IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

MARKSCHEME

May 2006

CHEMISTRY

Standard Level

Paper 3

18 pages

Option A – Higher physical organic chemistry

A1.

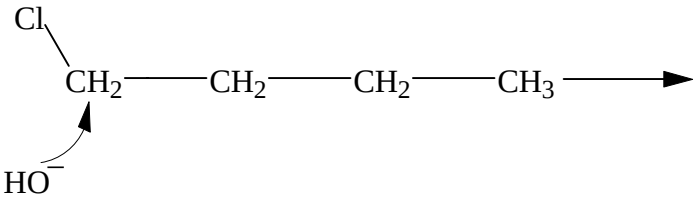
Information	Analytical technique
Number of differents hydrogen environments	(^{1}H) NMR;
Types of functional groups	IR;
Molecular mass	Mass spectrometry;

*Award **[2]** for three correct, **[1]** for two correct.* ***[2]***

A2. (a) (C=O) 1680 to 1750 (cm^{-1});
(C─O) 1000 to 1300 (cm^{-1});
(C─H) 2840 to 3095 (cm^{-1}); ***[1 max]***
*Award **[1]** for any two.*

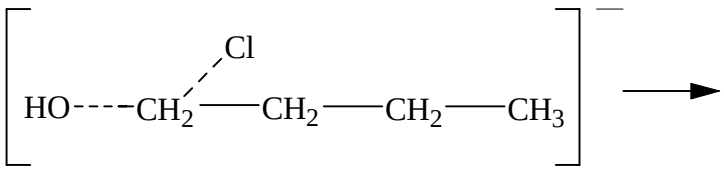
(b) (OH) 2500 to 3300 (cm^{-1}); ***[1]***

A3. (a) (i) (S_N2 *mechanism*)



;

curly arrow must start from O or negative charge



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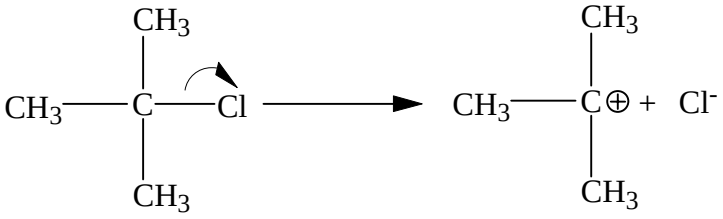
Intermediate structure showing overall negative charge and partial bonds.
Accept negative charge to be indicated as delocalised between the HO-CH_2-Cl.

$\rightarrow HO{-}CH_2CH_2CH_2CH_3 + Cl^-$; ***[3]***

(ii) (S_N1 *mechanism*)



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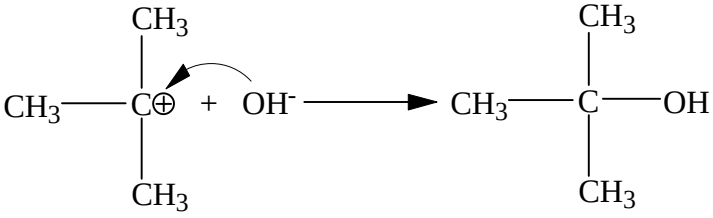
formation of carbocation / loss of Cl^-



;

carbocation + OH^- ***[2]***

(b) reaction in (a)(i)
(rate =) $k[OH^-][CH_3CH_2CH_2CH_2Cl]$;
Accept [KOH] in place of [OH^-]

reaction in (a)(ii)
(rate =) $k[(CH_3)_3C\ Cl]$; ***[2]***
ECF from mechanisms in (a).

