M10/4/CHEMI/SP2/ENG/TZ1/XX/M+

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MARKSCHEME

May 2010

CHEMISTRY

Standard Level

Paper 2

15 pages

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) (i) *Copper:*
0 to +2 / increases by 2 / +2 / 2+;
Allow zero/nought for 0.

Nitrogen:
+5 to +4 / decreases by 1 / –1 / 1–; ***[2]***
Penalize missing + sign or incorrect notation such as 2+, 2^+ or II, once only.

(ii) nitric acid/HNO_3 / NO_3^-/nitrate; ***[1]***
Allow nitrogen from nitric acid/nitrate but not just nitrogen.

(b) (i) 0.100×0.0285 ;
2.85×10^{-3} (mol); ***[2]***
*Award **[2]** for correct final answer.*

(ii) 2.85×10^{-3} (mol); ***[1]***

(iii) $(63.55 \times 2.85 \times 10^{-3}) = 0.181$ g ; ***[1]***
Allow 63.5.

(iv) $\left(\frac{0.181}{0.456} \times 100 =\right) 39.7\,\%$; ***[1]***

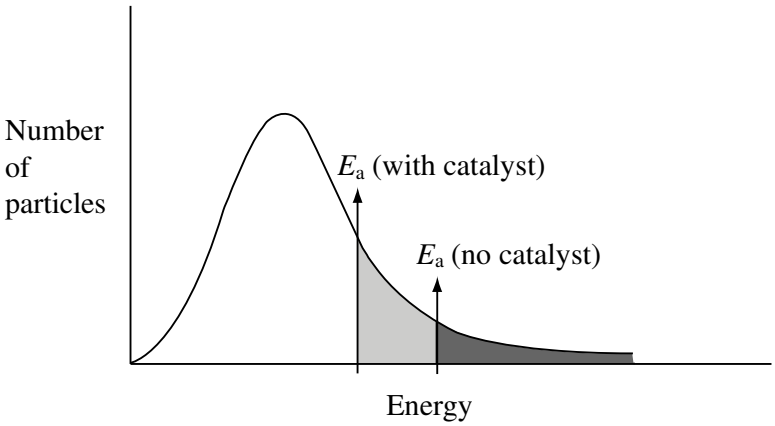
(v) $\left(\frac{44.2 - 39.7}{44.2} \times 100 =\right) 10/10.2\,\%$; ***[1]***
Allow 11.3 % i.e. percentage obtained in (iv) is used to divide instead of 44.2 %.

(c) *Brass has:*
delocalized electrons / sea of mobile electrons / sea of electrons free to move; ***[1]***
No mark for just "mobile electrons".

2. (a) $[I_2]$ does not affect rate / *OWTTE*;
neither correct/both partially correct with explanation as to how; ***[2]***

(b) more particles/molecules have sufficient energy to overcome activation energy / *OWTTE*;
more frequent collisions; ***[2]***

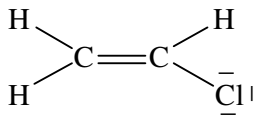
(c) (i)



axes correctly labelled x = energy/velocity/speed, y = number/% of molecules/particles/probability;
graph showing correct curve for Maxwell-Boltzmann distribution;
If two curves are drawn, first and second mark can still be scored, but not third.
Curve(s) must begin at origin and not go up at high energy.

two activation energies shown with E_{cat} shown lower; ***[3]***
Award the mark for the final point if shown on an enthalpy level diagram.

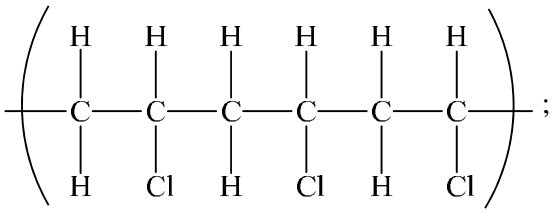
(ii) catalyst provides an alternative pathway of lower energy / *OWTTE*; ***[1]***
Accept catalyst lowers activation energy (of reaction).

