Name:		**Index Number:**		**Class:**	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H2 CHEMISTRY 9647/02

Paper 2 Structured **19 September 2013**

2 hours

Additional Materials: Data Booklet

INSTRUCTIONS TO CANDIDATES

1 Write your **name**, **index number** and **class** on this cover page.

2 Answer ***all*** questions.

3 Write your answers in the spaces provided on the question paper.

4 A *Data Booklet* is provided.

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

6 You may use a calculator.

For Examiner's Use	
1	**/ 12**
2	**/ 15**
3	**/ 9**
4	**/ 10**
5	**/ 15**
6	**/ 11**
Total	**/ [72]**
%	

This question paper consists of **18** printed pages and **0** blank page.

Answer **all** questions in the space provided.

For Examiner's Use

1 Planning

Solubility is defined as the mass of solid that will dissolve in and just saturate 100 g of solvent at a particular temperature.

When potassium nitrate dissolves in water, the temperature of the solution decreases as the enthalpy change of solution is endothermic.

You are to plan an experiment to investigate how the solubility of potassium nitrate varies with temperature. The units of solubility are grams per one hundred grams of water (g/100 g of water).

(a) (i) Predict how the solubility of potassium nitrate will change if the solution temperature is increased.

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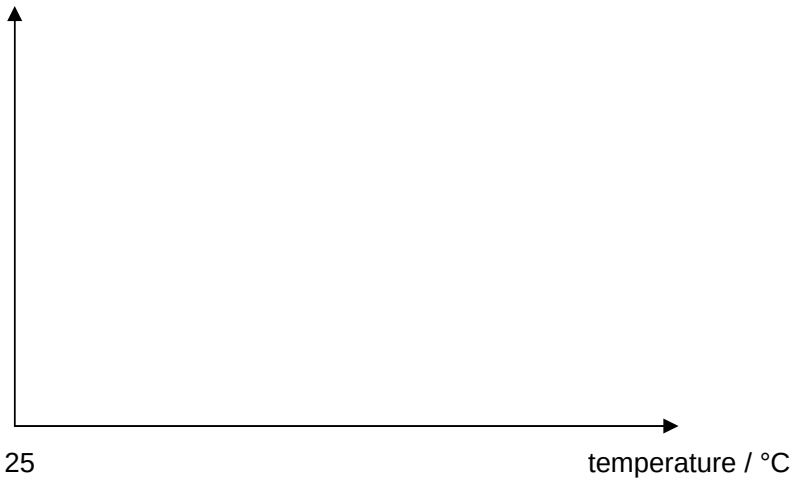
(ii) Display your prediction in the form of a sketch, labeling clearly the y–axis.



[3]

For Examiner's Use

(b) You are to design an experiment to test your prediction in **(a)**.

(i) Given that the solubility of potassium nitrate at 70 °C = 11.3 mol dm^{-3} Calculate the maximum mass of potassium nitrate that can be dissolved in 100 g of water at 70 °C.

(ii) Describe how you would carry out the experiment. You should

- include the apparatus used;
- ensure a wide range of results suitable for analysis by graph;
- decide on the amount of water and potassium nitrate to be used; and
- describe how the temperature of the solution is to be maintained.

You may also assume that standard laboratory apparatus are available.

For Examiner's Use

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(iii) Draw a table with appropriate headings to show the data you would record when carrying out your experiments and the values you would calculate in order to construct a graph to support or reject your prediction in **(a)**. The headings must include the appropriate units.

[7]

For Examiner's Use

(c) Potassium nitrate is used as an excellent additive in fertilisers. It dissolves in water with an enthalpy change of solution of +34.9 kJ mol^{-1}.
It is given that the lattice energy of potassium nitrate is –687 kJ mol^{-1} and the enthalpy change of hydration of potassium ion is –322 kJ mol^{-1}. With the aid of an energy level diagram, calculate the enthalpy change of hydration of nitrate ion.

[2]

[Total: 12]

2 The *use of Data Booket* is relevant to this question.

The nitrates, carbonates and hydroxides of Group II elements can undergo thermal decomposition.

The nitrates of lead and zinc can undergo thermal decomposition similar to calcium nitrate. The decomposition temperatures of the three nitrates are given in the table below.

