M13/4/CHEMI/SP2/ENG/TZ1/XX/M

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MARKSCHEME

May 2013

CHEMISTRY

Standard Level

Paper 2

10 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.

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) 0.675 (g) ± 0.002 (g);
Percentage uncertainty: 0.3 %; ***[2]***
Accept answers correct to one, two or three significant figures for percentage uncertainty.

(b) *In 25.0 cm³:* $n_{HA} = 1.21 \times 10^{-3}$ (mol);
In 100 cm³: $n_{HA} = 4.84 \times 10^{-3}$ (mol);
$M\left(= \frac{0.675}{4.84 \times 10^{-3}}\right) = 139\,(g\,mol^{-1})$; ***[3]***
*Award **[3]** for correct final answer.*
Accept suitable alternative methods.

(c) n_C: $\left(\frac{70.56}{12.01} =\right) 5.88$ **and** n_O: $\left(\frac{23.50}{16} =\right) 1.47$ **and** n_H: $\left(\frac{5.94}{1.01} =\right) 5.88$;
C_4H_4O; ***[2]***
*Award **[2]** for correct final answer.*
Accept answers using integer values of molar mass.

(d) weak acids partially dissociated/ionized **and** strong acids completely dissociated/ ionized (in solution/water) / *OWTTE*; ***[1]***

(e) measuring electrical conductivity;
strong acids have greater electrical conductivity / weak acids have lower electrical conductivity;

OR

adding a reactive metal / carbonate / hydrogen carbonate;
Accept correct example.

stronger effervescence with strong acids / weaker with weak acids / *OWTTE*;

OR

adding a strong base;
Accept correct example.

strong acid would increase more in temperature / weak acids increase less in temperature; ***[2]***

2. (a) decreases (from left to right/across period 3);
same number of shells/energy levels / shielding effect remains the same;
number of protons/nuclear charge increases so attraction of nucleus on outer electrons increases / *OWTTE*; ***[3]***

(b) hypothesis is wrong since ionic radius should be smaller than atomic radius/110×10^{-12} m;
greater attraction of the nucleus on outer electrons / effective charge of nucleus greater / repulsive forces between electrons smaller; ***[2]***

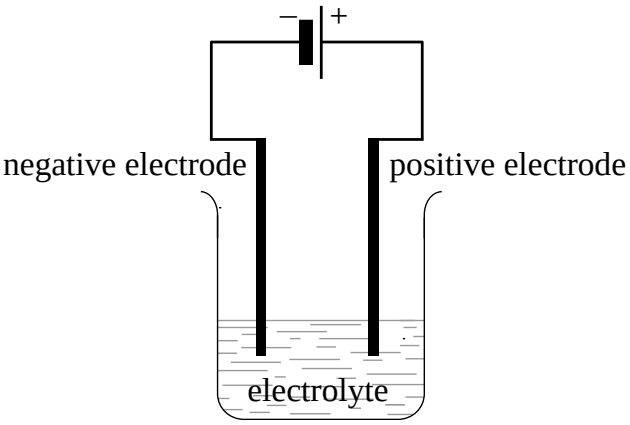
3. (a)

	Sodium	**Sodium chloride**
State of matter	solid (and liquid)	liquid / aqueous/solution ;
Particles that conduct the current	electrons	Ions / Na^+ **and** Cl^- ;
Reaction occurring	no reaction occurs	(redox) reaction occurs / electrolysis ;

[3]

*Award **[1]** for each feature that is correct for both sodium **and** sodium chloride.*
Accept equation or half-equations for the reaction of sodium chloride in "reaction occurring".

(b)



clear diagram containing all elements (power supply, connecting wires, electrodes, container and electrolyte);
labelled positive electrode/anode **and** negative electrode/cathode;
Accept positive and negative by correct symbols near power supply.
Accept power supply if shown as conventional long/short lines (as in diagram above) or clearly labelled DC power supply.

labelled electrolyte/NaCl(l); ***[3]***
State of NaCl not needed.

(c) production of aluminium/chlorine/lithium/magnesium/hydrogen/sodium hydroxide/ sodium chlorate / electroplating / purification of metals; ***[1]***
Do not allow production of sodium.

4. (a) loss of electrons; ***[1]***

(b) *Carbon:*
III to IV / +3 to +4 / (+)1;

Manganese:
VII to II / +7 to +2 / –5; ***[2]***
Penalize incorrect notation such as 3+ once only.

(c) *Oxidizing agent:* MnO_4^- **and** *Reducing agent:* $(COOH)_2$; ***[1]***
Accept correct names instead of formulas.
Do not accept Mn and C.

