

**SECTION A****Specific instructions for Section A**

Section A consists of 20 multiple choice questions. Section A is worth approximately 28 per cent of the marks available. You should spend approximately 25 minutes on Section A.

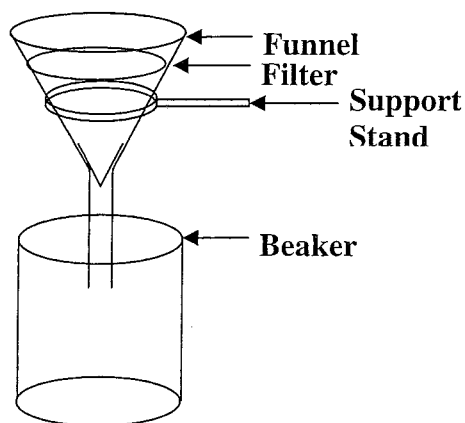
Choose the response that is **correct** or **best answers the question**, and mark your choice on the multiple choice answer sheet according to the instructions on that sheet.

A correct answer is worth 1 mark. No mark will be given if more than one answer is shown for any question. Marks will **not** be deducted for incorrect answers. You should attempt every question.

**Question 1**

Which of the following could be separated by using the apparatus shown in the diagram?

- A. glucose from sodium chloride
- B. graphite from iron filings
- C. solid silver chloride from ethanol
- D. silver from solid silver chloride

**Question 2**

When comparing the conductivity of the contents of a distillation flask and the distillate after the distillation of sea water

- A. the contents of the flask will be less conductive and the distillate will be less conductive.
- B. the contents of the flask will be more conductive and the distillate will be less conductive.
- C. the contents of the flask will be less conductive and the distillate will be more conductive.
- D. the contents of the flask will be more conductive and the distillate will be more conductive.

**Question 3**

Why is chlorine used to treat local water supplies?

- A. To make water suitable for swimming.
- B. To kill micro-organisms living in water.
- C. To promote sedimentation of finely suspended solids.
- D. To precipitate heavy metal ions such as lead and mercury.

**Question 4**

Sodium chloride solution and hydrogen chloride solution both conduct electricity because both of these solutions contain ions that are free to move through the solution. However, the processes by which these ions are formed are quite different.

Which one of the following most correctly names each process?

	The formation of ions when sodium chloride dissolves is called	The formation of ions when hydrogen chloride dissolves is called
A.	Ionisation	Dissociation
B.	Dissociation	Dissociation
C.	Dissociation	Ionisation
D.	Ionisation	Dissolving

**Question 5**

Which one of the following molecular substances would be expected to be the **most** soluble in water?

- A.  $\text{CO}_2$
- B.  $\text{CH}_4$
- C.  $\text{C}_2\text{H}_4$
- D.  $\text{NH}_3$

**Question 6**

Which one of the following sets **does not** contain all water soluble substances?

- A.  $\text{NH}_3$ ,  $\text{K}_2\text{CO}_3$ ,  $\text{HF}$ ,  $\text{HCl}$
- B.  $\text{AgCl}$ ,  $\text{Na}_2\text{CO}_3$ ,  $(\text{NH}_4)_2\text{SO}_4$
- C.  $\text{CH}_3\text{COONa}$ ,  $\text{C}_6\text{H}_{12}\text{O}_6$ ,  $\text{C}_2\text{H}_5\text{OH}$
- D.  $\text{LiCl}$ ,  $\text{NH}_4\text{Cl}$ ,  $\text{NaOH}$

**Question 7**

The volume of solution, in mL, of  $0.400 \text{ mol L}^{-1}$  KI solution that can be prepared from  $0.0300 \text{ mol}$  of solute is

- A. 0.012
- B. 0.0750
- C. 13.3
- D. 75.0

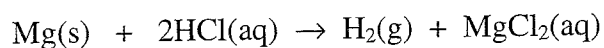
**Question 8**

The number of **anions** in 50 mL of an aqueous solution of 0.40 M  $\text{MgCl}_2$  will be closest to

- A. 0.040
- B. 0.60
- C.  $0.24 \times 10^{23}$
- D.  $0.36 \times 10^{23}$

**Questions 9 and 10 refer to the following information**

Magnesium metal reacts with dilute hydrochloric acid according to the equation

**Question 9**

If 0.243 g of magnesium is reacted with hydrochloric acid, the amount of hydrochloric acid, in mol, required would be

- A. 0.005
- B. 0.01
- C. 0.02
- D. 0.20

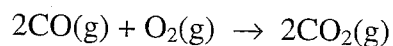
**Question 10**

The volume of hydrogen gas collected at **SLC** would be closest to

- A. 224 mL
- B. 245 mL
- C. 448 mL
- D. 490 mL

**Question 11**

Carbon monoxide can be oxidised to carbon dioxide as shown below.



