DAMAI
SECONDARY SCHOOL

DAMAI SECONDARY SCHOOL
End-of-Year Examination 2022

CANDIDATE NAME

CLASS

INDEX NUMBER

CHEMISTRY

6092/01

Paper 1 Multiple Choice

14 October 2022

Secondary 3 Express

1 hour

Setter: Ms Nur Diyana

40 marks

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction tape.
Write your name, index number and class on all the work you hand in.

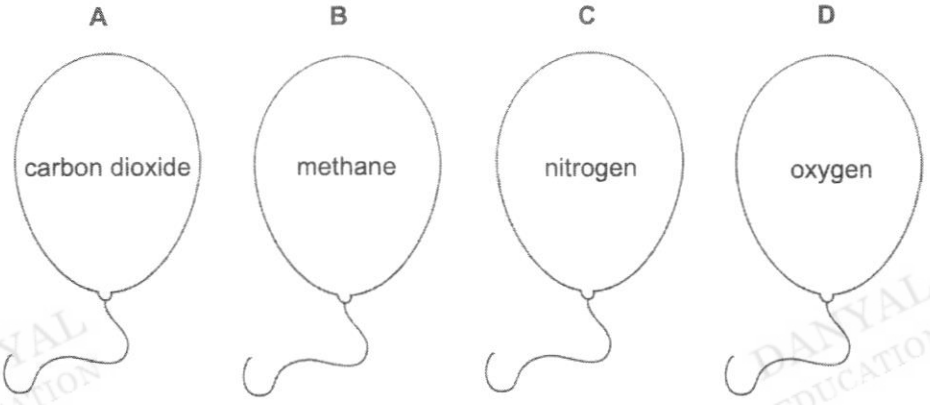
There are **forty** questions in this section. Answer **all** questions.
For each question, there are four possible answers, **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.
Each correct answer will score one 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 provided on page 16.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **16** printed pages.

1 Four balloons are filled with different gases at the same temperature and pressure.

Which balloon would deflate the quickest?



2 The properties of five different substances are shown in the table below.

substance	melting point / °C	boiling point / °C
E	50	80
F	70	500
G	65	67
H	-15	-12
I	0	99

At which temperature would two of the substances exist as liquids?

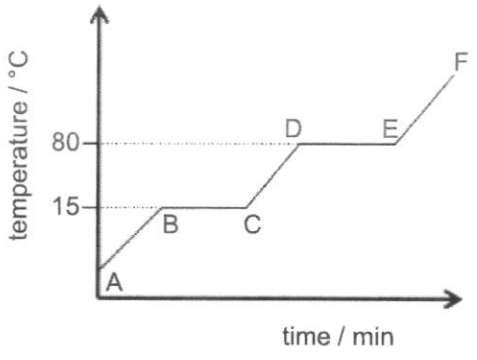
A – 20 °C

B – 15 °C

C 15 °C

D 85 °C

3 The graph shows the change in temperature with time when substance Y is heated.



Which stage does Y undergo the smallest change in its volume?

A A to B

B B to C

C D to E

D E to F

4 Which of the following best shows that matter is made up of tiny particles in random motion?

A Air has no definite volume.

B Steam occupies more space than water.

C A drop of oil occupies a large surface area when placed in water.

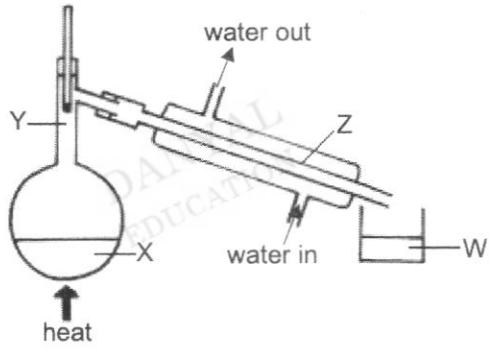
D When a bottle of perfume is opened, the smell is quickly detected in all parts of the room.

5 A technician was analysing some waste water from an industrial plant. He collected 500 cm^3 of the waste water and separated it into two 250 cm^3 samples. He filtered the first sample. The second sample was heated to evaporate out the water. He weighed the dried solid residue from each sample and found that the mass of the solid from the filtered sample was 40 g and the mass from the evaporated sample was 55 g.

What was the mass of soluble and insoluble material in 1000 cm^3 waste water?

	mass of soluble materials in 1000 cm^3 waste water / g	mass of insoluble materials in 1000 cm^3 waste water / g
A	15	40
B	30	80
C	60	160
D	60	220

6 The diagram shows the apparatus used to obtain water from aqueous iron(II) sulfate which is pale green in colour.



Which of the following statements about the separation process is true?

