INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

MARKSCHEME

May 2000

CHEMISTRY

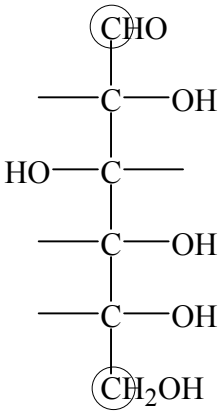
Higher Level

Paper 3

18 pages

OPTION C – HUMAN BIOCHEMISTRY

C1. (a) (i)



*(Award **[1]** for either circled C and **[1]** for the whole structure.)* ***[2]***

(ii) In the ring structure of glucose, on the C_1 atom/the "carbonyl" C ***[1]***
the H/OH are in different positions in α/β ***[1]***
OR illustration of this (diagrammatically).

(b) (i) glucose and fructose ***[2]***

(ii) glucose (and glucose) ***[1]***

(c) *(Award **[1]** for any of the below.)*

Food or energy reserves/resources/stores/glycogen/starch
Structure/cell walls/cellulose/chitin. ***[1]***

Total [8 marks]

C2. (a) 6. ***[1]***

(b) (i) Chromatography and electrophoresis. ***[2]***

(ii) *(Award up to **[4]** for the following points for EITHER paper chromatography OR electrophoresis.)*

Paper chromatography:

hydrolyse/release amino acids/heat with acid; ***[1]***
place sample spot on paper; ***[1]***
place paper in solvent (or suitable named solvent); ***[1]***
compare distances travelled/R_f values with known values. ***[1]***

OR Electrophoresis:

hydrolysis; ***[1]***
'loading' onto origin; ***[1]***
variable voltage/distance moved from origin; ***[1]***
compare isoelectric points (standards) *etc.* ***[1]***

(c)

pH 4.5	pH 6	pH 7.5	
$H_3^+N—$	$H_3^+N—COO^-$	$H_2N—COO^-$	
[1]	***[1]***	***[1]***	***[3]***

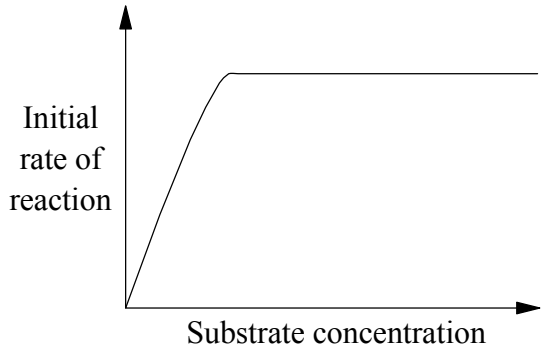
Looking for functional groups only.

*(In **absence** of other marks: three correct structures at wrong pH, award **[1]**.)*

Total [10 marks]

C3. (a) **Substrate concentration:** activity/rate increases initially (first order); ***[1]***
becomes constant/flattens out. ***[1]***

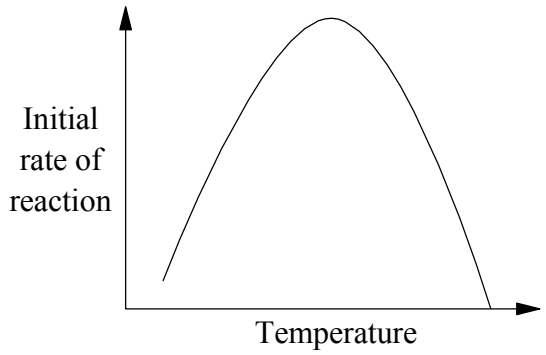
*A **labelled** correct diagram (i.e. axes labelled, correct shape) could score these two marks, for example:*



Satisfactory explanation of one region of graph:
Many free active sites initially;
[active sites being occupied/becoming more saturated]. ***[1]***

(b) **Temperature:** increased rate initially; ***[1]***
but then reduced markedly ($\rightarrow 0$); ***[1]***

