M11/4/CHEMI/SP2/ENG/TZ2/XX/M

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MARKSCHEME

May 2011

CHEMISTRY

Standard Level

Paper 2

13 pages

General Marking Instructions

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. 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.

9. Only consider units at the end of a calculation.

10. Significant digits should only be considered in the final answer. Penalize 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*

11. 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.

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.

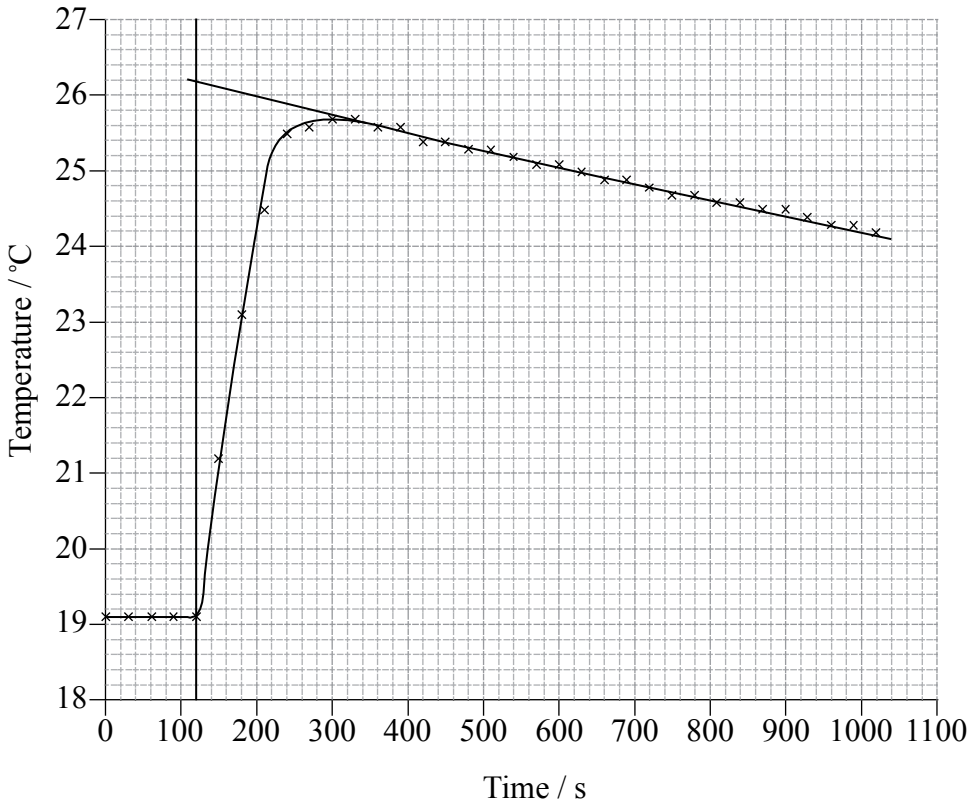
13. Ignore missing or incorrect state symbols in an equation unless directed otherwise in the markscheme.

SECTION A

1. (a) (i) $\text{amount} = \frac{3.99}{159.61} = 0.0250\,(\text{mol})$; ***[1]***

(ii) $26.1\,(^\circ\text{C})$;
Accept answers between 26.0 and 26.2 (°C).

$\text{temperature rise} = 26.1 - 19.1 = 7.0\,(^\circ\text{C})$; ***[2]***
Accept answers between 6.9 °C and (7.1 °C).
*Award **[2]** for the correct final answer.*
No ECF if both initial and final temperatures incorrect.



(iii) $\text{heat change} = \frac{50.0}{1000} \times 4.18 \times 7.0 / 50.0 \times 4.18 \times 7.0$;
Accept 53.99 instead of 50.0 for mass.

$= 1.5\,(\text{kJ})$; ***[2]***
Allow 1.6 (kJ) if mass of 53.99 is used.
Ignore sign.

(iv) $\Delta H_1 = -\frac{1.5}{0.0250} = -60\,(\text{kJ mol}^{-1})$; ***[1]***
Value must be negative to award mark.
Accept answers in range –58.0 to –60.0.
Allow –63 (kJ mol^{-1}) if 53.99 g is used in (iii).

