N99/420/S(2)M

INTERNATIONAL BACCALAUREATE
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MARKSCHEME

November 1999

CHEMISTRY

Standard Level

Paper 2

11 pages

SECTION A

1. (a) $CuSO_4 + Zn \rightarrow ZnSO_4 + Cu$

OR

$Cu^2 + Zn \rightarrow Zn^{2+} + Cu$ *[1]*

States not necessary to gain mark

(b) $\text{Amount of Zn} = \frac{1.20}{65.37} = 0.018 \text{ moles}$

$\text{Amount of } Cu^{2+} = \frac{50}{1000} \times 0.200 = 0.010 \text{ moles}$ *[1]*

therefore Zn is in excess *[1]*

(c) At point A the heat being given out by the reaction is equal to the heat being lost to the surroundings. *[1]*

*Do **not** give the mark for "the reaction is finished".*

(d) Correct extrapolation to when the zinc was added. *[1]*

Give no marks if the line is extrapolated to the Y axis.

Temperature rise $= 26.7 - 17.0 = 9.7^\circ$ C *[1]*

Accept $26.7 \pm 0.1^\circ$ C giving 9.6 to 9.8° C

(e) Heat $= 9.7 \times 4.18 \times 50$ *Give credit if 51.2 g taken as mass* *[1]*

$= 2027.3 \text{ J} = 2030 \text{ J}$ *Answer must be given to 3 s.f. to gain mark* *[1]*

Consequential markings from (d)

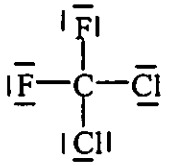
(f) $\Delta H = -2030 \times 100 \text{ J}$

$= -203 \text{ kJ mol}^{-1}$ *Must have – sign* *[1]*

(g) $\text{Error} = \frac{218 - 203}{218} \times 100 = 6.9\ \%$ *[1]*

(h) ***[1 mark]** for any valid reason*

e.g. solution assumed to have same specific heat capacity as 50 g of water;
Heating of metal (Cu + excess Zn), thermometer *etc.* ignored.
(not carried out under standard conditions (not on SL syllabus);) *[1]*

2. (a)  **or** 'dot and cross' diagram *[1]*

(b) Tetrahedral (as 4 bonding pairs around C atom). *[1]*

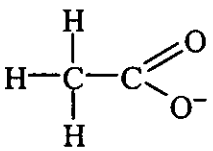
(c) It will be polar because: *[1]*
F is more electronegative than Cl

OR

The resultant dipole of the two C–F bonds will make it polar *[1]*

3. (a) A weak acid is only **slightly dissociated** into H^+ ions and its anions in aqueous solution. *[1]*

(b) $CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$ *[1]*
acid base acid base
[1] *[1]*

(c)  *[1]*

Allow resonance canonical forms

SECTION B

4. (a) (i) From orange to green.

both colours must be stated *[1]*

(ii) In ethanol and ethanoic acid a H atom is bonded directly to an O atom so that hydrogen bonding can occur between the molecules. *[1]*
Ethanal is polar due to the more electronegative O bonded to C *[1]*
but there is no hydrogen bonding and dipole:dipole attractions are weaker than hydrogen bonds. *[1]*

(b) (i)

[3]

*balanced equation **[1 mark]***
*structural formulas of both reactants **[1 mark]***
*structural formula of product **[1 mark]***

