



# **MARKSCHEME**

**May 2005**

**CHEMISTRY**

**Standard Level**

**Paper 3**

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

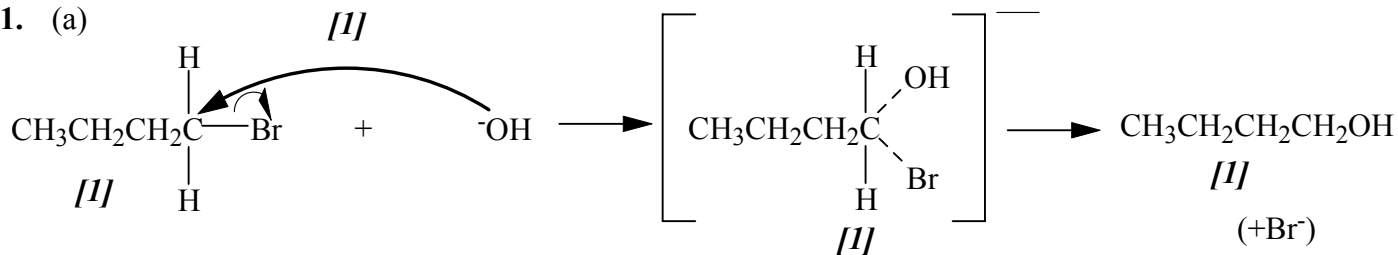
*It is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of IBCA.*

**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 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)**



suitable diagram with structure of 1-bromobutane;

two correctly positioned curly arrows; (*second one must start from O or - sign*)

transition state structure with partial bonds to OH and Br and a negative charge;

Correct structure of butan-1-ol;

[4]

- (b) the rate of the reaction doubles;  
 the rate is proportional to  $[\text{OH}^-]$  /  $\text{OH}^-$  appears in the rate-determining step / first order with respect to  $\text{OH}^-$  ;

[2]

**A2.** (1-chlorobutane reaction rate) is slower;  
 C—Cl bond is stronger/harder to break;

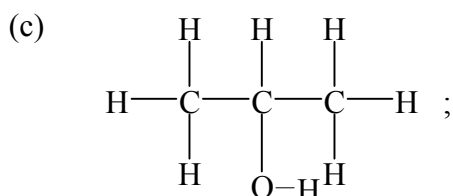
[2]

**A3. (a)** O—H and  $3230$  to  $3550 \text{ cm}^{-1}$ ;  
 C—O and  $1000$  to  $1300 \text{ cm}^{-1}$ ;  
 C—H and  $2840$  to  $3095 \text{ cm}^{-1}$ ;  
 Award [1] each for any two.

[2 max]

- (b) four peaks;  
 3:2:2:1;

[2]



$^1\text{H}$  NMR identifies the number of hydrogen environments;

propan-2-ol has a different number of peaks / 3 peaks / 6:1:1 ratio;

infrared spectroscopy shows the same functional groups / same absorptions / isomers have the same bonds;

[4]

- A4.** (a)  $2\text{NO}_2\text{Cl} \rightarrow 2\text{NO}_2 + \text{Cl}_2$ ; [1]
- (b) a species produced during a reaction that cannot be isolated / a species in which bonds are in the process of being formed and broken; [1]
- (c) (i) the slowest step in the reaction; [1]
- (ii) one / unimolecular; [1]

**Option B – Medicines and drugs**

- B1.** (a) used to overcome/neutralize (excess) acidity in the stomach; [1]
- (b) aluminium hydroxide neutralizes more acid / more HCl / more H<sup>+</sup> ions / contains more OH<sup>-</sup> ions;  
 $\text{Al(OH)}_3 + 3\text{H}^+ \rightarrow \text{Al}^{3+} + 3\text{H}_2\text{O}$ ;  
 $\text{Mg(OH)}_2 + 2\text{H}^+ \rightarrow \text{Mg}^{2+} + 2\text{H}_2\text{O}$ ;  
 Accept equations with HCl. [3]
- B2.** (a) *mild analgesic*  
 intercepts pain at the source / *OWTTE*;  
 by interfering with the production of substances / (enzymes) that cause pain/prostaglandins / *OWTTE*;
- strong analgesic*  
 binds to pain receptors in the brain;  
 preventing the transmission of nerve impulses; [4]
- (b) (i) *advantage*  
 prevents inflammation / thins blood / effective against blood clots / prevents strokes  
 / quick acting / prevents the recurrence of heart attacks / relieves symptoms of  
 arthritis/rheumatism / reduces fever;
- disadvantage*  
 irritates the stomach lining / produces allergic reactions / Reye's syndrome  
 / causes stomach bleeding / causes stomach ulcers; [2]
- (ii) increases the risk of stomach bleeding/haemorrhage / enhances depression of CNS; [1]
- (iii) may cause kidney/liver damage; [1]
- B3.** (a) narrow spectrum effective only against certain types of bacteria whereas broad spectrum  
 effective against a wider range of bacteria; [1]
- (b) penicillins prevent bacteria from manufacturing cell walls;  
 develop new penicillins to overcome the resistance that bacteria develop to existing antibiotics  
 / *OWTTE*; [2]
- (c) increases resistance to the penicillinase enzyme / alters shape/stability/solubility; [1]
- (d) (i) makes penicillins less effective;  
 destroys useful/good bacteria;  
 allows resistant population to build up; [3]
- (ii) use of penicillins in animal feeds / people not completing their course of penicillin; [1]