A X becomes darker in colour.

B A green precipitate is formed in W.

C W changes from colourless to green.

D The temperature at Y steadily rises as W is being collected.

7 Solutions of barium nitrate and potassium sulfate are mixed together to form barium sulfate.

Which method can be used to separate the barium sulfate from the mixture?

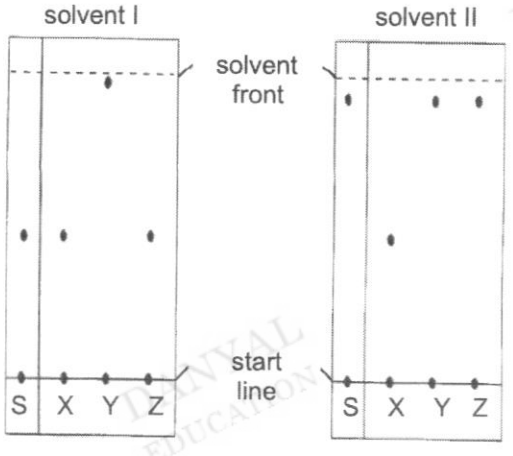
A crystallisation

B evaporation

C distillation

D filtration

8 It was believed that a substance S contained one of the three substances X, Y or Z. Two chromatograms of the four substances were obtained, using two different solvents. The results are shown in the diagrams below.



Based on the diagrams above, which statement below is correct?

A Z is not present in S.

B Y is the least soluble substance in both solvents.

C S is less soluble in solvent I than solvent II.

D The solubility of X and Z is different in solvent I but similar in solvent II.

9 Which of the following is a compound?

A air

B ammonia

C oil

D diamond

10 A sample of hydrogen contains a mixture of two isotopes, $^{2}_{1}H$ and $^{3}_{1}H$.

Which of the following is **not** a possible value of the molecular mass of hydrogen sulfide, H_2S, when this mixture is reacted with sulfur to form H_2S?

A 34

B 36

C 37

D 38

11 The table below gives the proton and nucleon numbers of atoms P, Q, R and S.

atom	proton number	nucleon number
P	6	14
Q	7	14
R	16	32
S	20	40

Which of the statements is true?

A P and Q are isotopes of the same element.

B P and R will combine to form a covalent compound.

C Q and S will form an ionic compound with the formula S_2Q_3.

D S can form a diatomic molecule.

12 Which statement about the particles, $^{19}_{9}F^{-}$, $^{20}_{10}Ne$ and $^{23}_{11}Na^{+}$ is correct?

A They all contain more electrons than protons.

B They all contain more neutrons than protons.

C They all contain the same number of electrons.

D They all contain the same number of protons.

13 Which salt contains covalent bonds?

A ammonium chloride

B magnesium bromide

C potassium iodide

D sodium fluoride

14 Phosphorus trichloride, PCl_3, is a molecule formed when the elements phosphorus and chlorine react together.

How many electrons in the outer shell of the phosphorus and chlorine atoms are **not** involved in bonding?

A 12

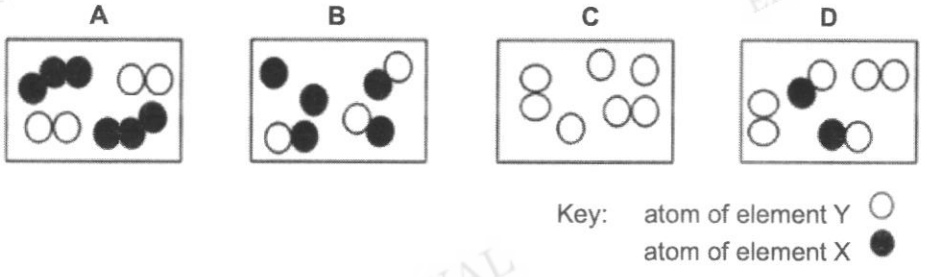
B 18

C 20

D 22

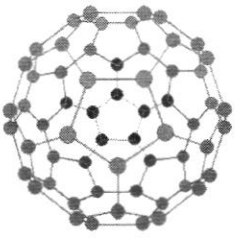
15 Diagrams A, B, C and D represent containers of gases.

Which diagram illustrates a mixture of allotropes?

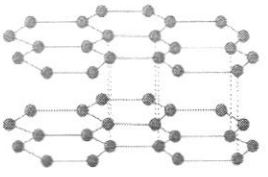


16 Buckminsterfullerene has the formula of C_{60}. Each carbon atom in Buckminsterfullerene is bonded to three other carbon atoms similar to those in graphite.

