RIVER VALLEY HIGH SCHOOL
YEAR 6 PRELIMINARY EXAMINATION II

CANDIDATE NAME									
CLASS									
CENTRE NUMBER	S	3	0	4	4	INDEX NUMBER	0	0	

H2 CHEMISTRY 9729/02

Paper 2 Structured Questions **13 Sep 2017**

2 hours

Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Write your name, class and index number in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.
The use of an approved scientific calculator is expected, where appropriate.
A Data Booklet is provided.

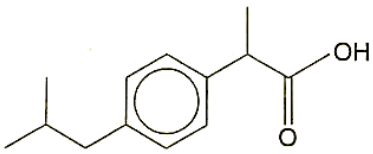
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use									
Paper 2									
P2	1	2	3	4	5	SF	UNITS	Total (P2)	
	/17	/14	/14	/15	/15			/75	
P1	/30	P3	/80	Total	/185	P4	/55	Grade	

This paper consists of **18** printed pages.

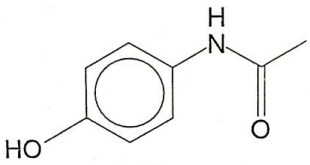
Answer **all** questions in the spaces provided.

1 Among the many pharmaceutical drugs manufactured worldwide, one of the most important types is the painkillers. The structures of three such painkillers are shown.



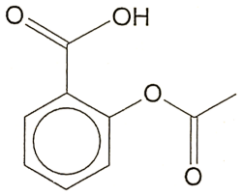
ibuprofen

(M_r = 206)



paracetamol

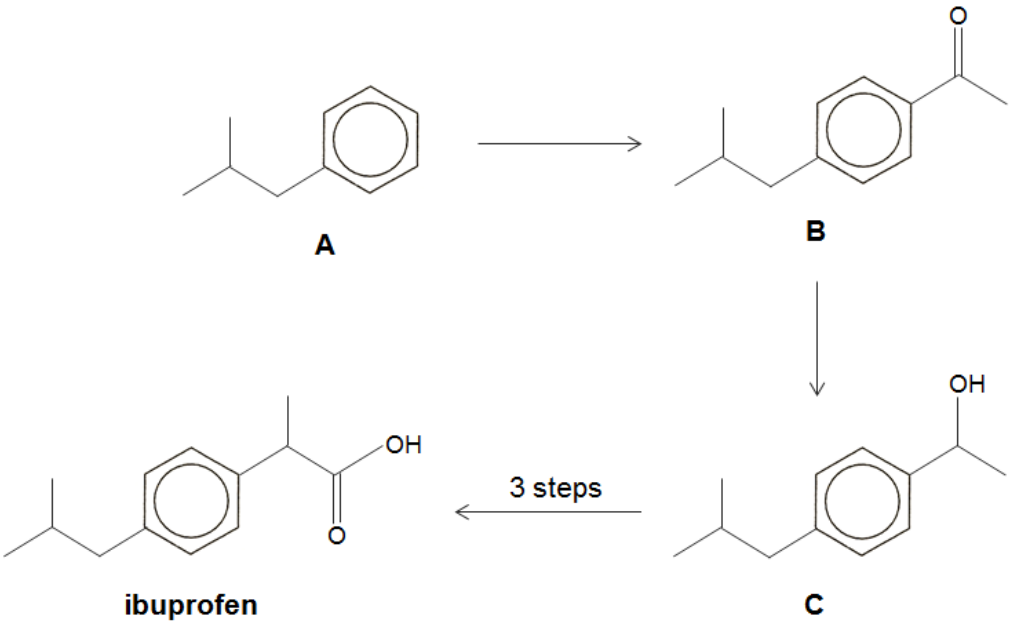
(M_r = 151)



aspirin

(M_r = 180)

Ibuprofen is used to treat arthritis and relieve pain, fever and swelling. It is available over-the-counter in 200 and 400 mg tablets. The recommended dosage varies with body mass and indication, but 1.20 g is considered the maximum daily adult dosage. Long term use of ibuprofen can lead to stomach ulcers. Ibuprofen can be synthesised via the following process:



(a) A man bought some ibuprofen tablets of dosage 200 mg over the counter and consumed one pill 4 times a day. Explain if this level of consumption safe for the man.