*A **labelled** correct diagram (i.e. axes labelled, correct shape) could score these two marks, for example:*



enzyme destroyed/denatured; ***[1]***
since stabilising H bonds disrupted (or words to that effect). ***[1]***

Total [7 marks]

OPTION D – ENVIRONMENTAL CHEMISTRY

			Source		Reduction of emission	
D1.	(a)	(i)	Incomplete combustion of C-containing fuel/named fuel	*[1]*	Use catalytic converter*	*[1]*
		(ii)	Burning sulfur-containing fuel/coal	*[1]*	Desulfurisation/scrubbing (flue gases)	*[1]*
		(iii)	Reaction of gases in air/nitrogen and oxygen (at high temperatrure)	*[1]*	Use catalytic converter*	*[1]*

* allow **catalytic converter** once only

(Award final mark for correct product from one of the above:)

(i) Carbon dioxide;

(ii) Sulfur/sulfate/hydrogen sulfide; *[1]*

(iii) Nitrogen. *[6]*

(b) One of SO_2 or NO_x (however described) *[1]*

EITHER $SO_2 + H_2O \rightleftharpoons H_2SO_3$ *[1]*

OR $2NO + 1\frac{1}{2}O_2 + H_2O \rightarrow 2HNO_3$ (for example)

Total [8 marks]

D2. (a) Amount of oxygen needed to break down organic wastes; *[1]*
Reduced availability of oxygen/fewer living organisms. *[1]*

(b) Secondary treatment; *[1]*
Activated sludge process; *[1]*
Organic matter broken down/oxidised by bacteria. *[1]*

(c) Plant growth encouraged; *[1]*
Oxygen concentration reduced by plant decay. *[1]*
(Allow eutrophication as alternative to either of the above.)

Total [7 marks]

D3. (a) (i) Lethal dose *[1]*

Amount needed to kill 50 % of animals given the dose. *[1]*

(ii) Advantage: Gives good indication of relative toxicities (of different chemicals) *[1]*

Disadvantage: does not indicate acceptable environmental level of chemical /does not help to make accurate assumptions re effect on humans. *[1]*

(b) Lead: Source: paints/$PbEt_4$ in petrol, therefore exhaust gas/lead pipes in plumbing; *[1]*

Effect: brain damage (especially in children); *[1]*

Reducing: unleaded petrol/lead-free paints/use of copper or plastic pipes. *[1]*

Nitrates: Source: leaching of nitrate fertilisers into rivers… *[1]*

Effect: stomach cancer/affects haemoglobin (in the young)/'blue baby' syndrome; *[1]*

Reducing: use less fertiliser/avoid use before rain is due. *[1]*

Total [10 marks]

OPTION E – CHEMICAL INDUSTRIES

E1. (a) Accept a temperature **range** 400–500 °C in **each** case. ***[1]***

Pressure 150–500 atm (Haber) 1–2 atm (Contact) ***[1]***

Catalyst iron/iron oxide Vanadium (pent/V) oxide ***[1]+[1]***

*(For **each** process, 3 correct conditions **[2]**, 2 correct **[1]**.)*

(b) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (state symbols NOT required). ***[1]***

*(**Don't** penalise absence of reversible symbol.)*

High temperature increases rate/gives greater rate of reaction ***[1]***
But low yield of NH_3 ***[1]***
Some comment on a compromise temperature ***[1]***

(c) **Raw Materials** – naphtha, methane, other hydrocarbon (saturated); ***[1]***

– high temperature/heat/catalyst *(**[1]** for any one of the three.)* ***[1]***

*(Award **[1]** for any one of the following equations.)*

$C_7H_{16} \rightarrow C_6H_5CH_3 + 4H_2O$
$C_6H_{14} \rightarrow C_6H_6 + 4H_2$
$C_2H_6 \rightarrow C_2H_4 + H_2$
etc.
(even) $CH_4 + H_2O \rightarrow CO + 3H_2$ ***[1]***

Total [11 marks]

E2. (a) *(Award **[2]** for any two of the following:)*

'close' to C_2H_4 source;
close to industries needing polythene;
workforce;
away from residential areas
etc. ***[2]***

(b) Polar C—Cl bonds in PVC; ***[1]***
stronger intermolecular forces (than polythene). ***[1]***

(c) $C_2H_3Cl + 2\frac{1}{2}O_2 \rightarrow 2CO_2 + H_2O + HCl$ (or doubled). ***[1]***

(Credit polymer equations if correct. Equations given are intentionally simplified.)

