

# **MARKSCHEME**

**November 2007**

**CHEMISTRY**

**Standard Level**

**Paper 3**

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**Subject Details: Chemistry SL Paper 3 Markscheme****General**

- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- Alternative answers are separated by a slash (/) – this means that either answer is acceptable.
- Words that are 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)  $(\text{CH}_3)_2\text{CHBr}$  / more detailed formula;  
secondary/ $2^\circ$  because two alkyl groups attached to C with Br; [2]
- (b) nucleophilic substitution;  
bimolecular / molecularity of two / two species in rate-determining step;  
*Accept second order*
- rate =  $k[(\text{CH}_3)_2\text{CHBr}][\text{OH}^-]$ ; [3]  
*No penalty for incorrect halogenoalkane formula*
- (c)  $(\text{CH}_3)_2\text{CH}^+$  / more detailed formula; [1]
- A2.** (a)  $3350\text{ cm}^{-1}$  due to O–H bond;  
 $2900\text{ cm}^{-1}$  due to C–H bond; [2]  
*Award [1] if both bonds given but not linked to correct absorption.*
- (b) (comparison of) fingerprint regions / comparison with library, database or known spectra; [1]
- (c) same molecular ion / parent ion /  $M_r^+$  / due to  $\text{C}_4\text{H}_9\text{OH}^+$  /  $\text{C}_4\text{H}_{10}\text{O}^+$ ; [1]
- (d) ( $m/z = 57$ )  $\text{C}_4\text{H}_9^+$  /  $(\text{CH}_3)_3\text{C}^+$ ;  
( $m/z = 45$ )  $\text{C}_2\text{H}_5\text{O}^+$  /  $\text{CH}_3\text{CHOH}^+$  /  $\text{C}_2\text{H}_4\text{OH}^+$ ;  
*Penalise missing charge once only in (c) and (d)* [2]
- (e) (i) (four peaks because) four different hydrogen environments / four different types of proton / *OWTTE*;  
 $6:2:1:1$ ; [2]
- (ii)  $(\text{CH}_3)_3\text{COH}$  / more detailed formula; [1]
- A3.** (a)  $(K_w = )[\text{H}^+][\text{OH}^-]/[\text{H}_3\text{O}^+][\text{OH}^-]$ ;  
 $= 2.89 \times 10^{-14} / 2.9 \times 10^{-14}$ ; [2]  
*Units not needed*
- (b)  $\text{pH} = 6.8$ ; [1]  
*Accept answer in range 6.7 to 6.8*
- (c) neutral;  
 $[\text{H}^+] = [\text{OH}^-] / [\text{H}_3\text{O}^+] = [\text{OH}^-]$  / *OWTTE*; [2]

**Option B – Medicines and drugs**

- B1.** (a) to try to improve the drug's effect / to minimize side effects / *OWTTE*; [1]
- (b) (i) the dose needed to kill 50 % of (animal) population (tested); [1]
- (ii) people responding positively to being given a substance that is not a drug / *OWTTE*; [1]
- B2.** (a) hydrochloric acid / HCl; [1]
- (b)  $\text{Mg}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{MgCl}_2 + 2\text{H}_2\text{O}$  ;  
 $\text{NaHCO}_3 + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$ ; [2]
- Accept equations with  $\text{H}^+$  instead of HCl /  $\text{OH}^-$  instead of  $\text{Mg}(\text{OH})_2$  and  $\text{HCO}_3^-$  instead of  $\text{NaHCO}_3$ .*
- (c)  $\text{Al}(\text{OH})_3$  ;  
 neutralize 0.03 mol of  $\text{H}^+$  / contains three  $\text{OH}^-$  ions / *OWTTE*; [2]  
*Do not award second mark if other than  $\text{Al}(\text{OH})_3$  chosen*
- (d) they provide a neutralizing layer on top of the stomach contents;  
 to prevent acid rising up the oesophagus / acid reflux;  
 to prevent heartburn; [2 max]  
*Award [1] each for any two*
- B3.** (a) *mild analgesics*  
 they prevent/interfere with the production of substances/prostaglandins that cause pain;  
 they intercept pain at its source;
- strong analgesics*  
 they bond to receptor sites in the brain;  
 pain signals within brain/spinal cord blocked; [4]
- (b) (i)  $\text{CH}_3\text{CO}$  /  $\text{COCH}_3$  ; [1]  
*Do not accept ester group/ $\text{CH}_3\text{COO}$*
- (ii) *acetaminophen (paracetamol)*  
 amide;  
 hydroxy(l) / phenol / alcohol;
- ibuprofen*  
 carboxylic acid;  
*Do not accept carboxyl* [3]  
*Ignore any formulas even if wrong*
- (iii) ibuprofen;  
 asymmetric/chiral carbon atom / carbon atom joined to four different groups; [2]  
*Award second mark even if ibuprofen not chosen*

