M12/4/CHEMI/SP2/ENG/TZ1/XX/M

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MARKSCHEME

May 2012

CHEMISTRY

Standard Level

Paper 2

13 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.

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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 underlined 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) (i) bromine/Br_2; ***[1]***
Do not allow Br or bromide/Br^-.

(ii) 7.9×10^{-5} (mol dm^{-3} s^{-1});
The number of significant figures must be correct.
Allow 8.0×10^{-5} (mol dm^{-3} s^{-1}).

(only 2 significant figures) because of precision of time/[Br_2] measurements; ***[2]***
Allow answers based on rate laws or orders of reaction.
M2 can only be scored if M1 correct.

(iii) *[Br_2]:* 1% **and** *Time:* 0.8%;
Percentage Uncertainty: 1.8%; ***[2]***
Accept Percentage Uncertainty: 2%.
Do not allow answers based on rate laws or orders of reaction.

(b) (i) rate doubles;
Do not allow rate increases.

increased frequency of collisions / more collisions per unit time; ***[2]***
Do not accept "more collisions".

(ii) catalyst increases rate of reaction without chemically changing/being consumed / *OWTTE*;
Do not award mark for stating catalyst increases rate of forward and reverse reactions (equally).

catalyst lowers activation energy / offers an alternative reaction pathway; ***[1 max]***

(iii) (valid hypothesis) as rate increases as [H^+] increases/comparing data in Experiments 1 and 4;
H^+ is not in equation/does not chemically change / *OWTTE*; ***[2]***
No marks awarded if invalid hypothesis stated.

2. (a) (i) $n(\text{Pb}): \left(\frac{64.052}{207.19}\right) = 0.30915\ (\text{mol})$

$n(\text{C}): \left(\frac{29.703}{12.01}\right) = 2.473\ (\text{mol})$

$n(\text{H}): \left(\frac{6.245}{1.01}\right) = 6.18\ (\text{mol})$

Do not penalize if integer values of atomic masses used.
Accept alternative calculation method.
*Award **[2]** for three correct.*
*Award **[1]** for any two correct.*

PbC_8H_{20}; ***[3]***

(ii) PbC_8H_{20}; ***[1]***

(iii) $PbC_8H_{20} + 14O_2 \rightarrow PbO_2 + 8CO_2 + 10H_2O$

correct reactants and products;
correct coefficients; ***[2]***
M2 can only be scored if M1 correct.

(b) *Local pollutant:*
carbon monoxide/CO / volatile organics/VOCs / nitrogen oxide/NO / (unburnt) hydrocarbons;
Do not accept methane/CH_4, ethane/C_2H_6, propane/C_3H_8 or butane/C_4H_{10}.

Global pollutant:
nitrogen oxide/NO / carbon dioxide/CO_2; ***[2]***
Accept nitrogen dioxide/NO_2 / NO_x for both local or global pollutant.
Accept other widely used names for NO such as nitric oxide/nitrogen monoxide/nitrogen(II) oxide or nitrogen(IV) oxide for NO_2.

3. (a) (carbon to carbon) double bond / alkene;
Accept if identified on diagram.

orange/brown/red/yellow to colourless / bromine is decolourized; ***[2]***
M2 can be only scored if M1 correct.

(b) (i) $COOH/CO_2H$ / carboxylic acid / alkanoic acid; ***[1]***
Do not allow carboxylic/alkanoic, carbonyl or carboxylate.

(ii) redox / oxidation (of alcohol); ***[1]***

(c) (i) aldehyde / alkanal / CHO; ***[1]***
Accept C=O / carbonyl.

(ii) **Z < X < Y**;
*Accept **Z,X,Y** or **ZXY**.*

no hydrogen bonding in **Z /** hydrogen bonding in **X and Y**;
*Accept statements such as **Z** has only van der Waals/London/dispersion forces **and** dipole-dipole forces.*

Y most polar / more electrons / forms dimers / forms two hydrogen bonds / greater molecular/molar mass; ***[3]***
*Do not accept **Y** has a larger mass.*

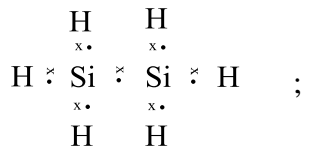
4. (a) (i) 2,8,2; ***[1]***

(ii) $Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$;
Fe/iron; ***[2]***
Do not accept Fe/Fe^{2+} half-equation or Fe^{2+}.

(b) $Mg(s) + Fe^{2+}(aq) \rightarrow Mg^{2+}(aq) + Fe(s)$; ***[1]***

SECTION B

5. (a) (i)



;

[1]

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

(ii) 109° / 109.5° / 109° 28' ;
four/tetrahedrally arranged negative charge centres/electron domains/electron pairs (around central/silicon atom) / equal repulsion between bonding pairs (around central/silicon atom) / *OWTTE*; ***[2]***
M2 is an independent marking point.
Reference must be made to negative or electron.
Do not accept tetrahedral molecule.

(iii) C–H;
larger difference in electronegativity (for C–H bond) / smaller difference in electronegativity (for Si–H bond) / ΔEN (CH) = 0.4 **and** ΔEN (SiH) = 0.3; ***[2]***

(iv) both (molecules) non-polar;
both (molecules) symmetrical / polar bond effects cancel out / *OWTTE*; ***[2]***

(v) stronger/larger/greater van der Waals'/London/dispersion forces;
Do not accept stronger/larger/greater intermolecular forces.

more electrons / stronger instantaneous dipole; ***[2]***
Do not accept larger mass.

