M07/4/CHEMI/SP2/ENG/TZ0/XX/M+

MARKSCHEME

May 2007

CHEMISTRY

Standard Level

Paper 2

14 pages

Subject Details: Chemistry SL Paper 2 Markscheme

General

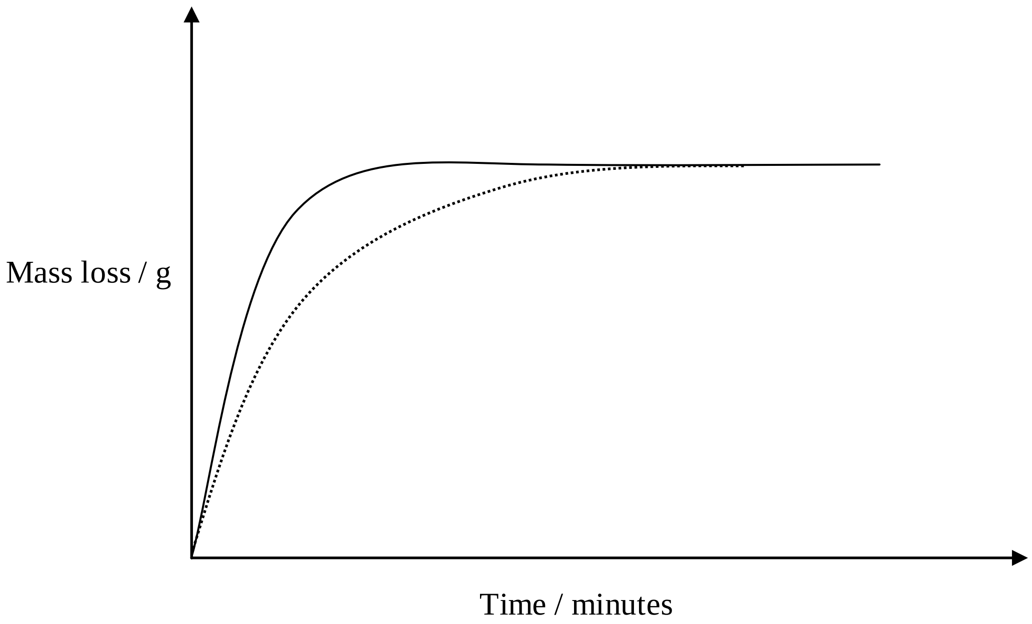
- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- Alternative answers are separated by a slash (/) – this means that either answer is acceptable.
- Words underlined are essential for the mark.
- Material in brackets (…) is not needed for the mark.
- The 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) change of concentration/mass/amount/volume / of a reactant/product with time; *[1]*
Do not accept "substance".

(b) all the $CaCO_3(s)$ has been consumed / no further $CO_2(g)$ is produced / reaction is complete ; *[1]*
Do not accept reaction has stopped or all reactants used up.

(c) line on graph should be initially less steep / a smaller gradient **and** should plateau at the same mass loss; *[1]*



(d) there are more particles with KE greater than or equal to E_a;
collisions more frequent / more collisions per unit time / more successful/forceful collisions per unit time;
the rate increases; *[3]*

(e) 1.00×10^{-3} (mol cm^{-3} s^{-1}) ; *[1]*
Ignore units even if wrong.
Apply –1(sf).

(f) $n(CO_2) = n(CaCO_3) = \dfrac{0.350}{100.09\,\text{g mol}^{-1}}$;

$V = \dfrac{nRT}{P}$ / $V(CO_2) = \dfrac{n(CO_2) \times 293 \times 8.31}{1.01 \times 10^5}$;

$= 8.43 \times 10^{-5}\,\text{m}^3$ / $84.3\,\text{cm}^3$ / $0.0843\,\text{dm}^3$; ***[3]***

Units required for mark.
Apply –1(SF).
*Award **[3]** for correct final answer.*
*Allow for ECF from $n(CaCO_3)$ up to **[2 max]**.*

2. (a) the ability of an element/atom/nucleus to attract a bonding pair of electrons; ***[1]***

(b) electronegativity increases (along period 3 from Na to Cl);
number of protons increases / nuclear charge increases / core charge increases / size of atoms decreases; ***[2]***
Do not accept greater nuclear attraction.

(c) Cl_2 is a stronger oxidizing agent / Chlorine's outer shell closer to nucleus;
Cl_2 has greater attraction for electrons / has a higher electron affinity; ***[2]***
Accept converse argument for Br_2.

