



RIVER VALLEY HIGH SCHOOL

YEAR 6 PRELIMINARY EXAMINATION

CANDIDATE
NAME

CLASS

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CENTRE
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INDEX
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H2 CHEMISTRY

9647/02

Paper 2 Structured Questions

24 September 2013

2 hours

Candidates answer on the Question Paper.

Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, class, Centre number and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the 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 in the space provided.
A Data Booklet is provided. Do NOT write anything on it.

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									
Question Number	1	2	3	4	5	6			Total
Marks	12	14	4	11	16	15			72
Paper 1	40		Paper 3		80		Total		192

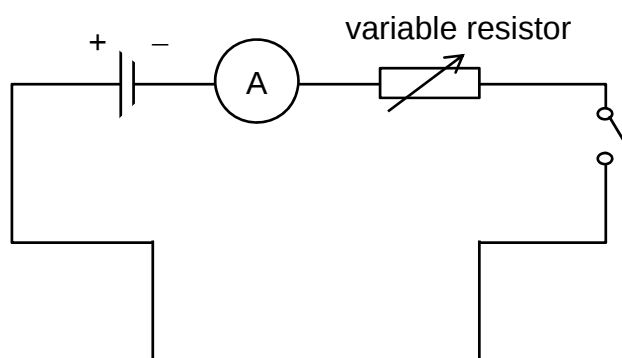
This document consists of **19** printed pages and **1** blank page.

1 Planning (P)

Rust is mainly made up of iron (III) oxide. An old rusty iron box can be restored by submerging the box in acid solution to remove the rust, followed by coating the iron box with a layer of metals such as chromium, aluminium or zinc using electrolysis.

A student tries to adapt this process to restore a rusty iron box using only materials that are available in the school laboratory.

She removed the rust on the box by submerging it in 1 mol dm^{-3} sulfuric acid. Then she coats the rust free box with a layer of copper using electrolysis. The diagram below shows part of the experimental set up.



- (a) Write a balanced equation, including state symbols, for the reaction that removes rust from the box using sulfuric acid.

[1]

- (b) Other than safety issues, what is the disadvantage of using strong acid to remove rust from the box?

[1]

- (c) Complete and label the diagram above to show the experimental set-up for coating the rust free box with copper metal by electrolysis. Give the composition of a suitable electrolyte.

[2]

- (d) Write the equation for the reaction at the anode and cathode.

Cathode: _____

Anode: _____

[1]

- (e) The variable resistor can be used to vary the current that is passed through a closed circuit.

Predict how does the amount of copper deposited in a fixed duration (t) varies as current is increased from 0.00A until 1.00A. Display your prediction in the form of a sketch graph.

[1]

- (f) Design a laboratory experiment to investigate your prediction in (e) and hence allow an experimental value for Faraday's Constant to be obtained.

The following apparatus and chemicals are available for used.

Wires	Batteries
Switch	Mass balance ($\pm 0.001\text{g}$)
Digital Ammeter ($\pm 0.001\text{A}$)	Pure copper strips
Variable resistor	Copper (II) sulfate solution

- (i) The percentage error for the mass weighed using the mass balance should not exceed 1%. Calculate the minimum duration of time, in minutes, for 0.400 A of current to be passed through the circuit.

- all essential experimental details
- the precautions taken to ensure accuracy
- outline of how the results would be used to verify your predicted graph in **(e)**.
- hence explain how the results can be used to determine a value for the Faraday constant.

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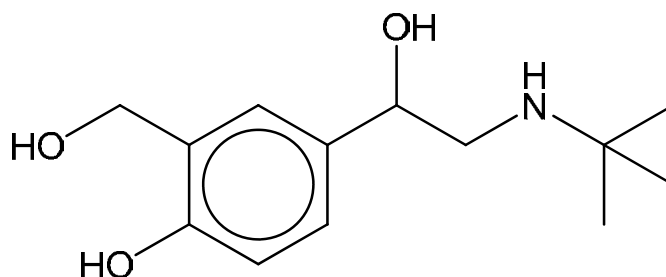
[6]

River Valley High School
Preliminary Examination 2013

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- 2 Haze levels in Singapore hit a record high of PSI 401 on 21 June this year, as a consequence of widespread forest fires in Indonesia. Many hospitals and clinics reported a spike in the number of patients seeking medical attention for respiratory problems, such as asthma and rhinitis.

To provide quick relief from asthma symptoms, the drug salbutamol is commonly prescribed.



salbutamol

- (a) Identify two functional groups, other than phenyl, that are present in salbutamol.

