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Name

Class

Register Number

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5073/01(with SPA)

14/4P1/CH/1

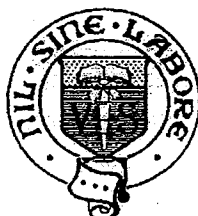
**CHEMISTRY
Paper 1**

Friday

16 May 2014

1 hour

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VICTORIA SCHOOL

**FIRST PRELIMINARY EXAMINATION
(SECONDARY FOUR)**

Additional Material: Optical Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Write your name, class and register number in the spaces provided at the top of this page.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B C, and D**.

Choose the one you consider correct and record your choice in **soft pencil** on the separate answer sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

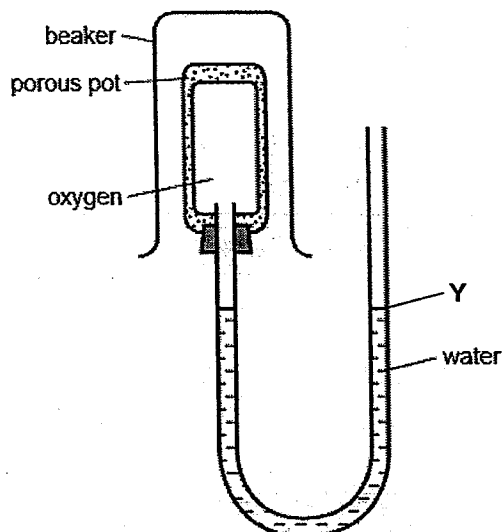
Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 14.

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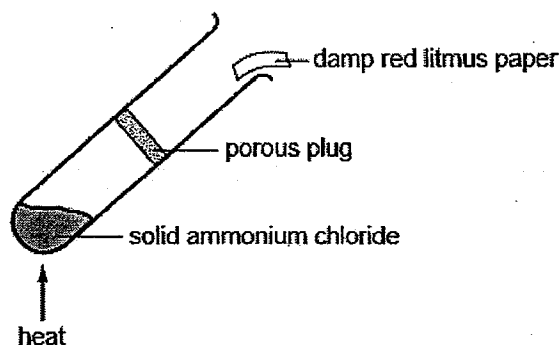
This question paper consists of 14 printed pages including the cover page.

- 1 The diagram shows a diffusion experiment.



Which gas, when present in the beaker over the porous pot, will cause the water level at Y to drop the most?

- A hydrogen
 - B carbon dioxide
 - C helium
 - D methane
- 2 Solid ammonium chloride decomposes upon heating to give ammonia gas and hydrogen chloride gas.



Which change occurs to the damp red litmus paper in the experiment above?

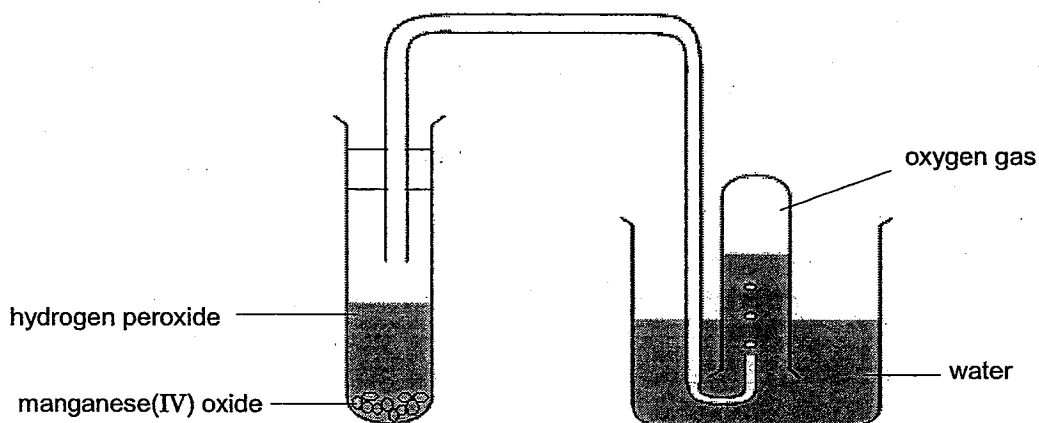
- A damp red litmus paper is bleached
- B damp red litmus paper remains red
- C damp red litmus paper turns blue and then turns red
- D damp red litmus paper turns blue, then turns red and eventually is bleached

- 3 An unknown substance **X** melts at -166°C and boils at -138°C .

Describe the arrangement and movement of the particles of substance **X** at -125°C .

	arrangement of particles	movement of particles
A	very closely packed in orderly manner	vibrate about fixed positions
B	loosely packed in orderly manner	slide over one another easily
C	loosely packed in random manner	slide over one another easily
D	spread very far apart in random manner	moves in all directions at high speeds

- 4 Oxygen was prepared and collected using the apparatus as shown in the diagram below.



The first tube of gas collected was rejected because the gas was contaminated by

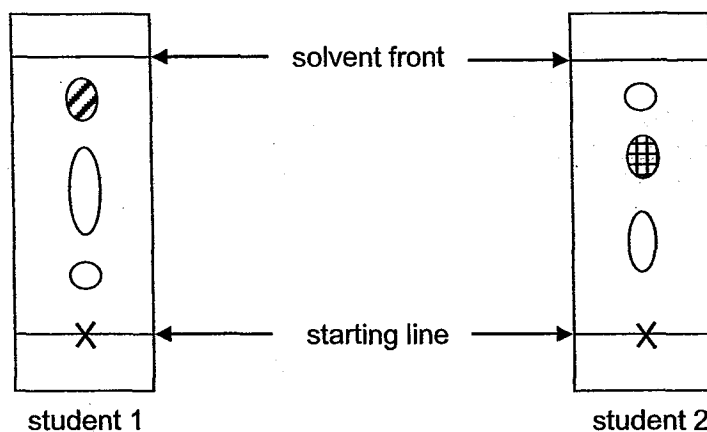
- A** hydrogen.
B hydrogen peroxide.
C manganese(IV) oxide.
D nitrogen.
- 5 A flask contains a mixture of benzene and aqueous sodium chloride. Benzene boils at 80°C and is immiscible with water.

Which of the following methods are suitable to obtain samples of benzene and dry sodium chloride?

	first method	second method
A	fractional distillation	evaporation
B	filtration	crystallisation
C	crystallisation	use a separating funnel
D	use a separating funnel	evaporation

- 6 Two students each carried out a chromatography experiment to see what dyes are present in the brown food colouring from a candy.

Their chromatograms are shown below.



Which of the following statements best explains the difference in their chromatograms?

- A Student 1 used a lesser volume of the same solvent than student 2.
 B Student 2 used a different solvent from student 1.
 C Student 1 started the chromatography later than student 2.
 D The concentrations of the food colouring used by students 1 and 2 are different.
- 7 The table shows the number of sub-atomic particles in four different ions.

Which ion has the correct number of sub-atomic particles shown?

	ion	number of sub-atomic particles		
		protons	neutrons	electrons
A	${}^{14}_{7}\text{N}^{3-}$	7	14	10
B	${}^{37}_{17}\text{Cl}^{-}$	17	20	18
C	${}^7_3\text{Li}^{+}$	4	4	2
D	${}^{64}_{29}\text{Cu}^{2+}$	29	64	27

- 8 Oxygen has two isotopes, namely oxygen-16 and oxygen-18.

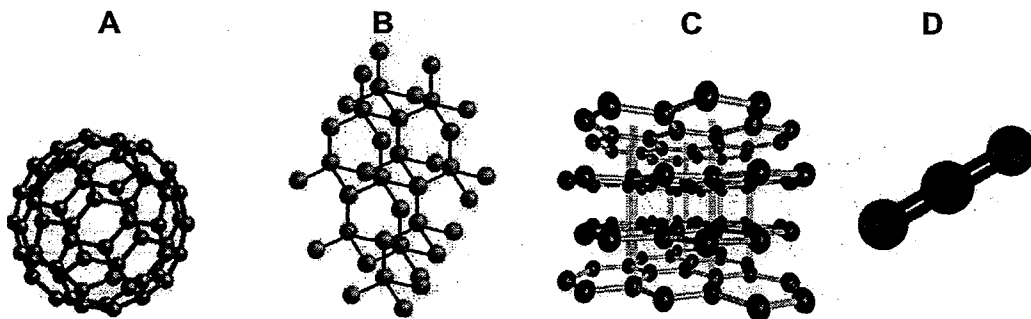
Which statement correctly describes the two isotopes of oxygen?

