INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

MARKSCHEME

November 2001

CHEMISTRY

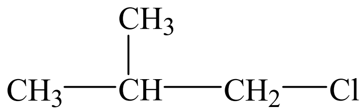
Standard Level

Paper 3

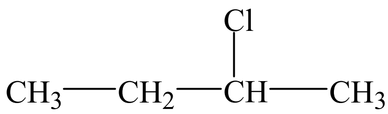
OPTION A – HIGHER ORGANIC CHEMISTRY

A1. (a)

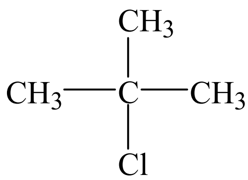
1-chlorobutane



1-chloro-2-methylpropane



2-chlorobutane

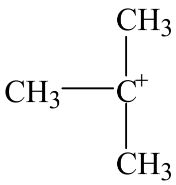


2-chloro-2-methylpropane ***[4]***

*(Award **[½]** for each correct answer (name, structure) then round **down** if necessary for total mark.)*

(b) (i) 2-chloro-2-methylpropane (*name or structure*). ***[1]***
Nucleophilic substitution first order or unimolecular. ***[1]***

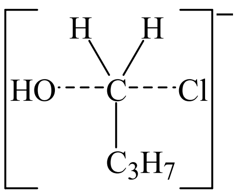
(ii)



[1]

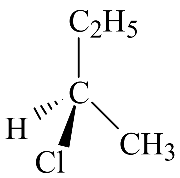
Formation of intermediate is slower than its decomposition. ***[1]***

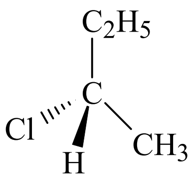
(c) 1-chlorobutane **OR** 1-chloro-2-methylpropane (*accept name or correct structure*) ***[1]***



[1]

(d)





*(Award **[1]** for each correct structure.)* ***[2]***

Total [12 marks]

A2. Accept either compound **B** or propanone. ***[1]***
Peaks at 15/43 consistent with CH_3^+ / CH_3CO^+ from CH_3COCH_3 ***[1]***
No peak at 29 consistent with $C_2H_5^+$ or CHO^+ from C_2H_5CHO ***[1]***

Total [3 marks]

OPTION B – HIGHER PHYSICAL CHEMISTRY

B1. (a) rate $= k[N_2O_5(g)]$ ***[1]***

(b) rate $= (0.0300)(8.10\times10^{-3}) = 0.243\ \text{mol dm}^{-3}\ \text{min}^{-1}$

*(Award **[1]** for correct numerical answer and **[1]** for correct units.)* ***[2]***

(c) $t_{\frac{1}{2}} = \dfrac{0.693}{8.10\times10^{-3}} = 85.6\ \text{min}$

*(Award **[1]** for correct set up and **[1]** for correct answer.)* ***[2]***

(d) The half-life will remain unchanged (as it does not depend on concentration, only temperature). ***[1]***

Total [6 marks]

B2. (a) (i) $[H^+] = 0.16\ \text{mol dm}^{-3}$ $\text{pH} = -\log[H^+] = 0.80$ ***[1]***

(ii) $[H^+] = 0.16\times0.031 = 4.96\times10^{-3}\ \text{mol dm}^{-3}$ ***[1]***
$\text{pH} = -\log 4.96\times10^{-3} = 2.30$ ***[1]***

(iii) HCl is a strong acid which ionises totally in solution. ***[1]***
Lactic acid is a weak acid, which ionises only partially, producing much lower $[H^+]$ so pH is higher. ***[1]***

(b) $K_a = \dfrac{[H_3O^+][C_3H_5O_3^-]}{[HC_3H_5O_3]}$ (*or implicit in calculation*) ***[1]***

$= \dfrac{(4.96\times10^{-3})(4.96\times10^{-3})}{(0.16-4.96\times10^{-3})} = 1.59\times10^{-4}\ \text{mol dm}^{-3}$ ***[1]***

