M09/4/CHEMI/SP2/ENG/TZ1/XX/M+

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

MARKSCHEME

May 2009

CHEMISTRY

Standard Level

Paper 2

13 pages

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 <u>underlined</u> 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. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

9. 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. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. Indicate this with **ECF** (error carried forward).

10. Only consider units at the end of a calculation. Unless directed otherwise in the markscheme, unit errors should only be penalized once in the paper. Indicate this by writing **–1(U)** at the first point it occurs and **U** on the cover page.

11. Significant digits should only be considered in the final answer. Deduct **1 mark in the paper** for 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*

Indicate the mark deduction by writing **–1(SD)** at the first point it occurs and **SD** on the cover sheet.

12. 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.

13. 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.

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

SECTION A

1. (a) ester; ***[1]***

(b) amount of oil $= \frac{1013.0}{885.6} = 1.144 \text{ mol}$;

amount of methanol $= \frac{200.0}{32.05} = 6.240 \text{ mol}$;

since three mol of methanol react with one mol of vegetable oil the amount of excess methanol $= 6.204 - (3 \times 1.144) = 2.808 \text{ mol}$; ***[3]***

(c) (i) rate of the forward reaction is equal to the rate of the reverse reaction / forward and reverse reactions occur **and** the concentrations of the reactants and products do not change / *OWTTE*; ***[1]***

(ii) $K_c = \frac{[\text{glycerol}] \times [\text{biodiesel}]^3}{[\text{vegetable oil}] \times [\text{methanol}]^3}$; ***[1]***

(iii) to move the position of equilibrium to the right/product side / increase the yield of biodiesel; ***[1]***

(iv) no effect (on position of equilibrium);
increases the rate of the forward and the reverse reactions <u>equally</u> (so equilibrium reached quicker) / it lowers E_a for both the forward and reverse reactions <u>by the same amount</u> / *OWTTE*; ***[2]***
No ECF for explanation.

(d) vegetable oil is mainly non-polar **and** methanol is polar / *OWTTE*;
stirring brings them into more contact with each other / increase the frequency of collisions / *OWTTE*; ***[2]***
Do not allow simply mixing.

(e) (relative molecular mass of biodiesel, $C_{19}H_{36}O_2 = 296.55$)
maximum yield of biodiesel = 3.432 mol / 1018 g ;
percentage yield $= \frac{811.0}{1018} \times 100 = 79.67\%$; ***[2]***
Allow 80 % for percentage yield.

(f) the carbon dioxide was absorbed by plants initially so there is no net increase / vegetable oil is not a fossil fuel / vegetable oil is formed from (atmospheric) carbon dioxide / *OWTTE*; ***[1]***

2. (a) energy required = C=C + H–H/612 + 436 and
energy released = C–C + 2(C–H)/347 + 2(413) /
energy required = C=C + H–H + 4(C–H)/612 + 436 + 4(413) and
energy released = C–C + 6(C–H)/347 + 6(413);

$\Delta H = (1048 - 1173)/(2700 - 2825) = -125 \text{ kJ mol}^{-1}$; ***[2]***

(b) $\Delta H = -1411 + (-286) - (-1560) = -137 \text{ kJ mol}^{-1}$; ***[1]***

(c) the actual values for the specific bonds may be different to the average values / the combustion values referred to the specific compounds / *OWTTE*; ***[1]***

(d) (i) -125 kJ mol^{-1}; ***[1]***

(ii) average bond enthalpies do not apply to the liquid state / *OWTTE*;
the enthalpy of vaporization/condensation of cyclohexene and cyclohexane / *OWTTE*; ***[2]***

3. (a) in the solid state ions are in fixed positions/there are no moveable ions / *OWTTE*; ***[1]***
Do not accept answer that refers to atoms or molecules.

(b) $2O^{2-} \rightarrow O_2 + 4e^-$ / $O^{2-} \rightarrow \frac{1}{2}O_2 + 2e^-$; ***[1]***
Accept e instead of e^-.