$—C_2H_4— + 3O_2 \rightarrow 2CO_2 + 2H_2O$ ***[1]***

Comment on HCl being toxic or poisonous/no poisonous gases from polyethene. ***[1]***

(d) (Radical mechanism):

Free radical mentioned *e.g.* $R\bullet$ or $A\bullet$ or $R—O—O\bullet$ ***[1]***
e.g. $R\bullet + CH_2 = CH_2 \rightarrow R—CH_2—CH_2\bullet$ ***[1]***
e.g. $R—CH_2—CH_2\bullet + CH_2 = CH_2 \rightarrow R—CH_2—CH_2—CH_2—CH_2\bullet$ ***[1]***

equation for termination step, *e.g.* $2R\bullet \rightarrow R_2$ ***[1]***

*(Detailed word descriptions of above may be awarded marks. If none of above marks are scored, **[1]** may be awarded for mention of initiation, propagation and termination.)*

(Ionic mechanism):

(Ziegler) catalyst. ***[1]***

e.g. $A—B + CH_2 = CH_2 \rightarrow A—CH_2—CH_2^+ (+B^-)$ ***[1]***

e.g. $A—CH_2—CH_2^+ + CH_2 = CH_2 \rightarrow A—CH_2—CH_2—CH_2—CH_2^+$ ***[1]***

(Detailed word descriptions of above may be awarded marks.)

Total [14 marks]

OPTION F – FUELS AND ENERGY

F1. (a) (i) 219; *[1]*
86. *[1]*

(ii) Mass number No change; *[1]*
Atomic number +1. *[1]*

(b) (i) Time taken for activity to decrease by half (or words to that effect). *[1]*

(ii) 11.7 days. *[1]*
Some working essential, *e.g.* 3-half lives mentioned. *[1]*

(iii) $\frac{7}{8}$ or 0.875 or 87.5 %. *[1]*

(iv) 12.5 % or $\frac{1}{8}$. *[1]*

Total [9 marks]

F2. (a) Zinc *[1]*
and graphite (accept carbon). *[1]*

(b) Voltage – potential difference between electrodes; *[1]*
Power – total quantity of electricity available. *[1]*

Voltage affected by the materials used; *[1]*
Power affected by the quantity of materials used. *[1]*

Total [6 marks]

F3. (a) Energy released when nucleus is synthesised from protons and neutrons/energy needed to split a nucleus into protons and neutrons. ***[1]***

^{223}Ra needs to become more stable. ***[1]***

This is achieved by losing mass/an α-particle. ***[1]***

(b)

