

# **MARKSCHEME**

**May 2007**

**CHEMISTRY**

**Standard Level**

**Paper 3**

*This markscheme is **confidential** and for the exclusive use of examiners in this examination session.*

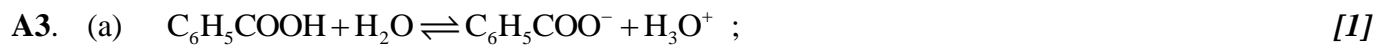
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**Subject Details: Chemistry SL Paper 3 Markscheme****General**

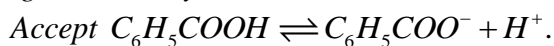
- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- Alternative answers are separated by a slash (/) – this means that either answer is acceptable.
- Words that are underlined are essential for the mark.
- Material in brackets ( ... ) is not needed for the 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) (i) aldehydes, ketones, (carboxylic) acids and esters; [1]  
*All four needed for mark, ignore any formulas.*  
*Do not award mark if any others included.*
- (ii) (carboxylic) acids and esters; [1]
- (b) (i) (15)  $\text{CH}_3^+$  ; [2]  
 (29)  $\text{CH}_3\text{CH}_2^+ / \text{C}_2\text{H}_5^+ / \text{CHO}^+$  ;  
*Do not accept  $\text{COH}^+$ .*  
*Penalize missing charge once only.*
- (ii)  $\text{CH}_3\text{CH}_2\text{CHO}$ ; [1]
- A2.** (a) (i) (C) first order;  
 doubling [C] doubles rate / *OWTTE*;  
 (D) zero order;  
 changing [D] has no effect on rate / *OWTTE*; [4]
- (ii)  $\text{rate} = k[\text{C}] / \text{rate} = k[\text{C}]^1[\text{D}]^0$ ; [1]  
*Apply ECF from (a)(i).*
- (iii)  $k = \frac{\text{rate}}{[\text{C}]} / \frac{1.0 \times 10^{-6}}{2.0 \times 10^{-3}}$  ; [3]  
 $= 5.0 \times 10^{-4}$  ;  
 $\text{min}^{-1}$  ;  
*Apply ECF from (a)(ii).*
- (b) time for half of (amount/concentration of) reactant to react/disappear; [2]  
 $t_{\frac{1}{2}} (= 0.693 \div 0.033) = 21 \text{ min}$  ;  
*Units needed for second mark.*



*Ignore state symbols.*



*$\rightleftharpoons$  needed for mark.*

(b)  $K_a (= 10^{-4.20}) = 6.31 \times 10^{-5} \text{ (mol dm}^{-3}\text{)}$ ; [1]

*Units not needed for mark, but penalise incorrect units.*

(c)  $K_a = \frac{[\text{C}_6\text{H}_5\text{COO}^-][\text{H}^+]}{[\text{C}_6\text{H}_5\text{COOH}]} / \frac{[\text{C}_6\text{H}_5\text{CO}_2^-][\text{H}_3\text{O}^+]}{[\text{C}_6\text{H}_5\text{CO}_2\text{H}]}$  ;

$[\text{H}^+] = \sqrt{K_a[\text{C}_6\text{H}_5\text{COOH}]} / 3.55 \times 10^{-3} \text{ (mol dm}^{-3}\text{)}$  ;

$\text{pH} = 2.45$ ;

*Apply ECF from (b) and from  $[\text{H}^+]$  to pH.*

*Correct final answer scores [3].*

[3]