(*units not necessary to gain mark*)

(c) $1.59\times10^{-4} = \dfrac{(x)(x+0.10)}{(0.16-x)}$ (*assume x is negligible*) ***[1]***

$x = [H^+] = 2.54\times10^{-4}\ \text{mol dm}^{-3}$ (*units not necessary to gain mark*) ***[1]***

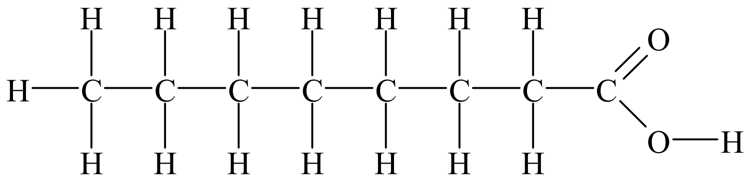
(N.B. Allow for error carried forward in (b) and (c).)

Total [9 marks]

OPTION C – HUMAN BIOCHEMISTRY

C1. (a) $CH_2OH–CHOH–CH_2OH$ ***[1]***

(b) –COOH ***[1]***



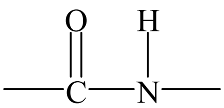
(Accept $CH_3(CH_2)_6COOH$ *or any correct alternative, including branched structures or alkenoic acids.)* ***[1]***

(c) Molecules of saturated fats contain only single C—C bonds in the carbon chains / contain no double bonds. ***[1]***
Molecules of unsaturated fats contain at least one $C=C$ double bond. ***[1]***
The degree of unsaturation can be found by determining the number of moles of iodine that react with one mole (or a stated mass) of fat. ***[1]***
Iodine adds across the $C=C$ double bond in a $1:1$ stoichiometric ratio. ***[1]***

Total [7 marks]

C2. (a) $–NH_2$ / amino group / amine. ***[1]***

(b) Peptide bond (*accept amide bond*) ***[1]***


(*must show* $C=O$ *bond for mark.*) ***[1]***

(c) First hydrolyse the peptide bonds to release individual amino acids ***[1]***
then use chromatography (comparison of R_f values) (*accept electrophoresis / mass spectrometry*). ***[1]***
(Award both marks if X-ray crystallography is given.)

(d) The secondary structure describes the type of coil or sheet / folding of polypeptide / α-helix and β-pleated sheet. ***[1]***
Tertiary structure describes the interactions between the R groups of the amino acid residues. ***[1]***

(e) Hydrogen bond. ***[1]***

Total [8 marks]

OPTION D – ENVIRONMENTAL CHEMISTRY

D1. (a) (i) $2CO + 2NO \rightarrow 2CO_2 + N_2$

*(Award **[1]** for correct products and **[1]** for balanced equation.)* ***[2]***

(ii) $CaO + SO_2 \rightarrow CaSO_3$ (or $2CaO + 2SO_2 + O_2 \rightarrow 2CaSO_4$)

*(Award **[1]** for reactants and **[1]** for product.)* ***[2]***

(b) $2NO + O_2 \rightarrow 2NO_2$ ***[1]***
$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$ ***[1]***
OR
$2SO_2 + O_2 \rightleftharpoons 2SO_3$ ***[1]***
$SO_3 + H_2O \rightarrow H_2SO_4$ (*accept* $SO_2 + H_2O \rightarrow H_2SO_3$) ***[1]***

(c) Irritation of the mucous membranes / fatigue / weakness / confusion (from exposure to $C_6H_5CH_3$) / cancer forming. ***[1]***

Total [7 marks]

D2. Fresh water not available uniformly around the world / 'locked up' in glaciers and icebergs. ***[1]***
Where the consumption is necessarily high it is easily contaminated with water borne diseases / by micro-organisms from human waste / from flooding / due to inadequate chemical treatment of water supplies. ***[1]***

