Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced

CYD-BWYLLGOR ADDYSG CYMRU
Tystysgrif Addysg Gyffredinol
Uwch

336/01

CHEMISTRY CH6a

A.M. MONDAY, 25 June 2007

(1 hour 10 minutes)

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1	
B	2	
C	3	
	4	
TOTAL MARK		

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** which contains a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer the question in the spaces provided.
Section B Answer the question in the spaces provided.
Section C Answer **both** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)**, **Section B (15 marks)** and **Section C (25 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 50.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

You are reminded that marking will take into account the Quality of Written Communication used in all written answers.

Page 11 may be used for rough work.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

SECTION A

Answer the questions in the spaces provided.

1. This question concerns the following six solids.

Aminoethanoic acid (glycine)	NH_2CH_2COOH
Ammonium ethanoate	CH_3COONH_4
Ethanamide	CH_3CONH_2
Lead(II) iodide	PbI_2
Sodium iodide	NaI
Triiodomethane (iodoform)	CHI_3

(a) State the **two** solids which are yellow in colour. [1]

..... and .....

(b) State the two solids which do **not** have ionic bonding in their structures. [1]

..... and .....

(c) Give the structure of the organic group which can be identified on warming with alkaline iodine solution due to the formation of triiodomethane. [1]

.....

(d) (i) Outline how a pure sample of lead(II) iodide can be prepared using sodium iodide. [2]

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(ii) Outline how ammonium ethanoate can be converted to ethanamide. [1]

.....

.....

(e) Choose **two** solids from the list which will **react** with sodium hydroxide solution. For each of the compounds you choose, give the observations and the product(s) for the reaction.

First solid .....

Observations .....

Product(s) .....

[2]

Second solid .....

Observations .....

Product(s) .....

[2]

Section A Total [10]

SECTION B

2. *Read the passage below and then answer the questions in the spaces provided.*

Hydrogen Peroxide

Hydrogen peroxide, H_2O_2, is a widespread compound. It can be detected in drinking water, rain water, sea water and polluted air such as smog. Discovered by Louis Jacques Thénard in 1818, it is a colourless liquid that resembles water, with similar physical properties.

Compared to the more stable water molecule, an H_2O_2 molecule contains one extra oxygen atom, with single covalent bonds H-O-O-H. The bond between the two oxygen atoms is the so-called "peroxide" bond. There are many uses for hydrogen peroxide, which rely on two reactions:

$$2H_2O_2 \longrightarrow 2H_2O + O_2 \qquad \text{Reaction } \mathbf{A}$$

$$H_2O_2 \longrightarrow 2HO\bullet \qquad \text{Reaction } \mathbf{B}$$

Hydrogen peroxide is a strong oxidising agent, more powerful than chlorine, Cl_2, or potassium manganate(VII), $KMnO_4$. The oxidising behaviour means it is an irritant of eyes, mucous membranes, and skin. One advantage of hydrogen peroxide is that the decomposition products, water and oxygen, are not harmful.

Hydrogen peroxide has been used for bleaching straw hats, pulp and paper, but perhaps its best known use is the bleaching of hair. H_2O_2 can oxidise double bonds in large organic molecules. Since the double bonds often cause the molecules to absorb light, and therefore give the molecules their colour, removal of them destroys the pigments and so removes the colour. The term "peroxide blondes" was made famous by movie stars such as Marilyn Monroe and Jean Harlow.

Another widespread application of hydrogen peroxide is as a mild disinfectant for treating cuts and scratches. What makes hydrogen peroxide unique is the foaming action that occurs when it is placed on a cut. People used to believe this indicated the presence of infection, and the H_2O_2 was foaming as it destroyed the disease. In reality, though Reaction **A** normally occurs very slowly at room temperature, hydrogen peroxide foams when it comes into contact with blood because enzymes in blood, such as catalases, catalyse Reaction **A**. H_2O_2 is present in trace amounts in honey, which, before the advent of modern preparations, was used for dressing wounds.

Hydrogen peroxide is commercially available in various grades based on the percentage of H_2O_2. For example, Pharmaceutical Grade (3%) contains 3.00 g H_2O_2 made up to 100 cm^3 solution. Beautician Grade, used for hair colourings, is typically 6% strength whilst 35% Food Grade is used in producing cheese and egg–containing foods, and is sprayed onto the foil lining of drink cartons.

– End of passage –

(a) Draw a dot and cross diagram to show the covalent bonding in hydrogen peroxide, H_2O_2 *(line 6)*. [1]

(b) (i) Calculate the enthalpy change, $\Delta H^{\ominus}$, for Reaction **A**:

$2H_2O_2(l) \longrightarrow 2H_2O(l) + O_2(g)$ [2]

Use the enthalpy changes of formation below.

$\Delta H_f^{\ominus}\ H_2O_2(l) = -187{\cdot}8\ kJ\ mol^{-1}$

$\Delta H_f^{\ominus}\ H_2O(l) = -285{\cdot}8\ kJ\ mol^{-1}$

$\Delta H_f^{\ominus}\ O_2(g) = 0\ kJ\ mol^{-1}$

.....

.....

.....

(ii) Explain why hydrogen peroxide foams when it comes into contact with blood *(lines 9, 25 to 27)*. [1]

.....

.....