……

…… **[1]**

(b) State the *type of reaction* that converts Compound **A** to **B**.

…… **[1]**

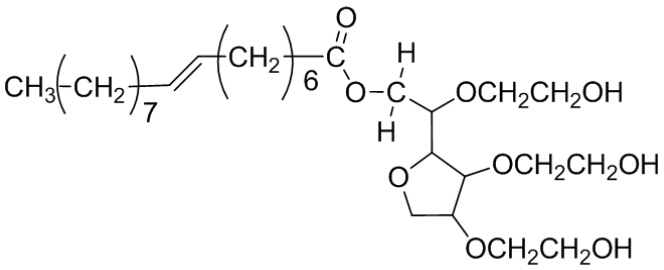
(c) In the laboratory, Compound **C** can be converted to ibuprofen using a 3-step synthesis route.

Suggest reagents and conditions for each step, and draw the structures of all intermediates.

[5]

(d) Young children often find it difficult to swallow tablets. Thus, ibuprofen is supplied as an "infant formula" emulsion.

Given that ibuprofen and water are immiscible, an emulsifier such as polysorbate 80 is used to create a homogeneous mixture.



polysorbate 80

Explain why this molecule is able to act as an emulsifier.

……

……

…… **[1]**

(e) A certain pharmaceutical brand claims that the ibuprofen tablets it manufactures are 95.0% pure by mass.

To investigate this claim, 5.00 g of a sample was crushed and dissolved in 250 cm^3 of 0.450 mol dm^{-3} aqueous KOH. 25.0 cm^3 of this solution was withdrawn and titrated against sulfuric acid. The unreacted KOH in this solution required 25.50 cm^3 of 0.180 mol dm^{-3} of sulfuric acid for complete neutralisation.

Showing relevant calculations, deduce if the claim is valid.

[3]

(f) Compare the acidity of ibuprofen and aspirin. Explain your answer.

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[2]

(g) Describe two simple chemical tests to distinguish between ibuprofen, paracetamol and aspirin.

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…… **[4]**

[Total: 17]

2 **(a)** Gaseous ethane can be used as a fuel for campers. A company manufactures compressed gaseous ethane in 400 cm^3 metal canisters. A typical metal canister at room temperature contains compressed gaseous ethane at a pressure of 4.00 atm.

(i) Suggest a reason why gaseous ethane in the metal canister does not behave like an ideal gas.

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……

…… **[1]**

(ii) One metal canister is used for heating water and the pressure decreases from 4.00 atm to 1.50 atm. Assuming that the compressed ethane behaves ideally, calculate the mass of water at room temperature that could be brought to boiling if the process is 80% efficient. The enthalpy change of combustion of ethane is -1420 kJ mol^{-1}.

[3]

(iii) Suggest a reason why butane is a better fuel for campers compared to ethane.

……

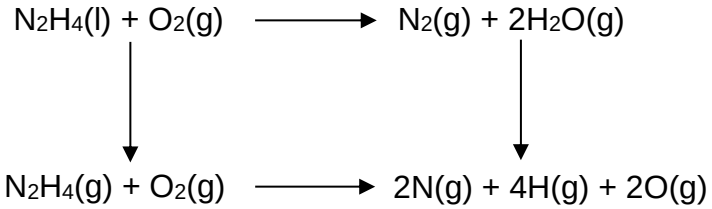
…… **[1]**

(b) Calcium fluoride is used for dental protection. It dissolves readily in water with an enthalpy change of solution of −125 kJ mol^{-1}. It is given that the lattice energy of calcium fluoride is −2350 kJ mol^{-1} while the enthalpy change of hydration of calcium ion is −1560 kJ mol^{-1}.

