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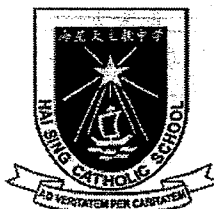


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Class:	Index No.:	Name:	Date:
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海星天主教中学
HAI SING CATHOLIC SCHOOL

9 Pasir Ris Drive 6, Singapore 519421 Tel: 5827864 Fax: 5822543

2014 PRELIMINARY EXAMINATION 1

Secondary Four Express

CHEMISTRY

Paper 1 Multiple Choice

Additional materials: Multiple Choice Answer Sheet

5073/1

12 May 2014

1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use paper clips, highlighters, glue or correction fluid.

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.

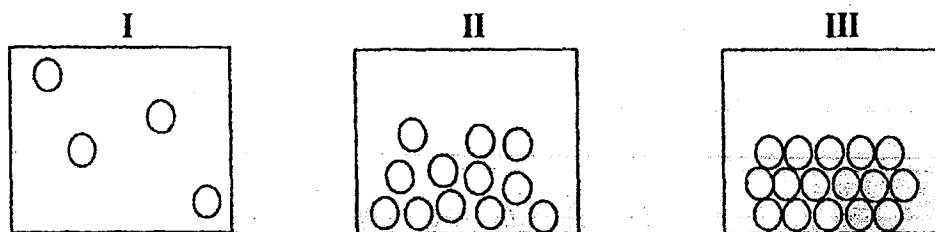
A copy of the Periodic Table is printed on page 15.

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



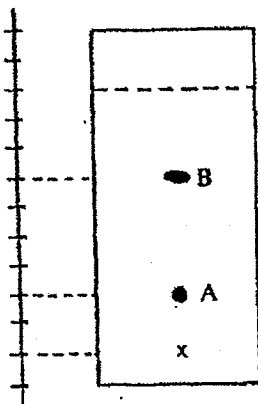
HAI SING CATHOLIC SCHOOL

- 1 Diagrams I, II and III show the particles of three substances at room temperature.



In which of the following are the substances correctly named?

- | | I | II | III |
|---|-------------------|----------------------|----------------|
| A | Argon | Water | Mercury |
| B | Helium | Mercury | Copper |
| C | Hydrogen chloride | Molten zinc chloride | Sugar solution |
| D | Methane | Sodium chloride | Copper |
- 2 The diagram represents a chromatogram which has been developed by standing the paper in a trough of solvent. Spots of a sample containing components A and B, were originally placed at x.



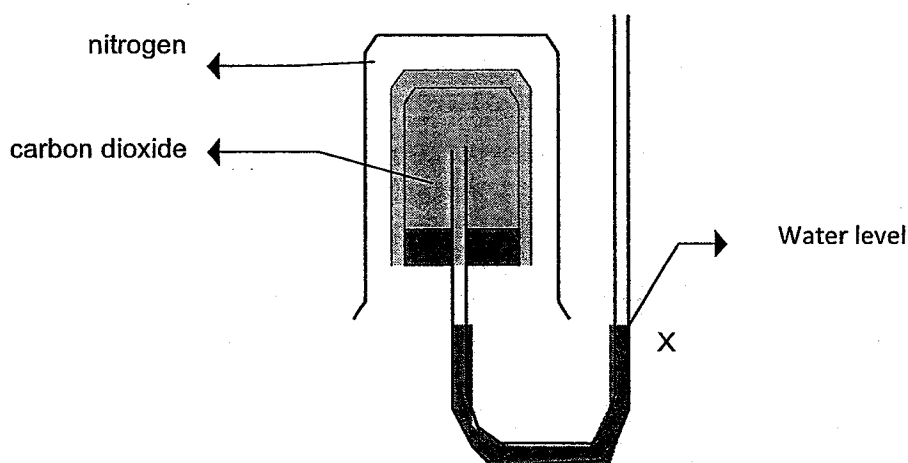
Compared to component A, component B is

- | | |
|---|---|
| A | less soluble and has a smaller R_f value. |
| B | less soluble and has a larger R_f value. |
| C | more soluble and has a smaller R_f value. |
| D | more soluble and has a larger R_f value. |
- 3 An element Y, has two isotopes of 16 and 18. Its relative atomic mass is 16.4. The proportion of each isotope will be
- | | | |
|---|-------------|-------------|
| A | 50% of Y-16 | 50% of Y-18 |
| B | 60% of Y-16 | 40% of Y-18 |
| C | 70% of Y-16 | 30% of Y-18 |
| D | 80% of Y-16 | 20% of Y-18 |

4 What are the operating conditions in the Haber process for the manufacture of ammonia?

	Pressure	temperature	catalyst
	1 atm	450°C	iron
B	200 atm	450°C	iron
C	200 atm	500°C	vanadium (V) oxide
D	200 atm	2000°C	vanadium (V) oxide

5 When a large beaker full of nitrogen is inverted over a porous pot containing carbon dioxide in the apparatus below, the water level at X



- A falls as carbon dioxide is denser than nitrogen.
- B falls as nitrogen is denser than carbon dioxide
- C rises as carbon dioxide is denser than nitrogen.
- D rises as nitrogen is denser than carbon dioxide.

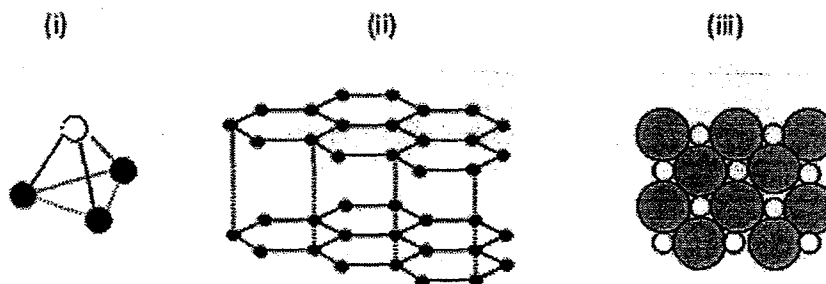
6 The atoms of element X have the electronic configuration 2.8.2. Which statement about X is correct?

- A It forms an ion of charge 2 -.
- B It forms an ionic compound with oxygen.
- C It has two protons in the outer shell of an atom.
- D It only reacts with metals.

7 How many electrons are present in one ion of $^{31}_{15}\text{X}^{3-}$?

- A 12
- B 18
- C 29
- D 34

- 8 Which of the following correctly identifies the structures shown?