**Option B – Medicines and drugs**

- B1.** (a) (i) (acidified)potassium dichromate(VI)/ $K_2Cr_2O_7$  /  $Cr_2O_7^{2-}$  is used which is reduced by/oxidises ethanol;  
orange to green; [2]
- (ii) infrared radiation is passed through breath (and reference sample);  
(C–H bond in) ethanol causes radiation to be absorbed at a specific wavelength;  
amount of absorption depends upon the amount of ethanol in the breath;  
*Award [1] each for any two.* [2 max]
- (b) diazepam / valium;  
nitrazepam / mogadon;  
fluoxetine hydrochloride / prozac; [2]  
*Award [2] for three correct, [1] for two correct.*
- B2.** (a) increase activity of central nervous system;  
increase glucose levels in blood;  
increase heart rate;  
increase in blood pressure;  
increase (mental) alertness / concentration;  
decrease appetite; [2 max]  
*Award [2] for three correct, [1] for two correct.*
- (b) (both) contain tertiary amine;  
(both) contain (pyrole) ring structures with nitrogen atoms;  
both contain alkene group;  
(only) caffeine has carbonyl/amide group; [2 max]  
*Do not accept ketone in place of carbonyl.*  
*Do not accept different numbers of methyl groups.*  
*Award [1] each for any two.*

- (c) (short term)  
increased heart rate (*only if not mentioned in part (a)*);  
increased blood pressure (*only if not mentioned in part (a)*);  
reduced urine output;  
increased concentration (*only if not mentioned in part (a)*); **[2 max]**  
*Award [1] each for any two.*

- (long term)  
(increased risk of) cancer;  
(increased risk of) stroke / heart disease / thrombosis;  
(stomach/peptic) ulcers;  
emphysema / bronchitis / shortage of breath;  
coughing / bad breath / yellowing of teeth or fingers;  
adverse effect on pregnancy; **[2 max]**  
*Award [1] each for any two.*

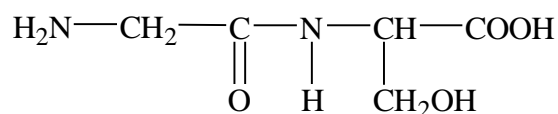
- B3.** (a) bacteria multiply by cell division/binary fission/mitosis;  
viruses insert DNA/RNA/genetic material into cells; **[2]**  
*For “bacteria multiply by themselves but viruses require a host cell” / OWTTE award [1].*

- (b) block enzyme activity within host cell/block reverse transcriptase;  
alter host cell's genetic material;  
prevent virus from multiplying/replicating;  
alter virus's binding site on cell wall / prevent virus binding with cell wall;  
prevent virus from entering/leaving cell; **[2 max]**  
*Award [1] each for any two.*

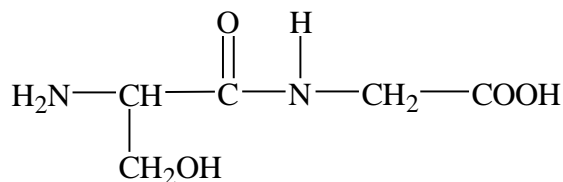
- (c) HIV virus mutates rapidly;  
HIV metabolism linked to that of host cell/HIV uses host cell;  
Drugs harm host cell as well as HIV/ difficult to target HIV without damaging host cell; **[2 max]**

**Option C – Human biochemistry**

**C1. (a) (i)**



**OR**



[2]

*Award [1] for peptide bonds correctly shown in full and a further [1] if rest of structure correct.*

*If peptide bond abbreviated, eg –CO–NH– but structure otherwise correct, award [1].*

(ii) condensation and water/H<sub>2</sub>O;

[1]

(b) (i) (warm with dilute) hydrochloric acid;  
to hydrolyse protein / to break it down into amino acids / to break the peptide bonds; [2]

(ii) (mixture of) amino acids spotted on paper (and known amino acids spotted on paper);  
water/solvent/eluent flows up/down paper;  
amino acids separate because they have different solubilities in water/solvent/eluent or  
different adsorption on paper;  
amino acid positions identified / sprayed with ninhydrin/locating agent;  
locations compared with known amino acids /R<sub>f</sub> values compared;

[4 max]



- C2.** (a) ester; [1]
- (b) saturated have only single carbon to carbon/C–C bonds / unsaturated have double carbon to carbon /C=C bonds;  
*Do not award mark if no reference to carbon-carbon bonds.*  
saturated have a straight hydrocarbon chain / unsaturated have a kinked hydrocarbon chain / OWTTE; [2]  
*Accept bond angle of  $109(.5)^\circ$  in saturated fats and  $120^\circ$  in unsaturated fats.*
- (c) chains pack closer together;  
stronger intermolecular forces / van der Waals' forces; [2]  
*Do not accept stronger hydrogen bonding.*  
*Award [0] if any reference to breaking carbon-carbon bonds.*