With the aid of a labelled energy level diagram, calculate the enthalpy change of hydration of fluoride ion.

[4]

(c) Liquid hydrazine reacts with oxygen to form nitrogen and steam which could involve the following energy cycle shown below.



(i) Given that the enthalpy change of vapourisation of hydrazine is +58.0 kJ mol^{-1}, use appropriate bond energies from the *Data Booklet* to calculate the enthalpy change of reaction between liquid hydrazine and oxygen.

[2]

(ii) The reaction shown above has a positive ΔS value. Account for its significance.

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…… **[1]**

(iii) Hence, under what conditions of temperature will the reaction be spontaneous?

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…… **[2]**

[Total: 14]

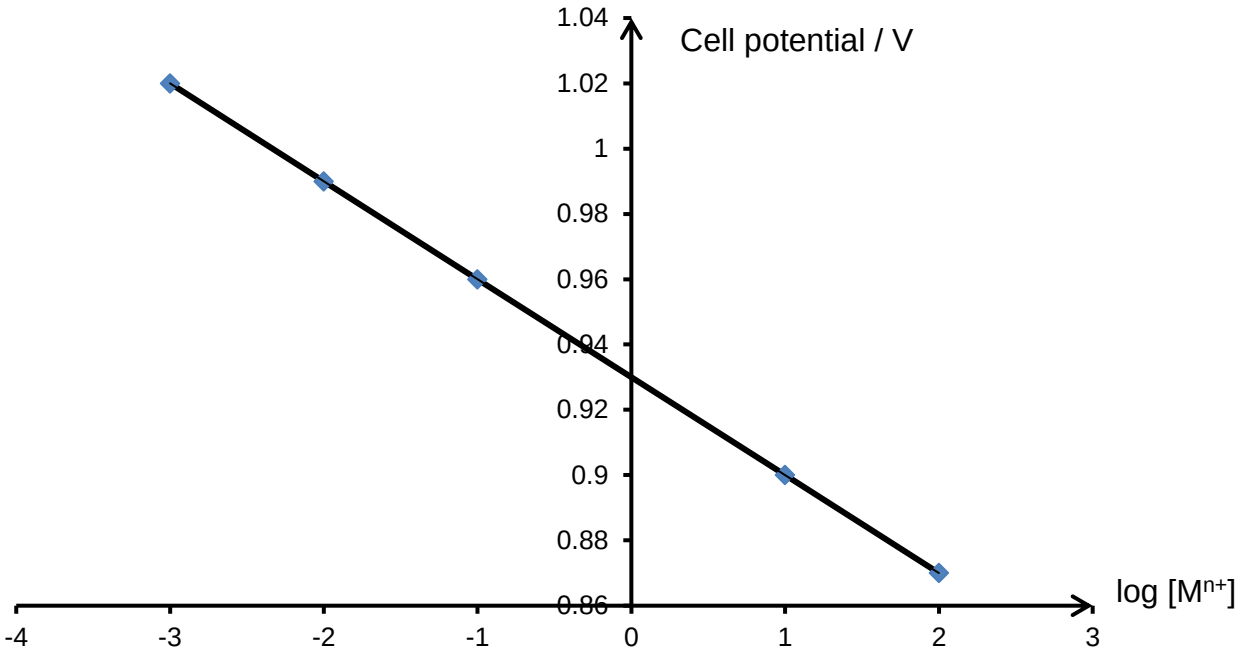
3 An experiment was set up to investigate how the cell potential of a cell containing a metal, M, in contact with an aqueous solution of its ions, $M^{n+}(aq)$, changed as $M^{n+}(aq)$ was diluted.

Since a standard hydrogen half-cell was not available, a half-cell consisting of Cl^-, ClO^- in alkaline medium under standard conditions was used to connect to the half-cell with M in contact with $M^{n+}(aq)$.