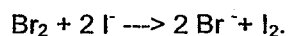


- | | (i) | (ii) | (iii) |
|---|---------|----------|-----------------|
| A | ammonia | diamond | silicon |
| B | ammonia | graphite | sodium chloride |
| C | methane | diamond | silicon |
| D | methane | graphite | sodium chloride |

- 9 What volume of 1.5 mol/dm^3 NaOH is needed to provide 0.75 mol of NaOH?

- A 500 cm^3
 B 0.75 dm^3
 C 5.0 dm^3
 D 500 dm^3

- 10 The reaction between bromine and iodide ions is shown in the equation:



What happens during the reaction?

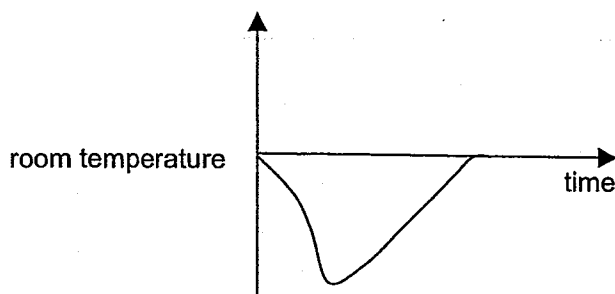
- A Bromine molecules are the oxidising agent.
 B Bromine molecules are oxidised into bromide ions.
 C Iodide ions are reduced to iodine molecules.
 D Iodide ions gain electrons.

- 11 A coil of clean copper wire is suspended in aqueous silver nitrate. Crystals of silver are deposited on the copper wire.

Which statement is **not** correct?

- A The copper is oxidised.
 B The total mass of the crystals of silver increases gradually.
 C The total number of positive ions in the solution is unchanged.
 D The solution turns blue.

- 12 The following graph was obtained when potassium iodide was dissolved in water.



Which of the following statements about the reaction is correct?

- A Ice is formed and has melted.
B The potassium iodide has sublimed.
C The reaction is endothermic.
D The reaction is exothermic.
- 13 A salt has the chemical formula $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 12 \text{H}_2\text{O}$. Excess aqueous sodium hydroxide was added slowly, with shaking to a hot solution of the salt in a boiling tube until there is no further reaction. The boiling tube was then left to stand for some time. Which one of the following observations would **not** be made?
- A A green precipitate was produced.
B A pungent gas which turned damp red litmus blue was produced.
C On standing, the precipitate turned brown.
D The precipitate dissolved in excess sodium hydroxide.
- 14 When a mixture of barium nitrate, sodium sulfate and potassium chloride is shaken up with water, a solid remains insoluble after shaking. The solid is most likely to be
- A BaSO_4
B BaCl_2
C K_2SO_4
D NaNO_3
- 15 Selenium has proton number 34 on the Periodic Table. Selenium forms
- A a covalent hydride
B a giant covalent chloride
C a fluoride of formula SeF_5
D an ionic oxide

- 16 The table below shows the colour of bromophenol blue and phenolphthalein in acid and alkali, as well as the pH at which the colour changes take place.

Indicator	Colour in strongly acidic solution	Colour in strongly alkaline solution	pH at which colour changes
bromophenol blue	yellow	blue	4
phenolphthalein	colourless	red	9

What is the colour of a mixture of bromophenol blue and phenolphthalein in a solution with pH 2?

- A blue
- B colourless
- C red
- D yellow

- 17 Which of the following statement is true for both graphite and diamond?

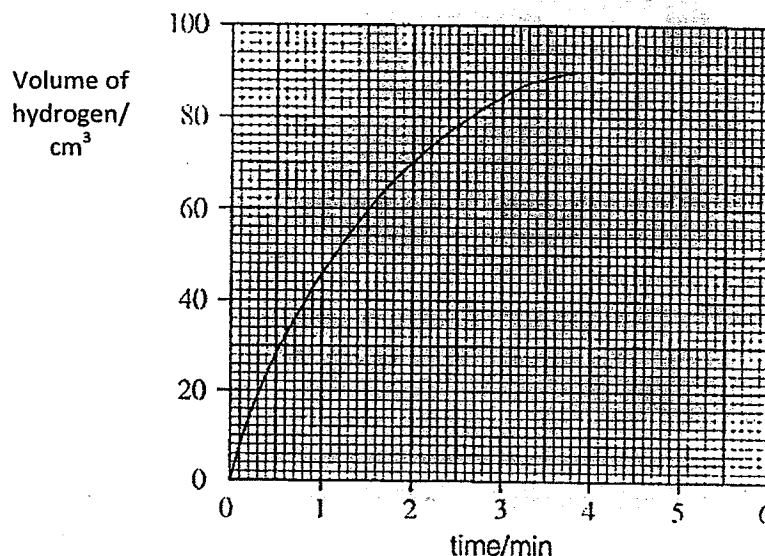
	Graphite	Diamond
A	Good conductor of electricity	Good insulator
B	Hard and transparent	Soft and opaque
C	Low boiling point	High boiling point
D	three ionic bonds between each carbon atom	four covalent bonds between each carbon atom

- 18 An excess of silver nitrate is added to aqueous barium chloride, and the precipitate is removed by filtration. What are the main ions in the filtrate?

- A Ag^+ and NO_3^-
- B Ag^+ , Ba^{2+} and NO_3^-
- C Ba^{2+} and NO_3^-
- D Ba^{2+} , Cl^- and NO_3^-

For questions 19 and 20, refer to the information below:

0.10 g of magnesium ribbon was allowed to react at 18°C with 20 cm³ of 1 mol/dm³ hydrochloric acid at atmospheric pressure. The total volume of hydrogen collected was noted at half minute intervals and the graph below was plotted.



19 Which one of the following factors would **not** result in an increase in the initial rate of reaction?

- A adding 10 cm³ of water to the hydrochloric acid
- B carrying out the reaction at 30°C
- C using 0.2 g of magnesium
- D using 20 cm³ of 2 mol/dm³ hydrochloric acid

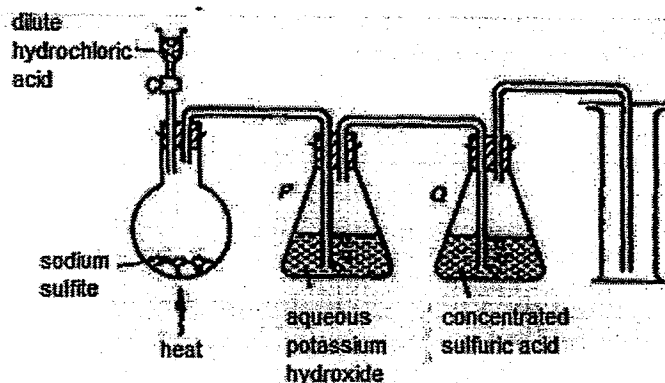
20 What time was required for half the magnesium to react?

