M12/4/CHEMI/SP3/ENG/TZ1/XX/M

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

MARKSCHEME

May 2012

CHEMISTRY

Standard Level

Paper 3

21 pages

General Marking Instructions

Assistant Examiners (AEs) will be contacted by their team leader (TL) through Scoris™, by e-mail or telephone – if through Scoris™ or by e-mail, please reply to confirm that you have downloaded the markscheme from IBIS. The purpose of this initial contact is to allow AEs to raise any queries they have regarding the markscheme and its interpretation. AEs should contact their team leader through Scoris™ or by e-mail at any time if they have any problems/queries regarding marking. For any queries regarding the use of Scoris™, please contact emarking@ibo.org.

If you have any queries on **administration** please contact:

Rachel Bengough
Subject Operations
IB Assessment Centre
Peterson House
Malthouse Avenue
Cardiff Gate
Cardiff CF23 8GL
GREAT BRITAIN

Tel: +(44) 29 2054 7777

Fax: +(44) 29 2054 7778

E-mail: rachel.bengough@ibo.org

1. Follow the markscheme provided, award only whole marks and mark only in **RED**.

2. Make sure that the question you are about to mark is highlighted in the mark panel on the right-hand side of the screen.

3. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded.**

4. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases use Scoris™ annotations to support your decision. You are encouraged to write comments where it helps clarity, especially for re-marking purposes. Use a text box for these additional comments. It should be remembered that the script may be returned to the candidate.

5. Personal codes/notations are unacceptable.

6. Where an answer to a part question is worth no marks but the candidate has attempted the part question, enter a zero in the mark panel on the right-hand side of the screen. Where an answer to a part question is worth no marks because the candidate has not attempted the part question, enter an "NR" in the mark panel on the right-hand side of the screen.

7. If a candidate has attempted more than the required number of options within a paper or section of a paper, mark all the answers. Scoris™ will only award the highest mark or marks in line with the rubric.

8. Ensure that you have viewed **every** page including any additional sheets. Please ensure that you stamp 'seen' on any additional sheet that contains no other annotation.

9. Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have got wrong. However, a mark should not be awarded where there is contradiction within an answer. Make a comment to this effect using a text box or the "CON" stamp.

Subject Details: Chemistry SL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer questions from **TWO** of the options **[2 x 20 marks]**. Maximum total = **[40 marks]**.

1. A markscheme often has more marking points than the total allows. This is intentional.

2. Each marking point has a separate line and the end is shown by means of a semicolon (;).

3. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.

4. Words in brackets ( ) in the markscheme are not necessary to gain the mark.

5. Words that are <u>underlined</u> are essential for the mark.

6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by ***OWTTE*** (or words to that effect).

8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script.

10. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the markscheme.

11. If a question specifically asks for the name of a substance, do not award a mark for a correct formula unless directed otherwise in the markscheme, similarly, if the formula is specifically asked for, unless directed otherwise in the markscheme do not award a mark for a correct name.

12. 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 directed otherwise in the markscheme.

13. Ignore missing or incorrect state symbols in an equation unless directed otherwise in the markscheme.

Option A — Modern analytical chemistry

A1. (a) mass spectrometry/spectroscopy / MS; ***[1]***

(b) (i) presence (or absence) of particular bonds; ***[1]***
Accept functional groups.