(c) (i) basic; ***[1]***
Allow alkaline

(ii) $Na_2O + H_2O \rightarrow 2NaOH$ / $Na_2O + H_2O \rightarrow 2Na^+ + 2OH^-$; ***[1]***
Do not accept $\rightleftharpoons$

4. (a) Loss of (one or more) electrons; ***[1]***

(b) (i) ($KMnO_4$) + 7;
($MnCl_2$) + 2; ***[2]***
Must have + sign for mark.
[1 max] *if roman numerals or 7+ or 2+ used or if + signs are missing.*

(ii) Cl^- / chloride / chlorine / Cl (has been oxidized) / HCl ;
oxidation number from –1 to 0 / has <u>increased</u> by one ; ***[2]***
If HCl is given for first mark, it must be clear that it is the Cl that has the change of oxidation number.

SECTION B

5. (a) (i) a vaporized sample must be used;
bombarded with (high energy) electrons to form positive ions;
accelerated by passing through an electric field;
deflected by passing through a magnetic field;
detected by producing a current; ***[5]***
*Award **[2 max]** if just the words vaporization, ionization, acceleration, deflection and detection are used with no explanation.*

(ii) (size of the positive) charge (on the ion);
mass (of the ion);
strength of the magnetic field;
velocity/speed (of the ions) / strength of electric field; ***[3 max]***
m/z scores the first two marking points.

(iii) $A_r = \dfrac{[(0.56 \times 84) + (9.90 \times 86) + (7.00 \times 87) + (82.54 \times 88)]}{100}$;
$= 87.71$; ***[2]***
*Award **[1 max]** if answer not given to two decimal places.*
*Award **[2]** for correct final answer.*
Apply –1(U) if answer quoted in g or g mol^{-1}.

(b) (i) first ionization energy: $M(g) \rightarrow M^+(g) + e^-$/e / the (minimum) energy (in kJ mol^{-1}) to remove one electron from a gaseous atom / the energy required to remove one mole of electrons from one mole of gaseous atoms;
periodicity: repeating pattern of (physical and chemical) properties; ***[2]***

(ii) 2.8.8/sp version;

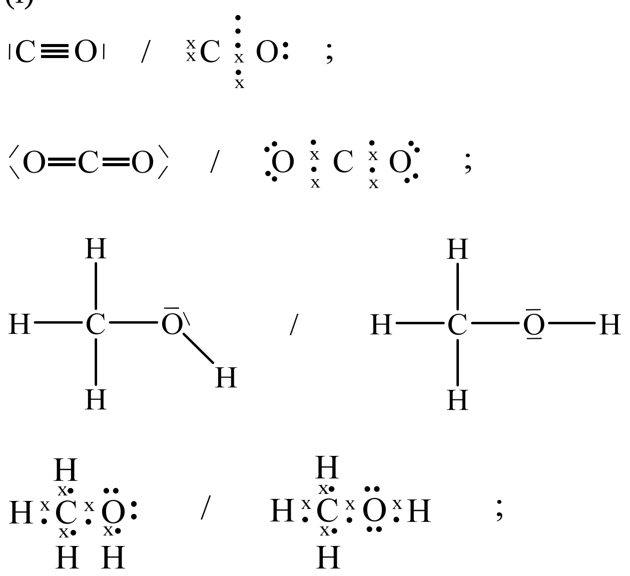
Accept any two of the following:
the outer energy level/shell is full;
the increased charge on the nucleus;
great(est) attraction for electrons; ***[3 max]***

(iii) 17 p in Cl nucleus attract the outer level more than 11 p in Na nucleus / greater nuclear charge attracts outer level more; ***[1]***
Allow converse for Na.
Do not accept larger nucleus.

(iv) S^{2-} has one proton less/ smaller nuclear charge so outer level held less strongly / *OWTTE*; ***[1]***
Allow converse for chloride.
Do not accept larger nucleus.

(v) the radii of the metal atoms increase (from $Li \rightarrow Cs$) (so the forces of attraction are less between them) / *OWTTE*;
the forces of attraction between halogen molecules are van der Waals;
forces increase with increasing mass/number of electrons; ***[3]***

6. (a) (i)



[3]

All outer electron pairs must be shown for mark in each case.
Accept electrons shown as all x *rather than* • *and* x.

