M08/4/CHEMI/SP3/ENG/TZ2/XX/M+

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MARKSCHEME

May 2008

CHEMISTRY

Standard Level

Paper 3

18 pages

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 underlined 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.

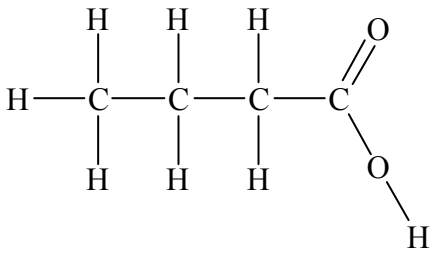
14. Ignore missing or incorrect state symbols in an equation unless directed otherwise in the markscheme.

Option A – Higher physical organic chemistry

A1. (a) (i) 88; ***[1]***
Ignore units

(ii) $29 = CHO^+ / C_2H_5^+$;
$45 = COOH^+$; ***[2]***
If no + sign shown, penalize only once.

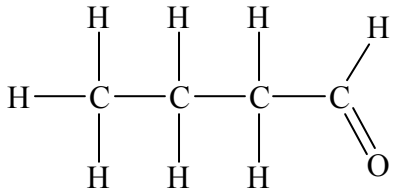
(b)



or $CH_3CH_2CH_2COOH / CH_3CH_2CH_2CO_2H$;

four hydrogen environments in the ratio of 3: 2: 2: 1 / this is the only carboxylic acid with 4 peaks / *OWTTE*; ***[2]***

(c)



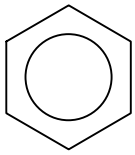
or $CH_3CH_2CH_2CHO$;

4 ^{1}H NMR peaks;
3 : 2 : 2 : 1; ***[3]***
*If wrong structure identified then **[1]** max for correct NMR peaks and ratio based on that structure.*

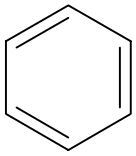
(d) (i) functional groups (present in compound);

the types of bonds (present in compound); ***[1 max]***
Examples of bonds must be given.

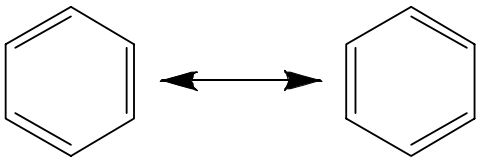
(ii) P has an absorption in the 2500 – 3300 cm^{-1} region due to the O–H bond;
N does not absorb at 2500-3300 cm^{-1} region due to absence of the O–H bond;
P also absorbs between 1000 – 1300 cm^{-1} for the C–O bond; ***[2max]***
***[1]** max if they only identify wavenumbers or bonds*

A2. (a)  ; the circle represents delocalized electrons / resonance hybrids;

OR

 ; each bond alternates between being a single and double bond;

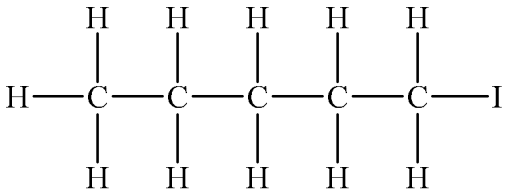
OR



2 diagrams, 2 marks ***[2 max]***

(b) C–C bond length are all the same in benzene/between single and double bond;
the enthalpy of hydrogenation of benzene is not three times the hydrogenation of cyclohexene (three times one double bond)/not equal to the enthalpy of hydrogenation of cyclohexatriene;
the ^{1}H NMR spectrum of benzene shows only one peak;
only one isomer exists for 1,2 – disubstituted benzene compounds;
does not (easily) undergo addition reactions/ undergoes substitution reactions; ***[2 max]***

A3. (a) (i)

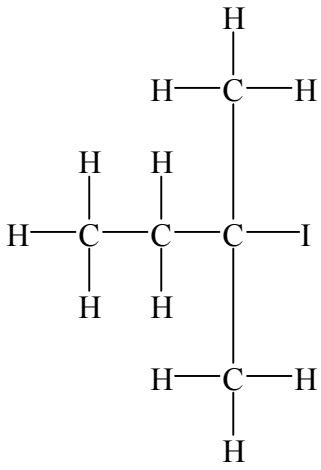


/ $CH_3CH_2CH_2CH_2CH_2I$; ***[1]***

Accept correct branched structure of primary halogenoalkane.

(ii) structural formula of $(CH_3CH_2)(CH_3)_2CI$; ***[1]***

e.g.



(b) (i) slowest step in a reaction;
step 1; ***[2]***

(ii) one /unimolecular; ***[1]***
Accept monomolecular but not first order.