**Option C – Human biochemistry**

- C1.** (a)  $\Delta T = 65.1 - 18.3 = 46.8$  (°C or K);  
 Heat produced ( $= mc\Delta T$ ) =  $400 \times 4.18 \times 46.8$ ;  
*Mark is for substitution of three values*  
*ECF from temperature rise*  
 $= 78\,249.6\text{ J} / 78.2496\text{ kJ}$ ;  
*Mark is for correct answer in J or kJ, with 3 or more sig fig*  
 $= 1565$  (kJ per 100g); [4]  
*Allow answers in the range of 1560-1600*  
*Mark is for conversion to correct unit*

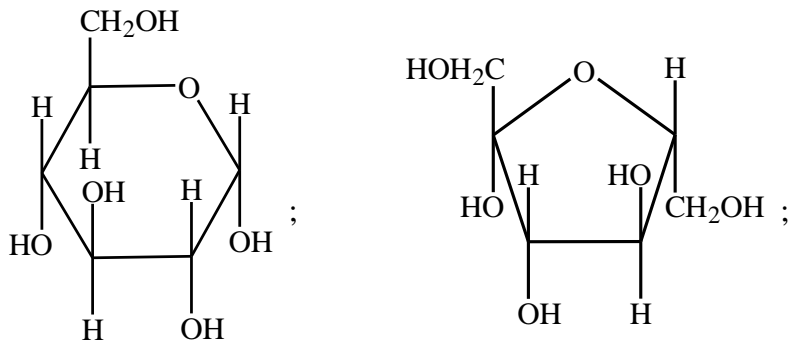
- (b) proteins  
 carbohydrates  
 fats  
 vitamins  
 minerals  
*Award [2] for any four, [1] for any three.*

vitamins / minerals; [3 max]

- (c) (i) addition; [1]

- (ii)  $n(\text{I}_2) = \frac{5}{253.8} = 0.0197$ ;  
 2 (double bonds); [2]

- C2.** (a) glycosidic / glucoside / ether; [1]

- (b) ; [2]

*Do not penalise candidates who draw bonds connected to incorrect atoms e.g. -HO instead of -OH*

- (c) water /  $\text{H}_2\text{O}$ ; [1]

- (d)  $\text{CH}_2\text{O}$ ; [1]

- C3.** (a) vitamin C / ascorbic acid;  
four/many OH groups / small proportion of hydrocarbon / can form hydrogen bonds  
with water / *OWTTE*; [2]
- (b) alkene and hydroxyl/alcohol; [1]
- (c) needed for uptake of calcium/phosphate;  
bone problem such as softening/weakness/malformation / rickets; [2]

**Option D – Environmental chemistry**

- D1.** (a) carbon monoxide / CO;  
(unburned) hydrocarbons;  
platinum / palladium / rhodium;  
 $2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$ ; [4]
- (b)  $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$ ; [1]
- D2.** (a) ultra-violet / uv;  
  
(increased) skin cancer;  
(eye) cataracts;  
suppression of plant growth/photosynthesis; [3 max]  
*Award [1] each for any two effects*  
*If candidates give more than two answers deduct marks for wrong answers such as global warming, melting ice caps.*
- (b)  $\text{O}_3 \rightarrow \text{O}_2 + \text{O}\cdot$ ;  
 $\text{O}_3 + \text{O}\cdot \rightarrow 2\text{O}_2$ ; [2]  
*No penalty for missing radical symbols.*
- (c) CFCs / any specified example such as freon;  
from spray cans / propellants / refrigerants / air-conditioning / fire extinguishers;  
nitrogen oxide(s) /  $\text{NO}_x$  / NO /  $\text{NO}_2$ ;  
*Do not accept  $\text{N}_2\text{O}$*   
  
from combustion of fuel in aircraft; [4]  
*Do not accept combustion of fuel in cars*
- D3.** *Award [1] for each of the following in order.*  
*Method:*  
*Primary:* filtration / screening;  
*Secondary:* aeration / activated sludge (process);  
*Tertiary:* (chemical) precipitation;  
*Material removed in secondary:* organic matter;  
*Substances used in tertiary:*  
hydrogen sulfide / calcium hydroxide / sodium carbonate;  
aluminium sulfate / calcium (hydr)oxide /  $\text{Al}^{3+}$  ions /  $\text{Ca}^{2+}$ ; [6]  
*Accept correct formula instead of names*  
*Do not accept names or symbols of metals, e.g. calcium, Al*



