INTERNATIONAL BACCALAURÉAT BACHILLERATO

IBO

BACCALAUREATE INTERNATIONAL INTERNACIONAL

MARKSCHEME

May 2004

CHEMISTRY

Standard Level

Paper 3

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General Marking Instructions

This is the ONLY markscheme released for this session.

Note:
Please use a personal courier service when sending sample materials to TLs unless postal services can be guaranteed. Record the costs on your examiner claim form.

1. Follow the markscheme provided, do **not** use decimals or fractions and mark in **RED**.

2. Where a mark is awarded, a tick (✓) should be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark.

3. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases write a brief annotation in the **left hand margin** to explain your decision. You are encouraged to write comments where it helps clarity, especially for moderation and re-marking.

4. Unexplained symbols or personal codes / notations on their own are unacceptable.

5. Record subtotals (where applicable) in the right-hand margin against the part of the answer to which they refer next to the mark allocation. Do **not** circle subtotals. **Circle the total mark for the question in the right-hand margin opposite the last line of the answer.**

6. Where an answer to a part question is worth no marks, put a zero in the right-hand margin.

7. For each Option: Add the totals for each question in the Option and write it in the Examiner column on the cover sheet.
   Total: Add the marks awarded and enter this in the box marked TOTAL in the Examiner column on the cover sheet.

8. After entering the marks on the cover sheet, check your addition to ensure that you have not made an error. Check also that you have transferred the marks correctly to the cover sheet. **We have script checking and a note of all clerical errors may be given in feedback to examiners.**

9. Every page and every question must have an indication that you have marked it. Do this by **writing your initials** on each page where you have made no other mark.

10. If a candidate has attempted more than the required number of Options within the paper, mark only the required number of Options in the order in which they are presented in the paper, **unless the candidate has indicated the Options s/he wants to be marked, on the cover sheet**.

11. A candidate can be penalized if s/he clearly contradicts him/herself within an answer. Make a comment to this effect in the left hand margin

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

General

- Each marking point is usually shown on a separate line or lines.
- 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 $-\textbf{1(U)}$ 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 $-\textbf{1(SF)}$ 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 incorrectly stated 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)   substitution;
              nucleophilic;
              bimolecular / two species in rate-determing or slowest step;   *[2 max]*
              Do not accept second order.
              Three correct [2], two correct [1], one correct [0].

(b)   aminoethane / ethylamine;   *[1]*

(c)   curly arrow from N of NH_3 to C joined to Br;
       curly arrow from C—Br bond to Br;
       central C of transition state joined to CH_3, H, H, Br and NH_3;
       transition state with no charge and with --- bonds to NH_3 and Br;   *[4]*
       Ignore products.

(d)   C—N and N—H;   *[1]*
       Accept CN and NH.

(e)   3 peaks;
       3:2:2 *(order not important)*;   *[2]*

A2. (a)   all C—C bonds in benzene or structure B are 0.139 (nm) (long) or the same length;
              structure A would have C—C bond lengths of 0.154 and 0.134 (nm) / benzene does
              not have C—C bond lengths of 0.154 or 0.134 (nm) / different bond lengths;   *[2]*
              If no reference to carbon-carbon bonds, award [1 mark].

(b)   value for cyclohexene / –120 is for (hydrogenation of) one $C = C$ bond;
       structure A / Kekulé structure would have value of (about) –360 (kJ mol^{-1});
       150 / difference between –360 and –210 represents greater stability of benzene /
       structure B;   *[3]*

A3. (a) $(K_w =)[H^+][OH^-]$;   *[1]*

(b) $[H^+] = \sqrt{K_w} / \sqrt{5.60 \times 10^{-14}}$;
       $= 2.37 \times 10^{-7}$ (mol dm^{-3}) *(accept* $2.3 - 2.4 \times 10^{-7}$, *no significant figure penalty)*;
       pH $= 6.6$ *(accept* $6.60 - 6.63$, *no significant figure penalty)*;   *[3]*

(c) $[H^+] = [OH^-]$/ concentrations or amounts or numbers of ; H^+ and OH^- are the same;   *[1]*
       Do not award mark if reference to H^+ *and* OH^- *or ions.*

