

2004
Higher School Certificate
Preliminary Examination

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Board approved calculators may be used
- Write using black or blue pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper
- Write your student number and/or name at the top of every page

Total marks (75)

Attempt ALL questions

Part A

Total marks (15)

Attempt questions 1 – 15

Allow about 30 minutes for this part

Part B

Total marks (60)

Attempt questions 16 – 29

Allow about 1 hour 30 minutes for this part

1. Use the Periodic table provided to identify the element with the electron configuration of 2,8,7.
 - (A) carbon
 - (B) chlorine
 - (C) fluorine
 - (D) neon

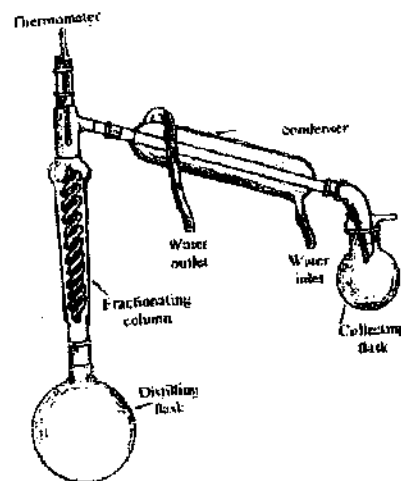
2. Identify the chemical change in the changes listed below.
 - (A) condensation of water vapour
 - (B) electrolysis of water
 - (C) dissolving of sugar in water
 - (D) evaporation of water

3. Which of the following changes increases the rate of a chemical reaction by increasing the kinetic energy of the reacting particles?
 - (A) Increase in concentration
 - (B) Increase in surface area of reacting solids
 - (C) Increase in temperature
 - (D) Increase in pressure

4. Identify the group in which all of the substances have covalent bonds.
 - (A) diamond, graphite, carbon dioxide, potassium fluoride
 - (B) hydrogen iodide, water, calcium chloride, paraffin wax
 - (C) iodine, ice, zinc sulfide, ethanol
 - (D) ammonia, oxygen, water, methane

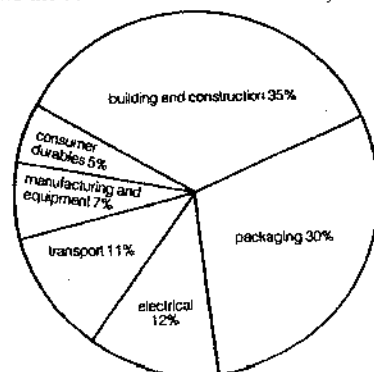
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5. The equipment shown below is used to separate a mixture.



Which mixture would be best separated using this equipment?

- (A) Sand and water
(B) Sodium chloride and water
(C) Oil and water
(D) Ethanol and water
6. The diagram below shows the uses of one common element.



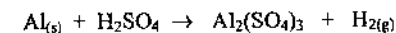
Which element best fits this pattern of use?

- (A) aluminium
(B) copper
(C) lead
(D) sodium

7. Solder is a common alloy used in plumbing. Which metals are present in solder?

- (A) Brass and copper
(B) Zinc and lead
(C) Lead and tin
(D) Tin and zinc

8. Identify the molar ratios of reactants to products in the reaction represented by the unbalanced equation:



	Reactants	Products
(A)	1 : 1	1 : 1
(B)	2 : 3	1 : 3
(C)	3 : 2	3 : 1
(D)	3 : 2	1 : 2

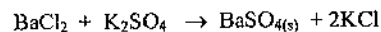
9. Which series of metals is in order from most to least reactive?

- (A) zinc, magnesium, lead, sodium
(B) lead, zinc, magnesium, sodium
(C) sodium, zinc, magnesium, lead
(D) sodium, magnesium, zinc, lead

10. Which is the strongest attractive force that exists between hydrogen fluoride molecules?

- (A) ionic bonds
(B) dispersion forces
(C) dipole-dipole forces
(D) hydrogen bonds.

11. The reaction between barium chloride and potassium sulfate solutions produces a precipitate of barium sulfate:



If 50mL of 0.50 mol L⁻¹ BaCl₂ was reacted with excess K₂SO₄ solution. How many moles of BaSO_{4(s)} would be precipitated?