**Option C – Human biochemistry**

**C1.** (a) saturated fats have only single C—C bonds / unsaturated fats have C=C bonds; **[1]**  
*Do not accept references to double or single bonds without mention of carbon,*

(b) palmitic acid is saturated / linoleic acid is unsaturated / *OWTTE*;

palmitic acid chains are straighter / linoleic acid chains are more kinked / *OWTTE*;

palmitic acid chains can pack more closely / linoleic acid chains can pack less closely  
 / *OWTTE*;

palmitic acid has stronger van der Waals' forces / linoleic acid has weaker van der Waals' forces;

**[3 max]**

(c) heat released by oil = mass of water × specific heat of water × change in temperature /  $q = mc\Delta t$ ;  
 $= 1000 \times 4.18 \times 47.3$ ;

$$\text{calorific value} = \frac{1000 \times 4.18 \times 47.3}{5.00 \text{ g}};$$

$$= 39.5 \text{ to } 40 \text{ (kJ g}^{-1}\text{)};$$

**[4]**

(d) energy source / energy storage;  
 thermal insulation;  
 provide protection to parts of the body;  
 required for the cell membrane;  
*Award [1] each for any two.*

**[2 max]**

**C2.** (a) vitamin C is water soluble and vitamin A/D is fat soluble;

vitamin C has 4/several OH groups / vitamin A/D has only 1/fewer OH groups;

vitamin A/D has large non-polar/hydrocarbon part/chain/ring;

vitamin C has hydrogen bonding and vitamin A/D has van der Waals' forces;

**[4]**

(b) *vitamin C function*

collagen formation / production of connective tissue / enhances absorption of iron (from food) / helps healing of wounds / can prevent bacterial infection / antioxidant / bone or teeth formation;

*disease:*

scorbutus / scurvy;

*vitamin D function*

uptake of calcium / phosphorus / bone or teeth formation;

*disease:*

rickets;

**[4]**

**C3.** *benefits*

improve food productivity / provide more food;

(food) crops are more resistant to disease / more resistant to insect attack / more tolerant to toxins;

improve aesthetics / composition of some foods;

improved flavour;

improved texture;

improved nutritional value;

improved shelf life;

incorporation of anti-cancer substances / vaccines / reduce exposure to less healthy fats;

**[2 max]**

*Award [1] each for any two.*



**Option D – Environmental chemistry**

- D1.** (a) *Any two of the following:* CH<sub>4</sub>, H<sub>2</sub>O, CO<sub>2</sub>, N<sub>2</sub>O, O<sub>3</sub>, CFCs, SF<sub>6</sub>; **[1]**  
*Do not accept NO<sub>x</sub> or other oxides of nitrogen. If any incorrect gas is given award zero.*
- (b) Earth radiates infrared radiation / long wavelength radiation;  
 gas molecules absorb radiation / bonds (in gas molecules) vibrate more;  
 (re-)radiated back to the Earth's surface; **[3]**  
*Do not accept reflected or bounced off.*
- (c) combustion of named carbon-containing fuel / industrial processes / mining / rubber tyres;  
 temperature of the Earth decreases; **[2]**
- D2.** (a)  $O_3 \rightarrow O_2 + O\bullet$ ;  
 $O_3 + O\bullet \rightarrow 2O_2$ ; **[2]**  
*Accept O instead of O• in both equations.*
- (b) chlorofluorocarbons / CFCs ;  
 from refrigerants / propellants for aerosols / fire extinguishers / foaming agents /  
 cleaning solvents / coolant / air-conditioning systems;  
**OR**  
 oxides of nitrogen / NO<sub>x</sub>;  
 (from) internal combustion engine / power stations / jet aeroplanes; **[2]**
- (c) *advantage*  
 does not produce Cl• / no weak C—Cl bonds/stable / has same properties as CFCs  
 / no (free) radicals formed / hydrofluorocarbons have shorter (atmospheric) lifetime;  
*disadvantage*  
 greenhouse gas / global warming / hydrofluorocarbons are flammable; **[2]**