5. (a) butan-2-ol/2-butanol; ***[1]***

(b) $CH_3CH_2CH_2CH_2OH$;
$(CH_3)_2CHCH_2OH$;
$(CH_3)_3COH$; ***[2 max]***
Accept condensed or full structural formulas.
Penalise missing H atoms or incorrect bonds (such as C–HO, C–H_2C) only once in the whole paper.

(c) $C_2H_5CHOHCH_3 + [O] \rightarrow C_2H_5COCH_3 + H_2O$; ***[1]***
Accept condensed or full structural formulas.
Accept [O] on top of the arrow.
Do not accept equation without H_2O.
Do not accept equation with $H^+/Cr_2O_7^{2-}$.

SECTION B

6. (a) (i) atoms of the same element/with the same number of protons/with same atomic number but different number of neutrons/mass number/mass; ***[1]***

(ii) $10x + 11(1-x) = 10.81$, $x = 0.19$;
Accept similar method.

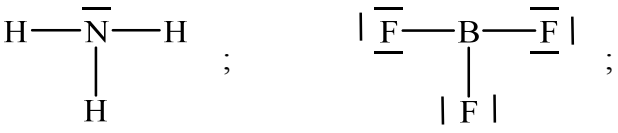
^{10}B: 19% **and** ^{11}B: 81%; ***[2]***

(b) (i) ***R***: acceleration **and** ***S***: deflection; ***[1]***

(ii) *Protons:* 5 **and** *Neutrons:* 6;
Electron arrangement: 2,2 / $1s^2\,2s^2$; ***[2]***
Allow suitable diagram.

(iii) ^{12}C/carbon-12; ***[1]***

(c) (i) *NH_3* *BF_3*



[2]
Accept any combination of lines, dots or crosses to represent electron pairs.

(ii) sharing of electrons between atoms; ***[1]***

(iii) *NH_3:* (trigonal/triangular) pyramidal;
BF_3: trigonal/triangular planar;
NH_3 has 4 negative centres of charge/three bonding pairs and one lone pair **and** BF_3 has 3 negative centres of charge/three bonding pairs / *OWTTE*;
(bond angles) 107° in NH_3 **and** 120° in BF_3; ***[4]***
Accept 107.5° for NH_3.

(iv) BF_3 not polar as no net dipole moment / BF bond polarities cancel each other out / symmetrical distribution of charge;
NH_3 polar as net dipole moment present / NH bond polarities do not cancel each other out / unsymmetrical distribution of charge; ***[2]***
Accept suitable diagram showing dipole moments.
Do not accept electronegativities cancel out.

(d) (i) electron pair acceptor; ***[1]***

(ii) *NH_3:* Lewis base;
BF_3: Lewis acid;
NH_3 has non-bonding/lone pair of electrons **and** BF_3 has only 3 pairs of electrons around B/incomplete octet; ***[3]***
Reference to outer electrons of N and B is needed for the mark.

7. (a) (i) ($q = mc\Delta T =$) $0.0500 \times 4.18 \times 21.3 = 4.45$ (kJ);
Do not accept m = 0.05023 kg.

(n *methanol* =) $\frac{0.230}{32.05} = 7.18 \times 10^{-3}$ (mol);

$\Delta H = \frac{4.45}{7.18 \times 10^{-3}}$;

$\Delta H = -6.20 \times 10^{2}$ kJ mol^{-1}; ***[4]***

Accept integer values of molar mass.
Final answer must have negative sign and correct units.
*Award **[4]** for correct final answer with correct units.*

(ii) less heat is liberated than theoretically/–726 kJ mol^{-1};
probably due to heat loss/incomplete combustion;
determine heat capacity of calorimeter and take heat absorbed by calorimeter into account / any suitable insulation method / measure temperature with time and extrapolation of graph to compensate heat loss / *OWTTE*; ***[3]***
If the value calculated in (a) (i) is more exothermic than theoretically, allow ECF for M1 and for improvement if consistent.

(b) $\Delta H^{\ominus} = \frac{1}{2}\text{II} + \text{III} - \frac{1}{2}\text{I}$ / correct diagram/energy cycle;
–283 – 572 – (–726);
–129 (kJ mol^{-1}); ***[3]***
*Award **[3]** for correct final answer.*

(c) (i) rate of forward reaction equals rate of backward reaction;
concentrations of reactants and products do not change / constant macroscopic properties; ***[2]***

(ii) $K_c = \frac{[CH_3OH]}{[CO][H_2]^2}$; ***[1]***
Do not award mark if incorrect brackets are used or brackets omitted.

