MARKSCHEME

November 2006

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) (i)

C	N	H
$\frac{62.0}{12.01}$ /5.16	$\frac{24.1}{14.01}$ /1.72	$\frac{13.9}{1.01}$ /13.8

*Award **[2]** for above.*
No penalty for use of whole number atomic masses.
If atomic numbers used then only mark for % of H can be awarded.
*If H % and calculation missing, award **[1]**, and last mark cannot be scored.*
If H % calculation incorrect apply ECF.

C_3NH_8 ; ***[3]***

*Correct empirical formula scores **[3]**.*

(ii) the average mass of a <u>molecule</u>;
compared to $1/12$ of (the mass of) one atom of ^{12}C / compared to C-12 taken as 12;

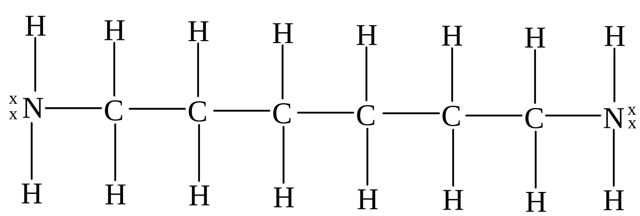
OR

$$\frac{\text{average mass of a molecule}}{\text{mass of } 1/12 \text{ of one atom of } ^{12}C}$$ ***[2]***

*Award **[2]** for the equation above.*

(iii) $C_6N_2H_{16}$; ***[1]***

(b) (i)



; ***[1]***

Accept dots or | (dash) instead of xx for lone pairs.
Accept condensed and branched structures provided that two NH_2 groups are shown.
Do not accept answer without lone pairs.

(ii) 109.5° / 109° ;
tetrahedral; ***[2]***

(c) hydrogen bonding;

N more electronegative than H / N–H bond (very) polar;
(strong) attraction between N of one molecule and H of another molecule; ***[3]***

2. (a) energy needed to break (1 mol of) a bond in a <u>gaseous</u> molecule;
averaged over similar compounds; ***[2]***

(b) bonds broken identified as C–O and N–H;
bonds formed identified as C–N and O–H;
$\Delta H = 748 - 768$ (kJ);
$= -20$ kJ / kJ mol^{-1} *(units needed for this mark)*; ***[4]***
If wrong bonds identified apply ECF to 3rd and 4th marks.
Accept answer based on breaking and making all bonds.
*Award **[4]** for correct final answer.*
*Award max **[3]** if only one bond missed.*
*Answer of 20 or +20 kJ (mol^{-1}) scores **[3]**.*

(c) (i) moles of $CH_3OH\,(= 2000 \times 10^3 \div 32.05) = 6.24 \times 10^4$ (mol) and moles of NH_3 $\left(= 2000 \times 10^3 \div 17.04) = 1.17 \times 10^5 \text{ (mol)}\right)$ / correct M_r values and 1:1 ratio; ***[2]***
Accept answers using whole-number A_r values and those using g instead of kg.
methanol is limiting reactant;

(ii) M_r of methylamine = 31.07 / 31;
mass = 1940 (kg); ***[2]***
Accept answer in range 1930 to 1940.
Units not needed for mark, but penalise incorrect units and answer in g.
*Award **[2]** for correct final answer.*

3. (a) delocalized electrons;
(attracted) to positive ions;
more delocalized / mobile / outer shell electrons / higher ionic charge; ***[3]***

(b) Si 2.8.4 / 2,8,4;
P^{3-} 2.8.8 / 2,8,8; ***[2]***

(c) 16 protons and 17 neutrons and 18 electrons; ***[1]***

(d) stronger van der Waals'/London/dispersion forces;
(sulfur has) bigger M_r / S_8 compared with P_4 / S_8 has a larger molar mass than P_4 / more electrons; ***[2]***

SECTION B

4. (a) (i) (chlorine has) an extra proton/more protons/greater nuclear charge / 17+ compared to 16+;
outer electrons attracted more strongly; ***[2]***

(ii) ability of atom to attract bonding pair of electrons / electrons in a covalent bond ;
chlorine has a smaller radius / (electrons) closer to nucleus / in lower energy level;
repelled by fewer inner electrons / decreased shielding effect; ***[3]***

(b) (i) orange/brown solution;
$Cl_2 + 2NaI \rightarrow I_2 + 2NaCl / Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$; ***[2]***