3. (a) (i)  ;

Accept lines, dots or crosses for electron pairs.
Lone pairs required on chlorine.

(approximately) 120°; ***[2]***

Accept any bond angle in the range $113 - 120^{o}$.

(ii)  ;

[1]

Brackets not required for mark.
Allow correct condensed structural formula.
Continuation bonds from each carbon are required.
Cl atoms can be above or below carbon spine or alternating above and below.

(iii) plastics are cheap/versatile/a large industry / plastics have many uses / *OWTTE*; plastics are not biodegradeable / plastics take up large amounts of space in landfill / pollution caused by burning of plastics / *OWTTE*; ***[2]***

Do not accept plastics cause litter.
Allow plastics don't decompose quickly / OWTTE.

(b) (i) *Step 1:*

$CH_2CHCl + H_2 \rightarrow CH_3CH_2Cl$;

Step 2:

$CH_3CH_2Cl + OH^- \rightarrow CH_3CH_2OH + Cl^-$; ***[2]***

Allow NaOH or NaCl etc. instead of OH^- and Cl^-.
Allow abbreviated formulas C_2H_3Cl, C_2H_5Cl, C_2H_5OH.

(ii) H_2SO_4/H^+/acidified **and** $Cr_2O_7^{2-}$/(potassium/sodium) dichromate;
Accept suitable oxidizing agents (e.g. $KMnO_4$ etc.) but only with acid.
Ignore missing or incorrect oxidation states in reagents.

(heat under) reflux; ***[2]***
Second mark can be scored even if reagent is incorrect.

(iii) $CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$

OR

$CH_3COOH(l) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$

OR

$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$

correct equation;
state symbols **and** $\rightleftharpoons$;
BL acid is CH_3COOH and cb is CH_3COO^- / BL acid is H_3O^+ and cb is H_2O; ***[3]***

SECTION B

4. (a) average mass of isotopes of an element compared to (1/12 g of) ^{12}C / average mass of an atom relative to C–12 having a mass of exactly 12 / *OWTTE*; ***[1]***
Allow element instead of atom.
Must refer to average mass and C–12.

(b) *Diagram of mass spectrometer containing in the correct sequence:*
vaporization/vaporized sample;
ionization/electron gun;
acceleration/oppositely charged plates;
deflection/magnetic field;
detection; ***[5]***
*Award **[3]** for 5 correct labels, **[2]** for 3–4 correct labels, **[1]** for 2 correct labels.*
*Award **[1]** for correct order for at least 4 correct labels.*
*Award **[1]** for diagram, which must at least show ionization (e.g. electron beam), acceleration (e.g. charged plates) and deflection (e.g. magnetic field) even if these are incorrectly labelled.*

(c) $63x + 65(1–x) = 63.55$;
(or some other mathematical expression).

$^{63}Cu = 72.5$ % **and** $^{65}Cu = 27.5$ %; ***[2]***
*Allow $^{63}Cu = 0.725$ **and** $^{65}Cu = 0.275$.*
*Award **[2]** for correct final answer.*

(d) ^{60}Co /^{131}I /^{125}I; ***[1]***
Must contain correct mass numbers.
Allow other formats such as cobalt-60, Co-60 etc.
Award no marks if a correct radioisotope is given with an incorrect radioisotope.
Allow any other radioisotope if you can verify its use.

(e) $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$ / $Na(s) + H_2O(l) \rightarrow NaOH(aq) + \frac{1}{2}H_2(g)$ ***[2]***
*Award **[1]** for correct balanced equation.*
*Award **[1]** for correct state symbols for sodium, water, sodium hydroxide and hydrogen.*
Second mark is not dependent on equation being correctly balanced.