- A Both oxygen-16 and oxygen-18 form ions with a charge of 2-.
 B Oxygen-16 has a smaller proton number than oxygen-18.
 C Both oxygen-16 and oxygen-18 have the same relative atomic masses.
 D Oxygen-16 has an electronic configuration of 2.8.6 while oxygen-18 has an electronic configuration of 2.8.8.

- 9 Which of the following statements correctly describe sodium chloride?
- A A sodium ion is bonded to the chloride ion which it donated its outermost electron to.
 - B A sodium atom with one outermost electron forms a single covalent bond with one chlorine atom, producing sodium chloride molecule.
 - C The attraction between oppositely charged sodium and chloride ions results in the charges being neutralised, forming neutral molecules.
 - D The sodium chloride lattice consists of sodium ions and chloride ions, in which every chloride ion is bonded to one sodium ion.

- 10 The diagram below shows the structures of four substances A, B, C and D.

Which of the substance can be used as a lubricant?



- 11 Which of the following gases will not result in a change of pH value when dissolved in water?
- A CO_2
 - B HBr
 - C NH_3
 - D O_2
- 12 25.0 cm^3 of two separate acid **HX** and acid **HY** of the same concentration 1.0 mol/dm^3 reacted with 0.5 g of calcium carbonate to form 14.5 cm^3 and 30.0 cm^3 of carbon dioxide respectively in two minutes.

What deductions can be made from the above statement?

- A The volume of carbon dioxide produced at the end of the reaction is not the same.
 - B The solution of acid **HY** has a lower pH than the solution of acid **HX**.
 - C Acid **HX** contains higher number of H^+ ions per unit volume as compared to acid **HY**.
 - D Reaction between **HY** and calcium carbonate produces a salt which reacts with more calcium carbonate to produce a larger volume of carbon dioxide.
- 13 Which one of the following produces an amphoteric oxide on heating?
- A silver carbonate
 - B sodium carbonate
 - C lead(II) carbonate
 - D copper(II) carbonate

14 Which of the following describes a step in the preparation of barium sulfate?

- A Add excess barium carbonate into dilute sulfuric acid, filter, wash and collect residue
- B Add excess barium hydroxide into dilute sulfuric acid, filter, wash and collect residue
- C Add barium carbonate into dilute nitric acid followed by ammonium sulfate before collecting the precipitate
- D Heat the filtrate to saturation, and then cool it till crystallisation occurs

15 The nature of the following gases may be tested using litmus paper.

sulfur dioxide

ammonia

nitrogen dioxide

chlorine

For how many of the gases must damp litmus paper be used?

- A 1 B 2 C 3 D 4

16 The labels on three separate bottles of zinc powder, magnesium powder and iron powder have dropped off.

Which of the following experiments will enable one to identify all three bottles of metal?

- A heat some metal powder in air
- B place some metal powder in dilute nitric acid
- C place some metal in aqueous copper(II) sulfate
- D weigh equal heap size of the metal powder

17 Methane, oxides of nitrogen and sulfur dioxide are gases which have an adverse impact on the environment.

Which of the following correctly show the sources of these gases?

	methane	oxides of nitrogen	sulfur dioxide
A	bacterial decay of organic matter	car engines	volcanic eruptions
B	bacterial decay of organic matter	lightning activity	car engines
C	bacterial decay of organic matter	lightning activity	acid rain
D	belching of cattles	lightning activity	car engines

18 Which of the following are true of greenhouse gases?

- I Methane and carbon dioxide are examples of greenhouse gases.
- II They are solely the result of human activities such as burning fossil fuels.
- III Increasing their concentrations will lead to an increase in Earth's temperature.

- A I and II only
- B I and III only
- C II and III only
- D All of the above

19 In moving across Period 3 from Group I to Group VII, the elements

- I show a gradual transition in properties from metallic to non-metallic.
- II have oxides whose property change from acidic to basic.
- III have mass numbers differing by one unit from the previous element.

- A I only
- B I and III only
- C II only
- D II and III only

20 The table below shows the atomic number of four elements.

element	W	X	Y	Z
atomic number	9	11	17	19

Which statement about the elements stated above is correct?

- A W is a metal.
- B X is more reactive than Z.
- C W is more reactive than Y.
- D X and Z are in the same period.

21 20 cm³ of oxygen is reacted with 20 cm³ of hydrogen.

What are the volumes of gases remaining at the end of the reaction?

	<u>volume of oxygen</u> cm ³	<u>volume of hydrogen</u> cm ³	<u>volume of product</u> cm ³
A	0	0	20
B	0	0	40
C	10	0	20
D	10	10	20

22 The following results were obtained from an experiment involving the reduction of an oxide of lead to lead metal.

mass of test tube = 21.28 g

mass of test tube + lead oxide = 29.84 g

mass of test tube + lead = 29.04 g

What is the empirical formula of this oxide of lead?

- A PbO
- B Pb₂O₃
- C PbO₂
- D Pb₃O₄

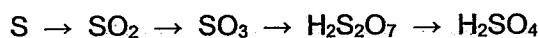
23 How many moles of hydrogen atoms does 4.8 g of methane contain?

- A 1.20 B 0.900 C 0.300 D 0.120

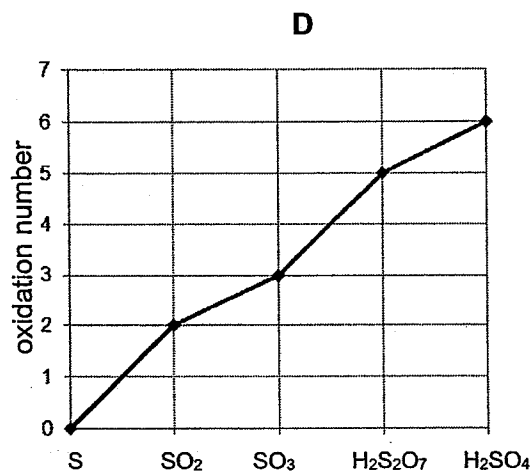
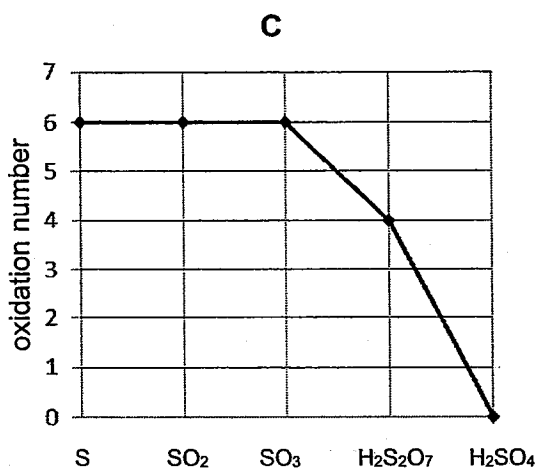
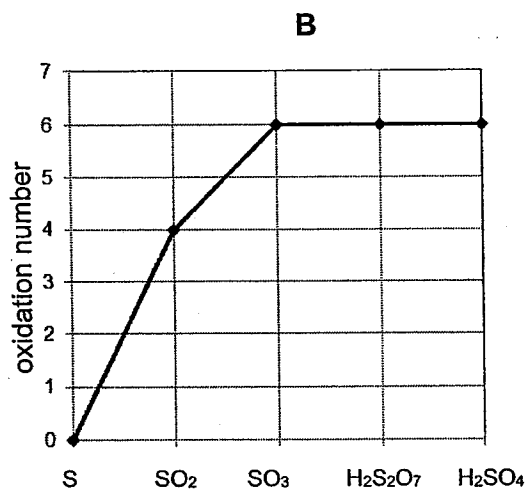
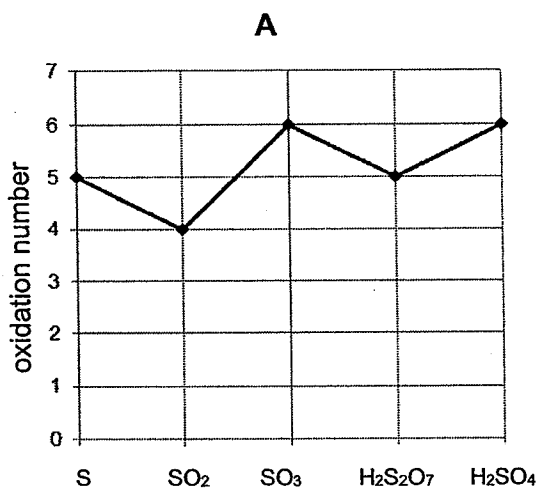
24 Which of the following is an example of a redox reaction?

