IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
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N07/4/CHEMI/SP2/ENG/TZ0/XX/M

MARKSCHEME

November 2007

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) $M\,(BaSO_4)\left(=137.34+32.06+4(16.00)\right)=233.40\,(g\,mol^{-1})$;

$n\,(BaSO_4)\left(=\dfrac{0.672\,g}{233.40\,g\,mol^{-1}}\right)=0.00288\,/\,2.88\times10^{-3}$ (mol); **[2]**

ECF from M value

(b) n (alkali metal sulfate) $= 0.00288\,/\,2.88\times10^{-3}$ (mol); **[1]**

ECF

(c) $M=\left(\dfrac{m}{n}=\dfrac{0.502\text{ g}}{0.00288\text{ mol}}=\right)174.31\,/\,174.3\,/\,174$;

ECF

units: $g\,mol^{-1}$; **[2]**

(d) $\left(2(A_r)+32+4(16)=174,\text{ thus}\right)A_r=39\,/\,A_r\left(=\dfrac{(174-(32+(4\times16))}{2}\right)=39$;

Accept answer between 39 and 39.16

ECF

potassium / K; **[2]**

ECF from A_r value

(e) $K_2SO_4(aq)+BaCl_2(aq)\rightarrow BaSO_4(s) + 2KCl(aq)$; **[2]**

*Award **[1]** for balanced equation and **[1]** for state symbols*

ECF if another alkali metal arrived at in (d)

Accept net ionic equation

*If no answer arrived at in (d), but correct equation given involving any alkali metal, then award **[1 max]**.*

2. (a) ratio of average mass of an atom to $\frac{1}{12}$ the mass of C-12 isotope / average mass of an atom on a scale where one atom of C-12 has a mass of 12 / sum of the weighted average mass of isotopes of an element compared to C-12 / *OWTTE*;

Award no mark if 'element' is used in place of 'atom' **[1]**

(b) ^{63}Cu (more abundant) since A_r (Cu) is closer in mass to 63; **[1]**

Explanation needed for mark

(c) different physical properties/melting points/boiling points/density/reaction rate/mass;
due to different masses/more neutrons/nucleons;
same/similar chemical properties/reactivity;
due to same arrangement of valence electrons; **[4]**

3. (a) (i) $0.0010 / 1.0\times10^{-3}$ (mol dm^{-3});
pH = 3; ***[2]***

(ii) HCl: strong acid / fully dissociated;
CH_3COOH : weak acid / partially dissociated;
HCl less concentrated / CH_3COOH more concentrated;
only one molecule in 100 dissociates in ethanoic acid so [H^+] 1/100/ *OWTTE* ***[3 max]***

(b) measure electrical conductivity;
strong acids are good conductors / weak acids are poor conductors;

OR

react with magnesium or a named active metal / (metal) carbonate;
hydrogen carbonate/bicarbonate;
strong acids have a faster reaction / more gas bubbles (per unit time) / more heat produced / weak acids have a slower reaction / less gas bubbles (per unit time) / less heat produced; ***[2 max]***
Accept answers based on:
titration curves: namely strong acid and strong base will have an equivalence point pH of 7 and a weak acid and strong base will have an equivalence point pH oF >7.
OR
temperature change: on neutralization for temperature change: namely, neutralization (H^+ +OH^-) is exothermic, weak acid is partially dissociated so some energy used up in dissociation of weak acid – net result, weak acid would produce less energy / less temperature increase compared to neutralization of strong acid.