(f) (Rb more reactive because) electron lost further from nucleus so less tightly held;
Rb electron is in 5th energy level **and** (Na less reactive) as electron lost in 3rd energy level / *OWTTE*; ***[2]***
*Allow **[1 max]** for electron arrangements of Na (e.g. 2,8,1) and Rb if second mark is not scored.*

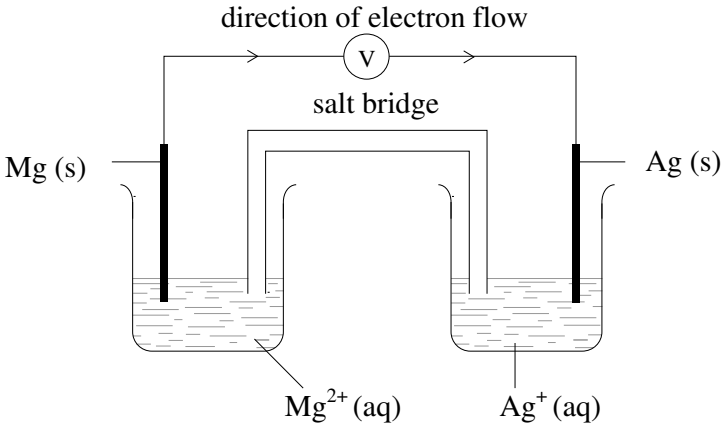
(g) (i) solution becomes yellow/orange/brown/darker;
chlorine is more reactive than iodine (and displaces it from solution) / *OWTTE*; ***[2]***
Allow correct equation $(2KI + Cl_2 \rightarrow 2KCl + I_2)$ for second mark or stating that iodine/I_2 is formed.

(ii) no colour change/nothing happens as fluorine is more reactive than chlorine / *OWTTE*; ***[1]***

(h) *Down group 1:*
metallic bonding gets weaker;
radii/atoms get bigger / delocalized electrons shielded/screened from nucleus by filled shells;

Down group 7:
increased M_r of halogen molecules / *OWTTE*;
intermolecular/van der Waals/London/dispersion forces increase; ***[4]***

5. (a) (i)



correctly labelled electrodes **and** solutions;
labelled salt bridge;
voltmeter;
Allow bulb or ammeter.

direction of electron flow; ***[4]***

(ii) *Oxidation:*
$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^{-}$;

Reduction:
$Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$; ***[2]***

Ignore state symbols.
*Award **[1 max]** if equations not labelled reduction or oxidation or labelled the wrong way round.*
Allow e instead of e^{-}.
Penalize equilibrium sign or reversible arrows once only in parts (a) (ii) and (c) (ii).

(b) (i) Zn > Cd > Ni > Ag
Zn most reactive;
rest of order correct; ***[2]***

(ii) *Best oxidizing agent:*
Ag^{+};
Do not accept Ag.

Best reducing agent:
Zn; ***[2]***
Do not accept Zn^{2+}.

(c) (i) sodium chloride crystals consist of ions in a (rigid) lattice / ions cannot move (to electrodes) / *OWTTE*;
when melted ions free to move / ions move when potential difference/voltage applied; ***[2]***

(ii) positive sodium ions/Na^+ move to negative electrode/cathode **and** negative chloride ions/Cl^- move to positive electrode/anode;

electrons released to positive electrode/anode by negative ions and accepted from negative electrode/cathode by positive ions / reduction occurs at the negative electrode/cathode **and** oxidation occurs at the positive electrode/anode / Na^+ ions are reduced **and** Cl^- ions are oxidized;

(Positive electrode/anode):
$2Cl^- \rightarrow Cl_2 + 2e^-$ / $Cl^- \rightarrow \frac{1}{2}Cl_2 + e^-$;

(Negative electrode/cathode):
$2Na^+ + 2e^- \rightarrow 2Na$ / $Na^+ + e^- \rightarrow Na$; ***[4]***

*Award **[1 max]** if equations not labelled or labelled wrong way round.*
Allow e instead of e^-.
Penalize equilibrium sign or reversible arrows once only in parts (a) (ii) and (c) (ii).