3. (a) amount of energy needed to break one mole of (covalent) bonds;
in the gaseous state;
average calculated from a range of compounds; ***[2 max]***
*Award **[1]** each for any two points above.*

(b) bonds broken: $612 + 2 \times 348 + 8 \times 412 + 6 \times 496$ / 7580 kJ mol^{-1};
bonds made: $8 \times 743 + 8 \times 463$ / 9648 kJ mol^{-1};
(bonds broken – bonds made =) $\Delta H = -2068 \text{ (kJ mol}^{-1})$; ***[3]***
*Award **[3]** for the correct answer.*
Allow full ECF – 1 mistake equals 1 penalty.
Allow kJ but not other wrong units.

(c) same/equal, because the same bonds are being broken and formed; ***[1]***

(d) ΔS would be positive as 7 mol $\rightarrow$ 8 mol of gas / more moles of gas on RHS; ***[1]***

(e) products more stable than reactants;
bonds are stronger in products than reactants / $H_P < H_R$ / enthalpy / stored energy of products less than reactants; ***[2]***

4. (a) $(K_c) = \dfrac{[NH_3]^2}{[H_2]^3[N_2]}$; ***[1]***

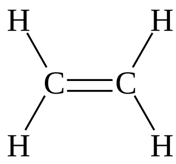
Do not allow round brackets unless K_p is used.

(b) equilibrium shifts to the right / products;
4 mol $\rightarrow$ 2 mol <u>of gas</u> / fewer moles of gas on the right/products; ***[2]***

(c) K_c decreases;
equilibrium position shifts to the left/reactants / forward reaction is exothermic / reverse reaction is endothermic; ***[2]***

(d) catalyst increases the rate of the forward and backward reactions <u>equally</u> / lowers the activation energy of both forward and backward reaction <u>equally</u> / <u>lowers E_a</u> so <u>rate</u> of forward and backward reactions increase; ***[1]***

SECTION B

5. (a)  ;

Allow CH_2=CH_2.

a hydrocarbon that contains at least one C=C (or C≡C)/carbon-carbon double bond (or triple bond)/carbon to carbon multiple bond; ***[2]***

Do not accept just "double bond".

(b) $C_2H_4 + H_2O \rightarrow C_2H_5OH$;

addition/hydration reaction; ***[2]***

(c) heat under reflux;

EITHER

potassium dichromate(VI) / $K_2Cr_2O_7$ / $Cr_2O_7^{2-}$ and acidified / H^+ ;

orange to green;

OR

potassium permanganate / manganate(VII) / $KMnO_4$ / MnO_4^- and acidified / H^+ ;

purple to colourless;

Penalise wrong oxidation state, but not missing oxidation state.

ethanoic acid; ***[4 max]***

(d) $CH_3COOH + C_2H_5OH \rightarrow CH_3COOCH_2CH_3 + H_2O$;

Accept $CH_3COOC_2H_5$.

sulfuric acid/ H_2SO_4 /(ortho)phosphoric acid/ H_3PO_4 ;

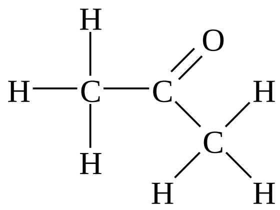
ethyl ethanoate;

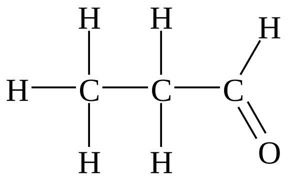
solvent / flavouring / perfumes / plasticizers; ***[4]***

(e) presence of double bond / multiple bond;

absence of two functional groups / no other functional groups; ***[2]***

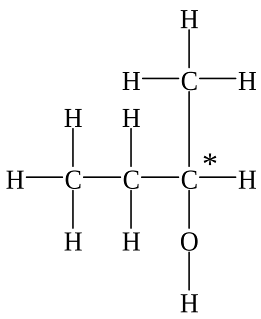
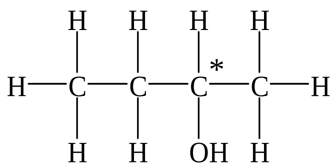
(f) (i) same molecular formula but different structural formula / arrangement of atom within a molecule / OWTTE; ***[1]***

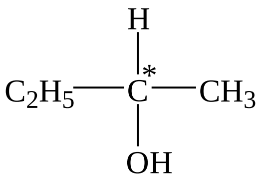
(ii) CH_3COCH_3 /  ;

CH_3CH_2CHO /  ; ***[2]***

Accept unsaturated alcohol and cyclic alcohol as alternative answers.
If more than two correct isomers given – no penalty – but a third incorrect structure cancels a correct one. i.e. two correct, one incorrect equals ***[1]***.