- A 0.95 min
- B 1.5 min
- C 2.0 min
- D 3.0 min

21 Which pair would react most violently together?

- A caesium and chlorine
- B caesium and fluorine
- C sodium and chlorine
- D sodium and fluorine

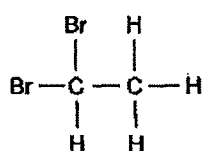
- 22 The diagram represents an unsuccessful attempt to collect sulfur dioxide.



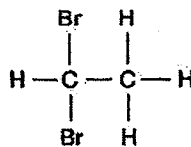
Which modification would make the experiment successful?

- A collect the gas using upward delivery
- B remove flask P
- C remove flask Q
- D using water in flask P instead of aqueous potassium hydroxide

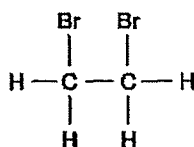
- 23 Which of these molecules are isomers?



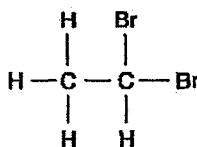
I



II



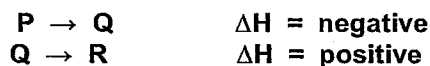
III



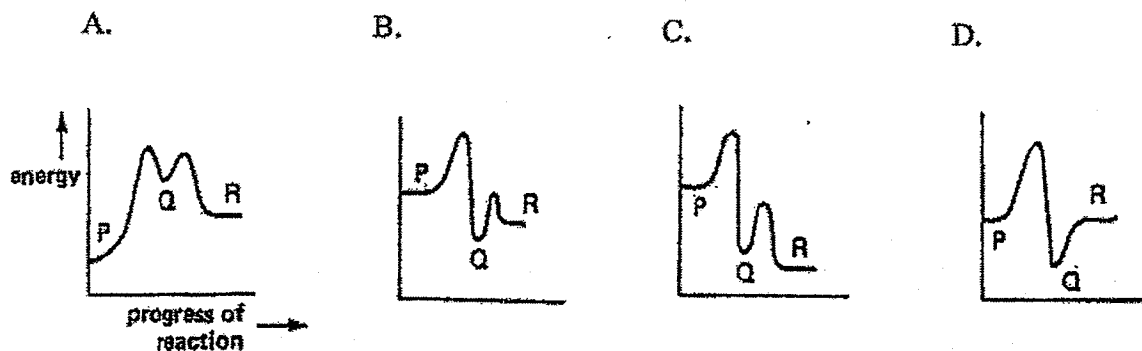
IV

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

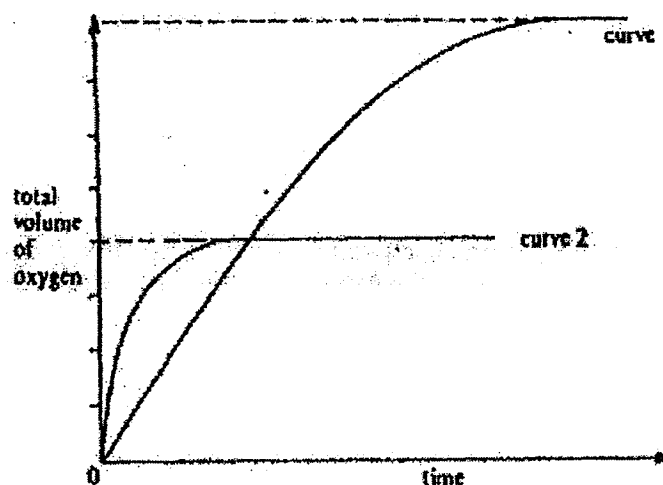
- 24 In which of the following substances does sulfur exhibit its highest oxidation state?
- A S_8
 - B SO_2
 - C SO_2Cl_2
 - D $Na_2S_2O_3$
- 25 A sample of 10 dm^3 of polluted air is passed through limewater so that all the carbon dioxide present is precipitated as calcium carbonate. The mass of calcium carbonate formed is 0.05 g . What is the percentage, by volume, of carbon dioxide in the air sample?
- A 0.03%
 - B 0.05%
 - C 0.12%
 - D 0.30%
- 26 In the conversion of compound P into compound R, it was found that the reaction proceeded by way of compound Q, which could be isolated. The steps involved were



Which one of the following reaction profiles agrees with the data?



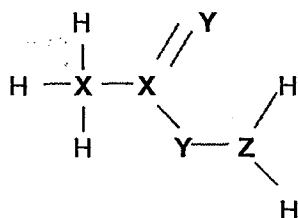
- 27 Manganese(IV) oxide catalyses the decomposition of aqueous hydrogen peroxide into water and oxygen. In order to follow the rates of this reaction for two different solutions of hydrogen peroxide, the total volumes of oxygen evolved were recorded at regular time intervals and the results were plotted. In each experiment, the same mass of catalysts was used and the temperature was the same.



If curve 1 corresponds to 20 cm³ of a 4.0 mol/dm³ solution, curve 2 would correspond to

- A 5 cm³ of a 8.0 mol/dm³ solution
- B 20 cm³ of a 8.0 mol/dm³ solution
- C 10 cm³ of a 4.0 mol/dm³ solution
- D 20 cm³ of a 2.0 mol/dm³ solution

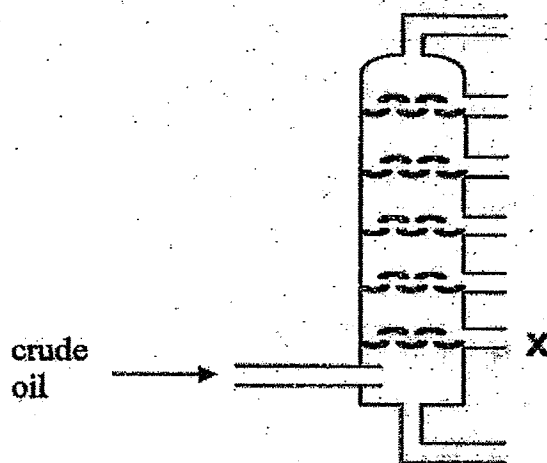
- 28 The diagram shows the structure of a covalent compound containing the element hydrogen, H, and the unknown elements X, Y and Z



To which groups of the Periodic Table do these three elements, X, Y and Z belong?