(a) Draw the setup of the galvanic cell as described above.

[3]

The cell potential was measured for various concentrations of $M^{n+}(aq)$ and the results of cell potential against log $[M^{n+}]$ obtained are plotted in the graph as shown below.



(b) It is known that the cell potential of a cell, E_{cell}, is related to the standard electrode potential, $E^{\ominus}_{cell}$, by the equation:

$$E_{cell} = E^{\ominus}_{cell} - \frac{0.06 \lg[M^{n+}]}{n}$$

(i) Use your graph to determine the gradient and the charge, n, of the M^{n+} ions.

[2]

(ii) Use your graph to determine the $E^{\ominus}_{cell}$, showing your working clearly.

[2]

(iii) In the determination of standard electrode potential of a half-cell, the polarity of standard hydrogen electrode can either be positive or negative.

The standard electrode potential for Cl^-, ClO^- in alkaline conditions is +0.80 V.

Hence, calculate the standard electrode potential of the metal, M, and suggest its identity.

[2]

(iv) Suggest one purpose of a salt bridge in a galvanic cell.

……

…… **[1]**

(v) A student suggested the use of aqueous potassium sulfate in the salt bridge. Do you think his choice is wise? Explain your reasoning.

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…… **[2]**

(c) Using Le Chatelier's Principle and relevant equations, explain why AgCl is soluble in excess aqueous ammonia.

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…… **[2]**

[Total: 14]

4 Viridian is a blue-green pigment used commonly in paints, inks, and stained glasses. The major constituent of viridian is the compound chromium(III) oxide, Cr_2O_3, that gives its characteristic colour.

Alumina, which is the common name for the chemical aluminium oxide (Al_2O_3), is a white solid which is commonly used as abrasive owing to its high hardness rating.

(a) Define the term *transition element.*

……

…… **[1]**

(b) In terms of structure and bonding, explain why alumina has a high hardness rating.

……

……

……

…… **[2]**

(c) Both Cr_2O_3 and Al_2O_3 are amphoteric oxides. Describe the observations and write balanced equations when Cr_2O_3 is dissolved in HC*l*(aq) and NaOH(aq). You can assume that the coordination number of chromium in NaOH(aq) is 6.

In HC*l*(aq)

Equation:

……

Observation:

……

In NaOH(aq)

Equation:

……

Observation:

…… **[4]**

(d) Explain why the resultant solution is coloured when Cr_2O_3 is dissolved in acid.

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[3]

(e) Another chromium-containing compound, $CrCl_3$, also exhibits similar properties to $AlCl_3$.

Predict the pH of the solution when a solid sample of $CrCl_3$ is dissolved in water. Use equations to justify your answer where possible.

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……

[2]

(f) *Use of the Data Booklet is relevant to this question.*

The element chromium shows a relatively similar increase in the 1st, 2nd, 3rd and 4th ionisation energy. Aluminium, however, shows a significant difference between its 3rd and 4th ionisation energy.

(i) By means of an equation, express the 2nd ionisation energy of chromium.

……

[1]

(ii) Explain fully why the 4th ionisation energy of aluminium has a significantly larger magnitude compared to its 3rd ionisation energy.

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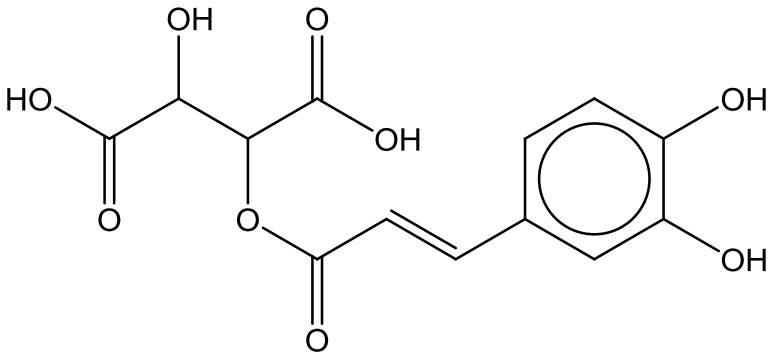
…… **[2]**

[Total: 15]

5 Caftaric acid is a compound found in grapes and is responsible for the yellowish-gold colour seen in some white wines.



caftaric acid

(a) Deduce the molecular formula of caftaric acid.