- A $\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$
 B $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$
 C $\text{Ca}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O}$
 D $\text{Mg}(\text{NO}_3)_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{MgCO}_3 + 2\text{NaNO}_3$

25 In an industrial scale, sulfuric acid can be prepared by Contact or Lead Chamber Process. The reaction for the manufacturing of sulfuric acid can be represented as follows.



Which of the following graphs correctly shows the oxidation number of sulfur at each stage of the process?



- 26 Chromium is a transition metal used in flash bulbs. When the filament inside the bulb gets hot, chromium burns with a white light to form a mixture of chromium(II) oxide and chromium(III) oxide. These oxides can react with both acids and bases. Chromium has no reaction with water or steam.

Which statement shows that chromium is a transition metal?

- A Chromium is unreactive.
 B The oxides of chromium are amphoteric.
 C Chromium oxide can react with acid to form a salt and water only.
 D Chromium can form two different oxides.
- 27 Strips of metal E were dipped into solutions of zinc nitrate and lead(II) nitrate. A metallic deposit appeared on both strips.

What could metal E be?

- A potassium B magnesium C iron D copper
- 28 The information below concerns three metals, F, G and H.

- I the oxide of F is decomposed by heat to the element F
 II the carbonate of G is not decomposed by heat
 III the oxide of H is not decomposed by heat, but its carbonate decomposes

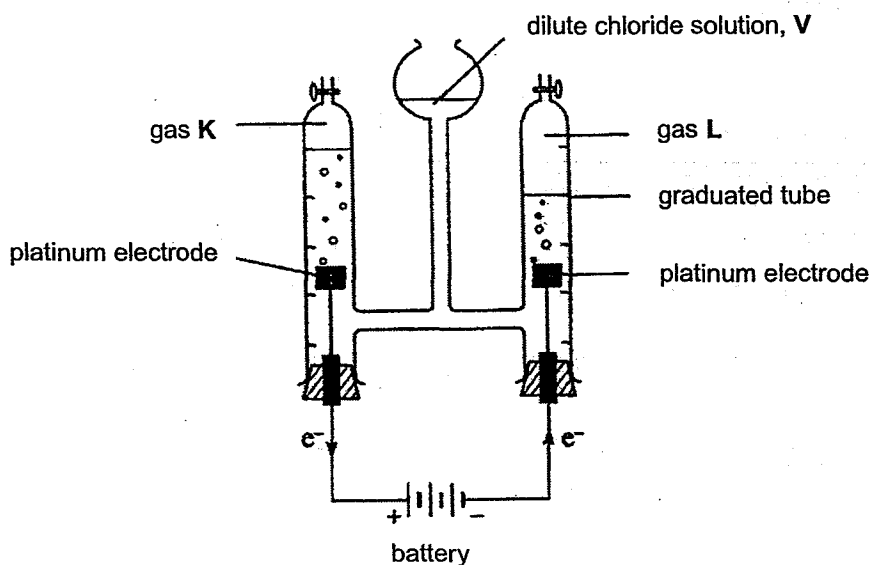
In order of decreasing reactivity, the three elements should be arranged as

- A F, G, H. B G, F, H. C G, H, F. D F, H, G.
- 29 Which substance could be added to remove the sand impurities during the extraction of metal from its ore?
- A slag
 B hot air
 C carbon
 D calcium oxide

- 30 In the electrolysis of concentrated potassium iodide solution using inert electrode, the products formed are

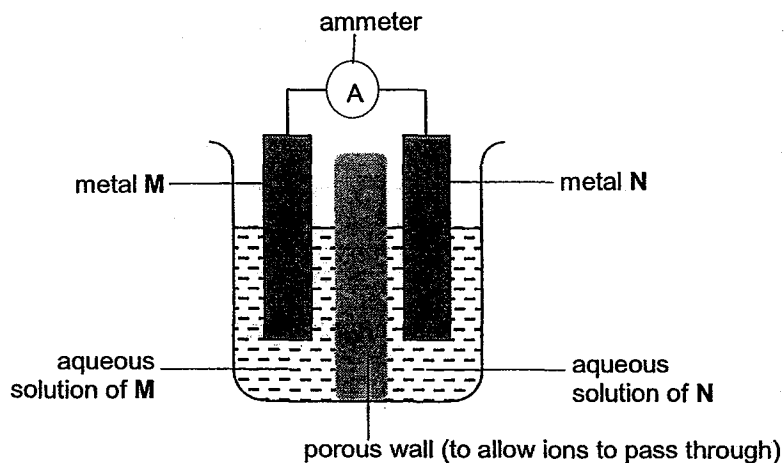
	cathode	anode
A	silvery metal	violet solution
B	silvery metal	black solid
C	colourless gas	violet solution
D	colourless gas	black solid

- 31 Gases **K** and **L** were two colourless gases produced during the electrolysis of a very dilute chloride solution, **V**. The electrolysis diagram of solution **V** is shown and some conclusions were made by a student at the end of the electrolysis.



Which of the following conclusions is correct?

- A gas **L** will extinguish a lighted splint with a 'pop' sound
 - B gas **K** is very soluble and some of it has dissolved into the solution
 - C gas **L** will turn moist blue litmus paper red
 - D electrolyte solution after electrolysis turned red litmus paper blue
- 32 A simple cell was set up as shown in the diagram.



Which pair of metals will give rise to the highest ammeter reading?

	metal M	metal N
A	copper	silver
B	magnesium	aluminium
C	aluminium	iron
D	silver	zinc

33 Which of the following reactions take place in a hydrogen fuel cell?

- A Hydrogen ions are reduced at the cathode.
- B Hydroxide ions are oxidised at the anode.
- C Hydrogen loses electrons to form H^+ at the anode.
- D Oxygen gains electrons to form O^{2-} at the cathode.

34 An enclosed container containing only ammonia gas was slowly heated from room temperature to $450^{\circ}C$.

What are the gas(es) which may be found in the enclosed container at $450^{\circ}C$?

- A ammonia only
- B nitrogen and hydrogen only
- C nitrogen and ammonia only
- D nitrogen, hydrogen and ammonia

35 Below are four statements about endothermic reactions.

- I The temperature of the surroundings decreases.
- II The temperature of reactants increases.
- III The products always have more energy than the reactants.
- IV The products formed are unstable and explosive.

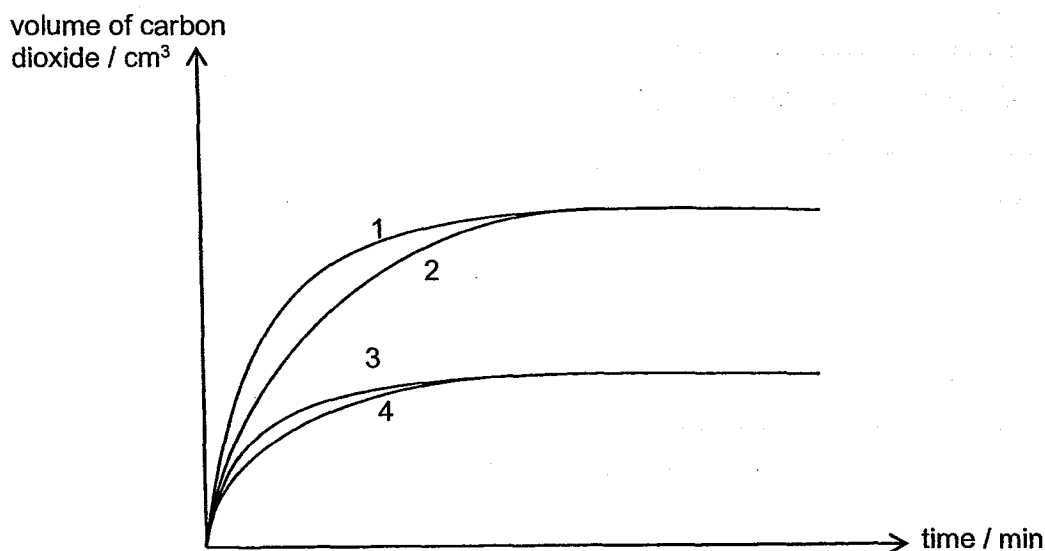
Which of these statements are true?