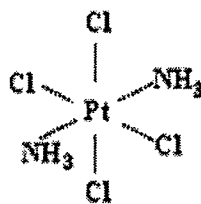
	X	Y	Z
A	I	V	VI
B	IV	V	I
C	IV	VI	V
D	V	I	IV

- 29 The diagram below shows the fractional distillation of crude oil. What is the main use of the fraction that comes out from X?



- A as a fuel for cooking and heating
- B as a fuel for aeroplanes
- C as a lubricant
- D for making roads

- 30 Platinum is a very expensive but unreactive metal. It has catalytic properties and certain platinum compounds are used to treat cancer. The structure of one such drug, diamminetetrachloroplatinum (IV), is shown in the diagram. What is the percentage by mass of the metal platinum in this molecule?



- A less than 25%
- B between 25% and 50%
- C between 50% and 75%
- D above 75%

31 Which compound is manufactured by reacting ethene with steam in the presence of a heated catalyst?

- A C_2H_6
- B $\text{C}_2\text{H}_5\text{OH}$
- C C_4H_8
- D $\text{C}_4\text{H}_9\text{OH}$

32 Which equation shows a reaction that would actually take place?

- A $2\text{MgO} + \text{C} \rightarrow \text{CO}_2 + \text{Mg}$
- B $\text{MgO} + \text{Cu} \rightarrow \text{CuO} + \text{Mg}$
- C $\text{PbO} + \text{Zn} \rightarrow \text{ZnO} + \text{Pb}$
- D $\text{ZnO} + \text{H}_2 \rightarrow \text{H}_2\text{O} + \text{Zn}$

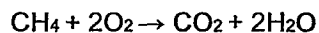
33 Which gas **cannot** be removed from the exhaust gases of a petrol-powered car by its catalytic converter?

- A carbon dioxide
- B carbon monoxide
- C hydrocarbons
- D nitrogen dioxide

34 A hydride is a compound containing only two elements, one of which is hydrogen. Which element forms the most hydrides?

- A carbon
- B chlorine
- C nitrogen
- D oxygen

35 The combustion of methane is exothermic. The equation is given below.



What can be deduced from the fact that the reaction is exothermic?

- A Fewer bonds are broken than are made.
- B Less energy is involved in breaking bonds than is involved in making bonds.
- C More bonds are broken than are made.
- D More energy is involved in breaking bonds than is involved in making bonds.

36 Which method of preparation of a pure salt solution requires the use of a pipette and burette?

- A $\text{BaCl}_2(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2\text{HCl}(\text{aq})$
 B $\text{CuO}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CuCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$
 C $\text{KOH}(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{KCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
 D $\text{MgCO}_3(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{MgSO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$

37 The data gives the concentration, in parts of pollutant per billion parts of air, of polluting gases in four different industrialised cities.

In which city are limestone buildings under greatest threat from pollution?

City	Sulfur dioxide	Nitrogen dioxide	ozone
A	17	46	23
B	32	33	30
C	38	40	11
D	45	14	21

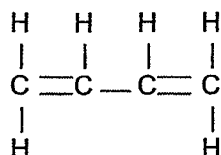
38 A coin is analysed by dissolving it in nitric acid. To the resulting solution an excess of aqueous ammonia is added and the mixture is filtered.

A brown precipitate remains in the filter paper and a deep blue solution is obtained as the filtrate.

Which metals does the coin contain?

- A aluminium and copper
 B copper and iron
 C iron and lead
 D lead and zinc

39 The diagram shows the structure of the compound 1,3-butadiene.



How many molecules of hydrogen are needed to saturate one molecule of 1,3-butadiene?

- A 1 B 2 C 3 D 4

- 40 A student investigated the reaction of different vegetable oils with hydrogen. 100 cm^3 of hydrogen was passed through 1 g samples of vegetable oils containing a suitable catalyst.

The volume of hydrogen remaining after each reaction was recorded as shown in the table below.

Vegetable	Volume of hydrogen remaining / cm^3
P	100
Q	87
R	63
S	0

Which vegetable oils are unsaturated?

- A P only
- B Q and R
- C Q, R and S
- D S only

2014 Midyr
4E Pure Chemistry 5073 P1

Question number	1	2	3	4	5	6	7	8	9	10
Answer	B	D	D	B	C	B	B	B	A	A

Question number	11	12	13	14	15	16	17	18	19	20
Answer	C	C	D	A	A	D	A	B	A	A

Question number	21	22	23	24	25	26	27	28	29	30
Answer	B	B	C	C	C	B	A	C	C	C

Question number	31	32	33	34	35	36	37	38	39	40
Answer	B	C	A	A	B	C	C	B	B	C

The Periodic Table of the Elements

[illegible]

50	*58-71 Lanthanoid series
51	+90-103 Actinoid series

[illegible]

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Class:	Index No.:	Name:	Date:
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2014 PRELIMINARY EXAMINATION 1
Secondary Four Express

CHEMISTRY
 Paper 2

5073/2
 12 May 2014

1 hour 45 min

READ THESE INSTRUCTIONS FIRST

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 paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** questions.
 Write your answers in the spaces provided on the question paper.

Section B

Answer all **three** questions, the last question is in the form either/or.
 Write your answers on the lined paper provided and, if necessary, continue on separate answer paper.

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 16.

FOR EXAMINER'S USE	
Section A	/50
B8	/10
B9	/10
B10	/10

Parent's Signature

This question paper consists of **16** printed pages, including the cover page.



HAI SING CATHOLIC SCHOOL

Section A

Answer **all** the questions in this section in the spaces provided.
The total mark for this section is 50.

- A1** The table gives some information about the melting and boiling points of substances, **A**, **B**, **C**, **D** and **E**.

Substance	Melting point / °C	Boiling point / °C	Electrical conductivity	
			Solid	Liquid
A	1083	3570	Yes	Yes
B	98	881	Yes	Yes
C	716	1412	No	Yes
D	-182	- 161	No	No
E	1610	2230	No	No

- (a) Which substance could be magnesium chloride?
Use the structure of magnesium chloride to explain its electrical conductivity when solid.

.....

.....

.....

..... [2]

- (b) Explain, in terms of its structure, how substance **A** conducts electricity.

.....

.....

.....

.....

..... [2]

- (c) Explain, using ideas about bonding, why substance **D** and substance **E** have different melting points.

.....

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.....

..... [3]

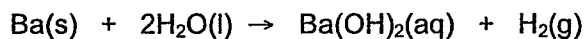
- (d) Which substance is most likely to be found in Group I of the Periodic Table? Explain your answer.

.....
.....

[2]

A2

- (a) Barium reacts with water in a redox reaction.



- (i) Explain in terms of electrons, what is meant by oxidation.

