61 g of $I_2 = \dfrac{7.61}{254} = 0.0300$ mol of I_2 ;
the fat contains three C=C bonds in each molecule; ***[2]***
*Correct final answer scores **[2]**.*
Accept 0.03 mol of I_2.

(iv) the C=C bond causes the chain to be more uneven/kinked in unsaturated fats;
unsaturated fats cannot pack as closely together as saturated fats;
the intermolecular forces/van der Waals' forces are weaker; ***[3]***

C2. (a) one of the four steroid rings is not complete / the steroid backbone is not present / *OWTTE*; ***[1]***

(b) because of the long non polar (hydrocarbon) part of the molecule / can form van der Waals' forces with fat molecules; ***[1]***

(c) (presence of) C=C/double bond(s)/alkene; ***[1]***
Accept unsaturated.

(d) malformed bones / deformed skeleton / bow legs / rickets;
uptake of calcium (and phosphate) from food hindered / *OWTTE*; ***[2]***

C3. (a) chemicals produced in glands which are transported through the blood to the site of action / chemical messengers; ***[1]***

(b) ovaries; ***[1]***

(c) (i) phenyl (group) / benzene ring / phenol; ***[1]***
Accept aromatic ring

(ii) ketone / alkanone / carbonyl **and** alkene; ***[1]***
Accept cycloalkene

Option D – Environmental chemistry

D1. (a) both gases allow radiation from the sun to pass through;
carbon dioxide <u>absorbs</u> the longer wavelength/lower energy/heat/IR radiation from the Earth (whereas nitrogen does not);
bonds in carbon dioxide stretch/bend/vibrate;
C=O bonds are polar / N_2 bonds are non-polar;
heat is re-radiated back to earth; ***[3 max]***

(b) the decomposition is anaerobic / decomposes in the absence of oxygen / not enough oxygen present; ***[1]***

(c) *Any **two** from*: H_2O, N_2O, O_3, CFCs, SF_6 ; ***[1]***
Accept names or formulas.
Penalize extra incorrect answers.

(d) particulates cool the earth / opposite effect to greenhouse gases;
scatter radiation from the sun / reflect radiation back into space / prevent radiation from the sun reaching the Earth; ***[2]***

D2. (a) carbonic acid is a weak acid / only partially dissociated / low solubility;
the pH must be lower than 5.6 for acid rain / *OWTTE*; ***[2]***

(b) H_2SO_4 / H_2SO_3 **and** burning coal/sulfur-containing fuels/fossil fuels / smelting of sulfide ores;
HNO_3 / HNO_2 **and** reaction (between N_2 and O_2) in internal combustion/jet engine; ***[2]***
*If both acids correct but sources incorrect award **[1]** mark.*
*If SOx / NOx given with two correct sources award **[1 max]**.*
Accept names or formulas of acids.

(c) $CO_3^{2-} + 2H^+ \rightarrow CO_2 + H_2O$ / H_2CO_3 ; ***[1]***

(d) plant growth is reduced;
nutrients (Ca^{2+}, Mg^{2+}, K^+) are leached from the soil / *OWTTE*;
reduction in Mg^{2+} reduces chlorophyll (so affects photosynthesis);
Al^{3+} leached from rocks damages roots (by preventing them from taking up water); ***[2 max]***

D3. (a) glaciers / ice caps / Antarctica; ***[1]***
Penalize extra incorrect answers.

(b) oxidize/kill bacteria;
can form polychlorinated organic/toxic/carcinogenic compounds / do not destroy viruses (O_3 does); ***[2]***

(c) high pressure / pressure greater than 50 atm applied to the sea water;
<u>semi/partially permeable</u> membrane / cellulose ethanoate/acetate;
water forced through, salts left behind / *OWTTE*; ***[3]***

Option E – Chemical industries

E1. (a) $2C + O_2 \rightarrow 2CO$;
$C + O_2 \rightarrow CO_2$ / $CaCO_3 \rightarrow CaO + CO_2$;
$CO_2 + C \rightarrow 2CO$; ***[3]***
Also accept equations showing the formation of CO during reduction of oxides of iron with carbon.

