N09/4/CHEMI/SP2/ENG/TZ0/XX/M+

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MARKSCHEME

November 2009

CHEMISTRY

Standard Level

Paper 2

13 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 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 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 markscheme, 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) $MnO_4^-(aq) + 5Fe^{2+}(aq) + 8H^+(aq) \rightarrow Mn^{2+}(aq) + 5Fe^{3+}(aq) + 4H_2O(l)$ ***[2]***

*Award **[2]** if correctly balanced.*
*Award **[1]** for correctly placing H^+ and H_2O.*
*Award **[1 max]** for correct balanced equation but with electrons shown.*
Ignore state symbols.

(b) Fe^{2+} / iron(II); ***[1]***

Do not accept iron.

(c) $n = 2.152 \times 10^{-2} \times 2.250 \times 10^{-2}$;

4.842×10^{-4} (mol); ***[2]***

*Award **[1]** for correct volume*
*Award **[1]** for correct calculation.*

(d) 1 mol of MnO_4^- reacts with 5 mol of Fe^{2+};

$5 \times 4.842 \times 10^{-4} = 2.421 \times 10^{-3}$ (mol); ***[2]***

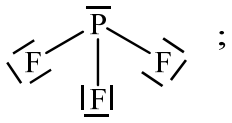
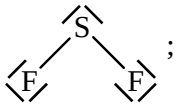
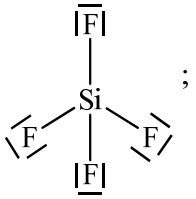
(same number of moles of Fe in the iron ore)
Allow ECF from part (a) and (c) provided some mention of mole ratio is stated.

(e) $2.421 \times 10^{-3} \times 55.85 = 0.1352\,(g)$;

$\frac{0.1352}{0.3682} \times 100 = 36.72\%$; ***[2]***

Allow ECF from part (d).

2.

	PF_3	SF_2	SiF_4
Lewis structure	 ; *1 lone pair on P required for the mark*	 ; *2 lone pairs on S required for the mark*	 ;
Name of shape	trigonal/triangular pyramidal;	bent/angular/V shaped;	tetrahedral/tetrahedron;

[6]

Penalise missing lone pairs on fluorine atoms once in correct structures only.
For Lewis structures candidates are not expected to draw exact shapes of molecules.
Do not allow ECF for wrong Lewis structures.
Accept dots or crosses instead of lines.

3.

$(C_2H_6(g) + 3\frac{1}{2}O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l))$ $\Delta H^{\ominus} = -1560$;

$(H_2O(l) \rightarrow H_2(g) + \frac{1}{2}O_2(g))$ $\Delta H^{\ominus} = +286$;

$(2CO_2(g) + 2H_2O(l) \rightarrow C_2H_4(g) + 3O_2(g))$ $\Delta H^{\ominus} = +1411$;

$(C_2H_6(g) \rightarrow C_2H_4(g) + H_2(g))$ $\Delta H^{\ominus} = +137\,(kJ)$; ***[4]***

Allow other correct methods.
*Award **[2]** for –137.*
Allow ECF for the final marking point.

4. (a) (i)

Isomer	A	B	C
Boiling point	36 °C	28 °C	10 °C

*Award **[1]** if correct boiling points are assigned to 3 isomers.*

increase in branching / more side chains / more spherical shape /
reduced surface contact / less closely packed;
weaker intermolecular force/van der Waals'/London/dispersion forces; ***[3]***
Accept the opposite arguments

(ii) *B*: 2-methylbutane/methylbutane;
C: 2,2-dimethyl propane/dimethyl propane; ***[2]***
Do not penalize missing commas, hyphens or added spaces.
Do not accept 2-dimethylpropane, or 2,2-methylpropane.

(b) C_5H_{12};
Accept any two of the following explanations.

$C_5H_{11}OH$ has greater molar mass / produces less grams of CO_2 and H_2O per gram of the compound / suitable calculations to show this;
$C_5H_{11}OH$ contains an O atom which contributes nothing to the energy released / partially oxidized / *OWTTE*;
analogous compounds such as butane and butan-1-ol show a lower value for the alcohol per mole in the data book / *OWTTE*;
the total bond strength in the pentanol molecule is higher than the total bond strength in pentane;
the total amount of energy produced in bond formation of the products per mole is the same;
fewer moles of pentanol in 1 g;
pentanol requires more energy to break intermolecular forces/hydrogen bonding / *OWTTE*; ***[3 max]***

(c) *Improvements **[2]***
less/no particulates/C/CO/VOC's produced with CNG;
less/no SO_2/SO_x produced;

*Reasons **[1 max]***
CO/SO_2 toxic/poisonous;
SO_2 causes acid rain;
CNG is likely to undergo complete/more combustion;
CNG has no/less sulfur impurities; ***[3 max]***