**D3.** (a) *primary stage*  
filtration / flocculation / sedimentation / settling tank / screening / grids;

*substance removed*  
solids / insoluble material / oxygen-demanding wastes;

*secondary stage*  
activated sludge process / use of bacteria and oxygen / trickle filter;

*substance removed*  
organic wastes / oxygen-demanding wastes;

**[4]**

(b) organic material;  
carbon bed;

heavy metals;  
chemical precipitation / description of reaction;

phosphates;  
chemical precipitation / description of reaction;

nitrates;  
ion exchange / algal ponds / denitrifying bacteria;

**[4 max]**

*Award [1] each for any two materials removed and award [1] each for two explanations corresponding to the stated materials removed.*

**Option E – Chemical industries**

- E1.** (a) *isotactic*  
methyl groups have the same orientation along the polymer;
- atactic*  
methyl groups are arranged randomly along the polymer; **[2]**  
*Award [2] for suitable diagram.*
- (b) crystalline;  
tough;  
high tensile strength;  
hard / stiff / rigid;  
can be moulded;  
can be drawn into fibres;  
*Award [1] for any two.*
- regular packing / strong(er) forces between chains; **[2 max]**
- E2.** (a) addition of plasticisers;  
more flexible / flexibility; **[2]**
- (b) *polymer disadvantages*  
difficult to dispose of polymer properly;  
fills up landfill sites;  
litter;  
lack of biodegradability;  
use of natural resources;  
*Award [1] each for any two.*
- PVC disadvantages*  
burning produces toxic gases / HCl; **[3 max]**
- E3.** (a) reduction / redox; **[1]**
- (b) position of metal in reactivity/electrochemical series;  
Al is higher in the series so harder to extract / Fe is lower in the series so easier to extract; **[2]**

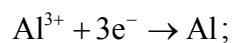
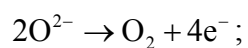
**E4.** (a) (i) silicon(IV) oxide **and**  $\text{SiO}_2$ ; [1]

(ii) limestone;

*Do not accept lime or calcium carbonate.*

$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$  **and**  $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$  /  $\text{CaCO}_3 + \text{SiO}_2 \rightarrow \text{CaSiO}_3 + \text{CO}_2$ ; [2]

(b) electrolysis;



(c) cryolite is a flux/solvent / reduces operating temperature;  
less energy is required; [2]

**Option F – Fuels and energy**

- F1.** energy should be released at a convenient rate;  
 produce minimal pollution;  
 low cost;  
 readily available;  
 large resources;  
 close by / ease of transport;  
 renewable; **[2 max]**  
*Award [1] each for any two.*
- F2. (a)** fuel produced by biological processes / photosynthesis / living things / plants / OWTTE; **[3]**  
 $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ ;  
*Award [1] for formulas and [1] for correct balancing.*
- (b) (i) *advantage*  
 can obtain a large fraction of the energy available / more efficient / ease of use;  
*disadvantage*  
 may cause a lot of pollution / expensive to transport / cannot replace liquid fuels; **[2]**
- (ii) *advantage*  
 liquid fuel has more uses (e.g. motor vehicles) / burns more cleanly;  
*disadvantage*  
 less energy is available from ethanol than from raw plants / time needed for conversion; **[2]**  
*Do not accept both an advantage and a converse disadvantage.*
- (c) *advantage*  
 renewable source of energy / no pollution / can be used continuously / in remote locations  
 / low maintenance / no moving parts;  
*disadvantage*  
 solar cells are expensive to produce / may not be effective in areas where there is little sunshine /  
 inefficient energy conversion; **[2]**

- F3.** (a) (i) one electrode is made of Pb;  
the other electrode is made of PbO<sub>2</sub>;  
electrolyte is H<sub>2</sub>SO<sub>4</sub>;  
 $\text{Pb} + \text{SO}_4^{2-} \rightarrow \text{PbSO}_4 + 2\text{e}^-$ ;  
 $\text{PbO}_2 + 4\text{H}^+ + \text{SO}_4^{2-} + 2\text{e}^- \rightarrow \text{PbSO}_4 + 2\text{H}_2\text{O}$ ; **[5]**
- (ii) oxidation;  
electrons are released / oxidation number of Pb increases;  
*If reduction given, second mark cannot be scored.* **[2]**
- (b) (i) number of cells connected together (in series) / concentration of acid / temperature; **[1]**
- (ii) size of the electrodes / amount of material; **[1]**
-