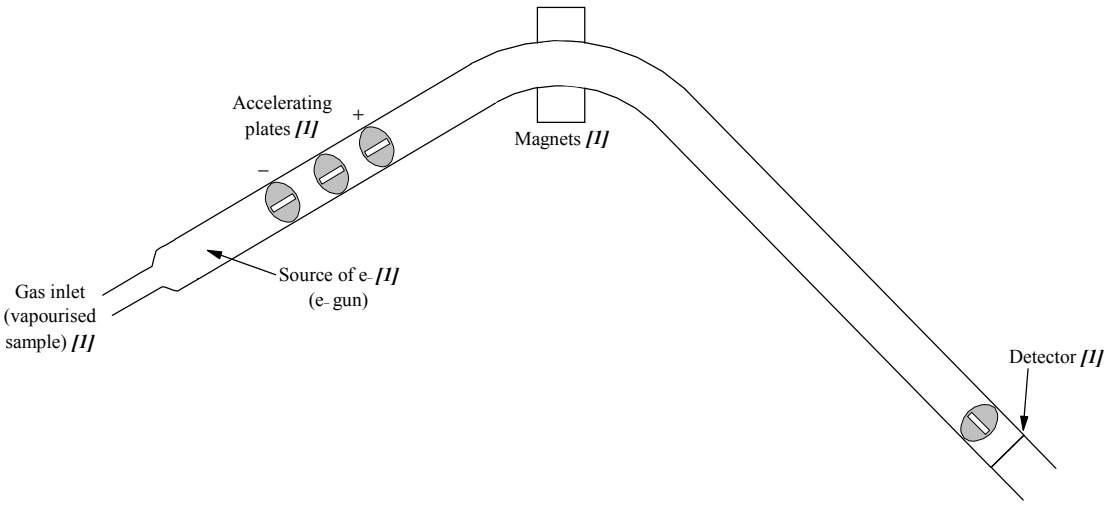
Nature of Waste	**Source**		**Characteristic**		**Storage**		
Low-level waste	Hospitals / checking welds / monitoring thickness of *e.g.* paper	***[1]***	Activity is low / short half-life / high volume	***[1]***	Stored until activity is reduced	***[1]***	
High-level waste	Nuclear industry / military	***[1]***	Activity is high / long half-life / low volume	***[1]***	Making into glass / deep burial	***[1]***	***[6]***

(Award final mark for one extra point from list above.) ***[1]***

Total [10 marks]

OPTION G – MODERN ANALYTICAL CHEMISTRY

G1. (a)

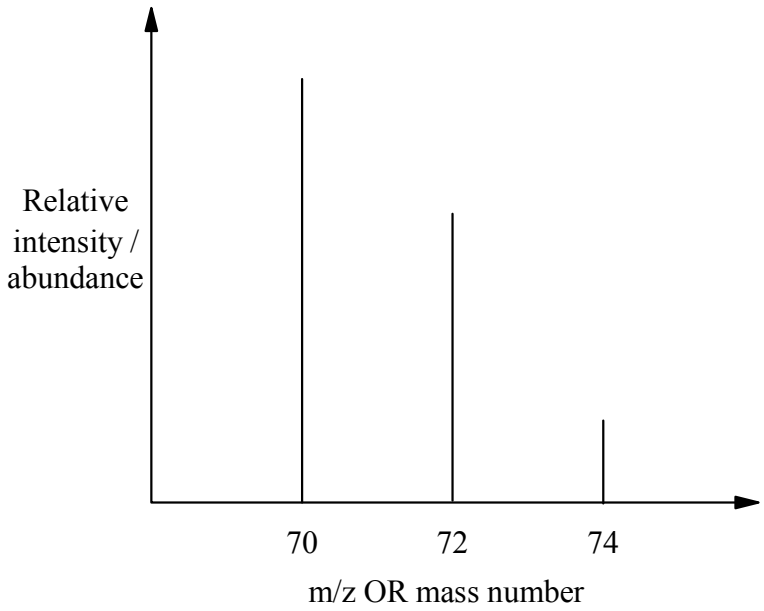


Light ions deflected more than heavy ions/> 1 signal obtained
OR ions(+) of different mass/charge ratio give > 1 line ***[1]***.
(General shape needed for full marks.) ***[6]***

(b) (i) $\left(35\times\frac{75}{100}\right)+\left(37\times\frac{25}{100}\right)$ ***[1]***

$= 35.50$ ***[1]***

(ii)



Both axes correctly labelled; ***[1]***
Three lines at 70, 72 and 74; ***[1]***
Heights of lines in correct order (70 > 72 > 74) ***[1]***

Total [11 marks]

G2. (a) $R_f = \dfrac{\text{distance travelled by 'solute'}}{\text{distance travelled by solvent}}$ ***[1]***

(b) (i) Measure distance travelled by blue spot (centre) and solvent ***[1]***
Divide one by the other ***[1]***

(ii) Each dye has different attractions/affinities for the paper ***[1]***
and the solvent (or words to that effect). ***[1]***

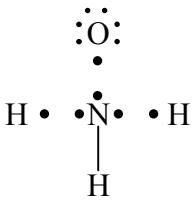
(Solvent reference may be to solubility rather than attraction/affinity.)