(b) (i) (amount of $CuSO_4 \cdot 5H_2O = \frac{6.24}{249.71}$ =) 0.0250 (mol);
(amount of H_2O in 0.0250 mol of $CuSO_4 \cdot 5H_2O = 5 \times 0.0250$ =) 0.125 (mol). ***[2]***

(ii) $(50.0 \times 4.18 \times 1.10 =)$ 230 (J);
$\left(\frac{229.9}{(1000 \times 0.0250)} =\right) + 9.20$ (kJ); ***[2]***
Accept mass of 47.75 or 53.99 instead of 50.00 giving answers of +.8.78 or +9.9.
Do not penalize missing + sign but penalize – sign unless charge already penalized in (a) (iv).

(iii) $(\Delta H_x = \Delta H_1 - \Delta H_2 = -58.4 - (+9.20) =) - 67.6$ (kJ mol^{-1}); ***[1]***

(c) (i) $\frac{[-78.0 - (-67.6)]}{-78.0} \times 100 = 13.3\%$; ***[1]***
If 70.0 kJ mol^{-1} is used accept 10.3%.

(ii) the anhydrous copper(II) sulfate had already absorbed some water from the air / *OWTTE*;
the value would be less exothermic/less negative than expected as the temperature increase would be lower / less heat will be evolved when the anhydrous salt is dissolved in water / *OWTTE*; ***[2]***
Do not accept less <u>without</u> a reason.

2. (a) (i) +3; ***[1]***
Do not accept 3, 3+ or the use of Roman numerals.

(ii) +5 / –3; ***[1]***
*Penalize incorrect format **only** if not penalized in (a)(i).*

(b) (i) $Sb_2S_3 + 4\frac{1}{2}O_2 \rightarrow Sb_2O_3 + 3SO_2$ / $2Sb_2S_3 + 9O_2 \rightarrow 2Sb_2O_3 + 6SO_2$;
$2Sb_2O_3 + 3C \rightarrow 4Sb + 3CO_2$ / $Sb_2O_3 + 3C \rightarrow 2Sb + 3CO$; ***[2]***
Ignore state symbols.

(ii) the SO_2 causes acid rain / *OWTTE*;
the CO_2 is a greenhouse gas/causes global warming / *OWTTE*;
CO is a poisonous gas / *OWTTE*; ***[2 max]***

3. (a) (let $x =$ fraction of ^{85}Rb)
$\frac{(x \times 85) + [(100 - x) \times 87]}{100} = 85.47$;
$^{85}Rb = 76.5\ \%$ **and** $^{87}Rb = 23.5\ \%$; ***[2]***
*Award **[2]** for correct final answer.*

(b) the (vaporized) ions are deflected by the (external) magnetic field;
the ^{85}Rb /lighter ions are deflected more than the ^{87}Rb /heavier ions / *OWTTE*;
Allow deflection depends on mass to charge ratio or momentum of ions.

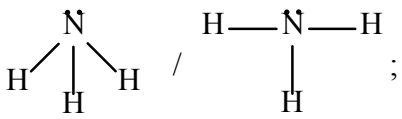
the ions are detected by conversion into an electrical current / *OWTTE*;
the ratio of the intensity of the peaks in the spectrum is equal to the ratio of the ions in the sample / the ratio of the height of the peaks due to ^{85}Rb and ^{87}Rb will be 76.5:23.5 / *OWTTE*; ***[3 max]***
If atoms/elements used instead of ions, penalize only once.
Allow the use of sample or isotopes instead of ions.

(c) 37 (electrons);
50 (neutrons); ***[2]***

4. methoxymethane is very weakly polar
weak van der Waals'/dipole-dipole forces exist between methoxymethane molecules;
Accept alternatives to van der Waals' such as London and dispersion forces.

ethanol contains a hydrogen atom bonded directly to an electronegative oxygen atom / hydrogen bonding can occur between two ethanol molecules / intermolecular hydrogen bonding in ethanol;
the forces of attraction between molecules are stronger in ethanol than in methoxymethane / hydrogen bonding stronger than van der Waals'/dipole-dipole attractions; ***[3 max]***
*Award **[2 max]** if covalent bonds breaking during boiling is mentioned in the answer.*
Penalize only once if no reference given to intermolecular nature of hydrogen bonding or van der Waal is missing.

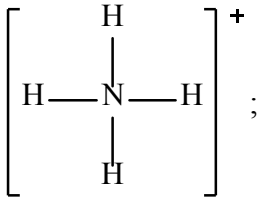
SECTION B

5. (a) (i)  ;

Accept any combination of dots/crosses and lines to represent electron pairs.

(trigonal/triangular) pyramid;
Allow 3D representation using wedges and dotted bonds of trigonal pyramidal molecule.
107°; ***[3]***

Accept any angle between 105° and 108.5°.
No ECF for shape based on incorrect Lewis structure.