(c) reaction is faster **and** C─Br bond enthalpy is lower (than C─Cl) / less energy needed to break C─Br / C—Br bond weaker. ***[1]***

A4. ([A] against time) - straight line with negative gradient;
Accept any decreasing curve
([B] against time) - decreasing curve;
*Award **[1]** unless half - lives clearly not constant*
(rate against [A]) - any horizontal straight line;
(rate against [B]) - straight line through origin; ***[3]***
*Award **[3]** for all four correct, award **[2]** for any three correct and **[1]** for any two correct.*

A5. (a) (i) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$; ***[1]***
Do not penalise $\rightarrow$
Do not accept NH_4OH

(ii) $K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$; ***[1]***

(b) $K_b = 10^{-4.75} = 1.78 \times 10^{-5}$;

$[OH^-] = \sqrt{1.78 \times 10^{-5} \times 0.2} = (1.89 \times 10^{-3})$;

$pOH = -\log[OH^-] = 2.72$; ***[3]***
Accept answer in range 2.68 to 2.76.
*Correct answer scores **[3]**.*
Apply ECF throughout this part.

Option B – Medicines and drugs

B1. (a) a moderate dose may induce sedation / reduce anxiety or tension / slower mental activity / slows CNS;
a high dose may induce sleep / coma / unconsciousness / death; ***[1]***
*Award **[1]** for both.*

(b) orange to green;
Cr^{3+} / chromium(III); ***[2]***

B2. (a) amphetamines / stimulants;
increased heart rate / increased blood pressure / increased breathing rate / dilation of pupils / constriction of arteries / sweating / increased alertness / decreased appetite; ***[2]***

(b) (i) nicotine; ***[1]***
Accept nicotin.

(ii) increased heart rate;
increased blood pressure;
reduced urine output;
increased concentration / stimulating effect; ***[2 max]***
*Award **[1]** each for any two.*

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

B3. (a) penicillins prevent bacteria cell wall formation / causes cell wall to burst or disintegrate; ***[1]***

(b) broad-spectrum antibiotics are effective against a wide range of bacteria /
(whereas) narrow-spectrum only attack a limited range of bacteria *OWTTE*; ***[1]***

(c) bacteria develop resistance / tolerance to doses of penicillins;
(penicillins lose effect and) increasing doses must be prescribed;
useful/harmless bacteria may be killed; ***[2 max]***
Do not accept good or friendly bacteria.
*Award **[1]** each for any two.*

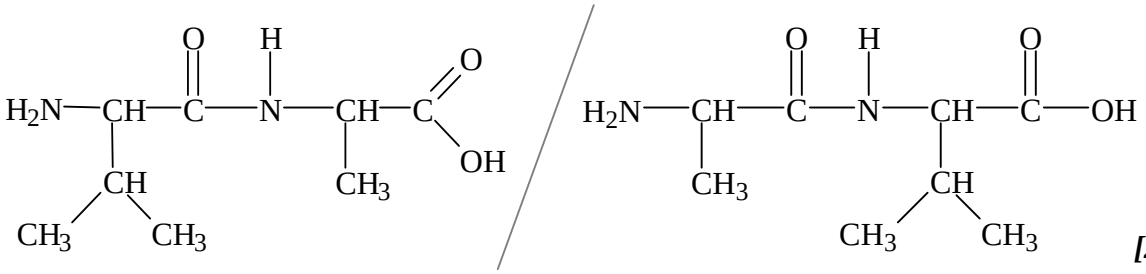
B4. (a) viruses are smaller;
viruses do not have nuclei/cell walls / bacteria do have nuclei/cell walls;
viruses do not have cytoplasm / bacteria do have cytoplasm;
viruses do not feed/excrete/grow / bacteria do feed/excrete/grow;
viruses use cell material of the invaded cell to reproduce themselves; ***[2 max]***
*Award **[1]** each for any two.*

(b) acyclovir becomes part of DNA of virus / mimics nucleotide or guanine;
prevents other nucleotides from attaching/stops virus replication; ***[2]***

(c) if receptor site is modified/altered, HIV virus could not bind to cells;
drug prevents HIV from losing the protein coat;
reverse transcriptase can be blocked (to avoid converting the virus into a structure that can enter the nucleus of the host cell);
the production of new viral RNA and proteins can be blocked;
drug stops viruses leaving the cells; ***[2 max]***
*Award **[1]** each for any two.*

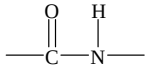
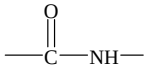
Option C – Human biochemistry

C1. (a) (i) structure of either dipeptide.