**Option E – Chemical industries**

- E1.** (a) rock is crushed/powdered;  
mixed with water and oil;  
air blown through;
- galena/lead sulphide/PbS sticks to oil;  
floats to top of liquid; **[3 max]**  
*Do not accept oxygen instead of air for third marking point*  
*Award [1] each for any three*
- (b) (i)  $2\text{PbS} + 3\text{O}_2 \rightarrow 2\text{PbO} + 2\text{SO}_2$ ; **[1]**
- (ii) sulfuric acid /  $\text{H}_2\text{SO}_4$ ; **[1]**
- (c) (i) reduction; **[1]**
- (ii)  $\text{PbO} + \text{C} \rightarrow \text{Pb} + \text{CO}$ ;  
 $2\text{PbO} + \text{C} \rightarrow 2\text{Pb} + \text{CO}_2$ ;  
 $\text{PbO} + \text{CO} \rightarrow \text{Pb} + \text{CO}_2$ ; **[2 max]**  
*Award [1] each for any two*
- E2.** (a) (aluminium) too reactive/very reactive/more reactive than carbon; **[1]**
- (b) (i) cryolite /  $\text{Na}_3\text{AlF}_6$ ;  
acts as a solvent;  
lowers the melting point of aluminium oxide/ $\text{Al}_2\text{O}_3$  / allows lower temperature to  
be used;  
saves fuel/electricity; **[3]**  
*Award [1] each for any two of last three*
- (ii)  $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$  /  $2\text{O}^{2-} - 4\text{e}^- \rightarrow \text{O}_2$ ;  
*Accept e instead of  $\text{e}^-$*
- oxygen produced oxidizes/burns electrodes/forms carbon dioxide; **[2]**
- (c) (i) lower density; **[1]**  
*Do not accept lighter*
- (ii) more resistant to corrosion / forms oxide layer/film / iron rusts; **[1]**
- E3.** mixed with hydrogen;  
at high pressure;  
using a catalyst of platinum/silica/alumina;
- branched / cyclic / aromatic; **[4]**

**Option F – Fuels and energy**

- F1.** (a) For C(s)  $\Delta H_c^\ominus = -394/395$  and  $M_r = 12.01$ ;  
calorific value = 32.8 / 33 (kJ g<sup>-1</sup>);  
For CH<sub>4</sub>(g)  $\Delta H_c^\ominus = -890$  and  $M_r = 16.05$ ;  
calorific value = 55.5 / 56 (kJ g<sup>-1</sup>); **[4]**  
*If 12 and 16 used instead of data book values, penalise once only*
- (b) (i)  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ ; **[1]**  
*State symbols not needed*
- (ii) bond energies of bonds formed greater than those of bonds broken / weaker bonds broken and stronger bonds made / products have lower enthalpy than reactants; **[1]**
- F2.** (a)  $\text{C} + \text{H}_2\text{O} \rightarrow \text{CO} + \text{H}_2$ ; **[1]**
- (b) (i) *synthesis gas has*  
no sulfur dioxide / contains no sulfur (compounds);  
no acid rain;  
no soot;  
only CO<sub>2</sub> and H<sub>2</sub>O are produced; **[2 max]**  
*Award [1] each for any two.*
- (ii) (cost of) the energy used; **[1]**

**F3.** (a) (in both fission and fusion reactions) there is a loss of mass / mass of products is less than mass of reactants;  
mass converted to energy; [2]

(b) (i)  ${}_{84}^{213}\text{Po}$ ; [2]  
*Award [1] for Po and [1] for atomic and mass numbers*

(ii) three half-lives;  
0.015 g  
*unit needed for mark;* [2]  
*Award [2] for correct final answer without working*

(c) (i)  ${}_{3}^{7}\text{Li} + {}_{1}^{1}\text{p} \rightarrow 2{}_{2}^{4}\text{He}$ ; [1]

(ii)

<i>Particle</i>	<i>Penetrating power in air</i>	<i>Direction of movement</i>	<i>Amount of movement</i>
<i>alpha</i>	a few centimetres;	towards negative;	slight;
<i>beta</i>	a few metres;	towards positive;	great;

[3]

*Award [1] for correct comparison of penetrating power / OWTTE*

*Award [1] for correct comparison of direction of movement*

*Award [1] for correct comparison of amount of deflection / OWTTE*

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