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MARKSCHEME

May 2012

CHEMISTRY

Standard Level

Paper 2

14 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 questions 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 page 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 2 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in Section A **[30 marks]** and **ONE** question in Section B **[20 marks]**. Maximum total = **[50 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.

SECTION A

1. (a) reaction is complete / all hydrogen peroxide/reactant is used up / no more bubbles are being produced / layer of bubbles is constant / *OWTTE*; ***[1]***

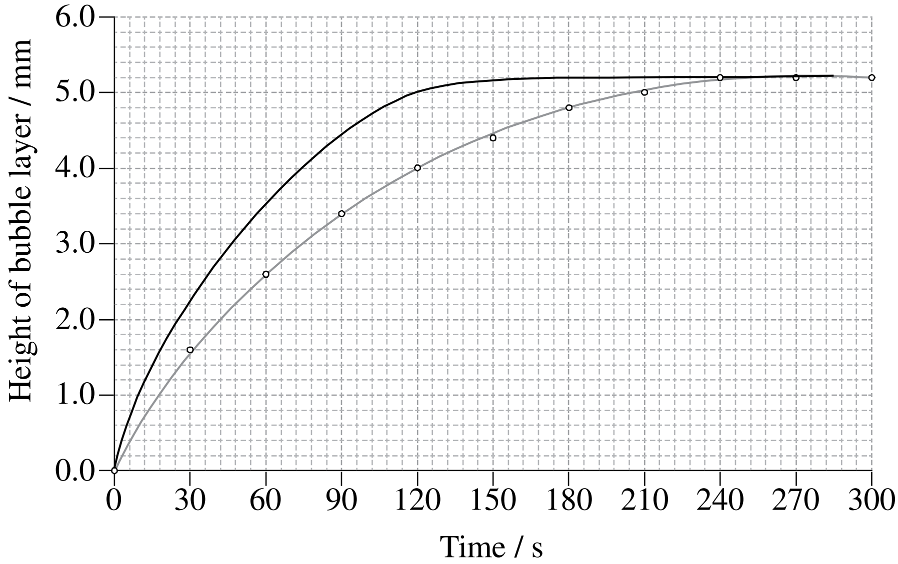
(b) correctly drawn tangent to the graph at 120 s;

rate = gradient of the tangent to the graph at 120 s / rate $= \frac{6.0-2.0}{240-0}$;

$= 0.017\ \text{mm}\,\text{s}^{-1}$; ***[3]***

Accept answers in the range 0.014 to 0.020 mm s^{-1}.
Units required for M3.

(c) (i) any line which shows the height of the bubbles increasing much faster; ***[1]***



(ii) catalyst provides an alternative reaction pathway/mechanism with a lower activation energy;
more molecules/particles have energy greater than or equal to the activation energy / *OWTTE*; ***[2]***
Accept alternative response which refers to mechanism of heterogeneous catalysts.

(d) (i)

Species	Oxidation number of oxygen
H_2O_2	–1
H_2O	–2
O_2	0

[2]

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

(ii) *Oxidation*:
$H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$;

Reduction:
$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$; ***[2]***

2. (a) $Mg(s) + 2HCl(aq) \rightarrow H_2(g) + MgCl_2(aq)$; ***[1]***

(b) $n(Mg) = \left(\frac{0.0740}{24.31}\right) = 3.04 \times 10^{-3}$ (mol);
Accept range 3.04×10^{-3} to 3.08×10^{-3}.

$n(HCl) = (2.00 \times 15.0 \times 10^{-3}) = 3.00 \times 10^{-2}$ (mol);
Mg; ***[3]***

(c) (i) $n(H_2) = n(Mg) = 3.04 \times 10^{-3}$ (mol); ***[1]***
Accept same value as in 2(b).
Answer must be in range 3.04×10^{-3} to 3.08×10^{-3} and must have 2, 3 or 4 significant figures.

(ii) $V\left(= \frac{nRT}{P}\right) = \frac{3.04 \times 10^{-3} \times 8.31 \times 293 \times 10^6}{1.01 \times 10^5}$;
$= 73.4$ (cm^3); ***[2]***
Accept answers in the range 72.3 to 74.3 (cm^3).

(d) gas leaks from apparatus / gas escapes;
the syringe stuck;
Mg impure; ***[2 max]***

3. (a) $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$; ***[1]***

Accept multiple and fractional coefficients.