**C3.** (a) chemical messengers;  
pituitary (gland) / hypothalamus; [2]

(b) (i) (testosterone)  
testes;  
development of male sex organs/characteristics / tissue/muscle/bone growth/ anabolic effect;

**OR**

(oestradiol)  
ovaries;  
ovulation / development of female sexual characteristics;

**OR**

(progesterone)  
ovaries;  
prepares uterus for fertilized egg;

[2]

(ii) (adrenaline / epinephrine)  
adrenal glands;  
regulates body's preparation for stress / *OWTTE*;

**OR**

(thyroxine)  
thyroid gland;  
regulates body's metabolism;

**OR**

(Insulin)  
pancreas / Islets of Langerhans;

Regulation of glucose concentration in bloodstream/ regulates blood sugar levels; [2]

**Option D – Environmental chemistry**

- D1.** (a) (i) visible; [1]  
 (ii) infrared; [1]  
 (iii) bonds in molecule/gas stretch/bend/vibrate/change in bond angle; [1]  
 (iv) more carbon dioxide in step III;  
*Accept CH<sub>4</sub>, CFCs, H<sub>2</sub>O, N<sub>2</sub>O or SF<sub>6</sub>.*

because of large scale/increase in burning fossil fuels;  
 so more infrared radiation/heat radiated back to earth's surface;  
*If gas other than CO<sub>2</sub> identified accept correct reason for its increase. [2 max]*  
*Accept either of above for 2<sup>nd</sup> mark.*

- (b) carbon dioxide is more abundant (than methane);  
 methane (molecule) is better/more effective at absorbing (infrared) radiation; [2]  
 (c) melting of ice caps/glaciers;  
 thermal expansion (of oceans); [2]

- D2.** (a) (i) 4.2 and 5.2; [1]  
 (ii) SO<sub>2</sub> / SO<sub>3</sub> / NO<sub>2</sub>;  
*Accept names, do not accept NO or NO<sub>x</sub>.*  
 $SO_2 + H_2O \rightarrow H_2SO_3 / SO_3 + H_2O \rightarrow H_2SO_4 / 2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4 /$   
 $2NO_2 + H_2O \rightarrow HNO_2 + HNO_3 / 4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3;$  [2]

- (iii) (SO<sub>2</sub>/SO<sub>3</sub>)  
 alkaline scrubbing;  
 removal of sulfur from coal before burning;  
 use of limestone to react with SO<sub>2</sub>/SO<sub>3</sub>;  
 fluidized bed combustion of coal;  
 less energy wastage/ use of alternative /renewable energy sources;  
*Do not accept washing or filtering.*  
*Award [1] each for any two.*

**OR**

- (NO<sub>2</sub>)  
 catalytic converter;  
 exhaust gas recirculation/ thermal exhaust reactor;  
 lean-burn engine / increase air:fuel ratio;  
 use of electric cars/greater use of public transport; [2 max]  
*Award [1] each for any two.*

- (b) (i) (marble) reacts / disintegrates / crumbles; [1]  
*Do not accept corrodes / erodes / wears away / dissolves in place of above unless equation also given.*
- (ii) reduction of pH / harm/kill fish/vegetation; [1]
- D3.** (a) amount of oxygen needed to decompose organic matter/waste;  
in specified time/5 days/at a specified temperature/20°C; [2]
- (b) (i) B because the amount/concentration (of oxygen) is less; [1]
- (ii) addition of sewage/organic waste / increase in temperature; [1]

**Option E – Chemical industries**

- E1.** (a) availability of raw materials / nearness to mine;  
 water for cooling;  
 energy supply;  
 labour supply / workforce;  
 transport links;  
 (existence of) market for products; **[2 max]**  
*Award [2] for three correct, [1] for two correct.*

- (b) coke/carbon/C **and** limestone/calcium carbonate/CaCO<sub>3</sub>;

(coke)  
 to produce heat;  
 $C + O_2 \rightarrow CO_2$ ;