(ii) $CO < CO_2 < CH_3OH$;
triple bonds are shorter than double bonds which are shorter than single bonds / the more pairs of electrons that are shared the stronger the attracting so the shorter the bond / *OWTTE*; **[2]**
The order must be correct to gain the second marking point unless ECF from (a).

(b) (i) (CO_2) linear ;
180°; **[2]**

(ii) (CO_3^{2-}) trigonal planar/triangular planar;
120°; **[2]**

(iii) (BF_4^-) tetrahedral;
109.5° / 109° / 109° 28’; **[2]**

(c) (i) donates a proton / H^+ ion; **[1]**

(ii)

(acid)	(conjugate base)
H_2O	OH^- ;
NH_4^+	NH_3 ;

[2]

[1 max] *if all four acids and bases given but not clearly paired.*

(iii) Lewis acid accepts an electron pair / Lewis base donates an electron pair;
F^- is the base / BF_3 is the acid; **[2]**

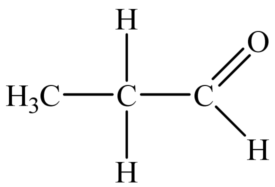
(d) (i) partially dissociated or ionized;
$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$ / $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$; ***[2]***
$\rightleftharpoons$ *required for mark.*

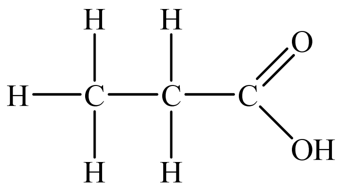
(ii) $2CH_3COOH + CaCO_3 \rightarrow Ca(CH_3COO)_2 + CO_2 + H_2O$ ***[2]***
*Award **[1]** for correct reactants and products and **[1]** for balancing.*

7. (a) (i) butane < propanal < propan-1-ol;
butane has van der Waals/London/dispersion forces;
propanal has dipole-dipole attractive forces;
propan-1-ol has hydrogen bonding; ***[4]***
imf marks are independent of the order.
Treat references to bond breaking as contradictions if the imfs are correct.

(ii) butane is least soluble;
it cannot form hydrogen bonds/attractive forces with water molecules; ***[2]***

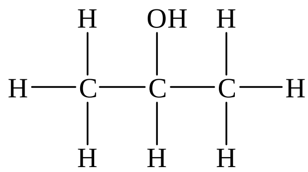
(iii) propanal and propanoic acid;

CH_3CH_2CHO / C_2H_5CHO /  ;

CH_3CH_2COOH / C_2H_5COOH /  ;

[3]

(iv) ***[1]***

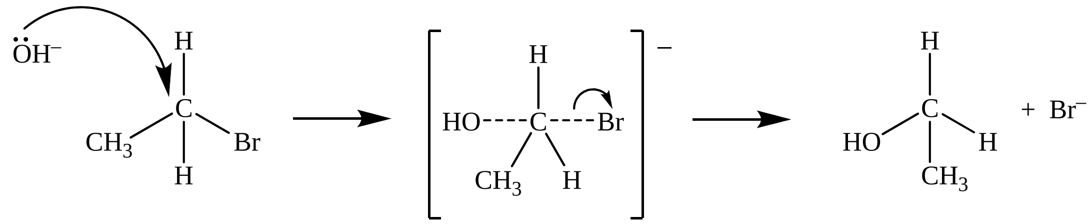
 /$CH_3CH(OH)CH_3$;

(v) secondary (alcohol);
propanone / acetone; ***[2]***

(b) (i) hydrogen bromide / hydrobromic acid; ***[1]***
Do not accept HBr, as name is asked for.

(ii) sodium hydroxide / hydroxide ions (name required);
dilute and aqueous / dilute and warm / aqueous and warm; ***[2]***

(iii)



curly arrow from OH^- to C atom;
Accept from lone pair or minus sign or O. Do not award marking point if arrow originates from the H of OH^-.

curly arrow from bond between C and Br to bromine atom on bromoethane or the transition state;
transition state including negative charge and partial bonds; ***[3]***

(iv) hydration of ethene / steam + ethene;
Allow equation

(ethanol used as) solvent/fuel/antiseptic/intermediate to form other compounds; ***[2]***