Compound	**Decomposition temperature / °C**
Lead(II) nitrate, $Pb(NO_3)_2$	290
Zinc nitrate, $Zn(NO_3)_2$	105
Calcium nitrate, $Ca(NO_3)_2$	132

(a) Explain the data above by quoting relevant values from the *Data Booklet* and using your knowledge and understanding of the trend in the decomposition temperature of the Group II nitrates.

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[3]

For Examiner's Use

(b) The mineral hydromagnesite is a hydrated carbonate of magnesium, with the formula $Mg_x(CO_3)_y(OH)_z.nH_2O$ and a molar mass of 466 g mol^{-1}. Group II carbonates and hydroxides decompose to give the same solid product.

When 1.00 g of a pure sample of hydromagnesite was heated to constant mass, 0.378 g of carbon dioxide was given off. Steam was also produced.

The remaining white solid from the above decomposition was completely dissolved in 50 cm^3 of a 1.0 mol dm^{-3} solution of hydrochloric acid. The resultant solution was transferred into a volumetric flask and diluted to 250 cm^3 with deionised water. A 25.0 cm^3 aliquot of this diluted solution required 28.50 cm^3 of a 0.10 mol dm^{-3} solution of sodium hydroxide for complete neutralisation.

(i) Calculate the value of *y*.

(ii) Calculate the value of *x*.

For Examiner's Use

(iii) Hence or otherwise, deduce the values of *z* and *n*.

(iv) Using your answers from parts **b(i)** to **(iii)**, write a balanced equation, with state symbols, for the thermal decomposition of hydromagnesite.

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[9]

(c) A mixture of magnesium oxide, alumina (Al_2O_3) and silica (SiO_2) is usually used in the manufacture of refractory material. Suggest, with explanation and suitable equations, how magnesium oxide can be separated from a mixture containing these three oxides.

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[3]

[Total: 15]

For Examiner's Use

3 The data for some liquids are given below:

	M_r	boiling point/ °C	density / g cm^{-3}
ethanol	46	79	0.79
cyclohexane	84	81	0.78
hexane	86	69	0.66

(a) **(i)** Suggest why the boiling point of cyclohexane differs from that of hexane.

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(ii) Suggest why the density of ethanol differs from that of hexane.

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[3]

(b) Equal volumes of 1.0 mol samples of the following liquids were mixed and the following results were obtained in the following table.

Mixture of liquids	Heat change
Hexane mixed with cyclohexane	No heat absorbed or given out
Hexane mixed with ethanol	?

(i) Explain why there was no heat change on mixing hexane and cyclohexane.

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For Examiner's Use

(ii) Predict, with reasoning, the heat change on mixing hexane and ethanol.

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[3]

(c) **(i)** Write a balanced equation, for the complete combustion of ethanol, C_2H_6O.

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(ii) By using appropriate bond energy data from the *Data Booklet*, calculate the enthalpy change of combustion of ethanol.

[3]

[Total: 9]

For Examiner's Use

4 **(a)** Chlorine forms an oxide Cl_2O_6 which exists as singly charged ions in the solid state. The oxidation states of chlorine are +5 and +7 in the cation and anion respectively.

Suggest the formulae of the ions and draw the dot–and–cross diagram for the **cation**.

[3]

Formula of cation: .....

Formula of anion: .....

dot–and–cross diagram of **cation:**

(b) When chlorine is bubbled through cold sodium hydroxide solution and acidified silver nitrate solution, only half of the chlorine that has dissolved is precipitated as silver chloride. When the sodium hydroxide is hot, up to five–sixth of the chlorine can be precipitated. Explain the observations, giving balanced equations where appropriate.

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[3]

For Examiner's Use

(c) Chlorate(VII) ion can be produced from the reaction of Cl_2O_7 with alkali.

(i) Write an equation for the formation of chlorate(VII) ion.

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(ii) State the type of reaction undergone.

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(iii) Given that Cl_2O_7 molecule is a symmetrical, draw the shape of the molecule, indicating the possible C*l*–O–C*l* bond angle.