(ii) (white) precipitate/solid formed;
$Ag^+ + Cl^- \rightarrow AgCl$; ***[2]***

(c) reaction in (i) is redox;
chlorine is reduced/gains electrons/decreases its oxidation number /
(sodium) iodide is oxidized/loses electrons/increases its oxidation number;
reaction in (ii) is not redox;
no electron transfer/change in oxidation number; ***[4]***

(d) (i) (diagram showing)
container, liquid, electrodes and power supply;
bromine formed at + electrode;
potassium formed at – electrode; ***[3]***
*Award **[1]** for both correct products shown at wrong electrodes, or if no polarity indicated.*

(ii) electrons flow through connecting wires;
ions move (through liquid) to electrodes (and lose/gain electrons); ***[2]***

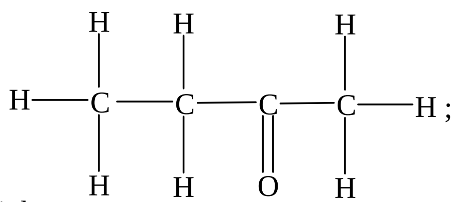
(iii) $K^+ + e^- \rightarrow K$;
$2Br^- \rightarrow Br_2 + 2e^-$; ***[2]***
No need to indicate polarity of electrodes.
Accept e instead of e^-.

5. (a) (i) $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$; ***[1]***

(ii) mix with bromine (water) / acidified $KMnO_4$/permanganate/manganate VII/ MnO_4^-;
bromine decolorized (with but–2–ene) / $KMnO_4$ decolourises; ***[2]***

(iii) $T = 70 + 273 = 343\ \text{K}$;
$V = nRT \div P$ / $V = 0.0200 \times 8.31 \times 343 \div 1.10 \times 10^5$;
$= 5.18 \times 10^{-4}\ \text{m}^3$ / $0.518\ \text{dm}^3$ / $518\ \text{cm}^3$; ***[3]***
*Correct final answer scores **[3]**.*
Apply ECF for incorrect value of temperature.

(b)



higher; ***[2]***

(c) (the molecule contains a) chiral/asymmetric carbon atom / carbon atom with four different groups;
polarized light passed through;
(plane of polarization) rotated in opposite/different directions; ***[3]***

(d) (i) (potassium/sodium) dichromate(VI) / potassium manganate(VII);
Accept just dichromate, permanganate, $KMnO_4$, MnO_4^-, $K_2Cr_2O_7$, $Cr_2O_7^-$.
(sulfuric) acid;
heat under reflux;
Do not accept just heat.
oxidation / redox; ***[4]***

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

(iii) ethyl ethanoate; ***[1]***

(e) (i) $HOCH_2CH_2OH$;
$HOOCC_6H_4COOH$; ***[2]***

(ii) reactants have two functional groups / *OWTTE*; ***[1]***

6. (a) (i) B and D;
(reactions are) endothermic / have positive $\Delta H^{\ominus}$ values; ***[2]***

(ii) B and D;
fewer gas volumes/moles on left / more gas volumes on right; ***[2]***

(iii) E;
gas changes to solid / gas moles/volumes decrease to zero / largest increase in order/decrease in disorder; ***[2]***

(iv) A;
most exothermic / most negative value of $\Delta H^{\ominus}$; ***[2]***
Ignore reference to ΔS.

(b) no effect on position of equilibrium;
forward and reverse reactions speeded up equally / effects the rate of reaction but not the extent of the reaction;
no effect on value K_c of ;
no change in concentrations of reactants or products / K_c only changes if temperature alters; ***[4]***

(c) (i) 0.1 (mol dm^{-3}); ***[1]***

(ii) 3; ***[1]***

(iii) 28(.0) (cm^3); ***[1]***

(iv) $\text{nNaOH} / \text{HNO}_3 (= 0.100 \times 0.0280) = 2.80 \times 10^{-3}$ (mol);
ECF from value in (iii).
$[\text{HNO}_3] (= 2.80 \times 10^{-3} \div 0.025) = 0.112 \text{ (mol dm}^{-3})$; ***[2]***
ECF from n above.
Correct final answer scores ***[2]***.

(d) (i) HCl / X is strong and CH_3COOH / Z is weak;
HCl / X is fully dissociated and CH_3COOH is slightly dissociated;
$[H^+]$ is greater in HCl/X than in CH_3COOH /Z; ***[2 max]***
Any two for ***[1]*** *each.*

(ii) a factor of 100; ***[1]***