(d) (i) macroscopic properties remain constant / concentrations remain constant / no change to copper solution seen;
rate of reverse/backwards reaction = rate of forward reaction; ***[2]***

(ii) K_c decreases;
position of equilibrium shifts to left; ***[2]***

6. (a) (i) $100 \times 4.18 \times 35.0$;
14630 J / 14600 J / 14.6 kJ; ***[2]***
*Award **[2]** for correct final answer.*
No ECF here if incorrect mass used.

(ii) $\frac{1.78}{46.08} = 0.0386 \text{ mol}$;

$\frac{14.6}{0.0386} = (-)378 \text{ kJ mol}^{-1}$; ***[2]***

Accept (–)377 and (–)379 kJ mol^{-1}.
*Award **[2]** for correct final answer.*

(iii) heat loss;
incomplete combustion;
heat absorbed by calorimeter not included; ***[2 max]***
Accept other sensible suggestions.

(b) same general formula;
same functional group;
successive members differ by CH_2;
Allow methylene for CH_2.

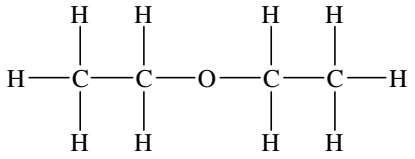
similar chemical properties;
gradually changing physical properties; ***[2 max]***

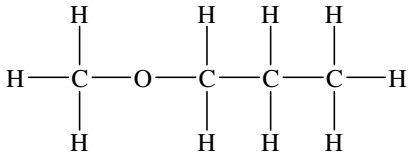
(c) (i) **A**: butan-1-ol;
B: butan-2-ol;
C: (2-)methylpropan-2-ol;
D: (2-)methylpropan-1-ol; ***[4]***
Accept answers in the form of 1-butanol and 2-methyl-2-propanol etc.
Penalize incorrect punctuation, e.g. commas for hyphens, only once.

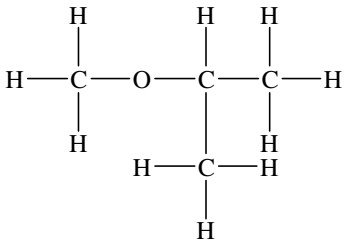
(ii) **C/**(2-)methylpropan-2-ol; ***[1]***

(iii) **A/**butan-1-ol; ***[1]***

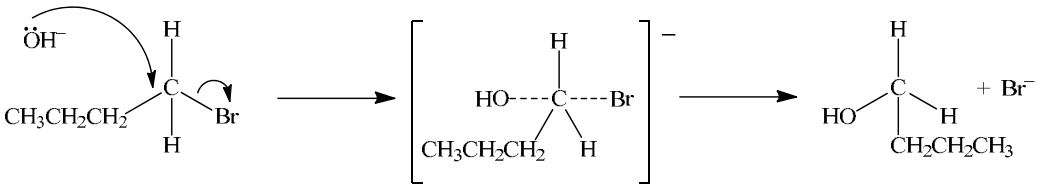
(iv) **B/**butan-2-ol; ***[1]***

(v)  / $CH_3CH_2OCH_2CH_3$ /

 / $CH_3OCH_2CH_2CH_3$ /

 / $CH_3OCH(CH_3)_2$; ***[1]***

(d) (i) S_N2; ***[1]***

(ii) 

curly arrow going from lone pair/negative charge on O in OH^- to C;
Do not allow curly arrow originating on H in OH^-.

curly arrow showing Br leaving;
Accept curly arrow either going from bond between C and Br to Br in 1-bromobutane or in the transition state.

representation of transition state showing negative charge, square brackets and partial bonds; ***[3]***
Do not penalize if HO and Br are not at 180° to each other.
Do not award third mark if OH----C bond is represented.