Option B – Medicines and drugs

B1. (a) hydrochloric acid; ***[1]***
Do not accept HCl.

(b) $NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$ / $HCO_3^- + H^+ \rightarrow H_2O + CO_2$; ***[1]***
Do not accept H_2CO_3 as product.

(c) form layer on top of stomach contents;
stop stomach contents / acid entering oesophagus / *OWTTE*; ***[2]***

(d) to prevent foaming/build up of gas; ***[1]***

B2. (a) esterification/condensation; ***[1]***

(b) OH/hydroxyl group replaced by OCH_3 /ether group / H replaced by CH_3 / *OWTTE*; ***[1]***

(c) *advantage*
<u>strong</u> analgesic/pain killer;
No mark for just pain killer

disadvantage
addictive / tolerance can lead to taking dangerously high doses / constipation; ***[2]***

(d) spread of AIDS/hepatitis / dangerous infectious diseases;
increased crime/theft;
loss of jobs/diversion of money;
prostitution;
family disintegration; ***[2 max]***

B3. (a) (i) stimulant(s); ***[1]***

(ii) copies/mimics stimulation of the nervous system / action of adrenaline / *OWTTE*; ***[1]***

(b) nicotine;

short-term
addiction
increase heart rate
increase blood pressure / constricts blood vessels
reduction of urine output
*Award **[1]** for any two.*

long-term
heart disease
peptic ulcers
lung cancer
emphysema
coronary thrombosis / clot inside blood vessel
pregnancy problems
addiction ***[3 max]***
*Award **[1]** for any two.*
Addiction can score only once in either short or long term.

(c) amphetamine is a primary amine and adrenaline is a secondary amine / *OWTTE*;
only adrenaline has an –OH/hydroxyl group / is a phenol / is an alcohol; ***[2]***

(d) (i) diuretic / frequent urination; ***[1]***

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

Option C – Human biochemistry

C1. (a) fats;
minerals;
vitamins; ***[2 max]***
*Award **[2]** for three correct*
*Award **[1]** for two correct*

(b) $\frac{418}{28.0} / 14.9 \text{ kJ g}^{-1}$;
$\frac{14.9}{0.1 \times 4.18}$;
35.7 °C/K; ***[3]***

C2. (a) ester / triglyceride; ***[1]***
No mark for water/H_2O

(b) (i) linoleic acid is unsaturated / contains C=C double bonds / linoleic has a kink/bend/120° bond angle within the molecule / *OWTTE*; ***[1]***

(ii) C=C double bonds stop molecules packing closely together;
resulting in weaker van der Waals' /London/dispersion forces of attraction / *OWTTE*; ***[2]***

(c) 2 C=C double bonds require 2 moles of iodine / *OWTTE*;
507.6 g; ***[2]***
Accept 507–508, units required for second mark.
*253.8 / 254 score **[1 max]**.*

C3. (a) alcohol/hydroxyl/OH;
alkene/C=C; ***[2]***

(b) fat-soluble because long hydrocarbon chain;
so cannot form hydrogen bonds with water / *OWTTE*; ***[2]***

(c) (i) rhodopsin;
converts light signals into electricity/electrical signals / *OWTTE*;
messages travel along optic nerve/ to the brain; ***[3]***

(ii) night blindness / nyctanopia / nyctalopia;
Xerophthalmia/(chronic) conjunctivitis/eyes fail to produce tears; ***[2]***
No mark for just eye problems.

Option D – Environmental chemistry

D1. (a) *CO_2:*
man-made:
combustion of fossil fuels / combustion of biomass;

natural:
respiration / forest fires / decay of plants/animals / oxidation of soil humus / volcanoes;

N_2O:
man-made:
combustion of biomass / (artificial/nitrogen based) fertilizers;

natural:
bacterial decomposition of nitrogen-containing compounds; ***[4]***

(b) CO_2 is less effective at trapping heat than N_2O / N_2O heat trapping effectiveness is much greater than CO_2;
CO_2 contributes more to the greenhouse effect because there is more of it in the atmosphere / N_2O contributes less to the greenhouse effect because there is less of it in the atmosphere; ***[2]***

(c) *Discussion of any three of the following*:
stated climate change (e.g. drought / increased rainfall / desertification);
rising of sea-levels / thermal expansion of oceans / coastal flooding;
melting of the polar ice caps and glaciers;
stated changes in agriculture (e.g. crop yields reduced/increased);
stated changes in biodistribution/biodiversity (e.g. loss of cold water fish habitat, desertification);
stated effect on forests (e.g. more forest fires, forests grow rapidly); ***[3 max]***