.....
.....

[1]

- (ii) Which element has been oxidized in this reaction? Deduce its change in its oxidation number.

element

oxidation number changes from to

[2]

- (b) Sulfuric acid was added to aqueous barium hydroxide until the solution was just neutralized, forming insoluble barium sulfate and water.
The electrical conductivity of the solution steadily decreased as sulfuric acid was added.

- (i) Write down a chemical equation with state symbols for the reaction.

.....

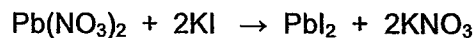
[2]

- (ii) Explain why the electrical conductivity decreases.

.....
.....
.....
.....

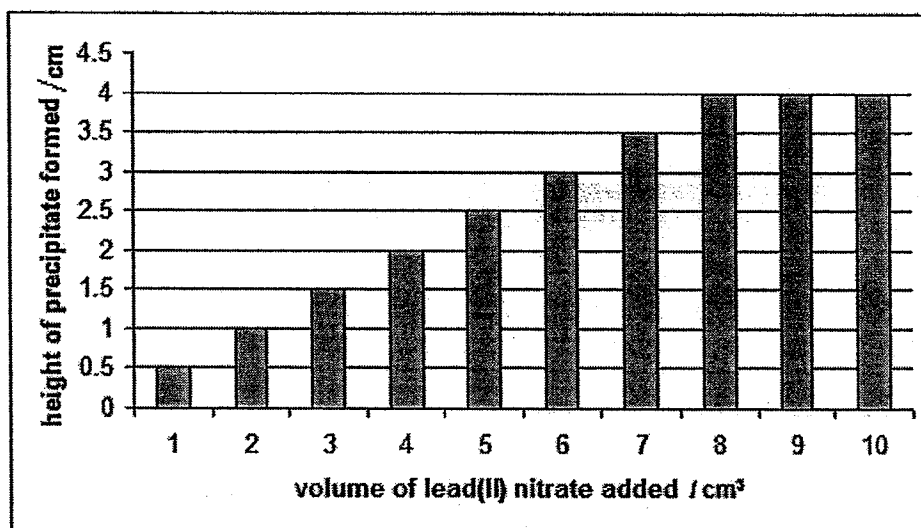
[2]

- A3** An experiment was carried out to study the reaction between aqueous lead(II) nitrate and aqueous potassium iodide solutions. This reaction proceeds as follows:



10 cm³ volume of 0.4 mol/dm³ potassium iodide was placed in each of 10 different boiling tubes. Different volumes of lead(II) nitrate solution of unknown concentration were added to each tube. The mixtures were then shaken and left to stand. In each case, a yellow precipitate was formed and the height of the precipitate in the test tube was measured.

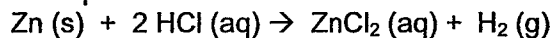
The following graph shows the relationship between the height of the precipitate and the volume of lead(II) nitrate that had been added.



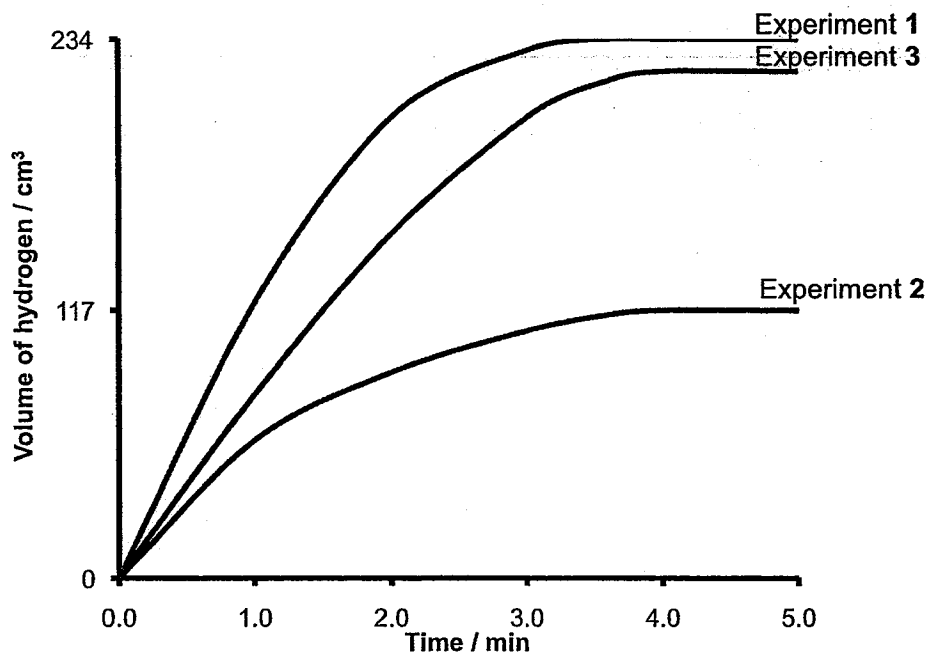
- (a) Name the yellow precipitate formed.
..... [1]
- (b) State the volume of lead(II) nitrate solution required to react completely with 10 cm³ of the potassium iodide solution.
..... [1]
- (c) Explain why the height of precipitate formed does not increase after the volume of lead (II) nitrate solution stated in (b) has been added.
.....
..... [1]
- (d) Using your answer from (b) above, calculate the concentration of the aqueous lead (II) nitrate solution in mol/dm³.

[1]

- A4** Three experiments were carried out to investigate the rate of reaction between zinc and dilute hydrochloric acid. The chemical equation is:



All three experiments were carried out at room temperature (25 °C), using excess hydrochloric acid. The results are shown on the graph below.



In Experiment 1, 0.78 g of powdered zinc was added.

- (a) Calculate the percentage purity of powdered zinc used in Experiment 1.

[3]

- (b) Suggest how you can alter one condition to produce the results for Experiment 2.

[1]

.....

.....

- (c) In Experiment 3, some copper (II) chloride solution was added. Suggest reasons for the results obtained for this experiment. [2]

.....

.....

.....

.....

- (d) If Experiment 1 was repeated using powdered magnesium instead of powdered zinc, how would the rate of reaction change? Give a reason for your answer. [2]

.....

.....

A5 Many inks contain salts of the metals potassium, iron, cobalt and nickel in addition to ethanoic acid and gallic acid.

- (a)(i) State **two** differences in the physical properties of the metals potassium and iron. [2]

.....

.....

- (ii) State **one** difference in the chemical properties of potassium and iron. [1]

.....

.....

- (b) Gallic acid can be used as a photographic developer. It reduces silver ions to silver.