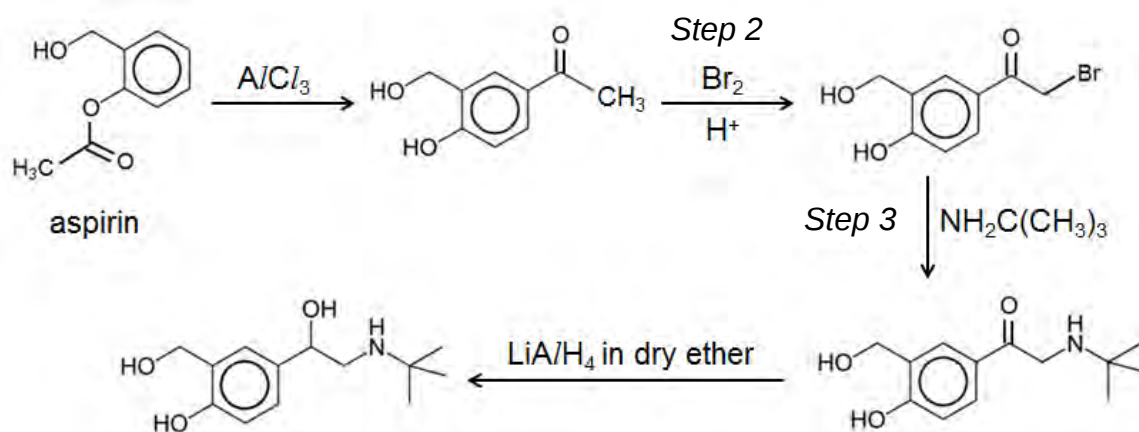
[1]

- (b) Salbutamol is sold in pharmacies as a racemic mixture, mainly because the (*S*)-enantiomer blocks metabolism pathways while the (*R*)-enantiomer shows activity.

Identify the type of stereoisomerism salbutamol exhibits and draw two structures to illustrate this.

[2]

A 4-step synthesis route of salbutamol is shown as follows:



- (c) An organic chemist suggested the use of bromine gas under ultraviolet light in Step 2. Explain why his choice of reagent and condition may not be appropriate for the conversion.

[1]

- (d) Name the reaction in Step 3 and outline the mechanism.
You may use **R** to denote bulky alkyl groups in your mechanism.

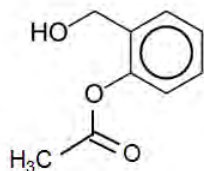
Name of reaction: _____

[4]

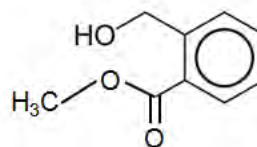
- (e) Explain why LiAlH_4 must be used in dry ether during the final step?

[1]

- (f) A laboratory technician realised that the labels to the bottles containing aspirin and another compound had fallen off.



aspirin



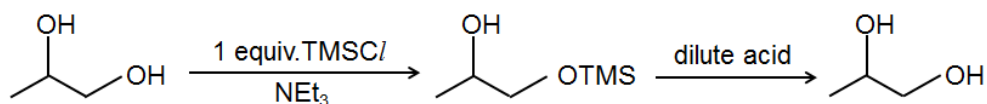
compound X

Suggest a simple chemical test to distinguish between these two compounds.

[2]

- (g) Chlorotrimethylsilane (TMSCl) in the presence of triethylamine (NEt_3) is usually used as a protecting group for alcohols in organic synthesis. This allows the alcohol group to remain unreactive while the rest of the molecule undergoes reaction. To regenerate the alcohol group, dilute acid can be added.

A representative equation is shown as follows:



Using the information provided, suggest a method to perform the following conversion.



[3]

[Total: 14]

3 *Use of Data Booklet is relevant to this question.*

Zinc has similar properties to Group II metals. For example, zinc and calcium reacts with oxygen to give their respective metallic oxide. Also, zinc carbonate and calcium carbonate decompose when heated to give similar products.

- (a)** Suggest why zinc carbonate is thermally less stable compared to calcium carbonate.

[2]

- (b)** Zinc however, reacts much more slowly with oxygen compared to calcium. Explain why this is so.

[2]**[Total: 4]**

- 4 A 2.80 g sample mixture of zinc chloride and calcium chloride was melted to form a homogeneous molten mixture. An electric current was applied to this mixture for 30 min using inert electrodes. The gas produced at the anode, gas **X**, was reacted with excess $\text{H}_2(\text{g})$, and dissolved in distilled water to make up to a 250 cm^3 solution. 25 cm^3 of this solution requires 27.95 cm^3 of $0.100 \text{ mol dm}^{-3}$ of $\text{NaOH}(\text{aq})$ for complete reaction.