SECTION B

5. (a) $(K_c) = \dfrac{[SO_2Cl_2]}{[Cl_2][SO_2]}$; ***[1]***

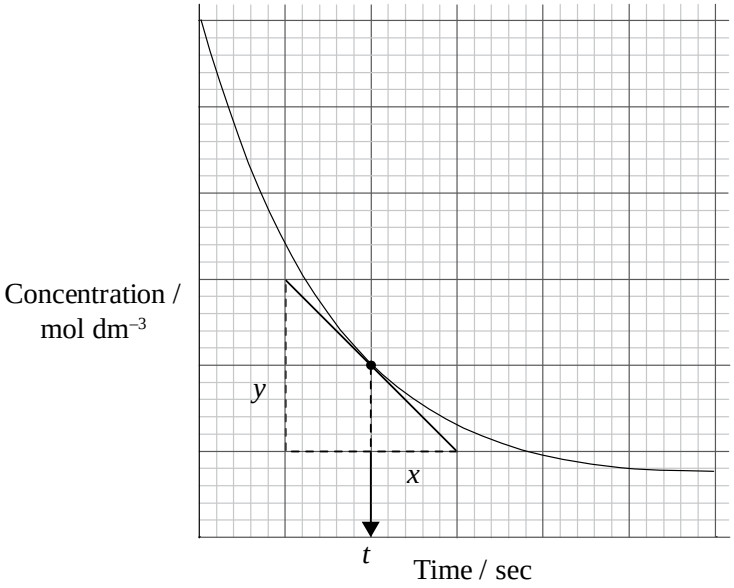
Ignore state symbols.
Square brackets [ ] required for the equilibrium expression.

(ii) value of K_c increases;
$[SO_2Cl_2]$ increases;
decrease in temperature favours (forward) reaction which is exothermic; ***[3]***
Do not allow ECF.

(iii) no effect on the value of K_c / depends only on temperature;
$[SO_2Cl_2]$ decreases;
increase in volume favours the reverse reaction which has more gaseous moles; ***[3]***
Do not allow ECF.

(iv) no effect;
catalyst increases the rate of forward and reverse reactions (equally) / catalyst decreases activation energies (equally); ***[2]***

(b)



labelled axes (including appropriate units);
correctly drawn curve;
correctly drawn tangent;

rate equal to slope/gradient of tangent (at given time) / rate $= \dfrac{y}{x}$ at time *t*; ***[4]***

[3 max] *for straight line graph or graph showing product formation.*

(c) (i) increases rate of reaction;
molecules (of H_2O_2) collide more frequently / more collisions per unit time;
No ECF here. ***[2]***

(ii) no effect / (solution) remains unchanged;
solid NaI is not reacting / aqueous solution of NaI is reacting / surface area of NaI is not relevant in preparing the solution / *OWTTE*; ***[2]***

(d) <u>kinetic</u> energy/speed of reacting molecules increases;
frequency of collisions increases per unit time;
greater proportion of molecules have energy greater than activation energy/E_a; ***[3 max]***
Accept more energetic collisions.

6. (a) (i) acid in both reactions;
because it loses a proton/hydrogen ion/H^+ / proton/hydrogen ion/H^+ donor; ***[2]***
Second mark can be scored if they do not identify it as an acid in both reactions.

(ii) NH_2^-;
more readily accepts a proton / equilibrium lies to the right / takes H^+ from H_2O; ***[2]***
*If OH^- chosen award **[0]***

(iii) NH_4^+;
donates a proton more readily than NH_3 / equilibrium lies to the left; ***[2]***
*If NH_3 chosen award **[0]***

(b) solutions of the same concentration;

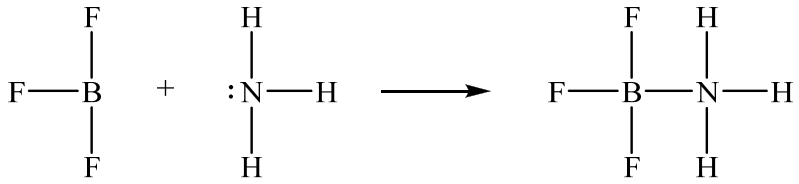
pH meter;
strong base has a higher pH / weak base has lower pH;
indicator paper/U.I solution;
strong base has a higher pH/more purple / weak base has lower pH/blue not purple / *OWTTE*;
measuring conductivity (with conductivity meter);
strong base has a higher conductivity / weak base has lower conductivity;
comparing heat of neutralisation with acid;
strong base releases more heat / weak base releases less heat;
*Award **[4 max]** for two correct methods with expected results.* ***[5]***

(c) (i) X;
$[X] = 10^{-2}\ (\text{mol dm}^{-3})$ **and** $[Y] = 10^{-6}\ (\text{mol dm}^{-3})$; ***[2]***

(ii) $10\,000/10^4 : 1$; ***[1]***
Ratio should be in form above.