- A I and III only
- B I, II and III only
- C I, II and IV only
- D II and IV only

36 Which of the following correctly describe the effects which increasing temperature and using catalyst have on ΔH and E_a ?

	increasing temperature		using catalyst	
	ΔH	E_a	ΔH	E_a
A	unchange	decrease	unchange	decrease
B	unchange	unchange	unchange	decrease
C	decrease	decrease	unchange	decrease
D	increase	increase	decrease	decrease

- 37 Four experiments were carried out by adding calcium carbonate to excess 1.00 mol/dm^3 hydrochloric acid in four separate beakers. The total volume of carbon dioxide gas evolved was collected and measured at various times for each experiment. The graphs of the results from the four experiments labelled 1, 2, 3 and 4 are shown.



The set of conditions for the four experiments are shown in the table below.

set of conditions	type of calcium carbonate	mass of calcium carbonate / g
R	granular	5.0
S	granular	10.0
T	powder	5.0
U	powder	10.0

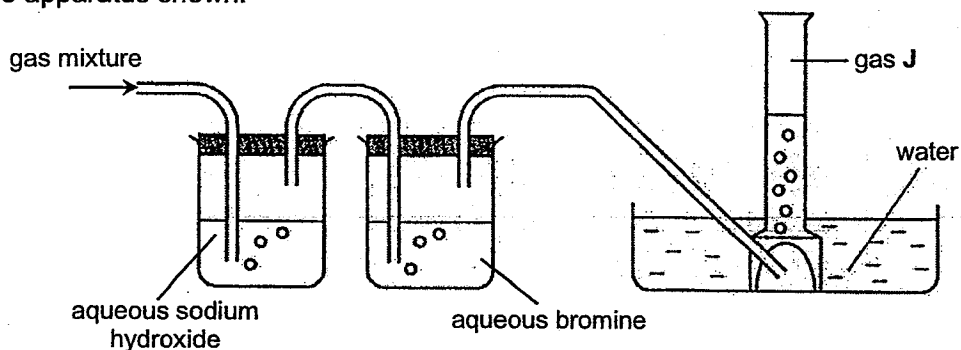
Which of the following matches the graphs of experiments 1, 2, 3 and 4 correctly with the set of conditions **R**, **S**, **T** and **U**?

	R	S	T	U
A	3	2	1	4
B	4	1	3	2
C	3	2	4	1
D	4	2	3	1

- 38 Which of the following is not a correct use for the petroleum fraction?

	fraction	use
A	naphtha	make drugs
B	kerosene	fuel for cooking
C	diesel oil	make plastic
D	lubricating oil	make shoe polish

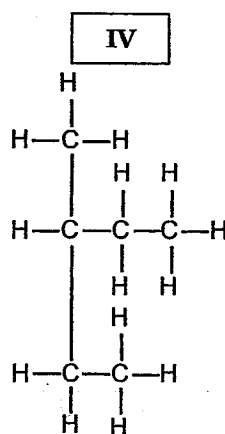
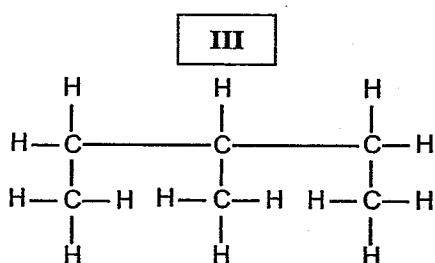
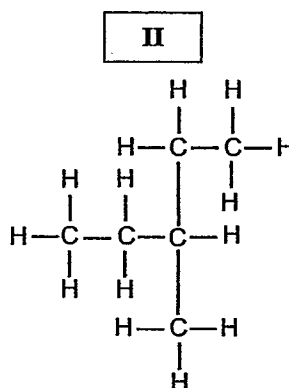
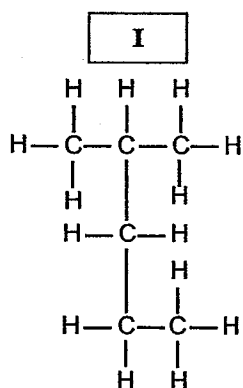
- 39 A gaseous mixture of carbon dioxide, ethane, ethene and sulfur dioxide is passed through the apparatus shown.



What is a property of the gas J collected?

- A** turns moist blue litmus paper red
B turns limewater chalky
C turns acidified potassium dichromate(VI) green
D burns in air

- 40** The structures of four alkanes are shown below.



Which structures are the same hydrocarbons?

- A** I and IV only
B II, III and IV only
C I, III and IV only
D all of them

End of paper

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II	III	IV	V	VI	VII	0										

Victoria School**Secondary 4 First Preliminary Examination 2014
Chemistry Paper 1 Answer Key**

1	2	3	4	5	6	7	8	9	10
B	C	D	D	D	B	B	A	A	C
11	12	13	14	15	16	17	18	19	20
D	B	C	C	D	A	A	B	A	C
21	22	23	24	25	26	27	28	29	30
C	D	A	B	B	D	B	C	D	D
31	32	33	34	35	36	37	38	39	40
A	D	C	D	A	B	D	C	D	B

Name	Class	Register Number

5073/02(with SPA)

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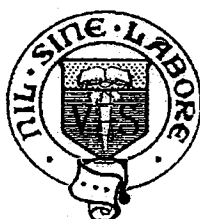
**CHEMISTRY
Paper 2**

Friday

09 May 2014

1 hour 45 minutes

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VICTORIA SCHOOL

**FIRST PRELIMINARY EXAMINATION
(SECONDARY FOUR)**

Candidates answer on the Question Paper and writing papers
Additional Materials: Writing Papers

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, class and register number in the spaces provided at the top of this page and on any separate answer paper used.

Write in dark blue or black pen in the spaces provided on the Question Paper.

You may use a pencil for any diagrams, graphs, or rough working.

Section A

Answer all questions.

Section B

Answer all **three** questions, the last question is in the form either/or.

Write your answers on the lined papers 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.

A copy of the Periodic Table is printed on page 15.

For Examiner's Use	
Section	Marks
A	/ 50
B	/ 30
Total	/ 80

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This question paper consists of 15 printed pages including the cover page.

Section A

Answer all questions in the spaces provided.

- 1 (a) The table below shows the electronic configurations of 3 different atoms of elements and one corresponding property of the element. Give an explanation for each of the following properties.

electronic configuration of atom	property	explanation
2.8.3	easily hammered into thin sheets	
2.8.8	to preserve paint and varnish after opening	
2.7	a strong oxidising agent commonly used in bleaches	

[3]

- (b) The table below shows a portion of Charles Janet's Periodic Table.

																1 H	2 He
																3 Li	4 Be
										5 B	6 C	7 N	8 O	9 F	10 Ne	11 Na	12 Mg
										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	19 K	20 Ca
21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	37 Rb	38 Sr

Give two differences in the arrangement of the elements between this Periodic Table and the modern Periodic Table.

.....

.....

.....[2]

(c) The table below shows some properties of 5 metals, P, Q, R, S and T.

element	able to catalyse reactions	number of electrons that can be lost during reactions	melting point °C	density g cm ⁻³	atomic radius m
P	no	2	842	1.55	1.97×10^{-10}
Q	yes	2, 3, 4 or 5	1910	5.80	1.34×10^{-10}
R	yes	1	97.0	0.97	1.86×10^{-10}
S	yes	1, 2 or 4	-39.0	13.50	1.51×10^{-10}
T	no	2	777	2.64	2.15×10^{-10}

(i) Identify which is/are the transition metal(s).

.....[1]

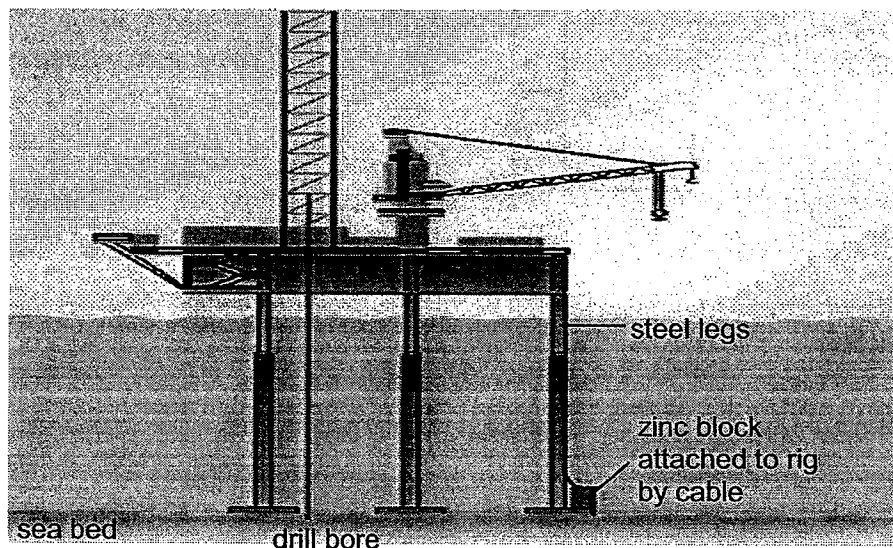
(ii) Can metal R be an alkali metal? Give a reason for your answer.