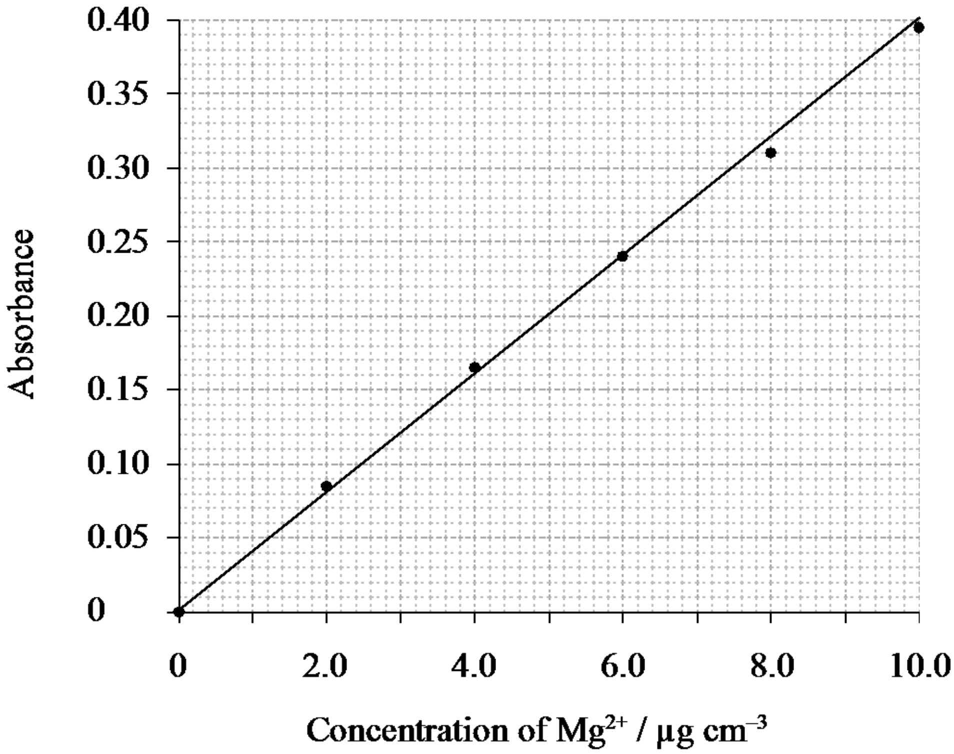
(ii) ***A****:* O–H/hydroxyl;
B*:* C=C/carbon-carbon double bond; ***[2]***

(iii) no C=O/carbonyl present; ***[1]***

(c) (i) protons/H's in three different chemical environments / *OWTTE*;
2:1:1 ratio of protons/H's (in these environments) / *OWTTE*; ***[2]***
Accept 4:2:2

(ii) HO–CH_2–CH=CH–CH_2–OH / CH_2=C(CH_2OH)$_2$;; ***[2]***

A2. (a)



points correctly plotted;
straight line/line of best fit (going through origin); ***[2]***

(b) concentration of solution = 3.2 (μg cm^{-3});
Accept any value in range 3.2 to 3.4.

concentration of metal in sample = $\left(\frac{0.200}{100}\times10^{6}=\right)$2000 (μg cm^{-3}) / 100 cm^3 of the solution contains 3.2×10^{-4} g of Mg $(3.2\times10^{-6}\times100)$;

percentage = 0.16 % $\left(=\frac{3.2}{2000}\times100 \text{ or } =\frac{100\times3.2\times10^{-4}}{0.200}\right)$; ***[3]***

Accept any value in range 0.16 to 0.17 %.
Accept other valid methods for calculation.

(c) different (monochromatic, hollow cathode) lamp/light source must be fitted; ***[1]***

A3. (a) place a spot of the liquid on a thin-layer chromatography/TLC plate;
place plate in a suitable solvent/eluent;
wait until solvent/eluent has almost reached the top of the plate;
spray/immerse plate in concentrated sulfuric acid/H_2SO_4/reagent to show spots / *OWTTE*;
*Do **not** accept ninhydrin.*

observe the plate to see how many spots are there on it; ***[3 max]***

(b) put spots of the pure sugars on the same plate as the mixture / produce chromatograms of the pure sugars under the same conditions as the mixture;
see if the spots in the mixture have moved the same distance/have same R_f as the pure sugars; ***[2]***

Option B — Human biochemistry

B1. (a) (i) heat $= \dfrac{4.18 \times 20.0 \times (51.3 - 17.8)}{1000}$;