- (i) Write an equation for the reduction of silver ions to silver. [1]

.....

- (ii) Explain why this is a reduction reaction. [1]

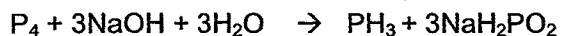
.....

- (c) The blue colour of ink is due to the reaction between gallic acid and iron(III) ions. Describe a standard test for iron(III) ions. [2]

test.....

result

- A6** Phosphine, PH_3 , is a gas which has a smell of garlic. It is formed when white phosphorus is warmed with aqueous sodium hydroxide.



- (a) Draw a 'dot-and-cross' diagram for phosphine. Show only the outer electrons. [1]

- (b) Phosphine decomposes into its elements on warming. Write an equation for this reaction. [2]

.....

- (c) Phosphine reacts with hydrogen iodide to form the salt phosphonium iodide, PH_4I . Phosphonium salts react in a similar way to ammonium salts when warmed with aqueous sodium hydroxide.

- (i) Write an equation for the reaction of phosphonium iodide with aqueous sodium hydroxide. [1]

.....

- (ii) What should you notice when sodium hydroxide is warmed with phosphonium iodide? [1]

.....

- (d) Phosphine is formed when water reacts with calcium phosphide, Ca_3P_2 . Calcium phosphide is an ionic compound.

- (i) Write the formula for the phosphide ion. [1]

.....

- (ii) Predict one physical property of calcium phosphide. [1]

.....

A7 Iron(II) sulfate, FeSO_4 , is a green salt.

- (a) A sample of iron(II) sulfate is dissolved in water. Describe a test to show the presence of sulfate ions in this solution. [2]

Reagents

.....

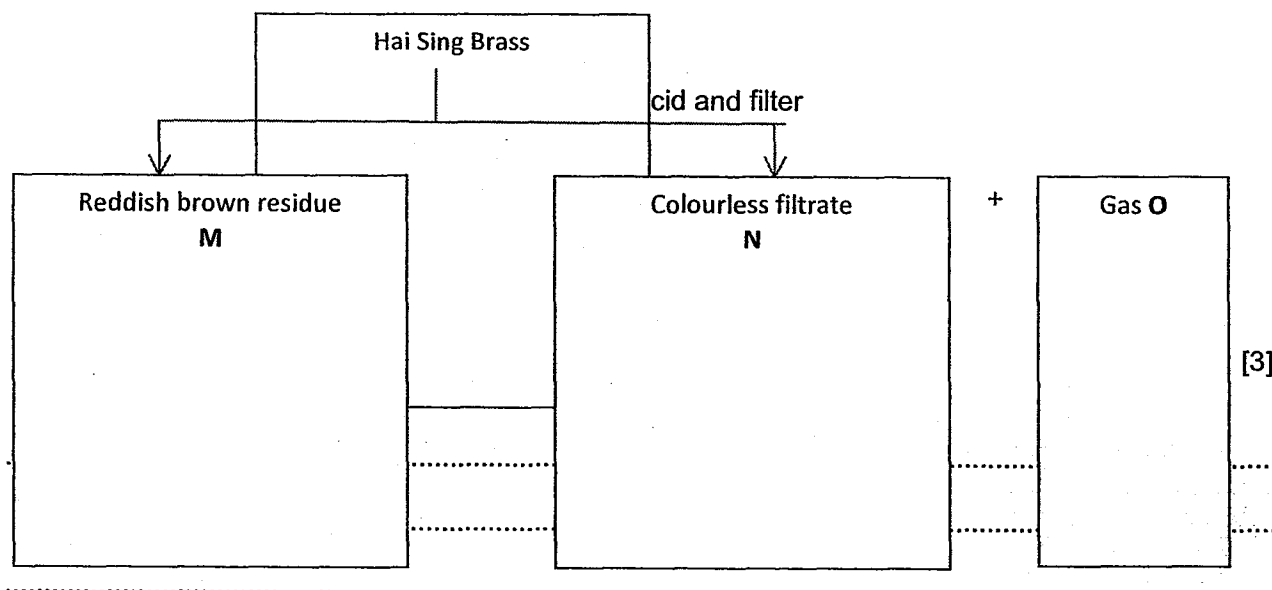
Observation

- (b) An impure sample of iron (II) sulfate was analysed by titration.
The sample was dissolved in 25.0 cm^3 of dilute sulfuric acid and then titrated against 0.0400 mol/dm^3 potassium dichromate (VI) solution.
 19.0 cm^3 of potassium dichromate (VI) solution was required to reach the end-point.

- (i) Calculate the number of moles of potassium dichromate (VI) used in the titration. [1]

- (ii) One mole of potassium dichromate (VI) reacts with six moles of iron (II) ions.
Calculate the mass, in grams, of iron (II) ions in the sample analysed. [2]

A8 The diagram below shows the reaction of an alloy, Hai Sing Brass.



Section B

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

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

The total mark for this section is 30.

B9(a)

Read carefully the information about Group I elements and use them to answer the questions below.

The atomic radius of an element is a measure of the size of its atoms, usually the mean distance from the nucleus to the boundary of the surrounding cloud of electrons. The unit of measurement is in nanometer, nm (or 1×10^{-9} m).

Table 9.1 below shows some information regarding some Group I elements.

Element	Li	Na	K	Rb
Atomic radius/ nm	0.16	0.19	0.24	0.25
Melting point/ °C	181	98	63	39
Boiling point/ °C	1342	883	760	686

- (i) Explain why the atomic radius of Group I elements increases down the group. [1]
- (ii) Group I elements are all metals with metallic bonding. Explain what is meant by 'metallic bonding'. [1]
- (iii) In the context of metallic bonding, suggest why the melting point of the elements decreases down the group. [2]
- (iv) Group I elements are good reducing agents. Explain why. [2]

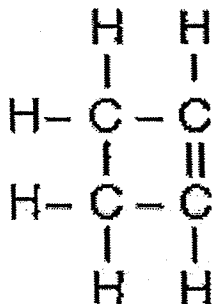
- (b) The ionization energy is the energy required to remove one electron from each atom to form a positive ion.
The first ionization energy is therefore the energy required to remove the first electron from the atom; the second ionization energy is the energy required to remove the second subsequent electron, and so on.

Table 9.2 below shows the ionization energies of sodium and magnesium.