.....[1]

(iii) Explain why metal P has a higher melting point than metal T.

.....[1]

(d) Zinc is a moderately reactive metal used as sacrificial anodes in oil rigs. For large structures like oil rigs, completely covering the steel with zinc is not practical. Instead, blocks of zinc can be bolted to the steel leg of oil rig as shown in the diagram below.



Explain why it is better for the steel leg of the oil rig to be bolted with zinc rather than an unreactive metal like copper.

.....[2]

[Total: 10]

- 2 Coconut oil is an edible oil that has been consumed in tropical countries for many years. Traditionally, coconut oil is produced by the fermentation method, where dried kernel or fresh coconut meat is crushed to extract the coconut milk first, then left to ferment overnight. During this period, the oil phase gets separated from the aqueous phase.

(a) Explain why it is easier to extract coconut milk from grated coconut and not big pieces of coconut meat.

.....[1]

(b) A simple method of extracting the coconut milk can be performed by washing the coconut gratings with some water and then strained in a cloth to extract the milk.

How does this method acts as a filtration process?

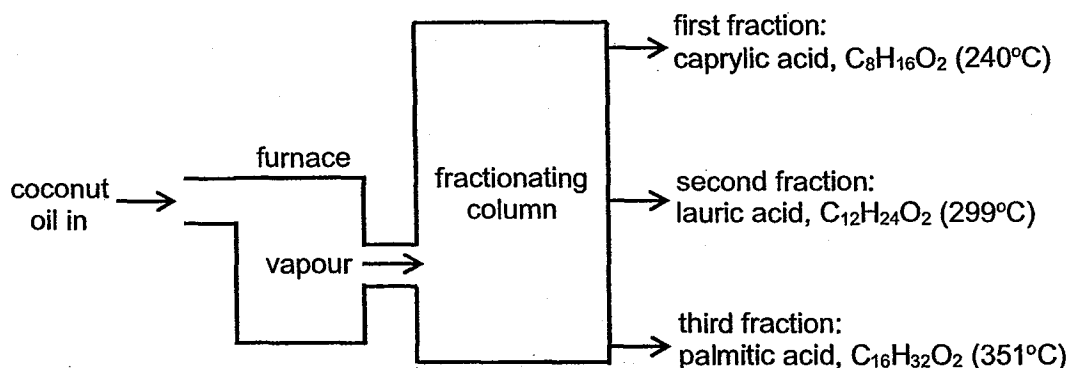
.....[1]

(c) The coconut milk is further processed to produce an intermediate product.

Describe an experiment to show how this intermediate product is actually a mixture.

.....[1]

(d) Coconut oil can be further separated into different components through fractional distillation. The three fractions are obtained from the process as shown.

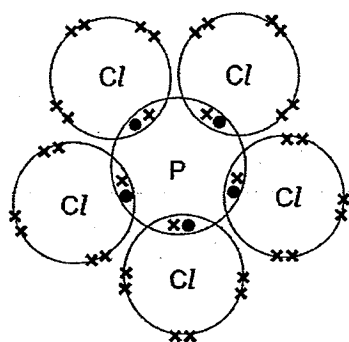


Describe two **other** differences in the physical properties between the first and third fraction.

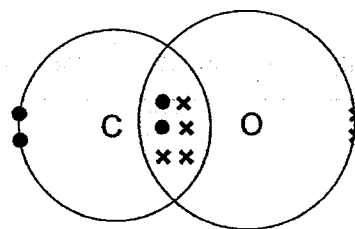
.....[2]

[Total: 5]

- 3 Covalent molecules such as phosphorus pentachloride and carbon monoxide are formed when the atoms are bonded together by covalent bond.



phosphorus pentachloride



carbon monoxide

- (a) What is a covalent bond?
-[1]
- (b) Suggest how the structure of phosphorus pentachloride is different from other 'normal' covalent molecules?
-[1]
- (c) Carbon monoxide is a good reducing agent and is used for that purpose in industries.
- (i) State how the structure of carbon monoxide is unusual.
-[1]
- (ii) Carbon monoxide burns with a blue flame in air.
- Explain how this shows that carbon monoxide is a reducing agent.
-[1]
- (iii) With the help of a balanced chemical equation, explain briefly how carbon monoxide is used as a reducing agent in industries.
-
-
-[2]
- (d) A textbook wrote "*Hydrogen chloride exist as a gas at r.t.p and does not conduct electricity under any conditions.*"
- Do you agree with the above statement? Explain your answer.
-
-
-[2]

[Total: 8]

- 4 (a) The presence of excess nitrate and lead(II) ions in food and drinks may pose health threats to human beings.

(i) Explain why it is difficult to remove nitrates from water.

.....[1]

(ii) Describe a chemical test to identify the presence of nitrate ions.

.....

.....[2]

(iii) Explain why adding aqueous sodium iodide into the water sample will enable one to identify the presence of lead(II) ions.

.....[1]

- (b) The temperature inside waste incinerators can typically go up to 850°C. A lot of water is required to cool the furnace and water mists are also periodically sprayed into the fire to lower the temperature of the fire.

(i) Suggest why the water mists can help to reduce the amount of oxides of nitrogen formed inside the incinerators.

.....[1]

(ii) Explain why it is important to control the emission of oxides of nitrogen from the incineration plants into the environment.

.....

.....

.....[2]

(iii) Another pollutant from waste incinerators is sulfur dioxide.

Name a reagent used to test for the presence of sulfur dioxide.

.....[1]

[Total: 8]

- 5 Hydrated nickel(II) chloride, $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ can be produced by reacting excess nickel(II) carbonate with dilute hydrochloric acid followed by addition of water. The chemical equation is shown.



The mixture is then filtered and the filtrate partially evaporated to obtain green crystals upon cooling.

- (a) (i) Explain why nickel(II) carbonate is used in excess but not the acid.

.....

[2]

- (ii) Explain why the filtrate is partially evaporated instead of evaporated to dryness.

.....
[1]

- (b) (i) 25.0 cm^3 of 1.00 mol/dm^3 dilute hydrochloric acid was reacted with excess nickel(II) carbonate in an experiment to produce hydrated nickel(II) chloride.

Calculate the percentage yield if 2.50 g of hydrated nickel(II) chloride was obtained at the end of the reaction.

[3]

- (ii) Suggest why the yield of hydrated nickel(II) chloride is expected to be lower than 100%.

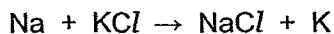
.....
[1]

[Total: 7]

- 6 (a) Potassium is the seventh most abundant element on earth and occurs in mineral deposits, mainly as potassium chloride.

Molten potassium chloride can be reacted with sodium vapour to produce potassium and sodium chloride. The potassium is boiled off and is therefore obtained in a reasonably pure state by distillation.

The equation is given.



- (i) Explain why this reaction is unusual.

.....
[1]

- (ii) Explain, in terms of electron transfer, why this is a redox reaction.

.....

[2]

- (b) In one of the processes in the industrial electrolysis of brine (sodium chloride) solution, sodium-mercury amalgam was passed into water where sodium will react with water in the vessel. The mercury does not react and is recycled.

- (i) Give the chemical formula of the product for the reaction below and balance the equation.



- (ii) During one run, the sodium-mercury amalgam was poured into a tank of water which measured 200 dm wide, 200 dm long and 200 dm high. After passing the amalgam into the water for 2 hours, the product formed in (b)(i) has a concentration of 0.0100 mol/dm³.