…… **[1]**

(b) **(i)** State the type(s) of stereoisomerism exhibited by caftaric acid.

…… **[1]**

(ii) Hence, state the total number of stereoisomers of caftaric acid.

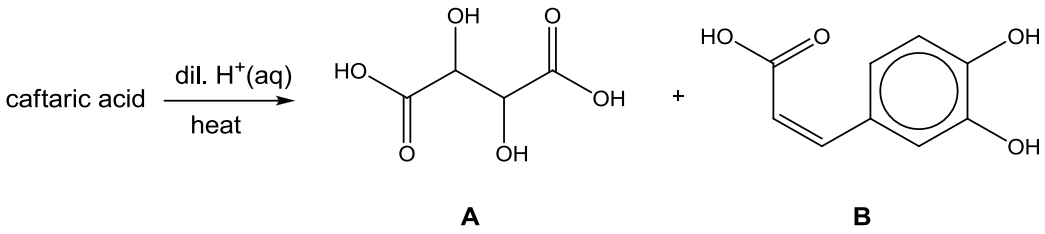
…… **[1]**

(c) The level of caftaric acid can be used to estimate the oxidation levels that a wine has undergone. Wines that undergo a high degree of oxidation, such as pressed wine, will have little to no caftaric acid in them.

Suggest the carbon-containing products formed when caftaric acid is heated with excess acidified $KMnO_4(aq)$.

[3]

(d) On heating with dilute aqueous acid, caftaric acid produces two compounds **A** and **B**.



A **B**

(i) State the *type of reaction* caftaric acid is undergoing when **A** and **B** are formed.

…… **[1]**

(ii) There are three types of molecules of **A**, one of which has no effect on plane polarised light.

Suggest the structure of the molecule and explain why it has no effect on plane polarised light.

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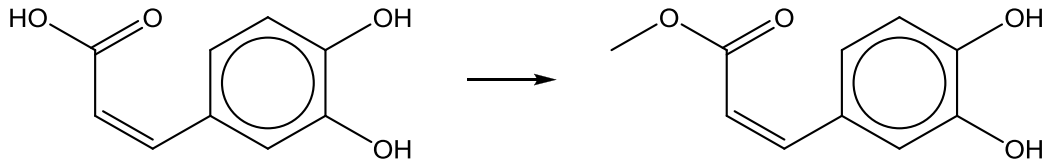
…… **[2]**

(e) Under suitable conditions, the carboxylic acid functional group in compound **B** can be converted to its methyl ester.



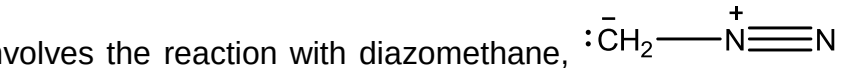
B

(i) State the *type of reaction* undergone by **B** above.

…… **[1]**

(ii) Suggest the reagents and conditions for the above reaction.

…… **[1]**

(f) Another method for conversion of carboxylic acids to their methyl esters involves the reaction with diazomethane,  , in an inert solvent.

$$RCO_2H + CH_2N_2 \rightarrow RCO_2CH_3 + N_2$$

This reaction occurs via a two-step mechanism.

- The carboxylic acid reacts with diazomethane to form a carboxylate ion intermediate in the first step.
- N_2 is formed in the second step.

Suggest the mechanism for this reaction. Show any relevant lone pairs, dipoles and charges, and indicate the movement of electron pairs with curly arrows.

[4]

[Total: 15]

END OF PAPER