(b) (i) (–1560 × 2 =) –3120 (kJ); ***[1]***

(ii) *Structure:*
CO_2 molecular **and** SiO_2 three-dimensional/network/giant lattice/giant covalent/macromolecular/repeating tetrahedral units;
CO_2 linear **and** SiO_2 tetrahedral;

Intramolecular Bonding:
covalent bonds in CO_2 **and** SiO_2;
double bonds in CO_2 **and** single bonds in SiO_2; ***[3 max]***
Accept diagrams showing bonding types (double and single) within the structures.

(iii) *CO_2:*
pH (of resultant solution) weakly acidic / pH in range 5.5–6.5 (accept any value in this range);

SiO_2:
pH remains as 7; ***[2]***

(c) (i) energy needed to break (one mol of) a bond in a gaseous molecule;
averaged over similar compounds; ***[2]***
Do not allow averaged over several compounds.

(ii) *Bonds broken:*
6Si–H, Si–Si, H–H / (+)2570 (kJ);
Bonds formed:
8Si–H / (–)2544 (kJ);
+26 (kJ);

OR

Bonds broken:
Si–Si, H–H / (+)662 (kJ);
Bonds formed:
2Si–H / (–)636 (kJ);
+26 (kJ); ***[3]***

6. (a) $H_2(g) + Br_2(g) \rightleftharpoons 2HBr(g)$; ***[1]***

(b) (i) shifts to right/toward products/forward reaction favoured; ***[1]***
Accept reverse statement if process written the other way around.
Answer must match stated equation.

(ii) no effect;
same amounts/number of (gaseous) moles/molecules on both sides; ***[2]***

(c) (i) $(K_c =) \frac{[HBr]^2}{[H_2][Br_2]}$; ***[1]***

(ii) no effect (only depends on the temperature); ***[1]***

(d) *Strong acid:* acid/electrolyte (assumed to be almost) 100%/completely dissociated/ionized (in solution/water) / *OWTTE* **and** *Weak acid:* acid/electrolyte only partially/slightly dissociated/ionized (in solution/water) / *OWTTE*;
$HBr(aq) \rightarrow H^+(aq) + Br^-(aq)$;
$HF(aq) \rightleftharpoons H^+(aq) + F^-(aq)$; ***[3]***

(e) (i) *Br_2:* 0
HBr: –1
HOBr: +1 ***[2]***
*Award **[2]** for three correct.*
*Award **[1]** for any two correct.*

(ii) bromine is oxidized **and** reduced / disproportionation; ***[1]***

(iii) $K_c < 1$; ***[1]***

(iv) shifts to right/toward products/forward reaction favoured;
to replace H^+/HBr/HOBr / to remove H_2O formed from neutralization; ***[2]***

(f) (i) F_2/fluorine; ***[1]***
Do not allow F.

(ii) 50 (cm^3) / 0.050 dm^3; ***[1]***

(iii) fluorine accepts/attracts electrons more readily/strongly / is a better oxidizing agent;
fluorine has smaller atomic radius/fewer energy levels/shells;
Do not allow fluorine atom smaller.

so <u>nucleus</u> attracts electrons more strongly; ***[3]***
Allow opposite argument for bromine.

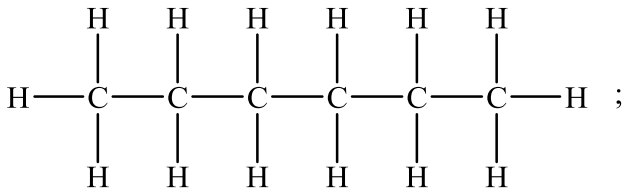
7. (a) (i) molar mass = 102.20 (g mol^{-1});
amount $\left(= \frac{5.00}{102.20}\right)$ = 0.0489 (mol); ***[2]***

(ii) theoretical yield = $(84.18 \times 0.0489 =)$ 4.12 (g);
percentage yield $= \left(\frac{2.62}{4.12} \times 100 =\right) 63.6\ \%$; ***[2]***
Accept alternative calculation method.

(iii) yield above 100% not possible / experimental yield > theoretical yield / *OWTTE*;
Must have reference to a final yield.

sample contaminated with hexan-1-ol/water / inadequate drying / *OWTTE*; ***[2]***
Do not accept error in reading balance/weighing scale.

(b) (i) hydrogen **and** Ni/Pd/Pt catalyst;


;

[2]
Allow condensed structural formula $CH_3(CH_2)_4CH_3$.

(ii) 2-methylpentane;
3-methylpentane;
2,2-dimethylbutane;
2,3-dimethylbutane; ***[3 max]***

(iii) hexane;
Accept the molecular structure, full structural formula or condensed structural formula.

straight chain/no branches, hence increased surface area/more closely packed;
stronger/larger/greater London/dispersion/van der Waals'; ***[3]***
Accept the opposite arguments.
Do not accept stronger/larger/greater intermolecular forces.

(iv) margarine; ***[1]***

(c) (i) *Initiation:*
$Cl_2 \rightarrow 2Cl\bullet$;

Essential condition:
UV/sunlight/*hf*/*hν* / heat;

Propagation:
$Cl\bullet + R\text{–}H \rightarrow HCl + R\bullet$ / $R\bullet + Cl_2 \rightarrow RCl + Cl\bullet$;

Termination:
$Cl\bullet + Cl\bullet \rightarrow Cl_2$ / $Cl\bullet + R\bullet \rightarrow RCl$ / $R\bullet + R\bullet \rightarrow R_2$; ***[4]***

Allow more specific detail of R based on hexane (e.g. $CH_3(CH_2)_4CH_2$–H) in mechanistic steps.

(ii) three/3; ***[1]***

If all three isomers are represented correctly award mark.