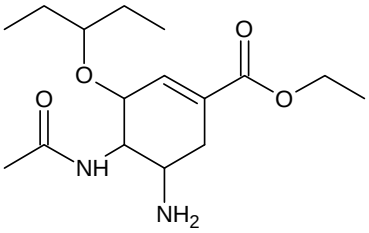
C*l*–O–C*l* bond angle: **.....**

[4]

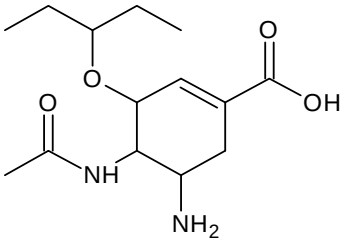
[Total: 10]

For Examiner's Use

5 **(a)** *Oseltamivir* is an anti–influenza drug being used to treat the so called 'Bird–flu'. This anti–viral drug can be converted to its active form *GS 4071*, in the body after being administered. The structure of *Oseltamivir* is shown below:



Oseltamivir



GS 4071

You may assume that the ether (–O–) group in *Oseltamivir* is unreactive in any reactions in this question.

(i) Circle and name four different functional groups present in *Oseltamivir*.

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(ii) *Oseltamivir* is actually sold as the phosphate salt rather than in the form as shown above. Suggest why this is so.

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(iii) What type of reaction is involved in the conversion of *Oseltamivir* into GS 4071?

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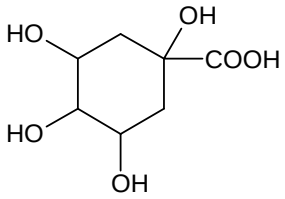
(iv) Draw the structural formula of all organic products formed when *Oseltamivir* is heated with excess sodium hydroxide.

For Examiner's Use

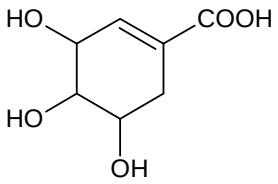
(v) At room conditions, *Oseltamivir* reacts with HBr in 1:2 ratio. Draw the structure of the product formed.

[6]

(b) *Oseltamivir* can be produced from *Quinic acid*, found in coffee beans or *Shikimic acid*, found in star anise.



Quinic acid



Shikimic acid

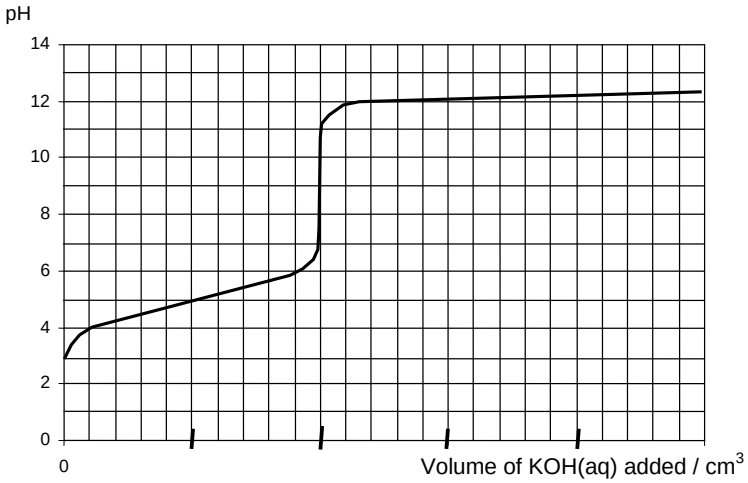
(i) Use the **table of characteristic values for infra–red absorption in the *Data Booklet***, identify an infra–red absorption range shown by *Shikimic* acid but not *Quinic* acid.

..... cm^{-1}

(ii) Give the structural formula of the organic product when *Shikimic* acid reacts with excess ethanoyl chloride.

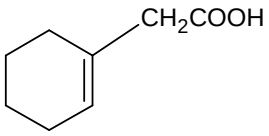
For Examiner's Use

(iii) The titration curve below shows the reaction between a solution of a 10.0 cm^3 of 0.10 mol dm^{-3} solution of *Shikimic* acid and 0.05 mol dm^{-3} KOH solution.



Calculate the value of K_a for *Shikimic* acid.

(iv) Suggest the reagents and conditions for a reaction that could be used to distinguish between *Shikimic* acid and another compound **R.**



R

State the expected observation of the reaction on each compound.

reagent/condition: .....

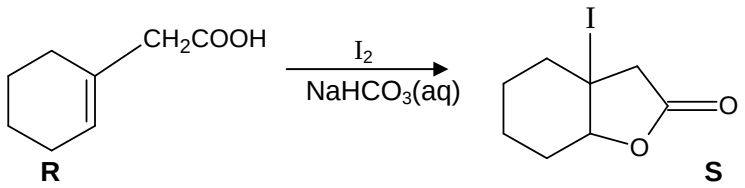
expected observation: .....