Element	Na	Mg
First ionization energy/ kJ	496	738
Second ionization energy/ kJ	4562	1451
Third ionization energy/ kJ	6910	7733

- (i) The electronic configuration of sodium is 2.8.1.
Write down the electronic configuration for magnesium. [1]
- (ii) From their electronic configuration, suggest why there is a large increase from the 1st to the 2nd ionization energy for sodium, but a similar increase is only observed from the 2nd to the 3rd ionization energies for magnesium. [3]

B10 Cyclobutene is a hydrocarbon and has the following structural formula.



- (a) Cyclobutene reacts with hydrogen to form cyclobutane.
- (i) Draw the full structure of cyclobutane. [1]
- (ii) By means of their structural formulae, write an equation to represent the reaction between cyclobutene and hydrogen. [2]
- (iii) State the conditions required for the above reaction. [2]
- (b) The table below gives the bond energies of some chemical bonds.

Bond	Bond energy (kJ/mol)
C - C	350
C = C	600
C - H	410
H - H	440

- (i) Calculate the enthalpy change, ΔH , of the reaction between cyclobutene and hydrogen. [2]
- (ii) Using the enthalpy change you have calculated, draw an energy profile diagram of the reaction between cyclobutene and hydrogen. [3]
On your diagram, show clearly the activation energy and enthalpy change.

EITHER

B11 Chlorine, bromine and iodine are elements in Group VII of the Periodic Table.

- (a) Describe the trend in colour and physical state at room temperature and pressure as the atomic number increases. [2]
- (b) Aqueous chlorine is an oxidising agent.
- (i) Name the products formed and write an ionic equation for the reaction between aqueous chlorine and aqueous potassium bromide. [2]

- (ii) Name the product formed when aqueous chlorine reacts with aqueous iron (II) chloride. [1]
- (c) An oxide of chlorine was analysed. A 0.366g sample was found to contain 0.224g of oxygen. Calculate the empirical formula of this oxide. [3]
- (d) Chlorine (IV) oxide, ClO_2 , is a powerful oxidising agent.
- (i) Construct an equation to show the decomposition of chlorine (IV) oxide into its elements. [1]
- (ii) Chlorine (IV) oxide reacts explosively with powdered sulfur. Suggest the name or formula of one of the products of the reaction between sulfur and chlorine (IV) oxide. [1]

OR

B12 In the experiment to find how atmospheric pollutants affect the rate at which metals corrode, strips of four different metals were left in contact with contaminated moist air.

After two weeks, the appearance of the surface of each of the metal strips was as shown in the table below.

Metal	Moist air alone	Moist air polluted with		
		Ammonia	Carbon monoxide	Sulfur dioxide
Aluminium	Still shiny	Still shiny	Still shiny	Still shiny
Copper	Small patch of green solid	Coating of blue-green solid	Small patch of green solid	Coating of a black and blue solid
Iron	Coating of red-brown solid	Thin coating of red-brown solid	Coating of red-brown solid	Thin coating of red-brown solid
Lead	Still shiny	Still shiny	Still shiny	Coating of black solid

- (a) Which atmospheric pollutant gave the greatest increase in the rate of corrosion? Explain your answer. [2]
- (b) Describe briefly how sulfur dioxide and carbon monoxide enter the atmosphere. [2]
- (c) Explain which metal would be most suitable for storing an acidic gas. [2]
- (d) The student repeated the experiments with iron but this time fixed pieces of magnesium ribbon to the iron strips. What changes in the observations would you expect? Explain your answer. [2]
- (e) Describe a test for sulfur dioxide and state the observation obtained. [2]

The End

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
1 Hhydrogen1																	
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	78 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	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54	137 Ba barium 56
133 Cs caesium 55	137 La lanthanum 57	139 Pr praseodymium 59	141 Nd neodymium 60	144 Pm promethium 61	146 Sm samarium 62	150 Eu europlum 63	152 Gd gadolinium 64	157 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	173 Yb ytterbium 70	175 Lu lutetium 71	181 Fr francium 87	186 Ra radium 88	189 Ac actinium 89	190-103 Actinoid series

a

X

b

Key

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

Key

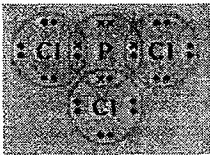
a	relative atomic mass
X	atomic symbol
b	proton (atomic) number

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

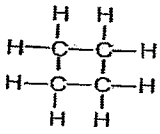
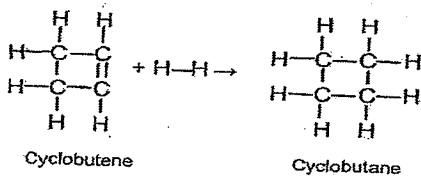
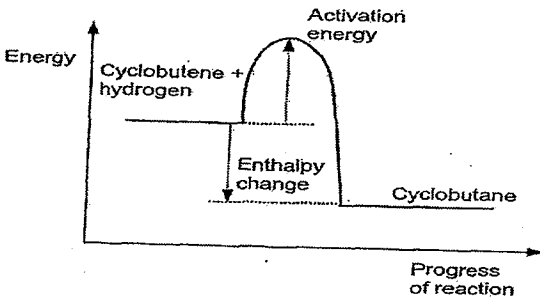
2014 Mid Year
4E Pure Chemistry 5073
Paper 2

Qn	Answer	Mark
	Section A	
1(a)	C. The Mg^{2+} and Cl^- ions in the ionic crystal lattice are not mobile as they are held in fixed positions so they are not able to conduct electricity.	1 1
(b)	Substance A has a giant metallic structure of positive metal ions in a sea of mobile electrons. The mobile electrons can move to carry electrical charges to conduct electricity.	1 1
(c)	Substance D has (a simple molecular structure with) weak intermolecular forces of attraction between the molecules. Substance E has(a giant covalent structure with) strong covalent bonds between the atoms. Mention of simple molecular structure for D and giant covalent structure for E will score additional mark.	1 1 1
(d)	Substance B. It is a group 1 metal with a low melting point and boiling point and (it conducts electricity in both solid and liquid states- optional)	1 1
2(a) (i)	Oxidation is the loss of electrons from a substance.	1
(ii)	Barium 0 to +2	1 1
2(b)(i)	$\text{H}_2\text{SO}_4 (\text{aq}) + \text{Ba}(\text{OH})_2 (\text{aq}) \rightarrow \text{BaSO}_4 (\text{s}) + 2 \text{H}_2\text{O} (\text{l})$ Balanced Correct state symbol	1 1
(ii)	Insoluble barium sulfate salt is formed. The concentration of mobile ions in the solution to conduct electricity reduces.	1 1
3(a)	Lead (II) iodide.	1
(b)	8 cm^3	1