(iii) Negligible attraction between the dye and paper ***[1]***
compared with that of dye and solvent (or solubility of dye in solvent). ***[1]***

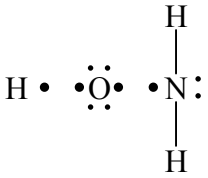
*(In **absence** of the above award **[1]** for the distance moved by the dye = distance moved by the solvent.)*

Total [7 marks]

G3. (a)



[1]



[1] ***[2]***

*(If both structures and bonding are correct but non-bonding electrons are not shown award a maximum of **[1]**.)*

(b)

	ONH_3		$HONH_2$	
Number of Peaks	1	***[1]***	2	***[1]***
Relative Areas			1:2	***[1]***
Reasoning	All protons chemically equivalent (or words to that effect)	***[1]***	Protons in different chemical environment	***[1]***

[5]

Total [7 marks]

OPTION H – FURTHER ORGANIC CHEMISTRY

H1. (a) Electrophilic addition. ***[1]***

Arrow from double bond to H^+ (or H of H—Cl) ***[1]***

Structure of carbocation $(CH_3—{}^+CH—CH_3)$ ***[1]***

Arrow showing attack by Cl^- on central carbon of carbocation ***[1]***

(b) $CH_3CH_2CH_2Cl$ ***[1]***

Primary carbocation/$CH_3CH_2CH_2^+$ is less stable or less likely to be formed (or secondary carbocation is more stable or more likely to be formed). ***[1]***

Explanation of different stabilities of carbocations (in terms of inductive effect or sharing of charge). ***[1]***

(c) (Substitution by) an electron-rich species (*e.g.* NH_3 ; X^-) ***[1]***

(lone pair)/Lewis base/Brønsted base

(d) Arrow from C—Cl bond to Cl atom ***[1]***

Structure of carbocation $(CH_3—{}^+CH—CH_3)$ ***[1]***

Arrow showing attack by ^-OH on central carbon of carbocation ***[1]***

OR

Arrow from C—Cl bond to Cl atom ***[1]***

Arrow showing attack by ^-OH on central carbon of halogenoalkane ***[1]***

Structure of intermediate (Cl and OH both bonded by --- to central C) ***[1]***

Total [11 marks]

H2. (a) dichlorodifluoromethane (accept difluorodichloromethane) ***[1]***
1,1,2-trichloro,1,2,2-trifluoroethane (accept 1,1,2-trifluoro,1,2,2-trichloroethane) ***[1]***

(b) absorbs UV-radiation from the sun. ***[1]***

(c) (i) (Saturated) compounds with high bond energies. ***[1]***

(ii) C—Cl bond weaker than C—F ***[1]***
C—Cl more easily broken (than C—F). ***[1]***

(d) $Cl\bullet + O_3 \rightarrow \underset{\text{(more correctly ClO•)}}{OCl\bullet} + O_2$ ***[1]***

Total [7 marks]

H3. (a) Chiral carbon atom/C atom joined to 4 different groups ***[1]***
Two drawings showing enantiomers/chiral structures (object-mirror images). ***[2]***
(These may be incomplete showing only the 'chiral centre'.)

(b) Light vibrating in one plane only. ***[1]***

Optically active compounds – rotate plane of polarisation of plane-polarised light. ***[1]***

When racemic mixture obtained ***[1]***
equimolar concentrations of stereoisomers affecting plane of polarisation equally and oppositely. ***[1]***

Total [7 marks]