(ii)  ;

Charge needed for mark.

tetrahedral;
Allow a 3D representation using wedges and dotted bonds of tetrahedral molecule.

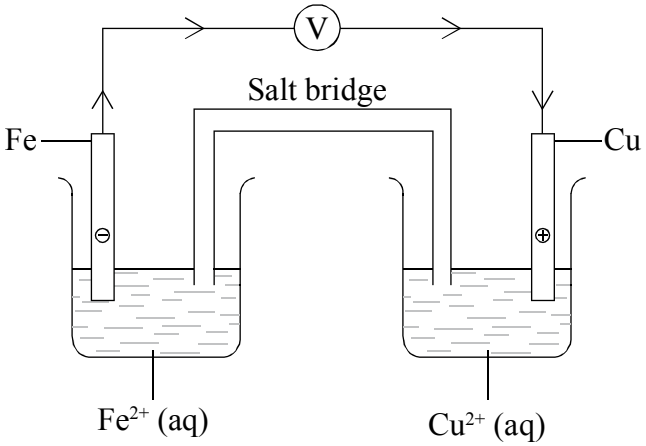
109.5° / 109° / 109° 28'; ***[3]***
No ECF for shape based on incorrect Lewis structure.

(iii) a Lewis acid can accept a pair of electrons;
it is a Lewis base as it can donate the lone/non-bonding pair of electrons (on the N atom); ***[2]***
Do not award second mark for simply stating it is a Lewis base with no reason given.

(iv) (measuring) the pH / the strong acid solution will have a lower pH;
conductivity (measurement) / the strong acid will be a better conductor;
the strong acid will react more vigorously with metals/carbonates / the reaction with metals/carbonates;
the heat change when it is neutralized with a base will be different / heat of neutralization / *OWTTE*; ***[2 max]***

(v) water can act as a Brønsted-Lowry acid by donating a proton/H^+ to form OH^-;
water can act as a Brønsted-Lowry base by accepting a proton/H^+ to form H_3O^+; ***[2]***
Accept equations showing the above clearly labelling the acid and basic behaviour and the conjugate acid or base.
*Award **[1 max]** for correct definition of how water can act as a Brønsted-Lowry acid or base.*

(b) (i)



correct diagram including voltmeter/meter, 4 correct species (state symbols not required) and connecting wires;
No credit if wires to electrodes immersed in the solutions.

labelled salt bridge;
Do not accept name of salt (e.g. potassium nitrate) in place of salt bridge.

correctly labelled electrodes (+)/cathode and (–)/anode;
flow of electrons from Fe to Cu in external circuit; ***[4]***

(ii) positive electrode: $Cu^{2+} + 2e^- \rightarrow Cu$;
negative electrode: $Fe \rightarrow Fe^{2+} + 2e^-$; ***[2]***
*Award **[1]** if equations correct but at wrong electrodes or if electrodes are missing.*
*Award **[2]** for correct equations if electrodes are missing but were correctly labelled in diagram.*
Accept e instead of e^-.
Ignore state symbols.
Penalize ⇌ once only in equations in (ii) and (iii).

(iii) $Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$;
Ignore state symbols.

Cu^{2+} is the oxidizing agent **and** the species that is reduced; ***[2]***

6. (a) (i) reactants and products in same phase/state;
rate of forward reaction = rate of reverse reaction;
concentrations of reactants and products remain constant / macroscopic properties remain constant; ***[2 max]***
Do not accept concentrations are equal.

(ii) $(K_c) = \frac{[HI]^2}{[H_2][I_2]}$; ***[1]***

(iii) no change to position of equilibrium;
no change to value of K_c; ***[2]***

(iv) the reaction is exothermic/heat is given out/ ΔH is negative; ***[1]***

(v) no effect (on the value of the equilibrium constant);
as it speeds up forward and reverse reaction / concentrations of reactants and products do not change / position of equilibrium does not change / no change in yield; ***[2]***

(b) (i) nickel / platinum / paladium;
150 – 200 °C / heat; ***[2]***
Accept temperatures in this range.
Accept room temperature as an answer if platinum or palladium used.

(ii) the enthalpy change when (one mole of) the gaseous bond is broken (or formed) / $X–Y(g) \rightarrow X(g) + Y(g)$ / $X(g) + Y(g) \rightarrow X–Y(g)$;
averaged for the same bond in a number of similar compounds / *OWTTE*; ***[2]***

(iii) energy in: C=C + H–H **and** energy out: C–C + 2C–H;
Accept energy in C–C + 6C–H + C=C + H–H and energy out 2C–C + 8C–H.

