N08/4/CHEMI/SP2/ENG/TZ0/XX/M+

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MARKSCHEME

November 2008

CHEMISTRY

Standard Level

Paper 2

11 pages

General Marking Instructions

Assistant Examiners (AEs) will be contacted by their team leader (TL) by e-mail (or telephone) – if by e-mail, please reply to confirm that you have downloaded the markscheme from EXAMNET. The purpose of this initial contact is to allow AEs to raise any queries they have regarding the mark scheme and its interpretation. AEs should contact their team leader by e-mail at any time if they have any problems/queries during the marking process.

Note:

The DHL courier service must be used to send assessment material to your team leader/senior moderator and to IB Cardiff. (However, this service is not available in every country.) The cost is met directly by the IBO. It is vitally important that the correct DHL account number is used.

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

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

2. 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.**

3. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases write a brief annotation to explain your decision. You are encouraged to write comments where it helps clarity, especially for moderation and re-marking. It should be remembered that the script may be returned to the candidate.

4. Unexplained symbols or personal codes/notations are unacceptable.

5. Record marks in the right-hand margin against each mark allocation shown in square brackets *e.g.* ***[2]***. The total mark for a question must equal the number of ticks for the question.

6. Do **not** circle sub-totals. **Circle the total mark** for the question in the right-hand margin **at the end of the question.**

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

8. Where work is submitted on additional sheets the marks awarded should be shown as ticks and a note made to show that these marks have been transferred to the appropriate square bracket in the body of the script.

9. For each option: Add the total for each question in the option and write it in the Examiner column on the front cover.
Total: Add the marks awarded and enter this in the box marked TOTAL in the Examiner column on the cover sheet.

10. After entering the marks on the front cover 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. **All scripts are checked and a note of all clerical errors will be given in feedback to examiners.**

11. If an answer extends over more than one page and no marks have been awarded on a section draw a diagonal line through that section to indicate that it has been marked.

12. If a candidate has attempted more than the required number of questions within a paper or section of a paper, mark all the answers and use the marks of those answers that have the highest mark, **unless the candidate has indicated the question(s) to be marked on the front cover**.

13. A mark should not be awarded where there is contradiction within an answer. Make a comment to this effect in the left hand margin.

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. Do not award more than the maximum marks allowed for part of a question.

2. Each marking point has a separate line and the end is signified 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 writing ***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. Indicate this with **ECF** (error carried forward).

10. Only consider units at the end of a calculation. Unless directed otherwise in the mark scheme, unit errors should only be penalized once in the paper. Indicate this by writing **–1(U)** at the first point it occurs and **U** on the cover page.

11. Significant digits should only be considered in the final answer. Deduct **1 mark in the paper** for an **error of 2 or more digits** unless directed otherwise in the markscheme.

e.g. if the answer is 1.63:

2	*reject*
1.6	accept
1.63	accept
1.631	accept
1.6314	*reject*

Indicate the mark deduction by writing **–1(SD)** at the first point it occurs and **SD** on the cover sheet.

12. 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.

13. 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.

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

SECTION A

1. (a) (i) gas/carbon dioxide/CO_2 is given off/evolves/escapes/formed; ***[1]***

(ii) $n(CaCO_3)\left(=\frac{5.00}{100.09}\right)=0.0500$;

$n(HCl)\left(=\frac{1.00\times 50.0}{1000}\right)=0.0500$; ***[2]***

Do not penalize significant figures.
No penalty for using 100 instead of 100.09.

(iii) $CaCO_3$ (because twice as much acid needed / *OWTTE*); ***[1]***
Allow HCl is limiting.
Allow HCl in excess as correct deduction from wrong values in (a)(ii).

(iv) (line 2) steeper;
levels off at same mass as Experiment 1;
Apply ECF from part (ii).

(line 3) steeper;
levels off halfway between zero and Experiment 1; ***[4]***

Allow ECF for lines on graph from HCl in excess in (a)(iii). This means that the lines are the same but numbered the other way round.
If lines are unlabelled allow ***[2 max]****.*

(b) (i) greater surface area (of $CaCO_3$);
more frequent collisions (between reactant particles) / *OWTTE*; ***[2]***
Accept ions, but not atoms or molecules, instead of particles.
Do not accept just more collisions without reference to time.