$= 2.80$ (kJ); ***[2]***

(ii) enthalpy of combustion $= \left(\dfrac{2.80}{0.421} =\right) -6.65$ (kJ g^{-1}); ***[1]***

(b) *Name:*
steroids;

Role:
(sex) hormones;

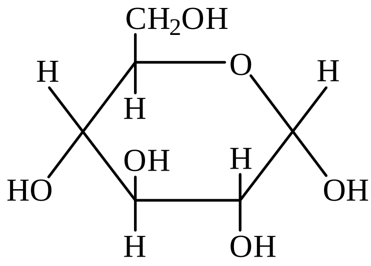
OR

Name:
phospholipids;

Role:
membranes; ***[2 max]***

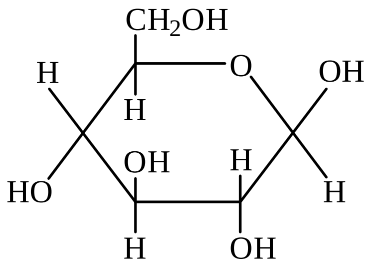
(c) lipids less oxidized/contain less oxygen / carbohydrates partially/more oxidized/contain more oxygen / *OWTTE*; ***[1]***

B2. (a) α: C-1 OH below plane



;

β: C-1 OH above plane



;

[2]

(b) (i) aldehyde/alkanal/CHO; ***[1]***

(ii) ketone/alkanone/CO; ***[1]***

(iii) glucose; ***[1]***

(c) cellulose is (condensation) polymer of β-glucose;
(rings in cellulose) joined by β-1,4 linkages; ***[2]***

(d) (i) absence of enzyme <u>cellulase;</u> ***[1]***

(ii) *Name:*
(dietary) fibre;
*Do **not** accept roughage.*

Condition:
Crohn's disease / diverticulosis / IBS / constipation / obesity / hemorrhoids / diabetes mellitus / colon/bowl cancer; ***[2]***

B3. (a) micronutrients required in much smaller quantities/very small amounts/less than 0.005 % of body mass; ***[1]***

Accept opposite statement for macronutrients.

(b) beriberi / weight loss / fatigue; ***[1]***

(c) provide a naturally vitamin rich diet;
adding vitamins to common foods / fortification of staple foods;
genetically modifying foods (to increase vitamin content);
providing vitamin tablets / nutritional supplements; ***[2 max]***

Option C — Chemistry in industry and technology

C1. (a) *Any two for **[1]***
alloying as in aircraft (bodies)
cooking foil/utensils
overhead power cables
window frames
drink cans
mirrors ***[1 max]***

(b) susceptible to rusting; ***[1]***
Accept corrosion.

(c) *Name:* steel **and** *other element:* carbon; ***[1]***

(d) atoms/ions of the alloying element are a different size/larger/smaller;
prevents the layers of atoms/ions sliding across each other; ***[2]***

C2. (a) *Similarity:*
both turn chemical energy into electrical energy / use chemical reactions to produce electricity/electrical energy / *OWTTE*;

*Difference **[1 max]**:*
rechargeable batteries have reversible reactions **but** fuel cells do not;
fuel cells consume fuel **but** rechargeable batteries do not require (external) fuel;
rechargeable batteries can be recharged by electricity **but** fuel cells cannot; ***[2 max]***

(b)

	Positive terminal (when delivering a current)	**Negative terminal (when delivering a current)**
Initial oxidation number	+3	0
Final oxidation number	+2	+2
Anode / cathode	cathode	anode

*All correct **[3]**, 4 or 5 correct **[2]**, 2 or 3 correct **[1]*** ***[3]***

(c) *Positive electrode:*
$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$;

Negative electrode:
$H_2(g) \rightarrow 2H^+(aq) + 2e^-$; ***[2]***

(d) large surface area;
changes only occur on the surface / where electron transfer occurs / *OWTTE*; ***[2]***

C3. (a) *Any two for* ***[1]***
petrol/gasoline
kerosene/paraffin/aviation fuel
diesel
fuel oil/gas oil
petroleum gas/refinery gas ***[1 max]***

(b) global warming;
carbon dioxide;

OR

air pollution;
carbon monoxide / particulates / oxides of nitrogen/NO/NO_2 / VOCs;
Accept oxides of sulphur/SO_2.