D2. (a) H_2SO_3 / sulfurous acid / H_2SO_4 / sulfuric acid; ***[1]***

(b) $S + O_2 \rightarrow SO_2 / SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$;
$SO_2 + H_2O \rightarrow H_2SO_3 / SO_3 + H_2O \rightarrow H_2SO_4$ / $SO_2 + H_2O + 1/2\ O2 \rightarrow H_2SO_4$; ***[2]***

*Award **[1]** for $S + O_2 + H_2O \rightarrow H_2SO_3$ / $S + 1½O_2 + H_2O \rightarrow H_2SO_4$.*

(c) *Any two of the following*:
alkaline scrubbing;
remove sulfur from coal;
using limestone-based fluidized beds; ***[2 max]***

D3. (a) increased plant growth;
death / decomposition of plants reduces O_2 concentration;
anaerobic decomposition occurs / NH_3/PH_3/H_2S formed;
fish/aquatic life harmed/killed; ***[4]***

(b) increased temperature leads to a decrease in the amount of dissolved oxygen/solubility of oxygen decreases;
metabolic rate of aquatic organisms increases / metabolism increases/is speeded up; ***[2]***

Option E – Chemical industries

E1. (a) (limestone) reacts with silica/acidic impurities;
$CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$ /
$CaCO_3 \rightarrow CaO + CO_2$ and $CaO + SiO_2 \rightarrow CaSiO_3$;
(coke) heats furnace / acts as a reducing agent / forms a reducing agent / forms CO;
$C + O_2 \rightarrow CO_2$ / $2C + O_2 \rightarrow 2CO$ /
$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ / $C + CO_2 \rightarrow 2CO$; ***[4]***

(b) oxygen added;
lime/limestone/calcium oxide/calcium carbonate added;
carbon/impurities react with oxygen / are oxidized;
impurities react with (the lime) to form a slag; ***[4]***
Accept relevant equations.

E2. (a) carbon is more reactive than iron (so can remove oxygen from its oxide);
carbon is less reactive than aluminium so cannot; ***[2]***

(b) cryolite is used to lower the melting point of aluminium oxide;
Do not accept aluminium.

less energy needed;
acts as an electrolyte / improves the conductivity of the electrolysis cell /
acts as a solvent; ***[2 max]***

(c) (i) carbon / graphite; ***[1]***

(ii) *Anode:*
$2O^{2-} \rightarrow O_2 + 4e^-$ / $O^{2-} \rightarrow \frac{1}{2}O_2 + 2e^-$;
Accept $C + O_2 \rightarrow CO_2$

Cathode:
$Al^{3+} + 3e^- \rightarrow Al$; ***[2]***

(iii) carbon is burnt away/consumed / $C + O_2 \rightarrow CO_2$; ***[1]***

E3. (a) air is blown through (during the condensation of) the polymer;

*properties award **[1]** for any two.*
insulation
flexible
compressible
soft
low density ***[2 max]***

(b) *Accept two of the following:*
produces toxic vapour in fire / produces carbon dioxide / a greenhouse gas on combustion;
non-biodegradable;
production of polymer depletes natural resources; ***[2 max]***

Option F – Fuels and energy

F1. abundant/renewable;
easily ignited;
safe storage/transport;
(energy source should have) a high heat of combustion;
cheap;
easily accessed;
release energy at a reasonable rate;
use should cause minimal environmental problems/non-polluting; ***[3 max]***

F2. (a) negative electrode (anode): $H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$;
positive electrode (cathode): $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$;

overall reaction: $2H_2 + O_2 \rightarrow 2H_2O$; ***[3]***

(b) (i) negative electrode (anode): $Pb + SO_4^{2-} \rightarrow PbSO_4 + 2e^-$;
positive electrode (cathode): $PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \rightarrow PbSO_4 + 2H_2O$; ***[2]***

(ii) water is electrolysed during charging / evaporation; ***[1]***

F3. (a) heat from sun is concentrated/focussed/collected using parabolic mirrors / heat is used to heat oil/liquid sodium;
heated liquid pumped into heat exchanger / used to produce steam;
steam $\rightarrow$ turbine $\rightarrow$ generator; ***[3]***

(b) *Two of the following disadvantages:*
large area required (for mirrors);
mirrors need to be constantly cleaned;
mirror surface needs to withstand extreme temperature;
loss of energy during conversion/transmission; ***[2 max]***

(c) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$;
food/energy source / converted into other fuel/raw material; ***[2]***
Two of these needed for the ***[1]***.

F4. fermentation of carbohydrates to form ethanol / $C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + 2CO_2$;
ethanol burnt to produce energy / $CH_3CH_2OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$;

decay of organic matter by bacteria;
to produce biogas such as CH_4 / CO_2 ; ***[4]***