(iii) isomers that can rotate plane polarized light in opposite directions;
Do not accept bend, reflect plane-polarized light.

 /  /

 / other correct structure;

Penalise missing bonds / hydrogens.

correct identification of chiral carbon (*); ***[3]***

6. (a) Al – 2,8,3;
N – 2,5;
F – 2,7; ***[2 max]***
Award ***[2]*** *for three correct,* ***[1]*** *for two or one correct.*
Accept correct configuration using s,p,d notation.

(b) *aluminium*
metallic bonding;
positive ions/ Al^{3+} ions in a sea of / delocalized (valence) electrons;

nitrogen, N_2
covalent/triple bond between nitrogen atoms;
van der Waals' forces between the molecules; ***[4]***

(c) AlF_3
giant / 3-dimensional ionic lattice;
strong ionic bonds / attraction between Al^{3+} and F^- ions;

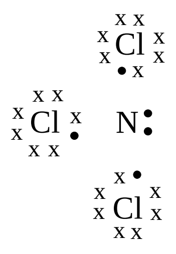
NF_3
simple molecular structure / strong covalent bonds within molecules;
weak(er) forces between molecules;
dipole-dipole / van der Waals' / London forces; ***[5]***

(d) (i) electrons delocalized/move through structure in both the solid and liquid state; ***[1]***

(ii) free moving ions in liquid state;
ions fixed in position in solid state; ***[2]***

(iii) no free moving charged particles / no ions and no electrons to carry charge; ***[1]***

(e)


;

All electrons must be shown.
Accept molecular structures using lines to represent bonding and lone electron pairs.

bond angle: $107^\circ - 109^\circ$;

greater repulsion between lone pair and bonding pairs / OWTTE; ***[3]***
NOT between electron pairs and atoms.
Award ***[1 max]*** *if lone pair missed on nitrogen, ECF for bond angle of* 120°.

(f) $A_r(\mathrm{Cl}) = 35.45 = \dfrac{35x + 37(100 - x)}{100}$;

$^{35}\mathrm{Cl} = 77.5\ \%$ and $^{37}\mathrm{Cl} = 22.5\ \%$; ***[2]***

7. (a) NaOH is a strong base / NH_3 is a weak base;
NaOH completely dissociates/ionizes;
NH_3 partially dissociates/ionizes;

pH 14 has high $[OH^-]$ / low $[H^+]$ / pH 12 has lower $[OH^-]$ / higher $[H^+]$;

$NaOH \rightarrow Na^+ + OH^-$;
$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$; ($\rightleftharpoons$ *required)* ***[5 max]***

(b) (i) $NaOH + HNO_3 \rightarrow NaNO_3 + H_2O$; ***[1]***

(ii) 1 pH / pOH unit represents a 10 fold change in concentration;

So if a 1.0mol dm^{-3} NaOH solution has a pH of 14
then a $\underline{0.10 \text{mol dm}^{-3}}$ solution will have a pH of 13; ***[2]***
Units needed for the mark.
Award ***[2]*** *for correct final answer.*

(iii) 18.0 cm^3;

$(\frac{0.10 \times 20.0}{18.0} =)\ 0.11 \text{mol dm}^{-3}$; ***[2]***
Allow ECF from an incorrect value of concentration in part (ii).

(iv) 18.0 cm^3; ***[1]***

(c) conductivity;
nitric acid will contain more ions and have a higher conductivity / ethanoic acid will have fewer ions and have a lower conductivity;

rate of reaction with metal / carbonate / hydrogencarbonate;
nitric acid will react more rapidly / produce bubbles faster / ethanoic acid will react less rapidly / produce bubbles more slowly;

reaction with alkali;
temperature change will be less for ethanoic acid; ***[4 max]***
Accept any two methods and explanations from above.

(d) (i) a solution which resists change in pH;
when a <u>small</u> amount of strong acid or base is added to it; ***[2]***

(ii) react excess ammonia with nitric acid;
stated volumes with about 50 % more ammonia solution;
gives a solution containing the weak base and its salt with the acid / NH_4^+ and NH_3; ***[3]***
Accept suitable volumes from about 20 cm^3 to about 500 cm^3 for 2nd mark.