Calculate the mass of sodium reacted in tonnes. [1 tonne = 1000 kg]

[3]

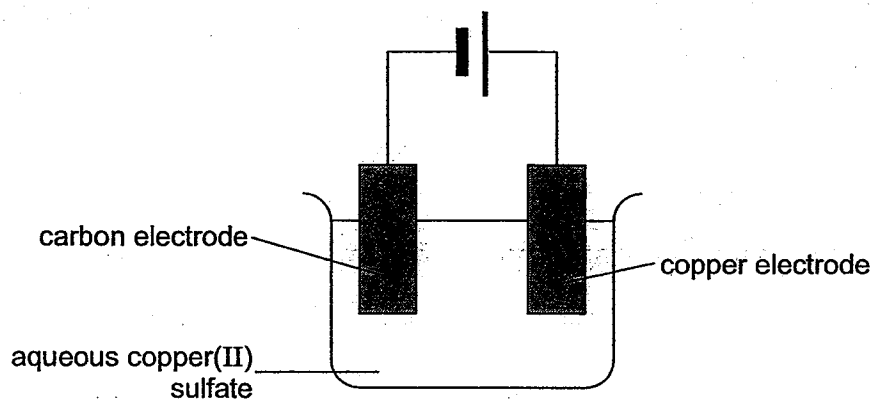
[Total: 7]

- 7 (a) When copper is extracted from its ore, it contains carbon impurities.

Suggest how the carbon impurities get into the copper.

.....[1]

- (b) A sample of aqueous copper(II) sulfate was electrolysed using copper and carbon electrodes as shown in the diagram.



- (i) Write an ionic equation, with state symbols, for the reaction that take place at the anode.

.....[1]

- (ii) Describe what will be observed at the cathode after some time.

.....[1]

- (b) Electroplating is one of the main uses of electrolysis industrially.

Draw a labelled diagram of an apparatus used to plate silver on a round object.

[2]

[Total: 5]

Section B

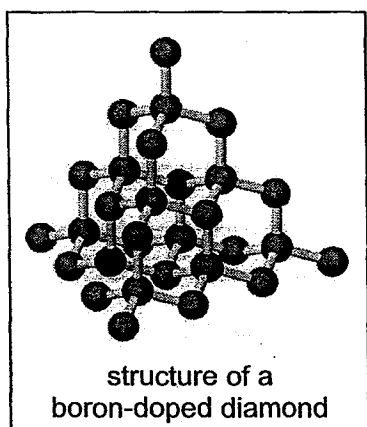
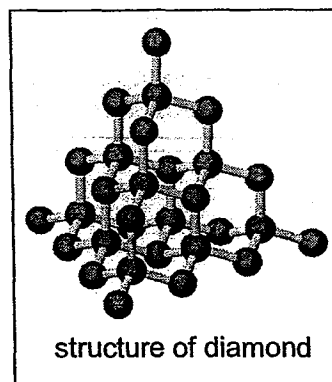
Answer all **three** questions from this section.

The last question is in the form of either/or and only **one** alternative should be attempted.

- 8 “Diamonds are a girl’s best friend”, a song made famous by Marilyn Monroe, clearly reflects many women’s obsession with this tiny little shiny thing over the centuries.

Natural diamonds are made of carbon that crystallised under crushing pressures and intense heat 150 to 190 km in the Earth’s mantle. It is the hardest mineral we know of and can only be cut by another diamond.

Diamonds are weighed in carats. 1 carat is equivalent to 0.200 g. It should be noted that the weight of the diamond does not correlate to its size. A 2-carat diamond does not necessarily appear to be twice the size of a 1-carat diamond when viewed from the top.



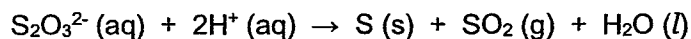
Each carbon atom in diamond is bonded to four other carbon atoms to form a tetrahedral unit. The angle between two adjacent bonds is 109.5° . Diamond is a very bad conductor of electricity except natural blue diamond which is a semiconductor due to the boron impurities. Phosphorus-doped diamonds are made by changing some carbon atoms with phosphorus atoms. Generally, diamond doped with Group III (such as boron-doped diamond) or Group V elements will form a semiconductor.

The bonding at the edge and corner of a diamond has intrigued many. Because there are carbon atoms at one side but no carbon atoms at the other side, it seems that these carbon atoms have “dangling bonds”. Researches and experiments have shown that the “dangling bonds” at the edges and corners normally pick up hydrogen or hydroxyl groups ($-OH$). As what the Nobel Prize winner for Chemistry Professor Richard Errett Smalley aptly describe, “when you touch a diamond, you’re not touching carbon. You’re touching a monatomic layer of hydrogen formed at its surface”.

- (a) Explain why substances with structure similar to that of diamond are expected to be very hard and have very high melting points. [3]
- (b) Explain why phosphorus-doped diamonds have free electrons to conduct electricity. [2]
- (c) Explain why the “dangling bonds” at the edges and corners of the diamond must pick up other atoms and cannot exist on their own. [1]
- (d) A 3.5 carat diamond was burnt in limited amount of oxygen to form carbon monoxide. Calculate the maximum volume of carbon monoxide produced. [3]
- (e) A student made the comment that “diamond is actually a compound and not an element”. Explain why he is justified in his statement. [1]

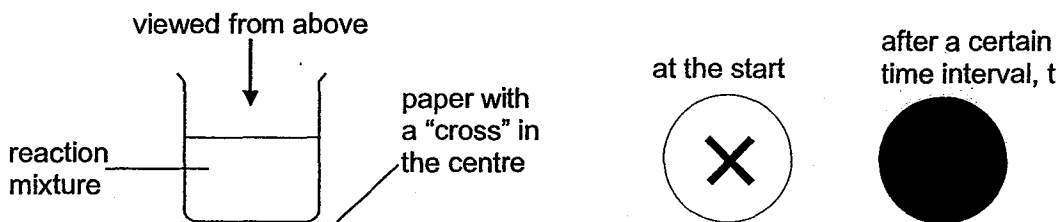
[Total: 10]

- 9 (a) Sodium thiosulfate reacts with an acid to form yellow solid sulfur in a colloidal suspension as shown in the equation below.



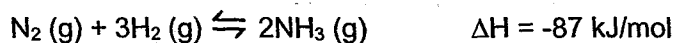
The table below shows how the speed of this reaction changes when different concentrations of sodium thiosulfate solution and dilute hydrochloric acid are used. The rate of the above reaction is inversely proportional to the time taken for sufficient sulfur to form and obscure a black "cross" drawn on a white piece of paper.

experiment	concentration of sodium thiosulfate solution mol dm ⁻³	concentration of dilute hydrochloric acid mol dm ⁻³	time taken for the "cross" to be obscured, t s
1	0.100	0.100	54
2	0.200	0.100	27
3	0.100	0.200	54
4	0.300	0.100	18
5	0.300	0.300	18
6	0.600	0.200	9



- (i) With reference from the experimental data, describe the effect of increasing concentration of sodium thiosulfate solution on the time taken for the "cross" to be obscured. [1]
- (ii) Explain the effect of concentration of sodium thiosulfate solution on the rate of reaction using collision theory. [2]
- (iii) Predict the time taken for the "cross" to be obscured if the concentration of sodium thiosulfate solution is halved for experiment 1. [1]
- (iv) What effect does increasing concentration of the dilute hydrochloric acid have on the rate of reaction? [1]

- (b) The Haber-Bosch process is an industrial process to produce ammonia from nitrogen and hydrogen. The chemical reaction is a reversible reaction and it is typically carried out at a temperature of 450°C and 250 atm with the use of iron as catalyst. The equation is shown.



- (i) What is a reversible reaction? [1]
- (ii) Explain why, in terms of collision theory, increasing pressure will increase the yield per unit time in the Haber-Bosch process. [2]
- (iii) Explain why increasing the temperature of a reaction need not always increase the yield per unit time. [1]
- (iv) Calculate the overall energy change when 17.0 g of nitrogen was completely reacted to form ammonia. [1]

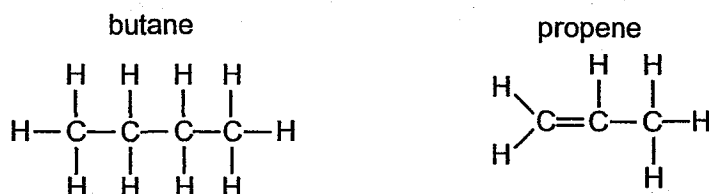
[Total: 10]

EITHER

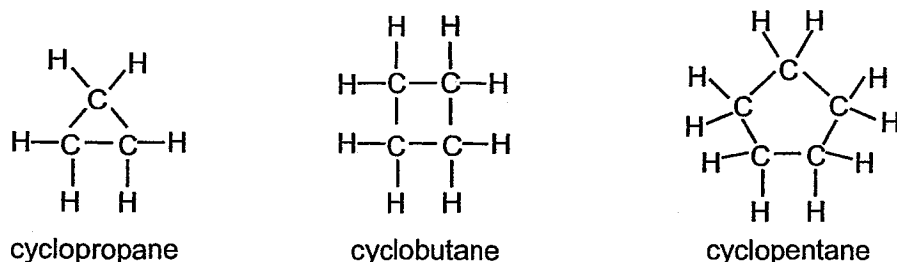
- 10 (a) An amateur chemistry website stated the following.