(c) (i) Reaction **A** can also be carried out in the gas phase

$2H_2O_2(g) \longrightarrow 2H_2O(g) + O_2(g) \qquad \Delta H^{\ominus} = -210\ kJ\ mol^{-1}$

Given the bond energies

O – H 464 kJ mol^{-1} and O = O 498 kJ mol^{-1}

use the $\Delta H^{\ominus}$ value to calculate the O – O bond energy. [2]

.....

.....

.....

.....

(ii) Explain why the O – O bond is normally the one involved when H_2O_2 reacts *(line 10)*. [1]

.....

(d) The following table shows some standard electrode potentials.

Half Reaction	*Electrode Potential* / V
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0·54
$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+ 1·36
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1·70
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+ 1·77

(i) Using the standard electrode potentials, explain why H_2O_2 is the strongest oxidising agent of those shown in the table *(lines 11, 12)*. [2]

.....

.....

(ii) Calculate the EMF for the oxidation of iodide ions, I^-, by hydrogen peroxide, H_2O_2, in acid solution and write a balanced equation for the reaction. [2]

EMF .....

Equation .....

(e) (i) State the general name given to a group of atoms which cause a molecule to be coloured *(lines 17, 18)*. [1]

.....

(ii) Explain why hydrogen peroxide bleaches many organic materials *(lines 16 – 19)*. [1]

.....

.....

(f) Calculate the concentration of Pharmaceutical Grade (3%) H_2O_2 in mol dm^{-3}, giving your answer to three significant figures *(lines 30, 31)*. [2]

.....

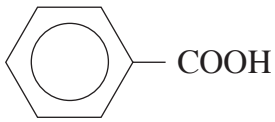
.....

Section B Total [15]

SECTION C

Answer **both** *questions in the spaces provided.*

3. The white crystalline solid benzenecarboxylic acid (benzoic acid) and its salts are widely used in industry as antimicrobial agents in products such as food, inks and hair spray.
It has the following structure.



benzenecarboxylic acid

(a) (i) Benzenecarboxylic acid can be prepared from a hydrocarbon, compound **A**. Compound **A** contains 91·23% carbon and 8·77% hydrogen by mass, with a relative molecular mass of 92·08. Its proton NMR spectrum shows two main peaks at shifts of 2·2 ppm and 7·3 ppm with peak areas in the ratio 3:5.
Showing your reasoning, determine the structure of compound **A** and state the reagent(s) and conditions needed to convert it to benzenecarboxylic acid. [4]

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(ii) Given that benzenecarboxylic acid is soluble in hot water but almost insoluble in cold water, describe an experimental technique you could use to purify the benzenecarboxylic acid produced. [3]

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.....

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.....

.....

(b) State the organic product, and name the type of reaction occurring, when benzenecarboxylic acid is

(i) heated with sodalime, [2]

Organic product .....

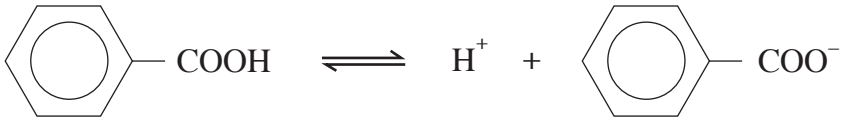
Type of reaction .....

(ii) treated with lithium tetrahydridoaluminate(III), $LiAlH_4$, in dry ether. [2]

Organic product .....

Type of reaction .....

(c) Benzenecarboxylic acid is a weak acid ($K_a = 6{\cdot}3 \times 10^{-5}$ mol dm^{-3}).



A solution of benzenecarboxylic acid has a concentration of $2{\cdot}79 \times 10^{-2}$ mol dm^{-3}. Calculate the pH of this solution of benzenecarboxylic acid. [2]

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.....

.....

Total [13]

4. *(a)* Aluminium chloride, $AlCl_3$, is an ***electron-deficient molecule***. Explain the meaning of this term and why it applies to $AlCl_3$. [2]

.....

.....

.....

(b) $AlCl_3$, under appropriate conditions, will react with a chloride ion to form $AlCl_4^-$.

(i) Describe the bonding change(s) which occur during this reaction. [1]

.....

.....

(ii) State the shapes of the $AlCl_3$ molecule and the $AlCl_4^-$ ion. [2]

$AlCl_3$ shape .....

$AlCl_4^-$ shape .....

(c) $AlCl_4^-$ is one anion found in *ionic liquids*, which in recent years have been developed as catalysts and solvents for a range of processes such as alkene polymerisation. *Ionic liquids* are organic salts that generally have melting temperatures below 100 °C and are liquid over a wide temperature range. Reactions may thus be performed under mild conditions.

(i) State **two** advantages of being able to carry out industrial reactions under mild conditions only just above room temperature. [2]

.....

.....

(ii) State the reaction type involved in the polymerisation of alkenes such as ethene. [1]

.....

(iii) State **one** organic preparation, other than polymerisation, in which aluminium chloride is used as a catalyst. [1]

.....

(d) Aluminium chloride can exist as a dimer

$$2AlCl_3\,(g) \rightleftharpoons Al_2Cl_6\,(g)$$

Giving your reasons in each case, state whether

(i) dimerisation, the forward reaction above, will be exothermic or endothermic, [1]

.....

.....

(ii) the proportion of dimer present at equilibrium is greater at high or low temperatures, [1]

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(iii) dimerisation in aluminium chloride would be favoured by high or low pressure. [1]

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Total [12]

Section C Total [25]

Rough Work