3 mol of CO and 2 mol of O<sub>2</sub> are mixed. When the reaction is complete, there will be

- A. 4 mol of CO<sub>2</sub> produced
- B. 2 mol of CO<sub>2</sub> produced
- C. 1 mol of CO unreacted
- D. 0.5 mol of O<sub>2</sub> unreacted

**Question 12**

When considering a range of acids, the strongest acid will be that which

- A. contains the largest number of ionisable protons per molecule.
- B. is the most soluble.
- C. results in the highest concentration of H<sup>+</sup> ions for a given concentration of acid.
- D. contains the largest number of hydrogen atoms per molecule.

**Question 13**

When dilute hydrochloric acid reacts with solid sodium hydrogencarbonate the products are

- A. salt, carbon dioxide and water
- B. salt and water
- C. salt and carbon dioxide
- D. carbon dioxide only

**Question 14**

The pH of a solution of 0.050 M NaOH is

- A. 1.30
- B. 12.0
- C. 12.7
- D. 13.0

**Question 15**

Which statement concerning galvanic cells is correct?

- A. The cathode is assigned a negative charge.
- B. An external power source must be present.
- C. Anions in the salt bridge migrate towards the positive electrode.
- D. Oxidation occurs at the negative electrode.

**Question 16**

In the manufacture of expanded polystyrene, industrial  $\text{CO}_2$  has replaced the use of halogenated hydrocarbons. The aim of this technological advancement was to reduce humanity's impact on

- A. the greenhouse effect
- B. the ozone layer
- C. air pollution that causes photochemical smog
- D. sequestration

**Question 17**

The smallest volume would be occupied by a given quantity of gas at

- A. low temperature and high pressure
- B. low temperature and low pressure
- C. high temperature and low pressure
- D. high temperature and high pressure

**Question 18**

Equal volumes of carbon monoxide and carbon dioxide gas at the same conditions of temperature and pressure will have the same

- A. density
- B. number of atoms
- C. number of molecules
- D. percentage by mass of carbon

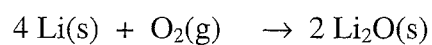
**Question 19**

The molar volume of oxygen, in L, at 1.00 atm and 100°C is closest to

- A. 30.6
- B. 24.5
- C. 22.4
- D. 8.2

**Question 20**

The metal lithium burns in oxygen gas to form lithium oxide,  $\text{Li}_2\text{O}$  (molar mass  $30 \text{ g mol}^{-1}$ ) according to the equation



The mass of lithium which would be needed to form 15 g of the oxide is closest to

- A. 0.7 g
- B. 1.7 g
- C. 3.5 g
- D. 7.0 g

**END OF SECTION A**

**SECTION B****Specific instructions for Section B**

Section B consists of seven short answer questions numbered 1 to 7; you must answer all of these questions. This section is worth 52 marks which is approximately 72 per cent of the total. You should spend approximately 65 minutes on this section.

The marks allotted to each question and the suggested times are shown at the end of each question.

Questions must be answered in the spaces provided in this book.

To obtain full marks for your response you should

- give simplified answers with an appropriate number of significant figures for all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure all chemical equations are balanced and that the formulas for individual substances include an indication of state (for example,  $\text{H}_2(\text{g})$ ;  $\text{NaCl}(\text{s})$ ).

**Question 1**

In the treatment of slightly acidic drinking water, both solid calcium hydroxide and solid aluminium sulfate are added. When the water is alkaline, a 'floc' or precipitate of aluminium hydroxide forms which traps other fine particles and removes colour and some microorganisms from the water.

- (a) Write the formula for all the ionic substances involved in the process.

---

- (b) (i) Name the substance responsible for neutralising the water?

---

- (ii) Write two separate balanced ionic equations to show how this substance does this.

---

---

- (c) Write a balanced ionic equation to explain the formation of the 'floc'.

---

- (d) Explain the role of the sulfate ions in the process.

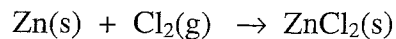
---

---

(3 + [1 + 2] + 1 + 1 = 8 marks)  
(Suggested time: 10 minutes)

**Question 2**

- (a) The equation for the redox reaction between zinc and chlorine is shown below.



Identify the reductant (reducing agent) in the reaction. Explain your reasoning.

---

---

- (b) A piece of magnesium is immersed in a copper (II) sulfate solution.

- (i) Describe two changes that you would expect to see.

---

---

- (ii) Write the **overall** ionic equation for the overall reaction.

---

- (c) An electrochemical cell was set up using two half-cells. One of the half-cells consisted of freshly cleaned aluminium metal and aluminium chloride solution. The other consisted of zinc metal and zinc sulfate solution.

- (i) Draw a neat and carefully labelled diagram of the complete electrochemical cell including the following: anode, cathode, polarities of electrodes, direction of electron flow, direction of cation / anion ion flow.

- (ii) Write a balanced ionic equation for the overall reaction that occurs in the cell.