(c)	The limiting reactant is potassium iodide which determines the yield of lead (II) iodide formed. OR All the potassium iodide reacted.	1
(d)	$(0.002 \times 1000) / 8$ $= 0.25 \text{ mol/dm}^3$	1
4(a)	No. of moles of $\text{H}_2 = 0.234 / 24 = 0.00975 \text{ mol}$ No. of moles of zinc = 0.00975 mol mass of zinc used $= 0.00975 \times 65 = 0.63375 \text{ g}$ $= 0.6338 \text{ g}$ % purity $= \text{mass of pure zinc} / \text{mass of impure zinc} \times 100 \%$ $= 0.663375 / 0.78 \times 100 = 81.3 \%$ (3 sf)	1 1 1
(b)	A lower concentration of dilute hydrochloric acid could have been used. Or The final volume of hydrogen produced is halved, so the mass of zinc used is halved (0.39 g of zinc has been used)	} 1
(c)	Zinc reacts with copper (II) chloride to form copper and zinc chloride. This results in less mass of zinc that react with dilute hydrochloric acid in Experiment 1. The concentration of dilute hydrochloric acid reacting with zinc is lowered , so the initial rate of reaction is slightly lower than that in Experiment 1.	1 1
(d)	Rate of reaction would be faster. Magnesium is more reactive than zinc , so it would react more readily with dilute hydrochloric acid.	1 1
5(a)(i)	- potassium soft but iron hard [ALLOW: iron is harder] - potassium low melting point but iron high melting point [ALLOW: iron has a higher melting point] - potassium not very dense but iron (very) dense [ALLOW: iron is more dense]	any two differences } 2
5(a)(ii)	- variable oxidation states - potassium is more reactive than iron - potassium reacts with cold water but iron does not - potassium tarnishes iron does not - potassium reacts with air at room temperature iron does not	any one difference } 1

(b)(i)	$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	1
(b)(ii)	Silver ion(s) gains electrons OR oxidation state of silver changes from +1 to 0 <u>Not accepted</u> :[because Q asked to explain why this is a reduction reaction] - It gains electrons -Silver gains electrons -Reduction is addition of electrons	1
(c)	add aqueous sodium hydroxide / add aqueous ammonia red brown precipitate [both red brown and ppt needed]	1 1
6 (a)	 correct electronic structure of three bonding pairs and a lone pair	1
6(b)	$2\text{PH}_3 \rightarrow 2\text{P} + 3\text{H}_2$ Correct chemical formulae Balanced equation	1 1
(c)(i)	$\text{PH}_4\text{I} + \text{NaOH} \rightarrow \text{PH}_3 + \text{NaI} + \text{H}_2\text{O}$	1
(c)(ii)	fumes of phosphine / bubbles seen / effervescence is seen / smell of garlic	1
(d)(i)	P_3^-	1
(d)(ii)	high melting point and high boiling point OR conducts electricity when it dissolves or when molten OR soluble in water OR insoluble in organic solvent	1
7a	Add dilute nitric acid and barium nitrate OR dilute hydrochloric acid and barium chloride White precipitate is seen	1 1

7(b)(i)	$0.04 / 1000 \times 19$ $= 0.00076 \text{ mol}$ OR $7.6 \times 10^{-4} \text{ mol}$	1
(ii)	No of mol of $\text{Fe}^{2+} = 0.00076 \times 6$ $= 0.00456 \text{ mol}$ Mass of $\text{Fe}^{2+} = 0.00456 \times 56$ $= 0.256 \text{ g (3sf)}$	1 1
8	M : copper N : zinc sulfate O : hydrogen	1 1 1
	Section B	
B9 (a)(i)	The <u>number of electron shells increases down the group</u> , therefore the atomic radius increases.	1
(ii)	Metallic bonding is the (electrostatic) force of attraction between the delocalized electrons and the positive metal ions.	1
(iii)	The atomic radius / size increases down the group so <u>the valence electron is further away from the positive nucleus.</u> <u>Hence the force of attraction is weaker.</u>	1 1
(iv)	Group I elements have only one valence electron in its outermost shell. Hence it loses/donates this valence electron readily, and are thus good reducing agents.	1 1
b(i)	Mg : 2.8.2	1
b(ii)	Sodium has only <u>1 electron in its valence shell.</u> The <u>second ionization energy for sodium involves removing an electron from a full electron shell.</u> This results in a large increase in the ionization energy. Similarly since <u>magnesium has 2 valence electrons, their 3rd ionization energies involve removing an electron from a full electron shell</u> resulting in a large increase in ionization energies.	1 1 1

B10 (a)(i)		1
(ii)	 Cyclobutene + H-H → Cyclobutane [1m correct formula of reactants] [1m for correct formula of products]	2
(iii)	200 °C, nickel catalyst	1, 1
b(i)	$\Delta H = 600 + 440 - (350 + 410 \times 2)$ $= -130 \text{ kJ}$	1 1
(ii)	Allow ecf  [1m for Ea] [1m for ΔH] [1m for reactants higher than products and shape of energy profile diagram]	3
B11(a)	The colour darkens. The element changes from gas to liquid to solid states.	1 1
(b)(i)	Aqueous potassium chloride and bromine. $\text{Cl}_2(\text{aq}) + 2\text{Br}^-(\text{aq}) \rightarrow 2\text{Cl}^-(\text{aq}) + \text{Br}_2(\text{aq})$	1 1
(ii)	Iron (III) chloride	1

(c)	Mass of Cl = $0.366 - 0.224 = 0.142$ g No of mol of Cl = $0.142 / 35.5 = 0.004$ mol No of mol of O = $0.224 / 16 = 0.014$ mol Simplest ratio of Cl : O = $0.004 / 0.004 : 0.014 / 0.004$ $= 1 : 3.5$ $= 2 : 7$ Empirical formula is Cl_2O_7	1 1 1
(d)(i)	$2\text{ClO}_2 \rightarrow \text{Cl}_2 + 2\text{O}_2$	1
(ii)	Sulfur dioxide SO_2 Or sulfur trioxide SO_3	1
B12 (a)	Sulfur dioxide. Three out of four metals were corroded by it.	1 1
(b)	Sulfur dioxide enters the atmosphere from combustion of fuels containing sulfur . Carbon monoxide enters the atmosphere from incomplete combustion of fuels .	1 1
(c)	Aluminium. It is not affected by the gasses and moist air.	1 1
(d)	The iron remains shiny while a layer of oxide forms on magnesium. Magnesium corrodes in place of iron in sacrificial protection.	1 1
(e)	Dip a piece of filter paper into acidified potassium manganate(VII) solution. The purple colour of potassium manganate (VII) solution turns colourless.	1 1