(a) Reverse Osmosis:
Uses high pressure ***[1]***
to force water from salt-water through partially (semi-) permeable membrane; ***[1]***
the partially permeable membrane does not allow the passage of dissolved ions. ***[1]***

OR Osmosis is the net movement of water molecules from a region of high concentration, *i.e.* pure water to one of lower concentration, *i.e.* less pure water through a partially permeable membrane **OR** osmosis is the tendency to equalise concentrations. ***[1]***
Due to osmosis, pure water will move through a partially permeable membrane into salt water, thus diluting it. ***[1]***
If pressure greater than osmotic pressure is applied, the flow of solvent takes place in the opposite direction, called reverse osmosis. ***[1]***

(b) Ion exchange:
Requires the use of both a positive ion exchange (which can replace metal ions in sea water with H^+ ions) ***[1]***
and a negative ion exchange (which can replace anions with OH^- ions). ***[1]***
The H^+ and OH^- ions combine to form fresh/pure water. ***[1]***

Total [8 marks]

OPTION E – CHEMICAL INDUSTRIES

E1. (a) (i) N_2 obtained from the fractional distillation of liquid air. *[1]*
(Not enough to just state 'from air'.)

(ii) H_2 obtained from cracking of petroleum products / from water using reduction with methane / from water using reduction with naptha / catalytic reforming / electrolysis of sodium chloride solution. *[1]*

(b) There are four volumes (moles) of gas on LHS and only two on RHS *[1]*
so increasing the pressure will move the position of equilibrium to the right *[1]*
Increasing the pressure increases the concentration of the gases *[1]*
So reaction rate increases. *[1]*

(c) The yield of ammonia is low *[1]*
so most of the N_2 and H_2 needs to go round again (to save waste/cost). *[1]*

Total [8 marks]

E2. (a) (i) Occurs at a lower temperature (therefore uses less energy so cheaper). *[1]*

(ii) $C_{12}H_{26} \rightarrow C_8H_{18} + 2C_2H_4$ (or C_4H_8) *[1]*
(Must have both an alkane and alkene as products to gain mark.)

Either octane used for car engines **OR** alkene used for polymers. *[1]*

(b) (i) balanced equation has **4**H_2 *[1]*
hexane and benzene. *[2]*

(ii) benzene: production of alkylbenzene / chlorobenzene / dodecylbenzene / detergents *etc.* *[1]*

Total [7 marks]

OPTION F – FUELS AND ENERGY

F1. (a) Anode: zinc *[1]*
Cathode: graphite (carbon) *[1]*
Electrolyte: ammonium chloride **OR** zinc chloride and ammonium chloride and water. *[1]*

(b) Anode: $Zn \rightarrow Zn^{2+} + 2e^{-}$ *[1]*
Cathode: $2NH_4^{+} + 2e^{-} \rightarrow 2NH_3 + H_2$ *[1]*
OR $2MnO_2 + 2NH_4^{+} + 2e^{-} \rightarrow Mn_2O_3 + 2NH_3 + H_2O$
(State symbols are not required.)

(c) *(Award **[1]** each for any **two** from the following:)*
No decline in performance under high loads / no gases formed at cathode / longer shelf life / able to produce more current for a longer time / good for emergency lighting. *[2]*

(d) Voltage does not change *[1]*
voltage depends primarily on materials used. *[1]*

Total [9 marks]

F2. (a) (i) Water absorbs the heat (as the waste decays). *[1]*
(Accept "it is cheaper" / "temporary".)

(ii) There is the possibility of (radioisotopes) escaping into the water table / environment. *[1]*

(b) (i) $^{239}_{94}Pu$ (*award **[1]** for Pu and **[1]** for correct numbers*) *[2]*

(ii) 96 000 years (*give **[1]** if answer wrong but four half-lives is stated*) *[2]*

Total [6 marks]