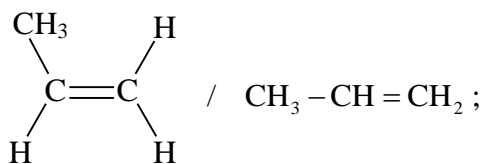
**OR**

to act as a reducing agent / to produce carbon monoxide;  
 $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$  /  $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$  /  $C + CO_2 \rightarrow 2CO$ ;

(limestone)  
 to remove impurities/silica;  
 $CaCO_3 \rightarrow CaO + CO_2$  **and**  $CaO + SiO_2 \rightarrow CaSiO_3$  /  $CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$  ;  
**[5]**

- E2.** (a) 90%-to burn / produce energy/heat / as fuels;  
 10%-main source of organic chemicals / produce useful or valuable substances / make  
 plastics/polymers/chemical feedstock /cracked to make alkenes; **[2]**
- (b) C<sub>8</sub>H<sub>18</sub> **and** higher boiling point / condenses at higher temperature / stronger  
 intermolecular or van der Waals' forces; **[1]**  
*Do not award mark if there is any reference to breaking covalent bonds.*  
*Do not allow bigger / heavier / denser.*
- (c)  $C_8H_{18} \rightarrow 2C_2H_4 + C_4H_{10}$  /  $2C_3H_6 + C_2H_6$  ; **[1]**
- (d) burning would form sulfur dioxide/SO<sub>2</sub>/acid rain / S is removed is because it poisons the  
 catalysts used in the refining processes;  
 manufacture of sulfuric acid/H<sub>2</sub>SO<sub>4</sub> / contact process / H<sub>2</sub>S obtained is used in the tertiary  
 treatment of sewage / to precipitate heavy metal ions; **[2]**

E3. (a) (i)



[1]

(ii) melting point;

*Do not accept boiling point.*

softness/hardness/flexibility/strength/rigidity/density;

[2]

(iii) atactic;

methyl groups arranged randomly / OWTTE;

[2]

(b) (metal)

does not rust/corrode;

low density;

thermal insulator / poor conductor of heat;

electrical insulator / poor conductor of electricity;

*Accept any answer above for [1].*

(wood)

easily moulded;

non biodegradable / does not rot;

low density;

*Accept any answer above for [1].**Do not accept reference to cost.*

[2 max]

**Option F – Fuels and energy**

F1. (a) plants/trees buried / compressed / high pressure;

high temperature;

for millions of years;

*Do not accept a long time.*

breaks down without oxygen / anaerobically;

*Any two of last three for [1] each.*

[3 max]

(b) (i)  $\left(\frac{802}{16.05}\right) = 50.0;$  [1]

*Ignore + and – signs.*

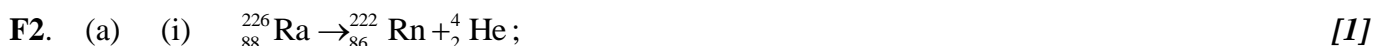
*No penalty for use of 16.*

(ii)  $\left(\frac{610}{20.0}\right) = 30.5;$  [1]

*Units not needed.*

(iii) produces less sulfur dioxide / particulates / carbon dioxide;  
easier to transport / easier to ignite / easier to store;  
*Do not accept cleaner.* [2]

(iv) abundant / larger reserves; [1]  
*Do not accept widely distributed.*



*If atomic numbers missing throughout but everything else correct, award [2]*

(b) alpha and beta particles are deflected in opposite directions;  
alpha particles travel shorter distances;  
alpha particles are deflected less than beta particles; [2 max]  
*Accept corresponding statements for beta particles.*  
*Award [1] each for any two.*

(c) 4 half-lives;  
0.025 g; [2]  
*Award [2] for correct final answer.*

- F3.** passive heating uses the sun's energy to warm a home by using well placed windows or glass roofs;  
active heating uses pumps/fans to distribute heat;  
direct conversion uses photovoltaic cells;  
indirect conversion uses (parabolic) mirrors to boil water / produce steam; **[4]**
-