[2]

*Award **[1]** for the correct peptide bond and an additional **[1]** if the rest of the structure is correct.*

Accept  *or*  *for the peptide bond.*

(ii) condensation;
H_2O / water; ***[2]***

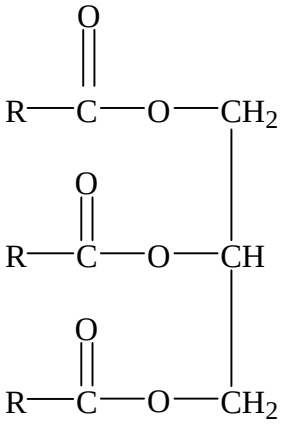
(b) mixture placed on gel/paper;
use of buffer solution;
potential difference applied;
amino acids move differently (depending on pH / isoelectric point);
develop/spray with ninhydrin;
compare distances travelled with standards (OWTTE) / compare the isoelectric points; ***[4 max]***
*Award **[1]** each for any four.*

(c) (i) sequence/chain of amino acids; ***[1]***

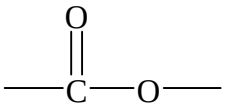
(ii) α-helix = intramolecular/spiral/*OWTTE*;
β-sheet = attraction between chains (accept intermolecular) / *OWTTE*; ***[2]***
Accept suitable diagram.

(iii) hydrogen bonding;
disulphide links / bonds / bridges;
van der Waals' forces;
ionic / ion-dipole / dipole-dipole; ***[2 max]***
*Award **[2]** for any three.*
*Award **[1]** for any two.*

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



;

Accept —COO— *in place of*  ;

(b) there are no more double bonds / all single bonds (in the R group);
molecules pack closer together/straighter chains / regular structure / fewer kinks / *OWTTE*;
stronger van der Waals' forces; ***[3]***
Accept London / dispersion forces / vdW but not intermolecular.

C3. A is fat soluble and C is water soluble;
A has only one OH group / A is mostly hydrocarbon;
C has many OH groups which can form hydrogen bonds with water; ***[3]***
Do not penalise if OH is stated with a minus sign.

Option D – Environmental chemistry

D1. (carbon monoxide)
incomplete combustion of fossil fuels/hydrocarbons;
any correct incomplete combustion (*e.g.* $C + \frac{1}{2}O_2 \rightarrow CO$);
it blocks the capacity of hemoglobin or blood to transport oxygen / poisonous;
catalytic converters / increase air to fuel ratio / use lean burn engine; ***[4]***

(sulfur oxides)
combustion of fossil fuels that contain sulfur / burning coal / smelting of sulfide ores;
$S + O_2 \rightarrow SO_2$;
Accept $2S + 3O_2 \rightarrow 2SO_3$.
SO_2 produces emphysema / irritates mucous membrane (tissues), or respiratory system / aggravates asthma;
fluidised bed combustion / desulfurization of fuels / alkaline scrubbing (of exhaust fumes); ***[4]***

D2. (a) (i) agriculture / irrigation **and** industry; ***[1]***
Both uses are needed.

(ii) oceans/seas;
glaciers; ***[2]***
Accept ice caps / polar regions / Antarctica or Arctic.
If more than two answers are given, wrong answers cancel out correct answers.

(b) (i) Passed through resins containing silicates/zeolites;
Na^+ replaced by H^+;
Cl^- replaced by OH^-;
$H^+ + OH^- \rightarrow H_2O$; ***[4]***
If positive ions and negative ions given in place of Na^+ *and* Cl^-*, award **[1]** max for second and third points.*

(ii) no heating/fuel needed;
resins need to be replaced/regenerated; ***[2]***

(c) amount of oxygen to decompose/oxidize the organic/biological matter;
in 5 days / in a given time / at a fixed temperature;
lower BOD for pure water / higher BOD for water containing organic waste; ***[3]***

Option E – Chemical industries

E1. environmental impact;
distance from sources of raw materials / transport links;
availability of energy / water;
labour force;
availability of investment / existence of markets; ***[2 max]***
Award ***[2]*** *for any three,* ***[1]*** *for any two*.