4. (a) (i) $I^- = -1/1-$
$IO_3^- = +5/5+$
$I_2 = 0$ ***[2]***
Award ***[2]*** *for all three correct,* ***[1]*** *for any two correct,*
Signs must be included
Do not accept Roman numerals

(ii) *oxidation*
I^- (to I_2), increase in oxidation number / loss of electron(s);
reduction
IO_3^- (to I_2), decrease in oxidation number / gain of electron(s); ***[2]***

(b) object to be plated is negative electrode/cathode;
pure copper is positive electrode/anode;
Accept inert electrode

(both electrodes in) solution/electrolyte of copper(II) sulfate/chloride/ $CuSO_4$ / $CuCl_2$;
Accept an annotated diagram showing all the information for the first ***[3]*** *marks*

$Cu^{2+} + 2e^- \rightarrow Cu$; ***[4]***

SECTION B

5. (a) (i) $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$; ***[1]***
State symbols not required for mark

(ii) products more stable than reactants / reactants less stable than products;
products lower in energy / reactants higher in energy; ***[2]***

(iii) (overall) bonds in reactants weaker / (overall) bonds in product stronger / all bonds in product are σ bonds / weaker π bond broken and a (stronger) σ bond formed;
less energy needed to break weaker bonds / more energy produced to make stronger bonds (thus reaction is exothermic) / *OWTTE*;

OR

bond breaking is endothermic / requires energy and bond making is exothermic / releases energy;
stronger bonds in product mean process is exothermic overall; ***[2]***

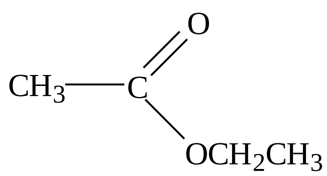
(b) (i) (ΔS) negative / – ;
decrease in gaseous moles;
decrease in disorder / increase in order / decrease in entropy; ***[3]***

(ii) less spontaneous;
($-T$ / $-T\Delta S$ term becomes larger) ΔG less negative / more positive; ***[2]***
ECF from part (b) (i)

(c) (i) oxidation;

X: ethanol
Y: ethanoic acid/acetic acid
Z: ethyl ethanoate/ethyl acetate
All three correct award ***[2]****, any two correct award* ***[1]***

$C_2H_5OH\,(l) + CH_3COOH\,(l) \rightleftharpoons CH_3COOC_2H_5\,(l) + H_2O\,(l)$;
Neither states nor equilibrium sign required for mark
H_2O is required for mark



; ***[5]***

(ii) flavouring agent; ***[1]***

(iii) CH_2CHCl;
chloroethene / vinyl chloride; ***[2]***

(iv) addition (polymerization);
all monomer atoms present in polymer / no elimination of a small molecule / (monomer contains) C=C double bond; **[2]**
No mark for just "unsaturation"

6. (a) (i) minimum energy required to remove one (mole of) electron(s) from (one mole of) (a) <u>gaseous</u> atom(s) / *OWTTE*; **[1]**

(ii) $2Li(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2(g) / Li(s) + H_2O(l) \rightarrow LiOH(aq) + 1/2H_2(g)$; **[1]**
State symbols not required

(iii) (ionization energy) decreases;
radius increases / valence electrons further away from nucleus / electron removed from higher shell;
(nuclear charge increases but) shielding/screening effect increases / more electrons between nucleus and valence electron / lower effective nuclear charge/ Z_{eff}; **[3]**

(iv) phosphorus has a higher (effective) nuclear charge/Z_{eff};
radius of P is smaller;
electron <u>pair</u>/<u>bonding electrons</u> attracted more strongly; **[2 max]**

(v) both have same number of protons/14 protons/nuclear charge/core charge;
Si^{4+} formed by electron loss, Si^{4-} formed by electron gain;
Si^{4+} : 2.8 arrangement / 2 (complete) energy levels / electrons in n = 2;
Si^{4-} : 2.8.8 arrangement / 3 (complete) energy levels / electrons in n = 3;
explanation of proton : electron ratio;
higher effective nuclear charge/Z_{eff} in Si^{4+}; **[4 max]**

(b) (i) molecules become larger / size increases / number of e^- increases / become heavier / M_r increases;
van der Waals'/London/dispersion forces increase; **[2]**

(ii) hydrogen bonding <u>between</u> NH_3 molecules;
which is stronger than van der Waals' forces;
higher value than expected; **[2 max]**

(c) $NH_4^+ > NH_3 > NH_2^-$;
NH_4^+ has four bonded electron pairs (and no lone electron pairs);
NH_3 has three bonded electron pairs and one electron lone pair;
NH_2^- has two bonded electron pairs and two electron lone pairs;
Accept correct Lewis structures with lone electron pairs clearly shown.

lone pair-lone pair > lone pair-bonded pair > bonded pair-bonded pair / lone pairs of electrons repel more than bonding pairs of electrons / *OWTTE*; **[5]**
Do not accept repulsion between atoms.