(iii) Haber process/production of NH_3 / contact process/production of H_2SO_4; ***[1]***
Accept suitable equation.

(d) (i) shifts to left/reactants;
to endothermic side / (forward) reaction is exothermic; ***[2]***

(ii) shifts to the right/products;
to the side with fewer gas molecules/moles of gas; ***[2]***

(iii) no effect on equilibrium;
rate of forward and backward reaction increase equally / activation energy of forward and backward reaction lowered equally; ***[2]***

8. (a) (i) same functional group / same general formula;
difference between successive members is CH_2;
similar chemical properties;
Do not accept "same" chemical properties.

gradually changing physical properties; ***[3 max]***

(ii) adding bromine (water);
ethene: brown/orange to colourless / decolourizes bromine water **and**
ethane: does not change colour; ***[2]***

OR

adding acidified potassium permanganate solution/$KMnO_4(aq)$;
ethene: purple to colourless/brown **and**
ethane: does not change colour;

OR

adding Baeyer's reagent;
ethene: purple/pink to brown **and**
ethane: does not change colour;

Do not accept "clear" or "transparent" for "colourless".

(iii) $C_2H_4 + HBr \rightarrow C_2H_5Br$;
$C_2H_6 + Br_2 \rightarrow C_2H_5Br + HBr$; ***[2]***
Accept structural formulas.
Penalise missing H atoms or incorrect bonds (such as C–HO, C–H_2C) in structural formulas only once in the paper.

(b) (i) $C_4H_9Br + OH^- \rightarrow C_4H_9OH + Br^-$; ***[1]***
Accept NaOH in the equation.

(ii) decreases; ***[1]***

(c) (i) *C_4H_9Br:*
$[C_4H_9Br]$ doubles **and** time halves/rate doubles / rate proportional to $[C_4H_9Br]$;
Do not accept rate increases when [C_4H_9Br] increases.

NaOH:
[NaOH] doubles **and** time/rate does not change / rate independent of [NaOH]; ***[2]***

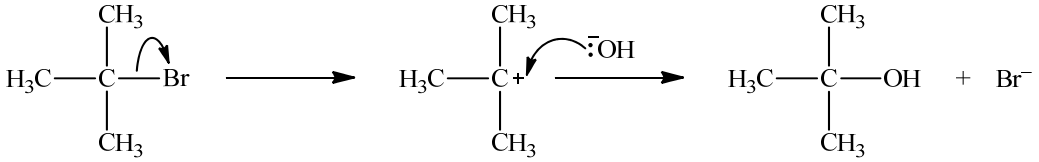
(ii) increases rate; ***[1]***
Accept increases number of collisions.

(iii) rate depends on $[C_4H_9Br]$ only / rate does not depend on $[OH^-]$ / S_N1 reaction / first order reaction / if it was primary, reaction would be S_N2;
tertiary; ***[2]***
Accept ECF.

(iv) $(CH_3)_3CBr$; ***[1]***
Allow both condensed and full structural formula.
Accept ECF.

(v) $C_4H_9Br + Br_2 \rightarrow C_4H_8Br_2 + HBr$; ***[1]***

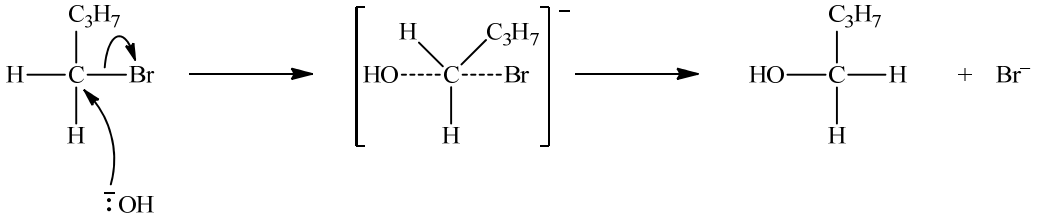
(d)



curly arrow showing Br^- leaving;
representation of tertiary carbocation;
curly arrow going from lone pair/negative charge on O in ^-OH to C^+;
Do not allow arrow originating on H in ^-OH.

formation of $(CH_3)_3COH$ **and** Br^-; ***[4]***
Accept Br^- anywhere on product side in the reaction scheme.

If primary halogenoalkane has been answered in (c)(iii) apply ECF for the mechanism:



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 bromobutane or in the transition state.

representation of transition state showing negative charge, square brackets and partial bond;
Do not penalize if HO and Br are not at 180° to each other.
Do not award M3 if OH—C bond is represented.

formation of organic product C_4H_9OH **and** Br^-;
Accept Br^- anywhere on product side in the reaction scheme.