TAYLOR'S COLLEGE

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Class	Student Number	Name

CAMBRIDGE A LEVEL PROGRAMME

AS TRIAL EXAMINATION AUGUST/SEPTEMBER 2012

(January and March 2012 Intakes)

Wednesday **29 August 2012** **9.45 am – 11.00 am**

CHEMISTRY 9701/23

PAPER 2 Structured Questions AS Core 1 hour 15 minutes

Candidates answer on the Question Paper
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, class and student number in the spaces at the top of this page.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples , paper clips , highlighters, glue or correction fluid.

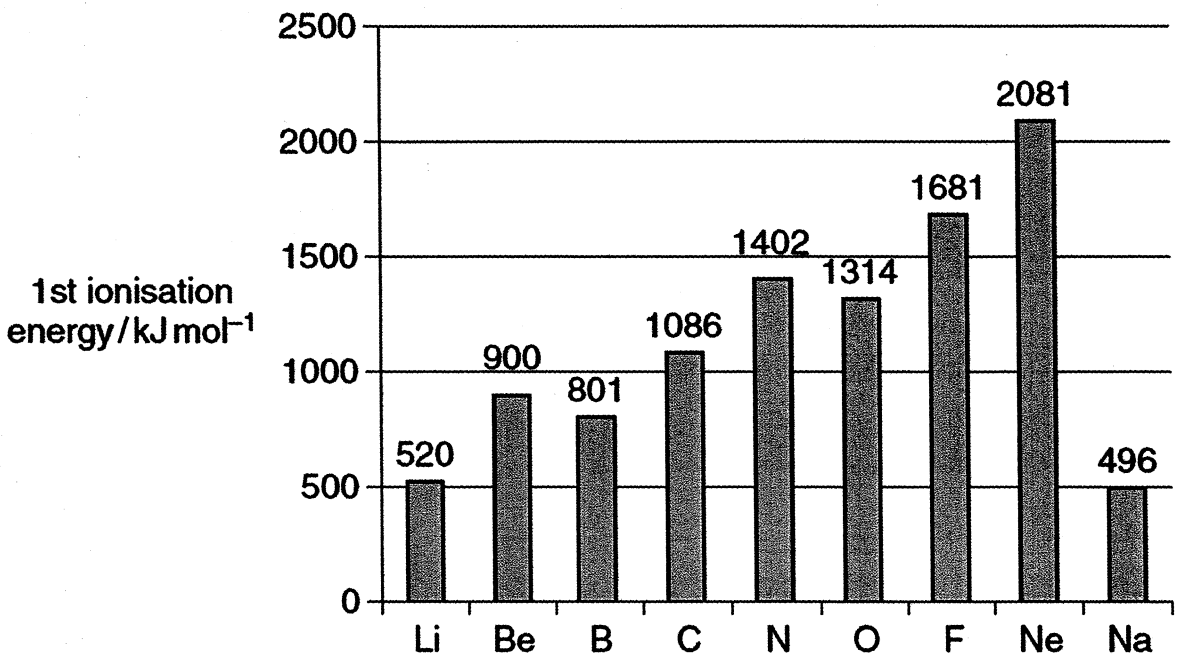
Answer **all** questions.
The number of marks is given in brackets[ ] at the end of each question or part question.
You may lose marks if you do not show your working or if you do not use appropriate units.
A Data Booklet is provided.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
Total	

This document consists of **11** printed pages.

[Turn over

1. Ionisation energies have been used to develop the model of the atom.
The first ionisation energies of the elements Li to Na are shown in the figure below.



(a) (ii) Define the term *first ionisation energy*.

.....

.....

(ii) Explain the difference between the first ionisation energies of N and O.

.....

.....

.....

(iii) Explain the significant drop in first ionization energy from Ne to Na.

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.....

.....

[7]

(b) The first ionisation energy of oxygen is 1314 kJ mol^{-1} and the second ionisation energy of oxygen is 3388 kJ mol^{-1}.

(i) Write an equation to represent the **second** ionisation energy of oxygen. Include state symbols.

.....

(ii) Suggest why the second ionisation energy of oxygen has a greater value than the first ionisation energy of oxygen.

.....

[3]

[Total: 10]

2. Hydrogen is used in large quantities in industry to convert nitrogen into ammonia for use in fertilizers. One method of manufacturing hydrogen is to pass methane and steam over heated nickel catalyst.

$$CH_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4H_2(g)$$

(a) Use the enthalpy changes of combustion below to calculate the enthalpy change of this reaction.

Substance	**ΔH_c/ kJ mol^{-1}**
CH_4	-890
H_2	-242

[3]

(b) Suggest and explain a suitable condition needed to obtain higher yield of hydrogen gas.

Condition.....

Explanation.....

.....

.....

[2]

(c) Predict and explain the effect of increasing the amount of nickel catalyst on the percentage yield of hydrogen gas.

.....

.....

.....

[2]

[Total: 7]

3. Boron trifluoride, BF_3, and aluminium fluoride, AlF_3, differ markedly in their physical properties.

Compound	**Melting point / °C**
BF_3	-144
AlF_3	1291

(a) Explain the difference in melting point in terms of structure and bonding.

.....

.....

.....

.....

.....