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

(c) calcium carbonate/limestone is added / $CaCO_3 \rightarrow CaO + CO_2$;
the product is calcium silicate/slag / $CaO + SiO_2 \rightarrow CaSiO_3$;
this sinks to the bottom of the furnace and is (periodically) tapped off; ***[2 max]***

(d) carbon; ***[1]***

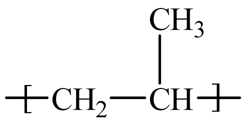
(e) use a magnet; ***[1]***
Accept any other simple method based on the different properties of iron and aluminium.

E2. (a) it poisons the catalyst(s) (used in refining);
to prevent the release of SO_2 / formation of acid rain (when it is combusted); ***[2]***

(b) used as raw material for Contact process / sulfuric acid production; ***[1]***

(c) mix with hydrogen;
high pressure / between 50 and 100 atmospheres;
catalyst of silica/SiO_2/alumina/Al_2O_3/aluminosilicate/(finely divided) platinum; ***[2 max]***
Catalyst must be identified.
No credit for reference to high temperature

(d) $C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$;
polymers / plastics / ethanol / polythene / <u>feedstock</u> for other chemicals; ***[2]***

E3. (a)  ; ***[1]***

Continuation bonds are required.
Brackets not needed for the mark.
Do not accept more than a single repeating unit.

(b) in isotactic all the methyl groups have the same orientation along the polymer chain;
in atactic the methyl groups are arranged randomly along the polymer chain; ***[2]***
Accept correct diagrams in place of words.

(c) isotactic polymers have a regular structure and atactic polymers have an irregular structure / isotactic polymers are more crystalline (than atactic polymers);
atactic polymers cannot pack so closely / are more loosely held / *OWTTE*;
the (van der Waals') forces of attraction between isotactic polymers are stronger / (van der Waals') attractive forces between atactic polymers are weaker; ***[2 max]***
Do not accept dipole-dipole attractions or hydrogen bonds.

Option F – Fuels and energy

F1. (a) $^{235}_{92}U \rightarrow {}^{4}_{2}He + {}^{231}_{90}Th$ ***[2]***

*Award **[1]** for correctly identifying $^{231}_{90}Th$, **[1]** for correct equation.*
Accept α in place of $^{4}_{2}He$.

(b) 7 alpha emissions;
4 beta emissions; ***[2]***

(c) the time taken for the amount/concentration/mass to decay/decrease to one half of its original value; ***[1]***

(d) six half-lives;
mass = 0.0375 kg; ***[2]***
*Correct mass scores **[2]**.*

(e) *Moderator*

made from:
water / heavy water / graphite;

function:
to slow down neutrons / to increase the number of collisions that lead to fission between neutrons and nuclei / *OWTTE*;

Control rods

made from:
cadmium / boron;

function:
to absorb (excess) neutrons; ***[4]***

F2. (a) (i) $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ / $C_8H_{18} + 12\frac{1}{2}O_2 \rightarrow 8CO_2 + 9H_2O$; ***[1]***

(ii) $M_r(CH_4) = 16$ so energy evolved $= \dfrac{890 \times 1000}{16} = 5.56 \times 10^4$ (kJ) ;

$M_r(C_8H_{18}) = 114$ so energy evolved $= \dfrac{5510 \times 1000}{114} = 4.83 \times 10^4$ (kJ) ;

(so methane gives out the most energy) ***[2]***

Penalize once only if 1.00 used instead of 1000.

Award ***[2]*** *if a comparison is made between 890/16 and 5510/114 and it is stated that the mass is the same.*

(b) *advantages:*

does not cause pollution / only water is formed;
oil can be used as a feedstock rather than a fuel;
do not have to use fossil fuels;

disadvantages:

technology still in its infancy / not yet as powerful / H_2 not a raw material;
hydrogen difficult/bulky to store / cannot be easily liquefied;
expensive; ***[4 max]***

Do not accept hydrogen is explosive/flammable/dangerous.

(c) *positive electrode:*

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$;

negative electrode:

$H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$; ***[2]***

If equations correct but at wrong electrodes award ***[1]****.*

Accept correct equations for acidic conditions

Positive electrode: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

Negative electrode: $H_2 \rightarrow 2H^+ + 2e^-$