$\Delta H = (612 + 436) - (347 + 826) = 1048 - 1173 / -125\ (kJ\,mol^{-1})$; ***[2]***
*Award **[2]** for correct final answer.*
*Award **[1]** for +125.*
If old Data Booklet values then allow: $\Delta H = 1048 - 1172 = -124\ (kJ\ mol^{-1})$

(iv) due to the relative strength of the C–C and 2C–H bonds compared to the C=C and H–H bonds / bonds in products stronger than bonds in reactants; ***[1]***

(c) (i) addition of bromine/bromine water;
the bromine colour remains with propane **and** propene decolourizes the bromine / solution changes from brown to colourless; ***[2]***
Do not accept "clear" instead of "colourless".

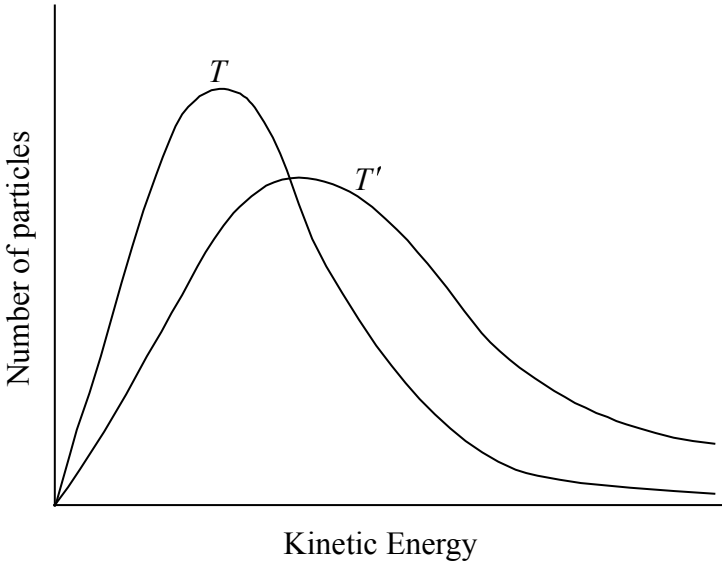
(ii) addition (polymerization);
$-(-CH(CH_3)-CH_2-)-$ / $-CH(CH_3)CH_2-$; ***[2]***
Continuation bonds necessary for mark, displayed formula or condensed structural formula can be given.
Accept if more than one repeating unit is shown.

(iii) hydrogenation (of vegetable oils) / manufacture of margarine / manufacture of ethanol / addition of water; ***[1]***
Accept manufacture of alcohol.
Do not accept hydrogenation of alkenes.

7. (a) (i) increase in concentration of product per unit time / decrease in concentration of reactant per unit time; ***[1]***
Accept change instead of increase/decrease and mass/amount/volume instead of concentration.

(ii) frequency of collisions;
kinetic energy/speed of reactant particles;
collision geometry/orientation; ***[3]***

(iii)



correctly labelled axes showing number of particles/frequency against (kinetic) energy;
correctly shaped graph for *T* (curve must not touch or cross *x* axes);
T′ curve to the right of *T* and with a peak lower than *T*;
increasing the temperature increases the (kinetic) energy of the particles / more particles will possess the necessary activation energy;
there will be more collisions per unit time / the frequency of collisions increases / there are more successful collisions; ***[5]***

(iv) the dust has a greatly increased surface area / more of the coal can come into contact with the oxygen molecules when it is in dust form / *OWTTE*; ***[1]***

(b) (i) $C_3H_8O + 4\frac{1}{2}O_2 \rightarrow 3CO_2 + 4H_2O / 2C_3H_8O + 9O_2 \rightarrow 6CO_2 + 8H_2O$ ***[2]***

*Award **[1]** for correct products and reactants and **[1]** for correct balancing. Ignore state symbols.*

(ii) acidic solution / H^+ / sulfuric acid;
warm / heat / reflux;
(the solution changes) from orange to green; ***[3]***

(iii) CH_3CH_2CHO and propanal;
CH_3CH_2COOH and propanoic acid;
CH_3COCH_3 and propanone/acetone;
*Award **[1]** for 2 or 3 correct names or structures, award **[2]** for 4 or 5 correct names or structures.*

propan-1-ol gives propanal and propanoic acid and propan-2-ol gives propanone;
propan-1-ol has two H atoms bonded to the C containing the –OH whereas propan-2-ol only has one / propan-1-ol is a primary alcohol and propan-2-ol is a secondary alcohol; ***[5]***