OR

acid rain;
oxides of nitrogen/NO/NO_2; ***[2 max]***
Accept oxides of sulphur/SO_2.

(c) slow decomposition / not biodegradeable; ***[1]***

(d) chemically stable;
liquid crystal phase over a suitable range of temperatures;
rapid switching speed; ***[2 max]***

Option D — Medicines and drugs

D1. (a) *Advantage*:
easily taken/convenient / no specialist equipment needed;

Disadvantage:
stomach acid reacts with drugs / slow effect / only small fraction of drug absorbed / vomiting / requires conscious patient / harm digestive system/can cause stomach bleeding; ***[2]***

(b) inhalation
parenteral / by injection / intravenous / intramuscular / subcutaneous
rectal
skin patches
eye/ear/nose drops
topical ***[2 max]***
*Award **[2]** for all 3 correct, **[1]** for 2 correct, **[0]** for 1 correct.*

D2. (a) *Individual **[2 max]**:*
dependence on alcohol/addiction;
liver damage/liver cancer/cirrhosis;
increased risk of cardiovascular disease/strokes/high blood pressure;
financial problems;
fetal alcohol syndrome
accidents (car and machines);

*Society **[2 max]**:*
cost of medical treatment;
broken homes / financial problems / increased crime/violence;
accidents (car and machines);
additional welfare payments;
lower economic production; ***[3 max]***

*Both individual and society must be included for **[3 max]**.*
Accept accidents in either individual or society but not both.

(b) diazepam/Valium® **and** nitrazepam/Mogadon®; ***[1]***
® *not necessary for mark.*

(c) salt has ions/ionic bonding;
forms polar/ion-diplole bonds/interactions with water / *OWTTE*; ***[2]***

D3. (a) (i) *Bacteria:*
tuberculosis/TB / syphilis / cholera / salmonella / bronchitis / botulism / lyme disease / (stomach) ulcers / anthrax / diptheria / meningitis / MRSA / gonorrhea / chlamydia / septicaemia;

Viruses:
influenza / common cold / AIDS / herpes / rabies / small pox / polio / rubella / yellow fever / measles / mumps / encephalitis / chicken pox / shingles / mononucleosis; ***[2]***

Do not accept name of an organism (such as e-coli) rather than a disease.

(ii) bacteria larger than viruses / viruses are smaller than bacteria;
bacteria are cells / viruses comprise DNA in a protein coat;
bacteria have cell wall/nucleus/cytoplasm / viruses do not have cell components;
bacteria can reproduce without a host / viruses require host/cell for replication/reproduction;
bacteria are not always harmful/parasitic / viruses are always parasitic; ***[3 max]***

(b) isolated/purified crude penicillins (making them useful to treat infections); ***[1]***

(c) patient non-compliance / not completing courses / *OWTTE*;
overprescription;
use for animals/in animal feedstock; ***[2 max]***
Accept overuse.
Do not accept overdose.

(d) becomes part of DNA of virus / alters virus DNA/genetic material / blocks enzyme (polymerase) which builds DNA;
changes the cell membrane so that it inhibits the virus entry/bonding to the cell;
prevents virus from leaving the cell (after reproduction);
prevents virus from using cell to multiply/reproduce/replicate; ***[2 max]***

Option E — Environmental chemistry

E1. (a) shorter wavelength/UV/high energy radiation from sun passes through;
long wavelength/infrared/IR radiation from Earth's surface (some of this radiation) is absorbed (by gas);
Do not accept "trapped" or "blocked".
Do not accept "IR from sun".

causes (increased) vibration in bonds;
re-radiates heat back to the Earth; ***[3 max]***
Do not accept "reflects/bounces".