(ii) particles move faster / have more energy;
Accept ions, but not atoms or molecules, instead of particles, unless already penalized in (b)(i).

more particles have $E > E_a$;
more successful collisions; ***[2 max]***

If no points scored, award ***[1]*** *for "more frequent collisions".*

2. (a) (atoms of the) same element / atoms with same number of protons/atomic number/Z;
Do not award mark if no mention of atom or element.

(but) different numbers of neutrons/mass number/A; ***[2]***

(b) (i) $(82\times0.1580)+(84\times0.6540)+(86\times0.1880)$ / other working;
84.06; ***[2]***
Consider ECF for final answer if correct method is used but transcription or arithmetic error is present in the first stage.
*Award **[2]** for correct final answer with or without working.*

(ii) 36 protons **and** 36 electrons;
48 neutrons; ***[2]***

3. (a) (i) *polar single*
O–H;
Accept C–H, H_2O

polar double
C=O;
Accept CO_2

non-polar double
O=O;
Accept O_2

non-polar triple
C≡C/triple carbon bond / O–H; ***[4]***

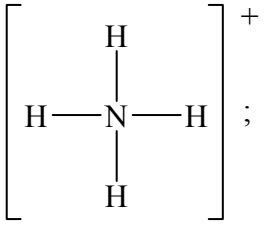
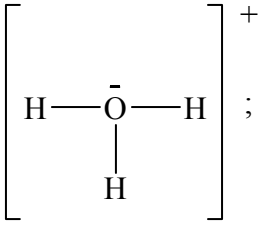
(ii) C≡C/triple carbon bond; ***[1]***

(b) (i) produces hydroxide/OH^- ions / accepts a proton/H^+ / donates pair of electrons; ***[1]***

(ii) $\rightleftharpoons$ / reversible arrow / incomplete/partial dissociation; ***[1]***

(iii) 11; ***[1]***

(c)

	NH_4^+	H_3O^+
Lewis structure	 ;  ; *Accept two dots or two crosses or one of each instead of —* *No penalty for missing + signs.*	
Name of shape	tetrahedral;	trigonal/triangular pyramidal/pyramidal;

[4]

SECTION B

4. (a) (i) energy change to break/make (one mole) of bonds (in molecule) in gaseous state; averaged over similar compounds; ***[2]***

(ii) H–H bond is only present in one molecule/*OWTTE*; ***[1]***

(iii) bonds broken: C=C and $\frac{1}{2}$ O=O / $612 + 248$ / 860;
bonds formed: C–C and 2 C–O / $348 + 720$ / 1068;
$\Delta H (= 860 - 1068) = -208$ kJ/kJ mol^{-1}; ***[3]***
*Correct final answer award **[3]** marks.*
*208 kJ/kJ mol^{-1} or +208 kJ/kJ mol^{-1} award **[2]** marks.*
ECF from bonds broken and formed.
No penalty for including 4 C–H bonds in both bonds broken and formed.

(iv) *diagram showing*

vertical axis labelled enthalpy/energy;
Do not accept enthalpy change.

reactants line above products line and ΔH; ***[2]***
ECF from sign in (iii).

Ignore connecting lines, intermediates, activated complexes.
*Enthalpy change value not needed, but if in wrong place, then deduct **[1]** mark.*

(v) negative;
decrease in gas moles/molecules/volume/decrease in disorder/increase in order; ***[2]***

(b) (i) *for first equation* $8 \times -394 / -3152$;
for second equation $9 \times -286 / -2574$;
for third equation $+5512$;
$\Delta H^{\ominus} = -214$ (kJ or kJ mol^{-1}); ***[4]***
*No penalty for missing units, but penalize wrong units by **–1(U)**.*
*Correct final answer award **[4]** marks.*
All marks can be scored from enthalpy cycle.
Consider ECF for final mark.

(ii) II;
heat evolved during condensation / when hydrogen bonds/intermolecular forces form / latent heat given out / *OWTTE*; ***[2]***

(c) (i) Standard (Gibbs') free energy change (of reaction); ***[1]***

(ii) ΔG must be negative for spontaneous reaction / if ΔG is positive reaction is not spontaneous;
at low temperatures ΔH is bigger than $T\Delta S$ so ΔG is positive;
at high temperatures ΔH is smaller than $T\Delta S$ so ΔG is negative; ***[3]***
Give credit for OWTTE in this part.
Answers will probably refer to $\Delta G = \Delta H - T\Delta S$, but this expression does not score by itself.