Option B – Medicines and drugs

B1. (a) *mild analgesics*
  intercept pain stimulus at source */ OWTTE*;

  strong analgesics
  interact with receptor sites in the brain */ OWTTE*;   *[2]*

  (b) amide;
  (tertiary) amine   *[2]*
  Do not accept primary or secondary amine;

  (c) OH / alcohol / phenol / hydroxyl;
  esterification / condensation;
  water / H_2O ;   *[3]*

B2. (a) bacteria;

  interfere with cell wall formation;
  prevent formation of cross-links (within wall);
  size / shape of cell cannot be maintained;
  water enters the cell / osmosis occurs;
  cell bursts / disintegrates;   *[4 max]*
  Award [1] each for any three of the last five points,.

  (b) (overprescription) makes penicillins less effective;
  they destroy useful bacteria;
  allow a resistant poulation to build up / *OWTTE*;   *[3]*

B3. (a) bacteria are larger / viruses are smaller;
  bacteria are cellular / viruses are non-cellular;
  bacteria have / nucleus / cytoplasm / cell membrane / organelles /
  opposite for viruses;

  bacteria can feed / excrete / respire / grow outside cells / opposite for viruses;
  Accept "bacteria are living whereas viruses are non-living".

  viruses insert DNA / RNA into cells / rely on a host cell to reproduce;
  bacteria multiply by cell division / binary fision / mitosis / meiosis;   *[4 max]*
  Award [1] each for any four.

  (b) they alter the host cell's genetic material;
  they prevent the virus from multiplying;
  they alter the virus's binding site on the cell wall / they alter the structure of
  the cell wall to prevent the virus entering;
  they prevent viruses from leaving the cell;   *[2 max]*
  Award [1] each for any two.

Option C – Human biochemistry

C1. (a) *vitamin A*
retinol is fat-soluble;

vitamin C
ascorbic acid is water-soluble;

vitamin D
calciferol is fat-soluble;

fat-soluble because mainly composed of hydrocarbon chain / non polar groups;
water-soluble because of presence of several/many hydroxyl / OH / polar groups;   *[5]*
Last [2] can be scored even if classification wrong or not attempted.

(b) Ca^{2+} / calcium;
Do not accept Ca.
vitamin D / calciferol;   *[2]*

(c)   vitamin A / retinol;
alkene;   *[2]*

(d)   helps to form collagen / connective tissue / acts as antioxidant;
scurvy / scorbutus;   *[2]*

(e)   dissolves in water;
oxidized / destroyed by heating / boiling;   *[2]*

C2. (a)   carbonyl / ketone
Accept alkanone but not aldehyde.

alkene;   *[2]*

(b)   progesterone;
ovaries;   *[2]*

(c)   change release of hormones / FHS / LH (from hypothalamus / pituitary gland);
prevent ovulation / egg release;
prevent attachment of egg to uterus;
prevent sperm from reaching egg;   *[3]*
Award [1] each for any three.
Do not accept "mimic pregnancy".

Option D – Environmental chemistry

D1. (a)   incoming radiation / energy / heat / light (from sun) is short wavelength / ultra-violet
             (radiation);
             long wavelength / infrared radiation leaves Earth's surface;
             (some of this radiation) is absorbed / trapped by gases in the atmosphere;
             by (vibration in) bonds in molecules / re-radiates heat back to the Earth;   **[4]**

  (b)   *natural*
         (evaporation from) oceans / seas / rivers / lakes;

         man-made
         burning (any specified) fossil fuel;   **[2]**
         *Do not accept objects such as "cars" or "car exhausts" or "aeroplanes" without a
         reference to combustion.*

  (c)   (i)   more abundant / *OWTTE*;   **[1]**

        (ii) more effective (at absorbing energy) / *OWTTE*;   **[1]**

  (d)   melting of polar ice caps;
         thermal expansion of oceans / rise in sea levels / coastal flooding;
         stated effect on agriculture (*e.g.* crop yields reduced);
         changes in flora and fauna distribution;
         stated effect on climate (*e.g.* drought / increased rainfall / desertification)
         Do not accept "climate change" alone.   **[4 max]**
         Award [1] each for any four.

