



MARKSCHEME

May 2008

CHEMISTRY

Standard Level

Paper 2

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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	<i>reject</i>
1.6	<i>accept</i>
1.63	<i>accept</i>
1.631	<i>accept</i>
1.6314	<i>reject</i>

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

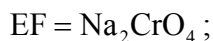
12. If a question specifically asks for the name of a substance, do not award a mark for a correct formula, similarly, if the formula is specifically asked for, do not award a mark for a correct name.
13. If a question asks for an equation for a reaction, a balanced symbol equation is usually expected, 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) increase in concentration of product(s) per unit time; [1]
- (b) volume of gas/carbon dioxide / mass of flask and contents / pH (of solution); [1]
- (c) (i) not enough energy / energy less than activation energy;
wrong collision geometry / *OWTTE*; [2]
- (ii) Experiment 3; [1]
- (iii) (on graph) peak of curve higher and shifted to left;
Do not award mark if curve clearly does not start at zero.
- (on graph) curve after E_a between original curve and x -axis; [2]
- (iv) new mark on x -axis to left of E_a labelled as E_{cat} / other suitable label; [1]
- (v) activation energy lower;
more molecules/collisions with E_a or greater / *OWTTE*; [2]

2. (a) % (of oxygen =) 39.5;

$$\begin{array}{ccc} \text{Na} & \text{Cr} & \text{O} \\ \frac{28.4}{22.99} = & \frac{32.1}{52} = & \frac{39.5}{16} =; \\ 1.24 & 0.617 & 2.47 \end{array}$$



[3]

Accept formula in different order

If % of oxygen incorrect or missing then only award [1] for method.

No penalty for using 23 instead of 22.99

If atomic numbers used instead of atomic masses, or expressions inverted then only award [1] for % of oxygen.

Correct final answer scores [3].

- (b) $(50 \times 0.043) + (52 \times 0.838) + (53 \times 0.095) + (54 \times 0.024);$

This mark can also be awarded for using % values in table and dividing by 100.

$$= 52.06 \text{ or } 52.07;$$

[2]

3. (a) $(K_c =) \frac{[\text{C}_2\text{H}_5\text{OH}(\text{g})]}{[\text{C}_2\text{H}_4(\text{g})][\text{H}_2\text{O}(\text{g})]};$

[1]

Do not award mark if curved brackets are used.

State symbols not needed for mark

- (b) (i) favours reactants / shifted to left / moves in endothermic direction / *OWTTE*;

[1]

- (ii) (sign of ΔH is) negative;

If sign stated to be positive, then no marks can be scored in this part

as (forward) reaction is exothermic;

(extra) heat is absorbed when equilibrium shifts to left;

No credit for just stating Le Chatelier's principle.

[3]

- (c) rate of reaction increased / *OWTTE*;

(because) increased collision frequency / *OWTTE*;

(position of) equilibrium shifted to right / yield (of ethanol) increased;

(because) fewer (gas) moles on right / more (gas) moles on left / *OWTTE*;

[4]

4. (a) (1.0 mol dm⁻³ HCl) A / 0
(1.0 mol dm⁻³ NaOH) F / 14
(0.1 mol dm⁻³ HNO₃) B / 1
(0.1 mol dm⁻³ KOH) E / 13
(0.1 mol dm⁻³ CH₃COOH) C / 3
(0.1 mol dm⁻³ NH₃) D / 10

[3]

Award [3] for all six correct, four or five correct = [2], two or three correct = [1].

- (b) H > G > I;
Accept alternative presentation

(H > G because) H₂SO₄ produces more/twice as many ions as HCl / *OWTTE*;

Accept H > G because H₂SO₄ → 2H⁺ + SO₄²⁻ and HCl → H⁺ + Cl⁻.

Do not accept "H is a stronger acid than G"

(G > I because) HCl stronger than CH₃COOH / CH₃COOH is a weak acid and only partially dissociates / *OWTTE*;

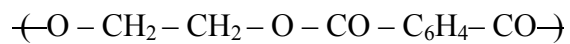
No ECF

[3]

SECTION B

5. (a) (i) $\text{CH}_3\text{CHBrCH}_2\text{CH}_3 / \text{CH}_3\text{CH}_2\text{CHBrCH}_3$;
addition; [2]
- (ii) two enantiomers / mirror-image/non-superimposable forms;
due to presence of chiral/asymmetric centre / four different groups around one
carbon atom;
*These marks can be scored by drawing two correctly related 3-dimensional
diagrams.*
- they rotate (the plane of polarization of) polarized light;
Do not accept bend / refract instead of rotate.
- in opposite directions / clockwise and anticlockwise (by equal amounts); [4]
- (iii) $\sum \text{BE (bonds broken)} = 612 + 366 = 978$;
 $\sum \text{BE (bonds formed)} = 348 + 412 + 276 = 1036$;
 $\Delta H = 978 - 1036 = -58 \text{ (kJ)}$;
ECF from first two answers.
Award [3] for correct final answer.
*Award marks for answer based on breaking four C-H bonds and forming
5 C-H bonds (2626 and 2684).* [3]
- (b) oxidation / redox;
orange to green;
- (for butanal) distillation;
butanal has low(er) boiling point / distils off (first) / prevents further oxidation /
OWTTE;
- (for butanoic acid) heat under reflux;
all butan-1-ol/butanal converted/oxidized to butanoic acid / *OWTTE*; [6]
- (c) $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} + \text{CH}_3\text{OH} \rightleftharpoons \text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_3 + \text{H}_2\text{O}$
correct structure of organic product;
correct formulas of other reactants and product; [2]
Accept \rightarrow , ignore state symbols.