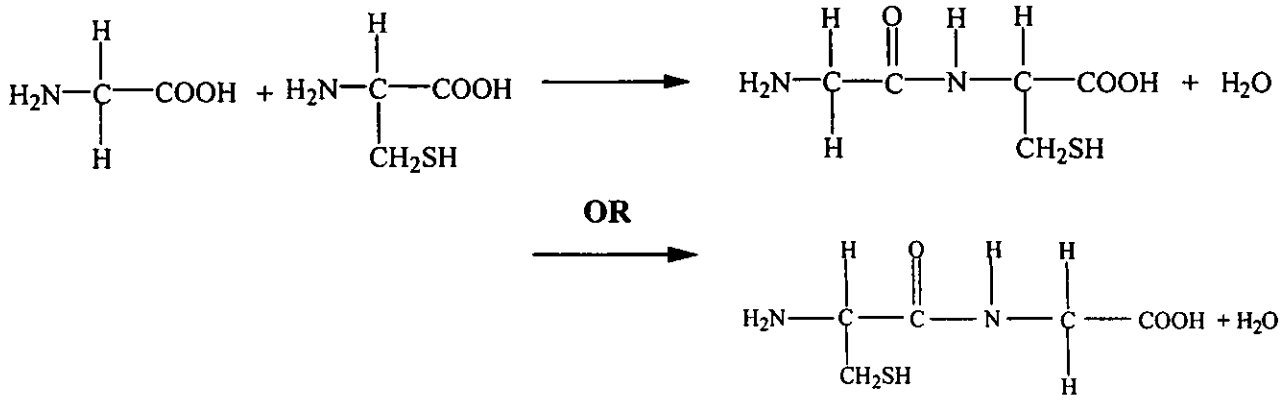
(ii) It has a fruity/sweet smell. *[1]*

(iii) The product (ester) would be less soluble in water. *[1]*
as it cannot hydrogen bond with water molecules,
unlike ethanol and ethanoic acid *[1]*

(c) (i) A substance which is optically active can rotate the plane of polarised light. *[1]*
One isomer will rotate the plane of polarised light to the right, the other isomer will rotate the light by the same amount to the left. *[1]*
Cysteine can show optical activity. *[1]*
It possesses an asymmetric carbon atom / chiral centre / carbon with four different groups attached. *[1]*

[2]

(ii)



OR

[3]

*Give **[2 marks]** for correct equation including water as a product and **[1 mark]** for correct structure of organic product.*

Peptide bond/amide bond *[1]*

5. (a) $Cl^-(-1)$, $Cl_2(0)$ *[1]*

$MnO_4^-(+7)$, $Mn^{2+}(+2)$ *[1]*

$\mathbf{10}Cl^-(aq) + \mathbf{2}MnO_4^-(aq) + \mathbf{16}H^+(aq) \rightarrow \mathbf{2}Mn^{2+}(aq) + \mathbf{5}Cl_2(g) + \mathbf{8}H_2O(l)$ *[2]*

Cl^- reducing agent *[1]*

(b) Diagram should show:

External source of electric current and circuit *[1]*

Bromine evolved at + electrode (anode) *[1]*

$Na^+ + e^- \rightarrow Na$ *[1]*

Reduction because Na^+ has gained an electron/oxidation number is decreased. *[1]*

Because sodium and bromine would recombine/they are reactive *[1]*

(c) Cl_2 should be added to NaBr(aq) *[1]*

A yellow/red colour of bromine will be observed. *[1]*

$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ *[1]*

Cl_2 should be added to NaI(aq) *[1]*

A red/brown *(accept orange)* colour of iodine will be observed *[1]*

$Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$ *[1]*

Br_2 should be added to NaI(aq) *[1]*

A red/brown *(accept orange)* colour of iodine will be observed. *[1]*

accept "darker colour formed" since colour change is sometimes difficult to see

$Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ *[1]*

$Cl_2 > Br_2 > I_2$ *[1]*

6. (a) Chlorine is non polar/exists as discrete small molecules. *[1]*
The forces of attraction between chlorine molecules are weak van de Waals forces. *[1]*
Sodium is a metal and there is metallic bonding between sodium atoms. *[1]*
Silicon has a network covalent/macromolecular/giant covalent structure. *[1]*
Strong covalent bonds hold the silicon atoms together. *[1]*

(b) K has 19 electrons and 19 protons, outer electron is in a higher energy level/further from nucleus. *[1]*
Cl^-, Ar and K^+ all have the same electronic configuration. *[1]*
Cl^- has 18 electrons and 17 protons so the outer electrons are not held so strongly. *[1]*
Ar has 18 electrons and 18 protons. *[1]*
K^+ has 18 electrons and 19 protons so the outer electrons are more strongly attracted to the nucleus. *[1]*

(c) Na_2O reacts with water forming a basic solution, a property typical of a metal oxide. *[2]*
Al_2O_3 can react with either acids or bases (it is amphoteric) *[1]*
a property typical of a metal oxide close to the metal/non metal border. *[1]*
SO_2 forms an acidic solution with water (a property typical of a non metal oxide). *[1]*

accept equations

(d) Na has the electronic configuration 2.8.1. It readily loses one electron from the third level to give a complete outer shell (inert gas configuration). *[1]*
Mg with configuration 2.8.2 has an extra proton which attracts the electrons in the third level more strongly making it harder to remove one electron. *[1]*
It requires more energy to remove an electron from a positive ion than a neutral atom because there is an excess of protons. *[1]*
Na^+ has the configuration of 2.8 so the second electron is being removed from the second energy level which is closer to the nucleus and more tightly held. *[1]*
Mg^+ has the configuration 2.8.1 so it is still losing a third level electron to give it an inert gas configuration. *[1]*