(d) (i) (Lewis acid) electron <u>pair</u> acceptor;
appropriate example (such as $AlCl_3$, BF_3 etc.); ***[2]***

(ii) structural formula of Lewis acid (*e.g.* BF_3, $AlCl_3$, Transition element etc);
structural formula of Lewis base (*e.g.* NH_3, H_2O etc);
structural formula of product (*e.g.* F_3BNH_3 etc);
dative covalent (bond)/coordinate (bond); ***[4]***



Lewis acid Lewis base Product

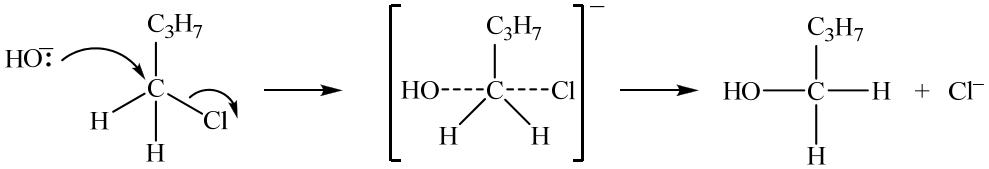
Penalize missing structural formulas once.

7. (a) (i) $C_4H_9Cl + KOH \rightarrow C_4H_9OH + KCl$; ***[1]***

(ii) (substitution)
nucleophilic;
unimolecular/*OWTTE*; ***[2]***

(iii) *1-chlorobutane:*
S_N2 ;
2-chloro-2-methylpropane:
S_N1 ; ***[2]***

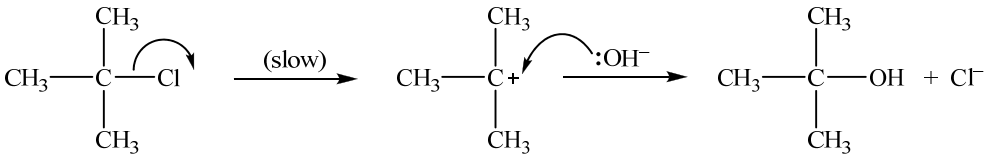
(iv) *S_N2 1-chlorobutane-allow ECF from (iii).*



curly arrow going from lone pair or negative charge on O in OH^- to C;
curly arrow for Cl leaving;
Can be shown in transition state.

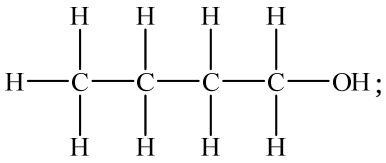
formation of the transition state in bracket, with negative charge and dotted lines to represent bonds;

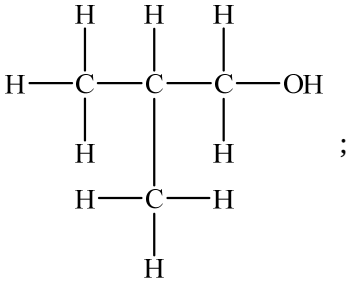
S_N1 2-chloro-2-methylpropane-allow ECF from (iii)



curly arrow showing Cl leaving;
formation of carbocation;
curly arrow from lone pair or negative charge on O in OH^- to C^+ ; ***[6]***

(b) (i)





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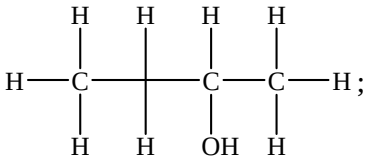

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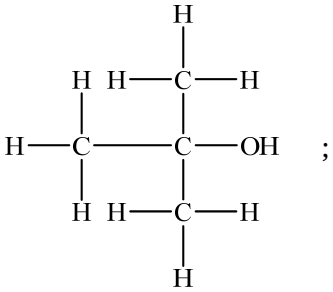


;

[4]

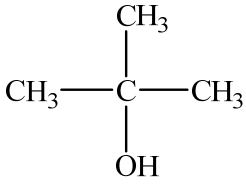
Penalise missing H atoms once only.
Accept correct condensed structural formulas.

(ii) $CH_3–CH_2–CH_2–CHO$ / $(CH_3)_2CHCHO$;
$CH_3–CH_2–CH_2–COOH$ / $(CH_3)_2CHCOOH$; ***[2]***

(iii) $CH_3–CH_2–CO–CH_3$; ***[1]***

(iv) orange to green; ***[1]***

(v)



/ 2-methylpropan-2-ol; ***[1]***