- (A) 0.025 mol
(B) 2.33 mol
(C) 25 mol
(D) 233 mol

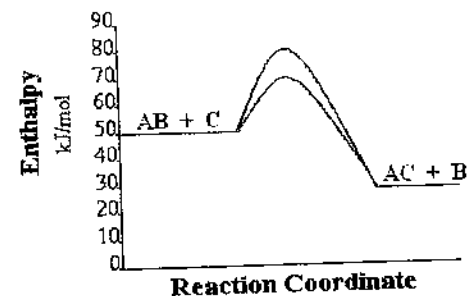
12. A student conducted an experiment on the solubility of various substances in water. Which set of results is correct?

Solubility in water			
Sodium chloride	Sucrose	Silicon dioxide	Cellulose
(A) soluble	not soluble	soluble	not soluble
(B) not soluble	soluble	soluble	not soluble
(C) soluble	soluble	not soluble	not soluble
(D) not soluble	not soluble	soluble	soluble

13. Which list below contains members of the same homologous series?

- (A) C₃H₆, C₅H₁₀, C₆H₁₂
(B) C₃H₈, C₄H₆, C₅H₄
(C) C₃H₈, C₄H₁₀, C₅H₁₀
(D) C₅H₁₀, C₇H₁₂, C₉H₁₄

14. Two reaction pathways are shown for a given reaction. Which is the approximate value of the activation energy for the catalysed reaction pathway, in kJ mol⁻¹?



- (A) 20
(B) 30
(C) 50
(D) 80

15. Which statement best describes an exothermic reaction?

- (A) More energy is required to break bonds in the reactants than is released when bonds form in the products.
(B) More energy is released when bonds form in the products than is required to break bonds in the reactants.
(C) More energy is released when bonds break in the reactants than is required to form bonds in the products.
(D) More energy is required to form bonds in the products than is released when bonds break in the reactants.

Part B**Total marks (60)****Attempt questions 16 – 29****Allow about 1 hour 30 minutes for this part**

Write your answers in the space provided after each question.

Question 16 (5 marks)**Marks**

You are provided with a mixture of sand, salt and water.

- (a) Describe, with the aid of a flow chart, how you would obtain samples of pure dry sand, pure dry salt and pure water from the mixture.

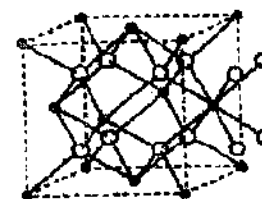
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- (b) If the total mass of the mixture provided was 250g and the mass of salt obtained was 8.8g, calculate the percentage (%) of salt in the original mixture.

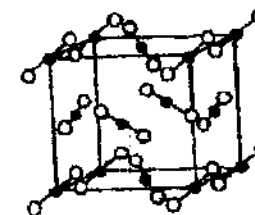
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Question 17 (6 marks)**Marks**

The diagrams below show the crystalline forms of calcium fluoride and carbon dioxide.

fluorite (CaF_2)

(● Ca, ○ F)

carbon dioxide (CO_2)

(● C, ○ O)

- (a) Compare, in detail, the bonding of these two compounds in their solid state.

3

- (b) Contrast TWO physical properties of these compounds and relate these to the types of bonding present in them.

3

Question 18 (4 marks)

Marks

- (a) Outline the electronic structure of an atom of aluminium.

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- (b) Explain the formation of an aluminium ion using electron dot formulae.

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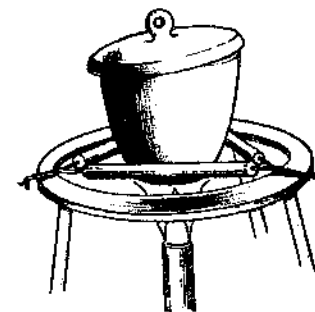
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Question 19 (4 marks)

Marks

A student performed a first-hand investigation to measure and identify the mass of the elements in magnesium oxide.



The information she recorded is as follows:

Mass of dry crucible + lid	= 32.14g
Mass of dry crucible + lid + magnesium	= 32.63g
Mass of dry crucible + lid + magnesium oxide	= 32.95g

- (a) Determine the empirical formula of magnesium oxide. (Show all working)

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- (b) Calculate the volume of oxygen taken from the air during this experiment. Assume the air temperature and pressure was 25°C and 100kPa respectively.