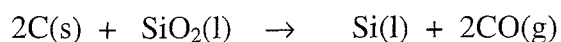
---

(1 + [2 + 1] + [5 + 1] = 10 marks)  
(Suggested time: 13 minutes)



**Question 3**

The element silicon is produced by heating silica,  $\text{SiO}_2$ , ( $M = 60 \text{ g mol}^{-1}$ ) with carbon to approximately  $2000^\circ\text{C}$ . The equation for the reaction is



In a small experimental reactor, 360 g of silica is heated with 108 g of carbon.

- (a) Is this reaction a redox reaction? Explain your response.

---

---

---

- (b) Determine the amount, in mol, of each reactant present.

---

---

---

---

- (c) Determine which reactant is in excess and by what mass, in g. Show all working.

---

---

---

---

---

- (d) Assuming complete conversion, calculate the mass of silicon formed.

---

---

(2 + 2 + 3 + 2 = 9 marks)  
(Suggested time: 11 minutes)

**Question 4**

(a) As a result of raised  $\text{CO}_2$  levels in recent years, rainwater can have a pH as low as 5.7.

(i) Write the formula for the acid produced in this process.

---

(ii) Explain, using a balanced equation, how this acid can cause a drop in pH.

---

---

(b) Acid rain in cities often results from a mixture of acidic oxides.

(i) Limestone is mainly composed of calcium carbonate,  $\text{CaCO}_3$ . Write an ionic equation for the reaction of acid rain on limestone buildings.

---

(ii) Calcium oxide,  $\text{CaO}$ , can be added to lakes to decrease the adverse effects of acid rain. Write an equation for the reaction of acid rain with calcium oxide.

---

(c) Catalytic converters are used in motor vehicles to reduce the emissions of certain harmful gases. Nitrogen(II) oxide reacts with carbon monoxide in a catalytic converter to produce two non-toxic gases commonly found in the atmosphere. Write an equation for this reaction.

---

([1 + 2] + [1 + 1] + 1 = 6 marks)  
(Suggested time: 6 minutes)

**Question 5**

Water has the ability to dissolve a variety of molecular substances such as hydrogen chloride gas,  $\text{HCl}$ , and ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , yet the nature of the resulting solutions is quite different. Explain this difference using **equations** to support your response.

---

---

---

---

---

---

(4 marks)  
(Suggested time: 5 minutes)

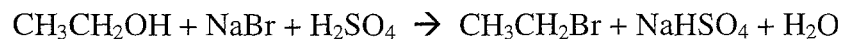
**Question 6**

One of the guiding principles of *green chemistry* is to maximise atom economy. This is achieved by incorporating into the final commercial product a maximum proportion of the starting material.

A common method of measuring this is to find the percentage of the mass of atoms in the final commercial product compared to the total mass of the reactants.

$$\text{Hence: \% atom economy} = \frac{\text{mass of atoms in commercial product(s)}}{\text{total mass of reactants}} \times 100$$

The production of bromoethane involves a substitution reaction described by the chemical equation



- (a) Find the *% atom economy* for this method of production of bromoethane.

---

---

---

- (b) In the given equation, explain the nature of the behaviour of  $\text{H}_2\text{SO}_4$ .

---

---

---

(2 + 1 = 3 marks)

(Suggested time: 5 minutes)

**Question 7**

A laboratory technician is given the task of preparing a 0.1 M solution of nitric acid. Supplied with 14 M concentrated nitric acid and pure solid anhydrous sodium carbonate, the technician first diluted the acid appropriately and then determined the exact acid concentration.

- (a) A large beaker was initially used to dilute the nitric acid before preparing the approximately 0.10 M nitric acid solution in a 2.0 L volumetric flask. What volume, in mL, of 14 M nitric acid is required by the technician?

---

---

---

- (b) A technician used a 250 mL volumetric flask to prepare an approximately 0.05 M anhydrous sodium carbonate,  $\text{Na}_2\text{CO}_3$ , solution. Determine the mass of sodium carbonate the technician will need to transfer.

---

---

---

- (c) The concentration of the standard sodium carbonate solution prepared was actually 0.05005 M. The titres of the sodium carbonate solution are shown in the table below.

- (i) Complete the table

Titration	1	2	3	4	5
Final burette reading (mL)	20.65	40.50	20.60	40.40	20.00
Initial burette reading (mL)	0.35	20.80	0.70	20.60	2.35
Titre (mL)					

- (ii) Calculate the average of the **concordant** results. Show all working.

---

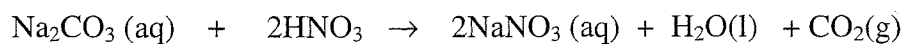
---

---

- (d) The aliquot of the nitric acid solution used in each titration was 20.00 mL. Name the piece of equipment used to measure the volume of the nitric acid solution.

---

The equation for the reaction between sodium carbonate and nitric acid is



- (e) Use some of the data from **part (c)** to calculate the exact concentration of the nitric acid solution in  $\text{mol L}^{-1}$ .

---

---

---

---

(2 + 3 + [1 + 2] + 1 + 3 = 12 marks)  
(Suggested time: 15 minutes)

**END OF EXAMINATION**