(b) reaction with K is more vigorous than with Na / reaction with K causes $H_2(g)$ to ignite / a lilac flame is observed with K / more heat produced / more exothermic / *OWTTE*;

K is oxidized more readily than Na / K is more reactive than Na / K loses an electron more readily than Na / K is higher than Na in reactivity series / *OWTTE*; ***[2]***

Mark M1 and M2 independently.

4. (a) (i) atoms which have same atomic number but different mass number / atoms of the same element which have different numbers of neutrons / atoms with the same number of protons but different numbers of neutrons / atom of an element with a fixed number of protons but a number of neutrons which can be variable; ***[1]***

(ii) 78; ***[1]***

(iii) medical tracer / used to investigate functioning of thyroid gland / to treat thyroid cancer / to treat hyperthyroidism;

produces gamma rays/ionizing radiation / destroys healthy cells / *OWTTE*; ***[2]***

Do not accept I-131 is radioactive.

(b) living organisms have ^{12}C:^{14}C ratio constant/same as atmosphere / *OWTTE*;

after death no more ^{14}C is absorbed and ^{14}C level drops / ^{12}C:^{14}C ratio changes with time / ^{14}C decays / remains become less radioactive;

rate of decay of ^{14}C is constant / half-life of ^{14}C is known;

measuring radioactivity indicates length of time since death / *OWTTE*; ***[3 max]***

SECTION B

5. (a) (i) *Empirical formula:*
simplest (whole number) ratio of atoms/moles of each element present in a compound/molecule;

Molecular formula:
actual numbers of atoms/moles of each element present in a compound/molecule / whole number multiple of empirical formula; ***[2]***

(ii) $n(\text{C}) = 4.54\ (\text{mol})$, $n(\text{H}) = 9.11\ (\text{mol})$ **and** $n(\text{O}) = 2.27\ (\text{mol})$;
C_2H_4O; ***[2]***
Accept other valid method for calculation.

(iii) $C_4H_8O_2$; ***[1]***

(iv) $CH_3CH_2CH_2COOH$; ***[1]***
Accept full or condensed structural formulas.

(v) $CH_3CH_2COOCH_3$ / $CH_3COOCH_2CH_3$ / $HCOOCH_2CH_2CH_3$ / $HCOOCH(CH_3)_2$; ***[1]***
Accept full or condensed structural formulas.

(vi) *Stronger bond:*
C=O/double bond;

Longer bond:
C–O/single bond; ***[2]***

(b) (i) methoxyethane/$CH_3OCH_2CH_3$ as there are only dipole-dipole forces (and van der Waals' forces) between molecules;
propan-1-ol has hydrogen bonding between molecules;
hydrogen bonding is stronger than dipole-dipole forces; ***[3]***

(ii) propan-1-ol/$CH_3CH_2CH_2OH$ as it has a smaller hydrocarbon chain;
the longer (non-polar) carbon chain in hexan-1-ol decreases the attraction between the alcohol and the (polar) water molecules / *OWTTE*; ***[2]***

(c) *graphite*: ***[3 max]***
forms flat hexagonal rings / layers of carbon atoms each (covalently) bonded to 3 other carbon atoms / trigonal planar around C / C has sp^2 hybridization;
layers are held together by weak intermolecular/van der Waals' forces;
layers can slide over each other;
delocalization of electrons / free moving electrons;

diamond:
all carbon atoms are (covalently) bonded to 4 other carbon atoms / tetrahedral around C / C has sp^3 hybridization;
strong covalent bonds;
no delocalized electrons / *OWTTE*; ***[6 max]***

6. (a) a strong base: base/electrolyte (assumed to be almost) completely/100% dissociated/ionized (in solution/water) / *OWTTE* **and** a weak base: base/electrolyte partially dissociated/ionized (in solution/water) / *OWTTE*;
example of a strong base: any group I hydroxide / $Ba(OH)_2$;
example of a weak base: NH_3 / CH_3NH_2 / any reasonable answer; ***[3]***

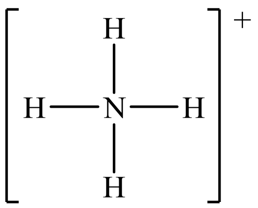
(b) (i) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$; ***[1]***

(ii) accepts a proton/H^+ / *OWTTE*; ***[1]***

(iii) donates an electron pair; ***[1]***

(c) (i) more vigorous reaction / more gas bubbles / *OWTTE*;
more heat released;
solid decreases more quickly; ***[1 max]***

(ii)