- (d) both (these) reactants have two functional/reactive groups / a reactive/functional group at each end of the molecule / *OWTTE*;
reactants in (c) have only one reactive/functional group per molecule / *OWTTE*;
Accept either of these answers for first mark.



[3 max]

This structure scores [2]

Award [1] for CH₂CH₂ and C₆H₄ and [1] for other atoms and bonds correct.

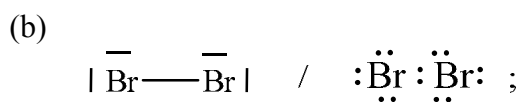
Accept circle-in-hexagon instead of C₆H₄.

Continuation bonds (full or dashed), but not brackets, needed for final mark.

6. (a) Li has one electron in its highest energy level/outer shell / 2.1;
 F has seven electrons in its highest energy level/outer shell / 2.7;
 Li transfers one electron to F;
 both ions formed have complete energy levels/shells / 2 and 2.8;
Above marks can be scored from suitably labelled (outer) electron shell diagrams.

(high melting point due to) strong (electrostatic) attractions between oppositely charged ions / between Li^+ and F^- ;
Do not accept "ionic bonds are strong".

[5]



Award marks for dots and/or crosses

(HBr molecules attracted by) weaker intermolecular forces/van der Waals' forces / has lower M_r / smaller surface area / fewer electrons;
Accept "dipole-dipole attractions in HBr are weaker than van der Waals' forces in Br_2 " but not "HBr has weaker dipole-dipole attractions".

[3]

- (c) lithium nitride is ionic and Li_3N ;
 chlorine(I) oxide is covalent and Cl_2O ;

[2]

- (d) NH_4^+ :
 four electron pairs / charge centres around N;
 all pairs are bonding pairs / no lone pairs;
 tetrahedral;
 109 / 109.5° ;



three electron pairs / charge centres around N / two bonding electron pairs ;
 one lone pair (of electrons);
 V-shaped / bent;
 115° ;

[8]

Accept answer in range 110 – 118° .

The shape and bond angle marks can be scored from diagram.

No marks allocated to describing the VSEPR theory.

- (e) NO_2^- is polar;
 (because it is) unsymmetrical / bond polarities do not cancel / OWTTE;

[2]

7. (a) (i) (electron arrangements) Na 2.8.1 and Na⁺ 2.8;
radius of Na⁺ (much) smaller than that of Na because it has (electrons in) one less energy level/shell / two energy levels/shells but Na has three; [2]
- (ii) (electron arrangements) Na⁺ 2.8 and F⁻ 2.8;
radius of Na⁺ smaller than that of F⁻ because of greater number of protons / nuclear charge in Na⁺ attracting (same number of) electrons; [2]
Accept converse arguments in both parts.
- (b) (i) melting point of Mg greater than that of Na because of greater nuclear charge / number of protons / more delocalized/free electrons;
and greater attraction between (+2 charge on) Mg²⁺ and delocalized/free electrons; [2]
- (ii) melting point of fluorine is less than that of chlorine because of weaker intermolecular/van der Waals' forces;
(which depends on, for F₂) smaller molecules / lower M_r / smaller surface area / fewer electrons; [2]
In (b)(i) and (b)(ii) accept answers based on explanation of why melting point of Na is less than that of Mg, and that of Cl₂ greater than that of F₂.
- (c) $2\text{FeCl}_2 + \text{Cl}_2 \rightarrow 2\text{FeCl}_3$;
(Fe in) FeCl₂ oxidized because it loses electrons / $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$;

(Fe in) FeCl₂ oxidized because its oxidation number increases / changes from +2 to +3;
chlorine/Cl reduced because it gains electrons / $\frac{1}{2}\text{Cl}_2 + \text{e}^- \rightarrow \text{Cl}^-$; [5]

and its oxidation number decreases / changes from 0 to -1;
- (d) *(suitable diagram) with marks awarded as follows:*
beaker / other suitable container labelled as containing lead bromide;
Do not award mark if contents of beaker labelled solution or (aq).
two electrodes labelled with opposite charges;
some indication of power supply, such as battery/power supply;
electrons flow through external circuit/connecting wires;
ions move to (oppositely charged) electrodes;

 $\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$;
 $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}^-$; [7]
Ignore state symbols.
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