(b) higher concentration / more abundant/increased combustion of fossil fuels (than other anthropogenic sources); ***[1]***

(c) methane/CH_4 ;
decomposition of organic matter / animals / oil fields / gas fields / intensive farming / landfills;

OR

dinitrogen monoxide/nitrous oxide/N_2O ;
Do not accept NO_x, NO, NO_2, *nitrogen oxides.*

decomposition of organic matter/fertilizers;

OR

ozone/O_3 ;
photochemical smog;

OR

CFCs;
aerosol cans / air conditioners / solvents / foam production / refrigerants;

OR

sulfur hexafluoride/SF_6 ;
electrical insulator;

OR

nitrogen trifluoride/NF_3 ;
production of electronic components; ***[2 max]***
[1] *for any correct gas and* ***[1]*** *for the corresponding source.*

E2. (a) dissolved carbon dioxide / $CO_2(g) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$;
$H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$ / $CO_2(aq) + H_2O(l) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$; ***[2]***

(b) (i) internal combustion engine / high temperature combustion;
$N_2(g) + O_2(g) \rightarrow 2NO(g)$; ***[2]***

(ii) catalytic converters / exhaust recirculation;
$2NO(g) + 2CO(g) \rightarrow N_2(g) + 2CO_2(g)$; ***[2]***

(iii) nitric acid/HNO_3 / nitrous acid/HNO_2; ***[1]***

E3. (a) *Any two for first two marks:*
plant/animal tissue;
decay products of plant/animal/organic matter;
high-molecular-mass organic material/polysaccharides/proteins;
simple organic material/sugars/amino acids;
humic substances/humus;

Any one for final mark:
provide source of nutrients;
improves structural stability;
source of energy;
cation exchange capacity/CEC;
binds toxic metal (ions)/cations/pollutants;
acts as buffer;
influences water retention properties / retains water/moisture;
alters thermal properties / retains heat; ***[3 max]***

(b) in nature nutrients (such as N, K or P) return to soil when plant dies / *OWTTE*;
harvesting/removal of plants removes nutrients;
adding fertilizers/compost / crop rotation / leave soil fallow; ***[3]***

(c) pesticides / insecticides / (selective) herbicides / fungicides; ***[1]***

Option F — Food chemistry

F1. (a) (sugar free chewing) gum / emulsifiers / synthetic antioxidants / food colourings / food flavourings / pepper;
Do not accept "additives".

Food: (substance) intended for (human) consumption;

Nutrient: (substances) obtained from food that provides energy/regulates growth/maintainenance and repair; ***[3]***

(b) ***A:*** protein / polypeptide/tripeptide;
B: carbohydrate / sugar / monosaccharide / glucose;
C: lipid / triglyceride / vegetable oil / fat; ***[3]***

(c) vitamins;
minerals;
water; ***[2 max]***

F2. (a) hydrolytic rancidity **and** oxidative rancidity;
hydrolytic rancidity involves (reaction with water) breaking ester bond / formation of a fatty acid and glycerol / *OWTTE*;
oxidative rancidity involves reaction of carbon-carbon double bond/C=C with oxygen / addition reaction with oxygen; ***[3]***

(b) (i) antioxidants; ***[1]***

(ii) *Award* ***[2]*** *for any one of the following combinations.*

Compound: vitamin C;
Food: fruit / vegetables;
Accept the name of a specific example.

Compound: vitamin E;
Food: nuts / seeds / grains / vegetable oils / leafy vegetables;
Accept the name of a specific example.

Compound: β-carotene;
Food: carrots / squash / tomatoes;

Compound: selenium;
Food: fish / shellfish / red meat / eggs;

Final mark for any of the following:
Benefit: lowering LDL cholesterol / reducing blood pressure / preventing cancer / reducing heart diseases; ***[3 max]***

F3. (a) (kinetically) stable mixture of two immiscible phases; ***[1]***
Accept colloid/colloidal system.