Because all the members of the same homologous series have the same general formula, it follows that they have the same empirical formula.

- (i) Define the term *homologous series*. [1]
- (ii) By using appropriate examples, explain why the above statement is true for the alkene homologous series but not for the alkane homologous series. [2]
- (b) The structures of butane and propene are shown below.



- (i) Name a method to make propene from butane. [1]
- (ii) State the conditions for the hydration of propene to propanol. [2]
- (iii) The hydration of ethene produces only one product.
The hydration of propene may produce two products.
- Explain the above observations. [2]
- (c) Cycloalkanes are a class of saturated hydrocarbons that have at least one ring of carbon atoms in the structure of their molecules. The structures of the first three members in the cycloalkane homologous series are shown below.

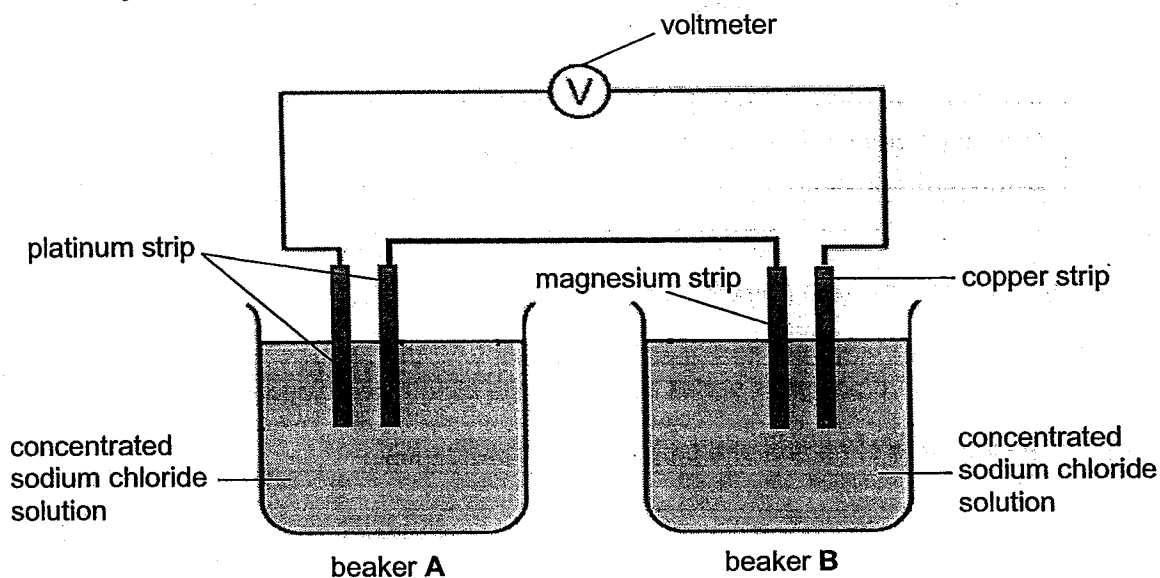


- (i) Write the general formula of cycloalkanes. [1]
- (ii) Explain why cycloalkanes are saturated compounds. [1]

[Total: 10]

OR

10 The diagram below shows an electric cell.



- Describe a difference in observations between the reactions in beaker A and B. [2]
- Describe how the electrons flow in this setup. [1]
- Describe the reactions occurring at both electrodes in beaker B. [2]
- Name the products formed in beaker A. [2]
- Write the ionic equation, with state symbols, for the reaction which takes place at the cathode in beaker A. [1]
- After some time, both beakers feel hot.

Draw the energy profile for any one of the beakers and indicate the ΔH . [2]

[Total: 10]

End of Paper

DATA SHEET

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
1 H Hydrogen 1																	
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	101 Ru Ruthenium 44	101 Rh Rhodium 45	103 Pd Palladium 46	106 Ag Silver 47	108 Cd Cadmium 48	112 In Indium 49	115 Sn Tin 50	119 Sb Antimony 51	122 Te Tellurium 52	128 I Iodine 53	131 Xe Xenon 54	
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
87 Fr Francium	88 Ra Radium	89 Ac Actinium															
58 – 71 Lanthanoid series 90 – 103 Actinoid series																	
140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	146 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71				
232 Th Thorium 90	232 Pa Protactinium 91	238 U Uranium 92	238 Np Neptunium 93	244 Pu Plutonium 94	244 Am Americium 95	254 Cm Curium 96	262 Bk Berkelium 97	267 Cf Californium 98	281 Es Einsteinium 99	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103				

a

X

b

a = relative atomic mass

X = atomic symbol

b = proton (atomic) number

Key

Key

$\begin{matrix} a & X & b \\ \hline \end{matrix}$

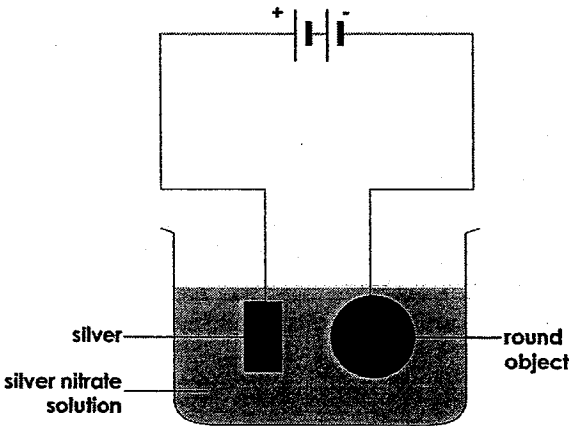
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one if any gas is 24 dm³ at room temperature and pressure (r.t.p.).

Victoria School Sec 4 First Preliminary Examination 2014 – Answer Key

Qn No	Suggested answers
1(a)	(i) layers/rows of metal atoms/ions can slide over one another easily (without breaking the metallic bonds) [1] (ii) noble gas is unreactive due to fully filled outermost electron shell hence protecting paint from tarnishing [1] (iii) able to gain an (outermost) electron easily/readily [1]
1(b)	Hydrogen, a non-metal, is placed in the same vertical group as the group I metals, whereas in the modern Periodic Table, hydrogen does not belong to a group. Helium is a noble gas and it is placed in the same group as group II metals. Lithium and beryllium are not placed in the same period 2 as in the modern Periodic Table. Any 2 – [2m]
1(c)(i)	Metal Q and S. [1]
1(b)(ii)	No. Metal R has a low density. [1] [R: only forms ions of +1 / low m.p.]
1(b)(iii)	Metal P has a <u>smaller atomic radius</u> compared to metal T, hence there is <u>stronger electrostatic forces of attraction</u> between the ions and delocalised mobile electrons in P/ <u>stronger metallic bonds</u> . [1]
1(d)	Zinc is a more reactive metal than iron and so zinc will corrode in place of iron. [1] Copper is a less reactive metal than iron and so iron will corrode in place of copper. [1]
2(a)	Grated coconut has a <u>larger total surface area</u> to volume ratio thus allowing the coconut milk to be extracted faster. [1]
2(b)	The holes in the cloth are small enough to allow coconut milk to pass through but not the coconut gratings. [1]
2(c)	Heat the intermediate product and measure its temperature. The intermediate product is a mixture if it melts/boils over a range of temperatures. [1]
2(d)	First fraction is less flammable as compared to the third fraction. First fraction is less viscous as compared to the third fraction. First fraction has a lighter colour compared to third fraction. First fraction burns with a less sooty flame compared to third fraction. Molecular mass of the first fraction is lower than molecular mass of third fraction. Any 2 - [2m]
3(a)	A covalent bond is a pair of electrons which are shared between two atoms. [1]
3(b)	In phosphorus pentachloride, the <u>phosphorus atom has 10 outermost electrons</u> after bonding with chlorine atom. [1]
3(c)(i)	Oxygen atom shared two extra electrons to form bond with carbon atom / one pair of the shared electrons comes from oxygen atom only (dative covalent bonding). [1]
3(c)(ii)	Carbon monoxide can <u>burn in / react with oxygen</u> and itself become <u>oxidised</u> . [1]
3(c)(iii)	Carbon monoxide is used to reduce iron(III)oxide (to molten iron) in the extraction of iron process in the blast furnace while itself is oxidised (to carbon dioxide). $\begin{array}{c} \text{reduction} \\ \downarrow \\ \text{Fe}_2\text{O}_3 + 3\text{CO} \longrightarrow 2\text{Fe} + 3\text{CO}_2 \\ \uparrow \\ \text{oxidation} \end{array}$ Equation [1] Explanation [1]
3(d)	No. Hydrogen chloride <u>dissolves in water</u> [1] and <u>dissociates to form</u> mobile ions to conduct electricity in aqueous state. [1]
4(a)(i)	All nitrates are soluble in water so there are no physical means to remove it from water. [1]

