MARKSCHEME

May 2005

CHEMISTRY

Standard Level

Paper 2

11 pages

Subject Details: Chemistry SL Paper 2 Markscheme

General

- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- Alternative answers are separated by a slash (/) – this means that either answer is acceptable.
- Words underlined are essential for the mark.
- Material in brackets (…) is not needed for the mark.
- The order in which candidates score marks does not matter (unless stated otherwise).
- The use of ***OWTTE*** in a markscheme (the abbreviation for "or words to that effect") means that if a candidate's answer contains words different to those in the markscheme, but which can be interpreted as having the same meaning, then the mark should be awarded.
- Please remember that many candidates are writing in a second language, and that effective communication is more important than grammatical accuracy.
- In some cases there may be more acceptable ways of scoring marks than the total mark for the question part. In these cases, tick each correct point, and if the total number of ticks is greater than the maximum possible total then write the maximum total followed by **MAX**.
- In some questions an answer to a question part has to be used in later parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in later parts then "follow through" marks can be scored. Show this by writing **ECF** (error carried forward). This situation often occurs in calculations but may do so in other questions.
- Units for quantities should always be given where appropriate. In some cases a mark is available in the markscheme for writing the correct unit. In other cases the markscheme may state that units are to be ignored. Where this is not the case, penalize the omission of units, or the use of incorrect units, once only in the paper, and show this by writing **–1(U)** at the first point at which it occurs.
- Do not penalize candidates for using too many significant figures in answers to calculations, unless the question specifically states the number of significant figures required. If a candidate gives an answer to fewer significant figures than the answer shown in the markscheme, penalize this once only in the paper, and show this by writing **–1(SF)** at the first point at which this occurs.
- 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.
- 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 the question specifically asks for this. In some cases, where more complicated equations are to be written, more than one mark may be available for an equation – in these cases follow the instructions in the mark scheme.
- Ignore missing or incorrect state symbols in an equation unless these are specifically asked for in the question.
- Mark positively. Give candidates credit for what they have got correct, rather than penalizing them for what they have got wrong.
- If candidates answer a question correctly, but by using a method different from that shown in the markscheme, then award marks; if in doubt consult your Team Leader.

SECTION A

1. (a) exothermic because temperature rises / heat is released; ***[1]***

(b) to make any heat loss as small as possible / so that all the heat will be given out very quickly; ***[1]***
Do not accept "to produce a faster reaction".

(c) heat released $=$ mass $\times$ specific heat capacity $\times$ temp increase / $q = mc\Delta T$ / $100 \times 4.18 \times 3.5$;
= 1463 J / 1.463 kJ; *(allow 1.47 kJ if specific heat = 4.2)*
amount of KOH / HCl used $= 0.500 \times 0.050 = 0.025$ mol;
$\Delta H = (1.463 \div 0.025) = -58.5$ (kJ mol^{-1}); *(minus sign needed for mark)* ***[4]***
Use ECF for values of q and amount used.
*Award **[4]** for correct final answer.*
*Final answer of 58.5 or +58.5 scores **[3]**.*
Accept 2,3 or 4 significant figures.

(d) heat loss (to the surroundings);
insulate the reaction vessel / use a lid / draw a temperature versus time graph; ***[2]***

(e) 3.5 °C / temperature change would be the same;
amount of base reacted would be the same / excess acid would not react / KOH is the limiting reagent; ***[2]***

2. (a) mole ratio $C:H = \frac{85.6}{12.01} : \frac{14.4}{1.01} = 7.13 : 14.3$;

No penalty for using integer atomic masses.

empirical formula is $\underline{CH_2}$; ***[2]***

(b) (i) number of moles of gas $n = \frac{PV}{RT} = \frac{\text{mass}}{\text{molar mass}}$; $\frac{1.01 \times 10^2 \text{kPa} (.399 \text{ dm}^3)}{8.314 \frac{\text{J}}{\text{mol K}} (273 \text{ K})}$;

$\frac{1.00\text{g}}{.017 \text{ mol}} = 56.3 \text{ (g mol}^{-1})$ ***[2]***

OR

molar mass is the $\frac{\text{mass of the molar volume}}{22.4 \text{ dm}^3}$ at STP;

$= \frac{1.00 \times 22.4}{0.399} = 56.1 \text{ (g mol}^{-1})$;

Accept answers in range 56.0 to 56.3.

Accept two, three or four significant figures.

(ii) C_4H_8; ***[1]***

No ECF.

(c) carbon monoxide / carbon is produced;

CO is toxic / poisonous / forms carboxyhemoglobin / interferes with oxygen transport in the body;

carbon (soot) is harmful to the respiratory system; ***[2 max]***

*Award **[1]** each for any two.*

3. (a) the particles/molecules of ammonia gas are in rapid/random/constant motion;
and will diffuse/spread out / *OWTTE*; ***[2]***

(b) less time;
(the particles/molecules of ammonia gas will have) greater velocity/greater kinetic energy/greater rate of diffusion/move faster; ***[2]***
Do not accept "greater energy".

4. (a) molecules must have sufficient/minimum energy / energy $\geq$ activation energy;
appropriate collision geometry / correct orientation; ***[2]***

(b) increased frequency of collisions / collisions more likely;
Not just "more collisions", there must be a reference to time.
increased proportion of molecules with sufficient energy to react / $E \geq E_a$;
Not "activation energy is reduced".
Proportion of molecules with $E \geq E_a$ is more important; *(dependent on correct second marking point)*; ***[3]***

5.

structural formula	name
$CH_3CH_2CH_2CH_3$;	butane / n-butane;
$CH_3CH(CH_3)CH_3$;	(2)-methylpropane;

[4]

Accept more detailed formulas, penalizing missing H atoms once only.
*If more than these two formulas given, subtract **[1]** for each extra formula.*
Mark names separately. Accept these two names only.