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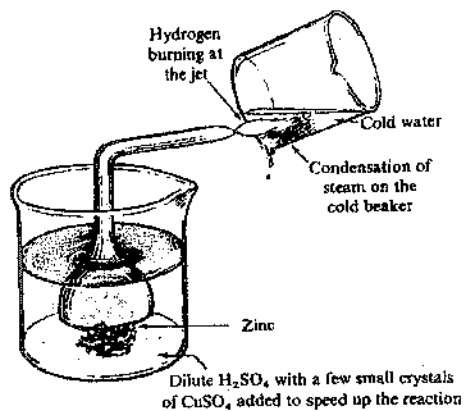
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Question 20 (5 marks)**Marks**

Hydrogen can be produced and burned in air using the apparatus shown in the diagram below.



- (a) Construct an equation for the production of hydrogen by this method.

1

- (b) Calculate the mass of zinc needed to produce 1.0 gram of water by combustion of the hydrogen gas.

3

- (c) Identify ONE safety precaution you would follow while performing this experiment

1

Question 21 (5 marks)**Marks**

- (a) Proceeding from left to right across the third period (Na to Ar) of the Periodic Table describe the trends in:

- first ionisation energy
- atomic radius
- boiling point

- (b) Account for the trend in electronegativity within any group of the Periodic Table.

Question 22 (5 marks)

Marks

- (a) Calculate the mass of barium chloride crystals ($\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$) required to prepare 200 mL of solution with a concentration of 0.50 mol L^{-1} .

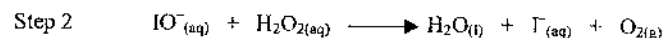
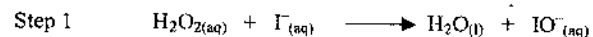
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- (b) This solution is diluted to a volume of 500 mL. Determine the chloride ion concentration in the diluted solution.

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Question 23 (2 marks)

The following equations represent two steps in the decomposition of hydrogen peroxide.



- (a) Identify the catalyst in this reaction.

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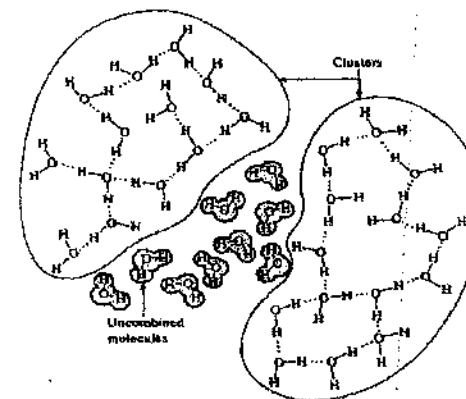
- (b) Describe how a catalyst speeds up a reaction.

1

Question 24 (5 marks)

Marks

It seems that liquid water consists of clusters of bonded water molecules together with some separate water molecules. This is shown in the diagram below



- (a) Explain with the aid of a diagram how the bonding between molecules of water within the clusters arises.

2

- (b) Explain why the boiling point of water is abnormally high compared to molecules of similar size and mass.

1

- (c) Describe and explain the changes in particle arrangements as dissolution occurs when a compound such as sodium chloride is added to water.

2

Question 25 (4 marks)**Marks**

- (a) If an aquarium tank holds 70 litres of water calculate how much heat energy would be required to heat the tank from 18.2°C to 26.5°C.

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- (b) In practice it is found that the amount of heat is 20% greater than the calculated amount. Identify reasons for this difference.

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Question 26 (4 marks)

A student added solid lead II nitrate to 200mL water to make a saturated solution.

- (a) Write an ionic equation to show the dissolving of lead nitrate in water.

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The student then took exactly 20mL of the saturated solution. An excess of sodium sulfate solution was added, to precipitate all the lead as lead sulfate. This precipitate was filtered off and dried. The mass of solid lead sulfate was found to be 8.61g.

- (b) Write an ionic equation to show the precipitation of lead sulfate.

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- (c) Calculate the solubility of lead nitrate in mol L⁻¹ at the concentration of the saturated solution.

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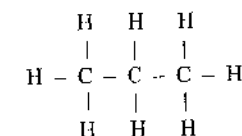
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Question 27 (3 marks)**Marks**

Below is the structural formula of a hydrocarbon.



- (a) State the systematic name for this compound.

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- (b) Describe TWO safety issues associated with the storage of hydrocarbons.