Qn No	Suggested answers
4(a)(ii)	To a portion of the sample, add a spatula of <u>aluminium powder/Devarda's alloy</u> , excess <u>aqueous sodium hydroxide</u> and then <u>warm</u> the mixture. [1] If colourless, pungent gas evolved which turns moist red litmus paper blue, ammonia gas is produced which means that nitrates are present. [1]
4(a)(iii)	Yellow precipitate is formed if lead(II) ions are present. [1] [R: ppt]
4(b)(i)	The water mists help to <u>lower the temperature</u> and <u>reduce the amount of heat energy</u> needed for the oxygen molecules and nitrogen molecules to react. [1]
4(b)(ii)	Oxides of nitrogen is <u>oxidised by oxygen in air</u> and <u>dissolve in rainwater</u> to form acid rain [1] which corrodes limestone buildings / metal infrastructures / destroys crops and damage forests. [1]
4(b)(iii)	acidified potassium manganate(VII)/dichromate(VI) solution [1]
5(a)(i)	Nickel(II) carbonate is used in excess so that all the (hydrogen ions in the) acid will completely react away. [1] Acid is not used in excess so as to prevent any unreacted acid to be present in the filtrate which will cause contamination to the eventual crystal formed. [1] or Nickel(II) carbonate is insoluble in water and can be removed by filtration. [1] The acid is soluble in water and cannot be removed by filtration. [1]
5(a)(ii)	To prevent the loss of water of crystallisation from nickel(II) chloride crystals which will otherwise form the powder instead of crystals. [1]
5(b)(i)	No. of moles of hydrochloric acid = $25.0/1000 \times 1.00 = 0.02500$ moles No. of moles of hydrated nickel(II) chloride = $0.02500 \div 2$ = 0.01250 moles [1] Theoretical mass of hydrated nickel(II) chloride = $0.01250 \times [59 + 35.5 \times 2 + 6 \times (1+1+16)]$ = 2.975 g [1] Percentage yield of the reaction = $2.50/2.975 \times 100\%$ = 84.0% (3 s.f.) [1]
5(b)(ii)	Not all the nickel(II) chloride crystals have precipitated out / Some of the product may be lost when transferred from one apparatus to another / some of the water molecules in the hydrated nickel(II) chloride crystals may have been lost.
6(a)(i)	Sodium is less reactive than potassium in the reactivity series hence it should not be able to displace potassium from molten potassium chloride. [1]
6(a)(ii)	Sodium atom is oxidised as it loses one valence electron to form sodium ion. [1] Potassium ion is reduced as it gains one electron to form potassium atom. Since oxidation and reduction occurs simultaneously / at the same time, this is a redox reaction. [1]
6(b)(i)	$2 \text{ Na} + 2 \text{ H}_2\text{O} \rightarrow 2 \text{ NaOH} + \text{H}_2$ [1]
6(b)(ii)	Volume of water = $200 \times 200 \times 200$ = 8000000 dm^3 No. of moles of sodium hydroxide = 0.0100×8000000 = $80\,000$ [1] No. of moles of sodium = $80\,000$ Mass of sodium = $80\,000 \times 23 = 1840000 \text{ g} = 1.84 \text{ tonnes}$ [1]
7(a)	The copper was extracted from its ore by heating / reducing / reacting its oxide with carbon. Excess carbon is dissolved into the molten copper. [1]
7(b)(i)	$\text{Cu (s)} \rightarrow \text{Cu}^{2+} (\text{aq}) + 2\text{e}^-$ [1]
7(b)(ii)	Reddish-brown / pinkish-brown / pink solid deposited at the cathode / The cathode increases in size. [1]

Qn No	Suggested answers
7(c)	
8(a)	giant covalent structure with <u>extensive</u> strong covalent bonding [1] <u>Rigid</u> 3-dimensional <u>network</u> which requires a lot of energy to move atom, so hard [1] A lot of energy to overcome / break all covalent bonds, so high melting point. [1]
8(b)	Every phosphorus atom has 5 outermost electrons [1] Only 4 of the outermost electron is used in covalent bonding (with carbon atoms) leaving one electron free to be delocalised to conduct electricity. [1]
8(c)	otherwise the atom will not have full outermost shell of electrons [1]
8(d)	mass of diamond = $3.5 \times 0.200 = 0.700 \text{ g}$ [1] number of mole of carbon monoxide = $\frac{0.700}{12} = 0.0583 \text{ mol}$ [1] maximum volume of carbon monoxide produced = $0.0583 \times 24 = 1.40 \text{ dm}^3$ [1]
8(e)	contains more than one kind atom or contains carbon, oxygen and hydrogen <u>chemically combined / bonded together</u> [1]
9(a)(i)	When the concentration of sodium thiosulfate is doubled, the time taken for the "cross" to be obscured is halved. [1]
9(a)(ii)	As the concentration of thiosulfate ions increases, the number of thiosulfate ions per unit volume increases. [1] This increases the frequency of effective collisions between thiosulfate ions and hydrogen ions. Hence the rate of reaction increase as concentration increases. [1]
9(a)(iii)	<u>108 s</u> [1]
9(a)(iv)	No effect on the rate of reaction. [1]
9(b)(i)	A reaction which can go both forwards and backwards until a dynamic equilibrium is reached. [1]
9(b)(ii)	Increasing the pressure will increase the number of nitrogen and hydrogen molecules per unit volume [1] thereby increasing the number of effective collisions between the nitrogen and hydrogen molecules, increasing the yield per unit time. [1]
9(b)(iii)	Increasing the temperature will cause the ammonia to be decomposed to form nitrogen and hydrogen. [1]
9(b)(iv)	Overall energy change $= \frac{17.0}{(14 \times 2)} \times (-87)$ $= -52.8 \text{ kJ}$ [R: kJ/mol as units]
Either 10(a)(i)	A homologous series is a set of organic compounds with the same general formula and rather similar chemical properties. Each member of the series differs from the next by a $-\text{CH}_2-$ unit. [1]
10(a)(ii)	Ethene and propene (any alkene) has empirical formula of CH_2 [1]. Methane has empirical formula CH_4 but ethane has CH_3 (or any alkane) [1]
10(b)(i)	(catalytic) cracking [1]
10(b)(ii)	300°C , 70 atm [1]

Qn No	Suggested answers
	phosphoric(V) acid catalyst [1]
10(b)(iii)	Hydration of ethene produces only ethanol [1]. Hydration of propene produces propan-1-ol and propan-2-ol (allow structure) [1]
10(c)(i)	C_nH_{2n} [1]
10(b)(v)	All the carbon atoms in cycloalkanes are bonded together by single covalent bonds only. [1]
Or 10(a)	Effervescence of pale green gas and colourless gas observed in beaker A [1] while only effervescence of colourless gas observed in beaker B. [1]
10(b)	Electrons flow from magnesium strip to platinum strip and from platinum strip to copper strip. [1]
10(c)	Magnesium atoms in the magnesium strip oxidises / lose electrons to form magnesium ions. [1] Hydrogen ions gain electrons / reduce to form hydrogen gas at the copper strip. [1]
10(d)	hydrogen gas chlorine gas aqueous sodium hydroxide [3 correct – 2 marks; 2 correct – 1 mark]
10(e)	$2H^+(aq) + 2e \rightarrow H_2(g)$ [1]
10(f)	