(b) <u>both</u> liquids; ***[1]***

(c) molecule contains both hydrophilic and hydrophobic parts/groups;
one part attracted to/joins to non-aqueous/oil phase;
one part attracted to/joins to water/aqueous phase;
behaves as surfactant / acts as a bridge between the phases;
stabilizes junction between phases; ***[3 max]***

Option G — Further organic chemistry

G1. all (C–C) bond lengths equal / C–C bond lengths intermediate between C–C and C=C;
benzene normally undergoes substitution not addition;
thermochemically more stable than predicted / produces less heat when hydrogenated/combusted than predicted; ***[2 max]***

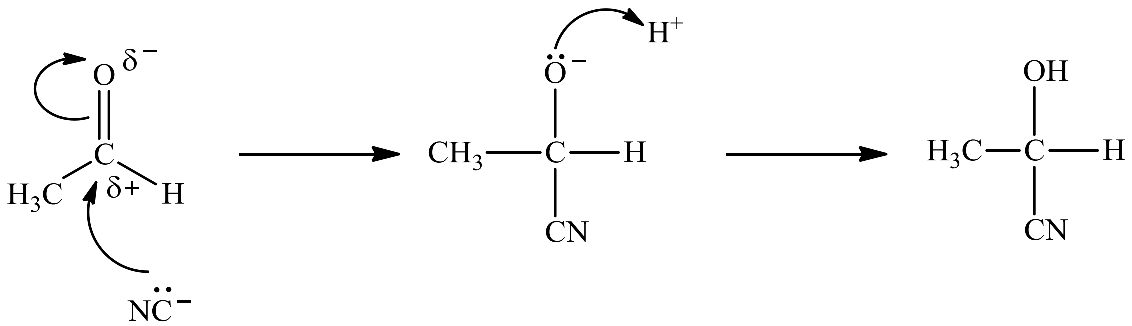
G2. (a) both reactions increase the length of the carbon chain / result in the formation of a new C–C bond / form a 3-carbon chain product from a 2-carbon chain reactant; ***[1]***

(b) C_2H_5–Mg–I/C_2H_5MgI; ***[1]***

(c) *Reaction **I**:*
magnesium/Mg;

*Reaction **II**:*
carbon dioxide/CO_2;
water/H_2O / H_3O^+ / H^+; ***[3]***

(d)



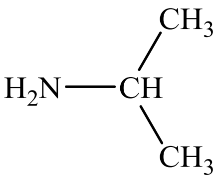
curly arrow going from lone pair/negative charge on C in NC^- to carbonyl C;
curly arrow going from C=O to O;
Do not allow curly arrow originating on N of NC^-.

representation of intermediate anion with negative charge on O;
curly arrow going from lone pair/negative charge on O of intermediate anion to H^+; ***[4]***

(e) red/yellow/orange precipitate/solid formed; ***[1]***

(f) hydroxypropanoic acid/$CH_3CHOHCOOH$/product of reaction **IV**;
OH electron withdrawing/has –I effect;
weakens/further polarizes OH bond (of COOH) / stabilizes anion/conjugate base; ***[3]***

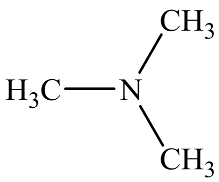
G3. (a) *Primary*

$H_3C{-}CH_2{-}CH_2{-}NH_2$ /  / $C_3H_7{-}NH_2$;

Secondary

$H_3C{-}CH_2{-}NH{-}CH_3$ / $C_2H_5{-}NH{-}CH_3$;

Tertiary

 / $(CH_3)_3N$;

[3]

Accept CH_3– instead of H_3C– and NH_2– instead of H_2N–.

(b) the methyl/alkyl group is electron donating/releasing / has a +I effect;
increases the electron density on N / therefore repulsion on the lone pair increases making it more ready to accept a proton/H^+; **[2]**