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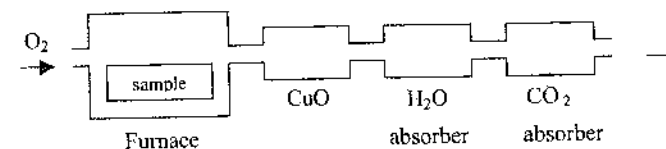
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Question 28. (5 marks)

A sample of hexane is completely burned in the apparatus shown below. All of the carbon is converted to carbon dioxide and all of the hydrogen is converted to water.



The masses of carbon dioxide and water produced are determined by measuring the increased mass in the CO₂ and H₂O absorbers.

- (a) Construct the empirical formula of hexane.

1

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Question 28 continued on next page

Question 28 (continued)

Marks

- (b) The reaction chamber containing copper oxide (CuO) is used to oxidize traces of carbon and carbon monoxide to carbon dioxide. Using an equation explain how conditions in the furnace might produce some carbon monoxide.

2

- (c) Compare the mass increases in the CO₂ and H₂O absorbers from the combustion of hexane. Use an equation to help explain your answer.

2

Question 29 (3 marks)

"The energy for life comes from the sun"

Outline the role of the photosynthesis process to explain what is meant by this statement.

3

End of Paper

NSW INDEPENDENT TRIAL EXAMS
CHEMISTRY PRELIMINARY - 2004

Suggested Answers

PART A

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B	B	C	D	D	A	C	B	D	D	A	C	A	A	B

PART B.

16. (a) Flow chart showing stages of, filtering → washing → drying sand → distilling or evaporation/condensation → drying salt. Description of equipment and procedure such as:

The mixture was filtered and the filtrate collected in a beaker. The sand was removed from the filter paper, washed and dried. The filtrate was placed in a distillation flask and distilled until only a small volume of mixture remained. The distillate was pure water. The residue was evaporated to dryness to obtain pure salt.

4

- (b) % salt in mixture = $8.8 / 250 \times 100 = 3.52\%$

1

17. (a) Fluorite – ionic bonds between Ca²⁺ and F⁻ ions due to electrostatic attraction
Carbon dioxide – strong covalent bonds by sharing electrons between C and O within each CO₂ molecule.
CO₂ has much weaker bonds between molecules. These are dispersion forces.

1

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- (b) Fluorite would have a much higher melting point.
When fluorite melts strong ionic bonds are disrupted. When CO₂ melts only weak dispersion forces between CO₂ molecules are disrupted.
Fluorite would be much harder than solid CO₂.
When fluorite is scratched strong ionic bonds are disrupted. When CO₂ is scratched only weak dispersion forces between CO₂ molecules are disrupted.

1

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18. (a) A labelled diagram or description indicating a nucleus, with 13 protons and 13 electrons arranged in shells with populations of 2,8,3.

2

- (b) Al: → Al³⁺ + 3e
The aluminium atom loses three electrons to attain the noble gas electron configuration, hence it forms an Al³⁺ ion.

2

19. (a) Mass of Mg = 32.63 – 32.14 = 0.49 g
Mass of MgO = 32.95 – 32.14 = 0.81 g
Mass of O = 0.32 g
Moles of Mg: 0.49/24.3 = 0.020
Moles of O: 0.32/16 = 0.020 Ratio is 1:1 therefore empirical formula is MgO
(b) Moles of O atoms = 0.020 mol from (a) and Moles of O₂ molecules = 0.010 mol
Volume of oxygen = moles X molar volume = 0.010 X 24.79 = 0.25 l.