E2. (a) scrap or recycled iron or steel; ***[1]***

(b) haematite / magnetite / limonite / iron pyrite;
Accept correct formula. Do not penalize incorrect formula if correct name given as well.

limestone / $CaCO_3$;
coke / C / carbon;
Do not accept coal.
air / air enriched with hydrocarbons; ***[3 max]***
Do not accept oxygen.
Any two other raw materials for ***[1]*** *each*

(c) (i) contains too much carbon / 4% C;
(and so it is) brittle / has low malleability / *OWTTE*; ***[2]***

(ii) (adding) oxygen / converting impurities to their oxides; ***[1]***
$C + O_2 \rightarrow CO_2$ / $2C + O_2 \rightarrow 2CO$ / $P_4 + 5O_2 \rightarrow P_4O_{10}$ / $Si + O_2 \rightarrow SiO_2$;

E3. (a) aluminium forms an oxide layer / OWTTE;
protects aluminium from further attack/corrosion/contact with oxygen/air;
iron oxide forms a loose/flaky layer; ***[3]***

(b) because it has a low(er) density; ***[1]***
Do not accept lighter.

E4. (a) as a chemical feedstock / as a source of other chemicals (plastics, dyes, *etc*); ***[1]***

(b) otherwise it would produce SO_X (*accept* SO_2 *or* SO_3) when burned / $S + O_2 \rightarrow SO_2$ / $2S + 3O_2 \rightarrow 2SO_3$;
producing acid rain / $SO_2 + H_2O \rightarrow H_2SO_3 / SO_3 + H_2O \rightarrow H_2SO_4$; ***[2 max]***
poisons catalysts;

(c) *hydrocracking*
high pressure / platinum/alumina/silica catalyst;
Accept formulas.
branched alkanes / cyclic alkanes / aromatic compounds;

steam cracking
1000 – 1150 K / high temperature;
small / low M_r alkenes; ***[4]***

Option F – Fuels and energy

F1. (a) energy to be released at practical/reasonable rates / not too fast and not too slow / controllable;
minimal pollution / no health hazards;
Must mention pollution, do not accept clean or environmentally friendly.
cheap / plentiful / renewable; ***[2]***
*Any two for **[1]** each.*

(b) (i) *Nuclear fusion*
technology not yet developed / *OWTTE* / releases too much energy in a very short period of time / hard to control;

(ii) *Tidal energy*
not every place has great tidal changes / needs energy storage facilities / *OWTTE*; ***[2]***

F2. (a) photosynthesis; ***[1]***

(b) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$;
light **and** chlorophyll; ***[2]***

(c) *advantages*
biomass is renewable;
biomass is easily available / plentiful (forests/sugarcane/crops);
when biomass grows it produces O_2 and captures CO_2;
biomass is a by product of agricultural activity; ***[2]***
*Award **[1]** each for any two correct*.

disadvantages
agricultural activity removes nutrients from the soil;
large area of land needed to produce small amounts of fuel;
energy content is lower than any fossil fuel (*e.g.* gasoline) / energy used in conversion; ***[2]***
*Award **[1]** each for any two correct*.

(d) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$; ***[1]***

F3. *advantages*
no pollution;
no moving parts / no maintenance;
no need for refueling / sunlight is free/unlimited;
produce less noise;
does not use non-renewable source of energy / conserves petroleum for other uses / OWTTE; ***[3 max]***
*Award **[1]** each for any three.*

disadvantages
low power output / not very efficient / need a large surface area;
battery/storage facilities needed (in absence of light);
high capital cost;
easily damaged; ***[3 max]***
*Award **[1]** each for any three.*

F4. $PbO_2 + 4H^+ + SO_4^{2-} + 2e \rightarrow PbSO_4 + 2H_2O$ /
$PbO_2 + 2H^+ + H_2SO_4 + 2e \rightarrow PbSO_4 + 2H_2O$;
positive because reduction occurs / electron gained; ***[2]***