D2. (a)   zeolites / silicates / resins;
             sodium ions / Na^+ removed;
             Do not accept Na.
             replaced by hydrogen ions / H^+;
             chloride ions / Cl^- removed;
             Do not accept Cl or chlorine.
             replaced by hydroxide or hydroxyl ions / OH^-;
             H^+ and OH^- react together;   **[5 max]**
             Any five, [1] each.
             Penalise missing "ions" once only.

  (b)   to kill microorganisms / pathogens / germs / bacteria;

         advantages of ozone
         more effective than chlorine / against viruses;
         leaves no taste;
         does not produce harmful by-products / no poisonous chlorine compounds;
         can be generated *in situ* / produced on site;   **[3 max]**
         Any two advantages, [1] each.

Option E – Chemical industries

E1. (a) (i) it can poison the catalysts used in oil refining;
it would form sulfur dioxide when burned;
leading to acid rain / affecting the catalyst in the catalytic converter / causing engine
damage / causing health problems; *[2 max]*
Award [1] each for any two.

(ii) $H_2S + CO_3^{2-} \rightarrow HS^- + HCO_3^-$; *[1]*

(iii) $2H_2S + SO_2 \rightarrow 3S + 2H_2O$; *[2]*
Award [1] for all formulas correct, [1] for balancing.

(b) (i) $(CH_3CH_2)_2CHCH_3$ C_6H_6

isomerization;   aromatization;
3-methylpentane;   benzene;
[4]

(ii) hydrogen / H_2;
Haber process / ammonia production / hydrogenation / margarine manufacture /
fuel / fuel cells; *[2]*

E2. (a) Al_2O_3; *[1]*

(b) it acts as a solvent;
it lowers the operating temperature / melting point;
it saves heat / energy; *[2 max]*
Award [1] each for any two.

(c) $Al^{3+} + 3e^- \rightarrow Al$
$2O^{2-} \rightarrow O_2 + 4e^-$; *[2]*
Accept e instead of e^-.

(d) carbon / graphite / C;
burns / oxidizes / reacts with oxygen;
$C + O_2 \rightarrow CO_2$; *[3]*

(e) (aluminium is) more valuable / more expensive to produce / electricity needed to
produce it; *[1]*

Option F – Fuels and energy

F1. reduction of SO_2 emissions;
cheaper / easier to transport / versatile;
no solid waste (when burned);   *[2 max]*
Award [1] each for any two.

F2. (a)   knocking / pre-ignition / *OWTTE*;   *[1]*

(b)   2,2,4-trimethylpentane;   *[2]*
Award [1] for trimethylpentane, [1] for correct locants.
Award [1] Isooctane.

(c)   heptane is straight-chain / trimethylpentane is branched;   *[1]*

(d)   branched alkanes / aromatic compounds / benzene compounds / lead compounds /
tetraethyllead;   *[1]*
Do not accept "lead" alone.

(e)   energy $= mc\Delta T / 250 \times 4.18 \times 52.7$;
energy $55.1 \times 10^4 J$;
Accept $55072\,J / 55.1\,kJ$.

M_r (heptane) $= 100$ (*or* 100.23);
energy given out per mole $\dfrac{55072}{\frac{2}{100}}$;

$$\Delta H = -\frac{55072}{\frac{2}{100}}$$

-2.75×10^6 J mol^{-1} / -2.75×10^3 kJ mol^{-1} ;
Accept answer in range 2.7×10^3 *to* 2.8×10^3 kJ mol^{-1}.   *[5]*
Must have correct unit and sign (or indication or exothermic).
Apply ECF throughout this part.

F3. (a) α, β, γ;
             α, β, γ;
             γ, β, α;
             β, α, γ;   *[4]*

    (b) *similarity*
         mass converted to energy / *OWTTE*;

         differences
         (fission) – one heavy nucleus / atom becomes two (or more) lighter ones;
         (fusion) – two light nuclei / atoms become one heavier one;   *[3]*

    (c) (nuclear) fission;   *[1]*