.....

.....

For Examiner's Use

(v) When compound **R** is reacted with iodine in the presence of aqueous sodium hydrogencarbonate, iodine does **not** add across the carbon–carbon double bond of compound **R** as might be expected. Instead, a compound **S**, which has a molecular formula, $C_8H_{11}O_2I$, is formed as shown:



R **S**

Suggest an explanation for the observation.

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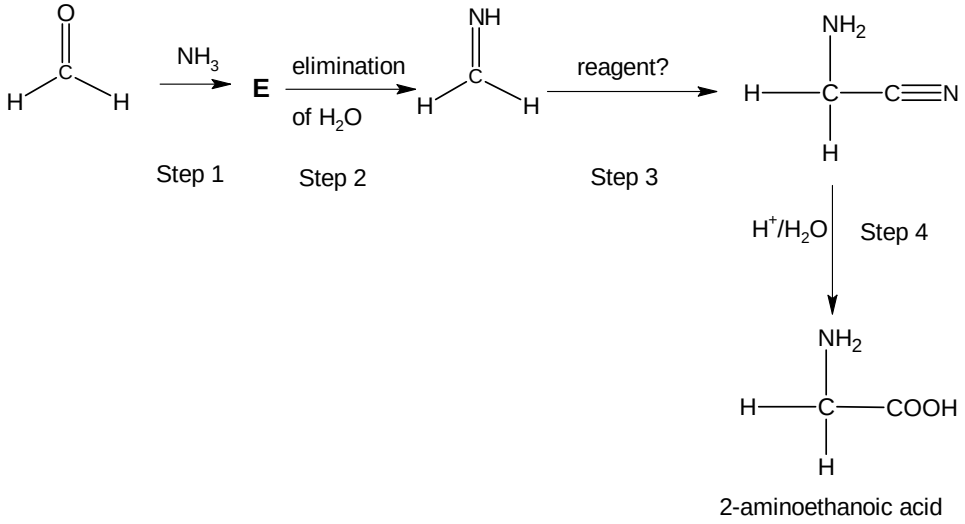
[9]

[Total: 15]

6 **(a)** The Strecker synthesis is a route to preparing amino acids.
Glycine, 2–aminoethanoic acid, can be prepared from methanal, as a starting material. This is shown in the four–steps reaction scheme below:

For Examiner's Use



(i) State the role of ammonia used in Step 1.

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(ii) Suggest a structure for compound **E**.

(iii) Suggest a suitable reagent used in Step 3.

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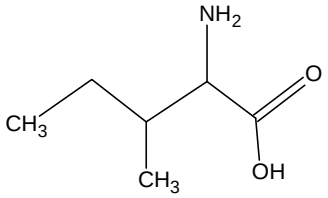
For Examiner's Use

A starting material, compound **Z**, can be used to prepare isoleucine, shown below using a Strecker synthesis.

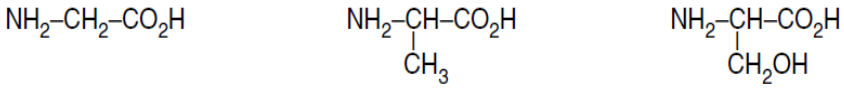


isoleucine

(iv) Draw the structure of compound **Z**.

[4]

Much research has been carried out in recent years investigating the exact structure of silk. A silk fibre is composed of many identical protein chains, which are mainly made from the amino acids glycine, alanine and serine, with smaller amounts of four other amino acids.



glycine alanine serine

(b) **(i)** A solution of glycine at its isoelectric point can act as a buffer.

By writing appropriate equations, show how a solution of glycine at its isoelectric point can function as a buffer.

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(ii) Predict the movement of glycine when a potential difference is applied at pH 13.

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[3]

For Examiner's Use

(c) Assuming that a silk protein made from equal amounts of the three amino acids glycine, alanine and serine has M_r of about 600 000. Calculate the average number of amino acids residues in the protein chain.
[M_r (glycine = 75; M_r (alanine) = 89; M_r (serine) = 105]

[3]

(d) Unlike silk protein, globular proteins such as enzymes contain relatively small amounts of glycine and alanine when compared to the amounts of some other amino acids. Suggest why this is so.

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[1]

[Total: 11]