7. (a) (i) $K_c = \dfrac{[SO_3]^2}{[SO_2]^2[O_2]}$; ***[1]***

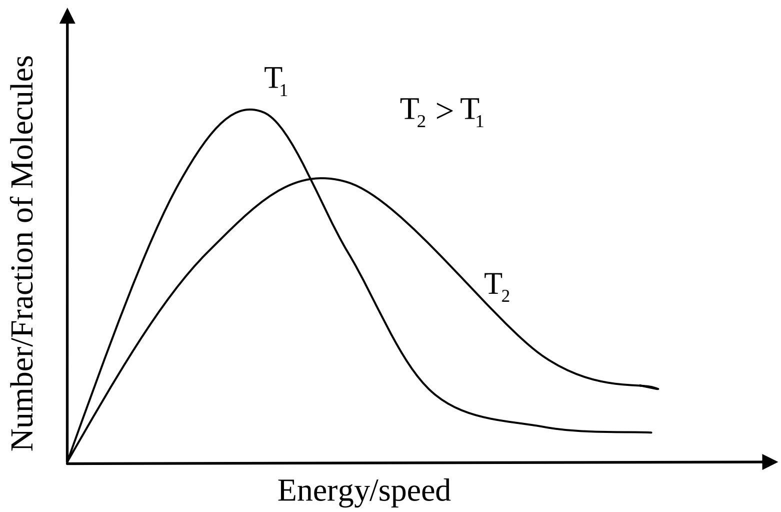
(ii) *pressure*
high pressure (will allow system to occupy smaller volume);
$V_{product} < V_{reactant}$ / equilibrium moves to the right to reduce pressure / reaction proceeds to lower/lowest number of <u>gaseous</u> molecules / *OWTTE*;

temperature
low temperature;
(exothermic reaction) forward reaction favoured to replace some of the heat removed / equilibrium moves to the right to produce heat / *OWTTE*; ***[4]***
No mark for just saying "due to Le Chatelier's principle"

(iii) rate is faster at $450\,°C$ (than at low temperatures);
$>95\,\% / 90-99\,\%$ yield / (very) high conversion takes place;
unnecessary to use expensive high pressure equipment / (to achieve) high pressure is very expensive; ***[3]***

(iv) vanadium pentoxide / vanadium(V) oxide / V_2O_5 / finely divided platinum / Pt;
no effect on K_c;
forward and reverse rates speeded up (equally); ***[3]***

(b) (i)



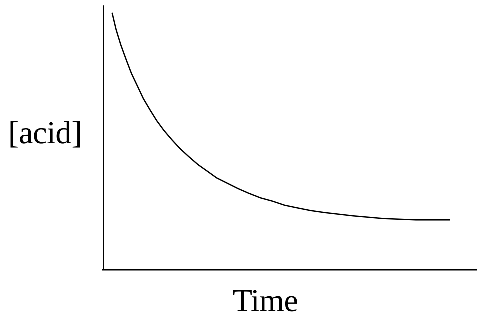
T_2 peak lower / T_1 higher;
T_2 peak at higher energies / T_1 curve at lower energies; ***[2]***
Maximum ***[1]*** *if axes not labeled correctly*

(ii) minimum energy required to react / energy difference between reactants and transition state; ***[1]***

(iii) makes the reaction go faster;
because it lowers the activation energy/Ea; ***[2]***

(c) (i) a curve showing concentration decreases with time; ***[1]***

i.e.



No penalty if curve reaches x axis
Do not accept a straight line

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

(iii) rate decreases;
fewer collisions per unit time; ***[2]***