1

1

1

1

20.	(a) $\text{Zn}_{(s)} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_{2(g)}$ OR $\text{Zn}_{(s)} + 2\text{H}^+ \rightarrow \text{Zn}^{2+} + \text{H}_{2(g)}$	1	26.	(a) $\text{Pb}(\text{NO}_3)_{2(s)} \rightarrow \text{Pb}^{2+} + 2\text{NO}_3^-$	1
	(b) $\text{H}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O}$ Moles of H_2O = mass/molar mass = $1.0/18.016 = 0.0555$ mol Moles of Zn = moles of $\text{H}_{2(g)}$ = Moles of H_2O = 0.0555 mol mass Zn = moles x molar mass = $0.0555 \times 65.38 = 3.63$ grams	1 1 1		(b) $\text{Pb}^{2+} + \text{S}^{2-} \rightarrow \text{PbS}_{(s)}$	1
	(c) any one of:- wear safety goggles, complete in a fume cupboard, blow out the flame before removing the jet	1		(c) Moles of PbS ppt. formed = $8.61 \div (207.2 + 32.0) = 0.036$ mol Moles Pb^{2+} in 20 mL = 0.036 mol Solubility of lead nitrate = $0.036 \times 1000/20 = 1.8$ mol L^{-1}	1 1
21.	(a) From left to right across the period:- -first ionisation energy increases. - atomic radius decreases. - boiling point increases to the middle of each period, then sharply decreases for the remainder	1 1 1	27.	(a) Propane	1
	(b) Electronegativity decreases down any group because of increasing atomic radius and the valence electrons, being further from the nucleus, are more weakly attracted	2		(b) Pressure build-up in storage container due to volatile nature of the alkanes. Risk of fire due to the flammability of the vapours produced.	2
22.	(a) Moles of barium chloride required = $0.20 \times 0.50 = 0.10$ mol Molar mass of barium chloride = $137.3 + 35.5 \times 2 + 18 \times 2 = 244.3$ g Mass of barium chloride required = $0.10 \times 244.3 = 24.43$ g	1 1 1	28.	(a) C_3H_7	1
	(b) Concentration of diluted solution = $0.50 \times 200/500 = 0.20$ mol L^{-1} [Cl ⁻] = 0.40 mol L^{-1}	1 1		(b) Carbon monoxide is a product of the incomplete combustion of a hydrocarbon, when there is insufficient oxygen present for complete combustion. $\text{C}_6\text{H}_{14} + \frac{13}{2}\text{O}_2 \rightarrow 6\text{CO} + 7\text{H}_2\text{O}$	1 1
23.	(a) Γ^- ion	1		(c) $\text{C}_6\text{H}_{14(l)} + \frac{19}{2}\text{O}_{2(g)} \rightarrow 6\text{CO}_{2(g)} + 7\text{H}_2\text{O}$ 6 moles $\text{CO}_2 = 6 \text{ mol} \times 44 \text{ g mol}^{-1} = 264 \text{ g CO}_2$ 7 moles $\text{H}_2\text{O} = 7 \text{ mol} \times 18 \text{ g mol}^{-1} = 126 \text{ g H}_2\text{O}$ Therefore the CO_2 absorber would show the greatest increase in mass.	1 1
	(b) A catalyst lowers the activation energy for the reaction. This allows a greater number of molecular collisions to overcome the activation energy barrier and results in a reaction.	1	29.	Photosynthesis is a complex process involving many steps. The overall process can be represented by the following equation. $6\text{CO}_{2(g)} + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_{2(g)}$ This reaction is endothermic requiring the absorption of energy. Light energy from the sun is trapped by chlorophyll in plants to produce glucose using photosynthesis. This energy from the sun is thus transformed into chemical energy. This energy stored in glucose can be released by respiration and used by the plants for their own energy requirements or by animals that have eaten the plant material. Photosynthesis is at the beginning of nearly all food chains and supplies the energy for ecosystems to function. Thus the energy for life comes from the sun via photosynthesis.	3
24.	(a) Water is a polar molecule. The positive charge on the hydrogen atoms attracts to the negative charge on adjacent oxygen atoms. This is called hydrogen bonding. A diagram of a polar water molecule showing a negative charge on the oxygen atom and a positive charge on the hydrogen atoms.	1 1			
	(b) The hydrogen bonding between adjacent water molecules in a sample of water is stronger.	1			
	(c) Sodium chloride is an ionic compound composed of Na^+ and Cl^- ions. When added to water the negative ends of the water molecules attract to the Na^+ ions, surround them and pull them away from the ionic crystalline lattice. The positive ends of the polar water molecules attract the Cl^- ions, surround them and pull them away from the lattice.	2			
25.	(a) $\Delta H = -mC\Delta t$ Heat energy = $70 \times 1000 \times 4.18 \times (26.5-18.2)$ = $2430000 \text{ J} = 2430 \text{ kJ} = 2.43 \text{ MJ}$	2			
	(b) Any two reasons such as heat loss to container, to surrounding air, evaporation of water, aquarium may contain dissolved substances etc.	2			

The Preliminary examination, marking guidelines /suggested answers and 'mapping grid' have been produced to help prepare students for the HSC to the best of our ability.
Individual teachers/schools may alter parts of this product to suit their own requirements.