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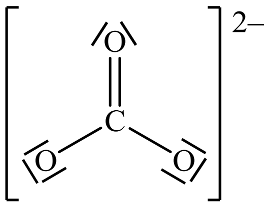


; ***[2]***

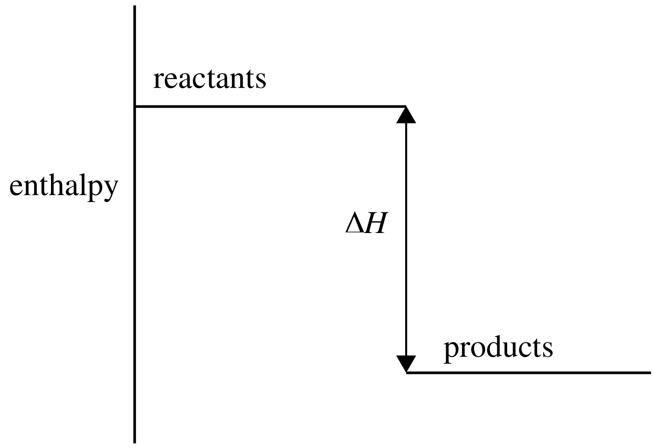
Accept any combination of lines, dots or crosses to represent electron pairs.

(iii) *NH_4^+*:
tetrahedral;

CO_3^{2-}:
trigonal/triangular planar; ***[2]***

(d) (i) enthalpy on *y*-axis;
Do not accept energy.

reactants higher than products;
ΔH labelled; ***[3]***



Accept appropriate formulas for reactants and products.
Arrow heads not needed.
57.6 is acceptable as an alternative to ΔH *.*

(ii) products are more stable as they are at a lower enthalpy level / energy has been given off by the reactants / reaction is exothermic / *OWTTE*; ***[1]***

(iii) $n(\text{NaOH}) = 0.125\text{ mol}$;
change in heat energy $= (-57.6 \times 0.125) = -7.20\text{ (kJ)}$ / heat released $= (57.6 \times 0.125) = 7.20\text{ (kJ)}$; ***[2]***

(e) $q = (mc\Delta T =)\, 100.0 \times 4.18 \times 3.50 / 1463\text{ J} / 1460\text{ J}$;
$n(\text{NH}_4\text{Cl}) = \frac{5.35}{53.5} / 0.100\text{ mol}$;
$\Delta H = +14.6/14.6\ (\text{kJmol}^{-1})$; ***[3]***
Accept $q = 105.35 \times 4.18 \times 3.50 / 1541\text{ J}$.
Accept. $\Delta H = +15.4 / 15.4\ (\text{kJ mol}^{-1})$

7. (a) (i) compounds with the same molecular formula but different arrangements of atoms / compounds with the same molecular formula but different structural formulas; *[1]*

(ii) $CH_3CH(Br)CH_2CH_3$;
secondary/ 2° ;

$CH_2(Br)CH(CH_3)CH_3$;
primary/ 1° ; *[4]*
Accept full or condensed structural formulas.

(b) (i) relatively strong bonds/high bond enthalpies so large amounts of energy must be provided for a reaction to occur;
non-polar bonds so not susceptible to attack / no C=C so no addition reactions; *[2]*

(ii) bond breaks and one electron (from the covalent bond) goes to each atom / *OWTTE*; *[1]*

(iii) bromine (free) radical / a bromine atom (with an unpaired electron); *[1]*

(iv) $CH_3CH_3 + Br_2 \rightarrow CH_3CH_2Br + HBr$; *[1]*
Accept further substitution.

(v) *Initiation*:
$Br_2 \rightarrow 2Br\bullet$;

Essential condition:
UV/sunlight/*hf*/*hv*;

Propagation:
$Br\bullet + CH_3CH_3 \rightarrow \bullet CH_2CH_3 + HBr$;
$Br_2 + \bullet CH_2CH_3 \rightarrow BrCH_2CH_3 + Br\bullet$;
Accept other valid propagation reactions.

Termination:
$Br\bullet + Br\bullet \rightarrow Br_2$; *[5]*
Accept other valid termination reactions.

(c) (i) (concentrated) sulfuric acid/ H_2SO_4 / phosphoric acid/ H_3PO_4; ***[1]***

Acid must be named or formula given.

(ii) step **I**:
HBr/hydrogen bromide;
gaseous / anhydrous / inert/non-polar solvent;

step **II**:
sodium hydroxide/NaOH / potassium hydroxide/KOH;
aqueous (solution) / dilute / warm / heat / reflux; ***[4]***