5. (a) (oxidation is) loss of electron(s);
Br^- / bromide; ***[2]***

(b) Ti +4 and +4;
Cl 0 and –1;
C 0 and +4; ***[3]***
Penalize missing +, or answers written as 4+ once only.
*If no marks scored allow **[1]** if all oxidation numbers for reactants or for products are correct.*

(c) (i) Cr oxidation number +6/same on both sides/does not change;
neither oxidation nor reduction occur; ***[2]***
No ECF.

(ii) Cl oxidation number 0 on left and –1 and +1 on right;
both oxidation and reduction occur / disproportionation; ***[2]***
No ECF.

(d) (i) W > Z > Y > X;
*Award **[1]** mark for correct order.*

X below Y because of reaction 2/because X will not displace Y;
X below Z because of reaction 4/because X displaced by Z;
X below W because of reaction 1/because Z displaced by W and Z displaces X;
Y below Z because of reaction 3/because Y will not displace Z; ***[4 max]***
Give credit for OWTTE in this part.
*Any three of last four score **[1]** each.*

(ii) $2V + 3XO \rightarrow V_2O_3 + 3X$; ***[1]***

(e) (i) allows ions to flow through it / to complete the circuit/balances charge;
potassium chloride/KCl / potassium nitrate /KNO_3; ***[2]***
Accept any other unreactive soluble salt including sulfates.

(ii) P is magnesium sulfate/$MgSO_4$;
Accept magnesium chloride $MgCl_2$ or magnesium nitrate $Mg(NO_3)_2$.

Q is zinc/Zn; ***[2]***

(iii) $Mg \rightarrow Mg^{2+} + 2e^-$; ***[1]***
Accept e instead of e^-.
Accept $-2e^-$ on left.
Ignore state symbols.

(iv) $Zn \rightarrow Zn^{2+} + 2e^-$; ***[1]***
Accept e instead of e^-.
Accept $-2e^-$ on left.
Ignore state symbols.

6. (a) (i) C_2H_4O ; ***[1]***

(ii) $CH_3CH_2CH_2COOH$ / $CH_3CH_2CH_2CO_2H$;
butanoic acid; ***[2]***

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

(b) (i) potassium dichromate / $K_2Cr_2O_7$ / $Cr_2O_7^{2-}$ / $KMnO_4$ / MnO_4^- ;
acidified / sulfuric acid / H_2SO_4 ;
butanal;
heat under reflux / use excess oxidising agent / heat for longer / use higher temperature; ***[4]***

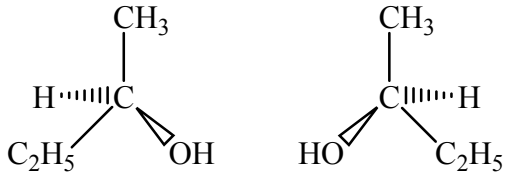
(ii) $CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$;
Accept reversible arrow symbol and more detailed structures.

ethyl ethanoate; ***[2]***

(iii) $HCOOCH_2CH_2CH_3$;
$CH_3CH_2COOCH_3$; ***[2]***
Accept structures in reverse order.

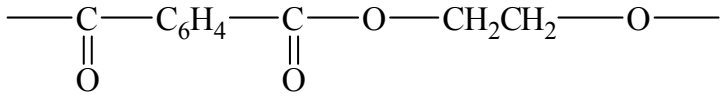
(iv) A (is higher) because of (stronger) hydrogen bonding;
B (is lower as it) has (weaker) dipole-dipole attractions; ***[2]***

(c) chiral/asymmetric carbon atom / carbon atom joined to 4 different groups;



correct 3-D structure of either isomer;
other correct 3-D structure clearly showing relationship;

planes <u>rotated</u> in opposite directions; ***[4]***

(d)  ***[2]***

*Award **[1]** for correct ester link and **[1]** for complete structure showing one complete repeat unit with continuation bonds – do not penalize incorrect arrangement of C_6H_4.*
Repeating unit can start/stop in different places.