[4]

(b) Boron trifluoride forms a compound with ammonia. Draw the 'dot–and –cross' diagram of the product.

[1]

(c) Explain why 1 mole of boron trifluoride reacts with 1 mole of ammonia. State the type of bond involved in the formation of the product.

.....

.....

.....

[2]

[Total: 7]

4. One way of decreasing "acid rain" is to remove sulfur dioxide from the gaseous emissions of power stations.

(a) Give one major source of sulfur dioxide emission by power stations.

.....[1]

(b) Write equations showing nitrogen oxides acting as a catalyst in the formation of acid rain.

.....

.....

.....

[3]

(c) Several methods for SO_2 removal have been suggested. One of the methods uses a suspension of calcium carbonate which is heated. Write equations for reaction of heated calcium carbonate with SO_2 gas.

.....

.....

.....

[2]

(d) A 4.50 g sample of Group II carbonate lost 1.34 g in mass when heated strongly. Identify the metal, showing clearly your working.

[2]

[Total: 8]

5. The gaseous hydrogen halides HCl, HBr and HI, may be prepared by reacting the corresponding sodium salt with anhydrous phosphoric(V) acid, H_3PO_4. When the sodium halide NaX was used, the following reaction occurred and a sample of gaseous HX was collected in a gas jar.

$$\mathbf{NaX + H_3PO_4 \rightarrow NaH_2PO_4 + HX}$$

A hot glass rod was placed in the sample of HX and immediately a brown colour gas was observed.

(a) What is the identity of NaX?

..... [1]

(b) When the anhydrous phosphoric(V) acid, H_3PO_4 is replaced with **concentrated sulfuric acid** a different product will be obtained depending on the identity of X. A sample observation and explanation is given for one of the halides. Complete the following table with suitable observations and explanations.

Halide	Observation	Explanation and equation
Cl^-		
Br^-	***Brown fumes obtained.***	***Some of the HBr produced is oxidised to Br_2 by the concentrated H_2SO_4*** ***$2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + 2H_2O$***
I^-		

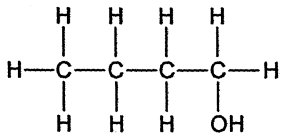
[6]

[Total: 7]

[Turn over

6. (a) There are four structural isomers of $C_4H_{10}O$ that are alcohols. One of the isomers has been drawn for you.

Complete the table below to show the other structural isomers.

			
butan-1-ol	isomer **1**	isomer **2**	isomer **3**

[3]

(b) Butan-1-ol is oxidised by an acidified solution of potassium dichromate (VI) to form a carboxylic acid.

(i) State the colour change that you would see.

Colour changes from ..... to .....

(ii) One of the isomers of $C_4H_{10}O$ is chiral. Draw displayed formulae of the two optical isomers, indicating with an asterisk (*) the chiral carbon atom.

(iii) Identify which of the isomers, **1**, **2** or **3**, in (a) could also be oxidised to form a carboxylic acid.

isomer .....

[4]

(c) Butan-1-ol reacts with hot concentrated sulphuric acid to form compound **B**.

(i) Compound **B** has an empirical formula of CH_2 and a relative molecular mass of 56. Use this information to deduce the molecular formula of compound **B**. Show your working.

(ii) Write a balanced equation to show the conversion of butan-1-ol into compound **B**.

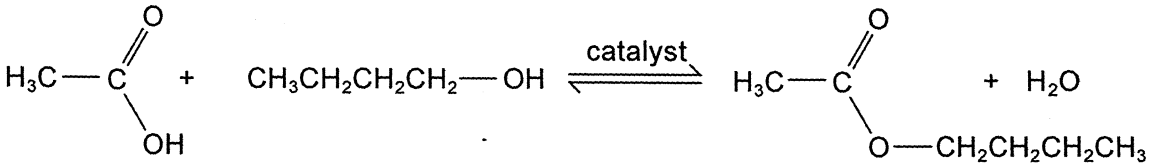
.....

(iii) One of the isomers, **1**, **2** or **3**, in (a) also reacts with hot concentrated sulphuric acid to form compound **B**.

Identify which isomer. isomer .....

[4]

(d) The ester, $CH_3CO_2CH_2CH_2CH_2CH_3$, was formed by reacting ethanoic acid with butan-1-ol.



butan-1-ol

ester
M_r = 116

State the name of the ester produced.

.....[1]

[Total: 12]

[Turn over

7. Oxidation of C_7H_{14} with hot concentrated $KMnO_4$ produces two organic compounds **A** and **B**:

$(CH_3)_2CHCO_2H$	CH_3COCH_3
A	**B**

(a) Suggest a structure for the compound with molecular formula of C_7H_{14} oxidised by $KMnO_4$.

[1]

(b) Describe a suitable test to differentiate both compound **A** and **B**.

.....

.....

.....

.....

[2]

(c) Give the name and displayed formula of the compound formed by treating **B** with $NaBH_4$ in ethanol.

[2]

(d) Compound **B** undergoes nucleophilic addition when treated with an appropriate nucleophile. Write the mechanism for the reaction of compound **B** with hydrogen cyanide in the presence of sodium cyanide. Use curly arrows to show the movement of electrons, and indicate any dipoles that exist.

[4]

[Total: 9]