(a) Write an equation for the anode reaction.

[1]

(b) Write an equation for the reaction of the gas produced at the anode with $\text{H}_2(\text{g})$.

[1]

(c) Calculate the number of moles of gas **X** produced. Hence, calculate the average current that was applied to the electrolyte.

[3]

- (d) State the possible cathode reactions, and deduce which reaction is more likely to take place at the start of the electrolysis process.

[2]

- (e) Given that 0.0729 g of calcium metal was produced at the end of the electrolytic process, calculate the percentage mass of zinc chloride in the original solid sample. State any assumptions that you made.

[4]

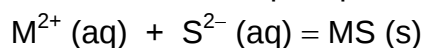
[Total: 11]

- 5 (a) Selective precipitation of sulfides may be used to separate the cations present in a solution containing Cu^{2+} and Ni^{2+} .

Aqueous hydrogen sulfide behaves as a dibasic acid.



Metal sulfides are precipitated by the following reaction.



Relevant K_{sp} values are given in the table.

Salt	$K_{sp}/\text{mol}^2 \text{ dm}^{-6}$
CuS	6.0×10^{-36}
NiS	3.0×10^{-19}

- (i) Given that a solution contains $0.20 \text{ mol dm}^{-3} \text{ Ni}^{2+}$ and $0.10 \text{ mol dm}^{-3} \text{ Cu}^{2+}$, determine the maximum sulfide concentrations for each metal cation so that no precipitation occurs.

- (ii) Show that $[\text{H}^+] = \sqrt{\frac{K_{a1}K_{a2}[\text{H}_2\text{S}]}{[\text{S}^{2-}]}}$

(iii) Considering the answer in (i) and using the expression in (ii), calculate the maximum pH that must be maintained to separate Ni^{2+} and Cu^{2+} ions, given that the concentration of H_2S in the solution is 0.10 mol dm^{-3} .

(iv) Calculate the actual concentrations of both metal ions in solution at the pH used in (iii).

[8]

(b) Ni and Cu are transition metals. Explain why transition metal complexes and compounds are usually coloured.

[3]

- (c) (i) The melting points of NiS and H₂S are as shown below. Explain the difference in their boiling points in term of structure and bonding.

Compound	Melting point / °C
NiS	797
H ₂ S	- 82

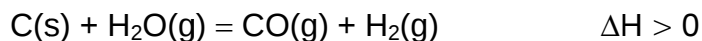
- (ii) The Claus process is used in the industry to partially oxidise H₂S to form water and elemental sulfur, S₈. Write a balanced equation and calculate the mass of elemental sulfur produced when 1 tonne of H₂S is used.

[1 tonne = 1000 kg]

[5]

[Total: 16]

- 6 Water gas is a synthesis gas that consists of carbon monoxide and hydrogen. The gas is made by passing steam over coke:



- (a) The system was initially at equilibrium. At time t_1 , the volume of the reaction vessel was then suddenly reduced and the system allowed to reach equilibrium. Pressure was then increased by adding argon at constant volume at t_2 . A new equilibrium was established before temperature was increased at t_3 .

Sketch on the axes the graph that should be observed from time = 0 to time = t when equilibrium is re-established once again.

Total no. of moles of gas



[4]

- (b) When steam was passed over coke at temperatures near 800 °C with a pressure of 8.81 atm and allowed to reach equilibrium in a 1.00 dm³ vessel, the partial pressure of steam was found to be 2.67 atm.

- (i) Write the K_p expression for the reaction. Include units in your answer.

(ii) What is K_p at 800 °C?

(iii) The numerical value of K_p at 25 °C is 1.7×10^{-21} . Compare the K_p values at 25 °C and 800 °C and comment on their difference in relation to ΔH of the reaction.

[5]

(c) The behaviour of magnesium and aluminium in the presence of steam is notably different. Magnesium is observed to react vigorously with steam while that of aluminium takes place much slower.

(i) Write balanced equations for the reactions of magnesium and aluminium with steam.

(ii) Explain why aluminium reacts more slowly than magnesium.

[3]

(d) Sodium belongs to the third period of the Periodic Table. 50 cm^3 of 1.3 mol dm^{-3} of its hydroxide reacted with 30 cm^3 of 2.7 mol dm^{-3} ethanoic acid in a polystyrene cup. The maximum temperature rise recorded was 11.3°C . Specific heat capacity of the solution = $4.18 \text{ J g}^{-1} \text{ K}^{-1}$

(i) Write an equation for the enthalpy change of neutralization for this reaction.

(ii) Calculate the enthalpy change of neutralization for this reaction.

[3]

[Total: 15]

END OF PAPER