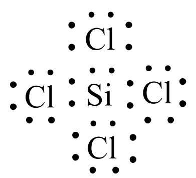
SECTION B

6. (a) (i) $W^{3+}Y^{3-}$;
*Award **[1]** for formula (WY) and **[1]** for charges* (W:3+Y:3-) ***[2]***
*Accept WY, charges W: 3+ Y: 3– for **[2]**.*
Answers must be in terms of W and Y.

(ii) XZ_2; ***[1]***
Accept XZ.
Answers must be in terms of X and Z.

(b) 7 protons, 8 neutrons, 10 electrons; ***[2]***
*Award **[2]** for three correct and **[1]** for two correct.*

(c) Si—Cl bonds are covalent;



[3]

Accept lines for electron pairs.
*Award **[1]** for covalent bonds and **[1]** for lone pairs.*

(d) find number of electron pairs/charge centres in (valence shell of) <u>central atom</u>;
electron pairs/charge centres (in valence shell) of central atom repel each other;
to positions of minimum energy/repulsion / maximum stability;
pairs forming a double or triple bond act as a single bond;
non-bonding pairs repel more than bonding pairs / *OWTTE*; ***[3 max]***
Do not accept repulsion between bonds or atoms.
*Award **[1]** each for any three points.*

(e) (i) SCl_2 two bonding pairs, two non-bonding pairs;
angular / bent / non-linear / V-shaped;
Both these marks can be scored from a diagram.
$90° <$ angle $< 107°$;

C_2Cl_2 two charge centres around each C;
linear;
Both these marks can be scored from a diagram
angle $= 180°$; ***[6]***

(ii) SCl_2 is polar;
C_2Cl_2 is non-polar;
No net dipole movement for C_2Cl_2 but angular SCl_2 has a resultant dipole *OWTTE*; ***[3]***
Mark can be scored from a diagram.
Allow ECF based on the answers given to (i).

7. (a) (i) *Li to Cs*
atomic radius increases;
because more full energy levels are used or occupied / outer electrons further from nucleus / outer electrons in a higher shell;
ionization energy decreases;
because the electron removed is further from the nucleus / increased repulsion by inner-shell electrons; ***[4]***
Accept increased shielding effect.

(ii) *Na to Cl*
atomic radius decreases;
because nuclear charge increases **and** electrons are added to same main (outer) energy level;
ionization energy increases;
because nuclear charge increases **and** the electron removed is closer to the nucleus/is in the same energy level; ***[4]***
Accept "core charge" for "nuclear charge".
In (i) and (ii) explanation mark dependent on correct trend.

(b) (i) *similarities* ***[3 max]***
the metal floats / moves on the surface;
fizzing / effervescence / bubbles; (*accept sound is produced*)
solution gets hot;
solution becomes alkaline / basic;
they react to form the metal hydroxide;
hydrogen is evolved;

differences ***[1 max]***
flame / hydrogen burns with potassium (and not with lithium) / reaction faster / more vigorous with potassium / slower or less vigorous with lithium; ***[4 max]***

(ii) $2Li + 2H_2O \rightarrow 2Li^+ + 2OH^- + H_2$ / $2K + 2H_2O \rightarrow 2K^+ + 2OH^- + H_2$;
Accept LiOH / KOH.
$pH \geqslant 11$;
LiOH/KOH is a strong base/strong alkali / high concentration of OH^-; ***[3]***

(c) (i) *aluminium oxide*
amphoteric;

(ii) *sodium oxide*
basic;

(iii) *sulfur dioxide*
acidic; ***[3]***

(d) (i) $Na_2O + H_2O \rightarrow 2Na^+ + 2OH^-$;
(ii) $SO_2 + H_2O \rightarrow H_2SO_3$; ***[2]***
Accept NaOH and $H^+ + HSO_3^- / 2H^+ + SO_3^{2-}$.

8. (a) **A** CH_3CH_2COOH / $CH_3CH_2CO_2H$;
Accept C_2H_5 for CH_3CH_2.
propanoic acid;

B or **C** CH_3COOCH_3 ;
methyl ethanoate;

C or **B** $HCOOCH_2CH_3$;
Accept $HCOOC_2H_5$.
ethyl methanoate; ***[6]***

(b) (i) **A** forms hydrogen bonds with water;
A ionizes / dissociates to give H^+ ions; ***[2]***
Accept correct equation.

(ii) $C_2H_5COOH + NaOH \rightarrow C_2H_5COONa + H_2O$; ***[1]***
Allow ECF from A.

(iii) no $C{=}C$ bond; ***[1]***
Do not accept "no double bonds".

(c) highest boiling point is **A**;
molecules of **A** can form hydrogen bonds (with other molecules of A); ***[2]***

(d) (i) esters;
flavourings / plasticizers / solvents / perfumes; ***[2]***

(ii) carboxylic acid / alkanoic acid;
alcohol / alkanol;
water; ***[3]***

(e) any feasible formula containing C=C (*e.g.* $CH_3CHC(OH)_2$ or $HOCH{=}C(OH)CH_3$) ;
Accept more detailed formula.
addition;
mixture is decolorised / colour change is from yellow/orange to colourless; ***[3]***
Do not accept discoloured instead of decolorised.