Their structures are as shown.



Buckminsterfullerene



graphite

Four statements regarding Buckminsterfullerene are given below.

1 The melting point of Buckminsterfullerene is higher than that of graphite.
2 Buckminsterfullerene is a good electrical conductor.
3 Buckminsterfullerene is a good lubricant.
4 On complete combustion, Buckminsterfullerene forms carbon dioxide.

Which of the above statements are true?

A 1 and 2

B 1 and 4

C 2 and 4

D 2 and 3

17 The table gives information about the ability of four substances to conduct electricity.

substance	electrical conductivity
P	does not conduct under any condition
Q	conducts only when molten
R	conducts when in solid and molten state

What could the four substances be?

	P	Q	R
A	S	Pb	MgO
B	S	CH_4	MgO
C	CH_4	MgO	Pb
D	Pb	MgO	CH_4

18 The formula of thallium carbonate is $TlCO_3$ and the formula of sodium chlorite is $NaClO_2$.

What is the formula of thallium chlorite?

A $TlClO_2$

B Tl_2ClO_2

C $Tl(ClO_2)_2$

D $Tl_2(ClO_2)_3$

19 A solution of a chloride is made by reacting hydrochloric acid with the hydroxide of metal M.

$$M(OH)_2\,(s) + 2HCl\,(aq) \rightarrow MCl_2\,(aq) + 2H_2O\,(l)$$

Which metal could M be?

A lead

B calcium

C silver

D sodium

20 Four particles are present in dilute sulfuric acid.

Which particle is present in the highest concentration?

A hydrogen ion, H^+

B sulfate ion, SO_4^{2-}

C hydroxide ion, OH^-

D hydrogen sulfate ion, HSO_4^-

21 When aqueous sodium hydroxide is mixed with solid Z, a pungent gas which turns moist red litmus paper blue is released.

Which of the following is Z?

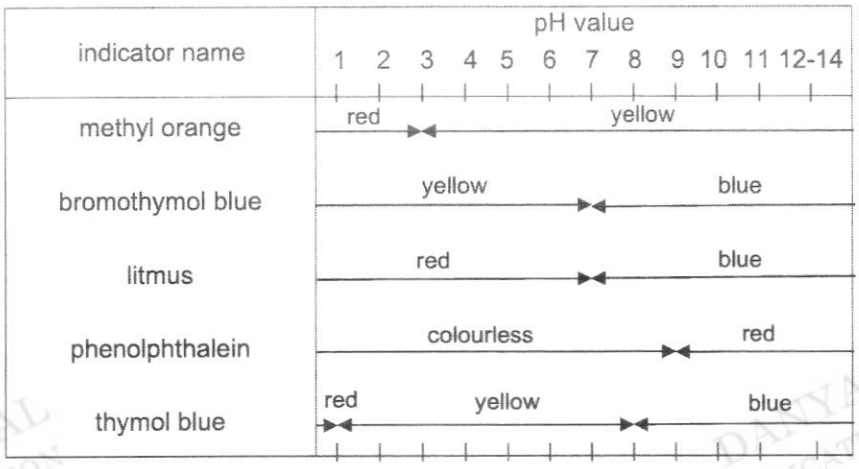
A aluminium oxide

B ammonium chloride

C copper(II) sulfate

D potassium carbonate

22 The table shows five indicators and their colours at various pH.



Which indicators would show the same colour in a solution of aqueous sodium hydroxide.

A methyl orange and thymol blue

B methyl orange and bromothymol blue

C methyl orange, litmus and thymol blue

D bromothymol blue, litmus and thymol blue

23 Which salt **cannot** be prepared by precipitation?

A barium sulfate

B magnesium carbonate

C silver chloride

D sodium nitrate

24 Which of the following solutions can be used to distinguish between aqueous sodium hydroxide and aqueous ammonia?

A calcium nitrate

B iron(II) chloride

C iron(III) chloride

D zinc sulfate

25 Which element burns in excess oxygen to form an oxide which, when shaken with water, gives a solution with pH greater than 7?

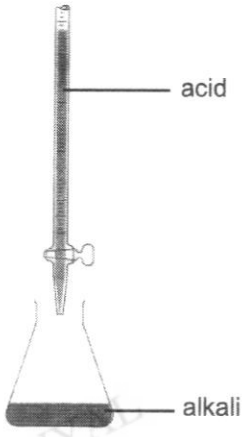
A hydrogen

B carbon

C sulfur

D calcium

26 In a volumetric analysis between an acid (in the burette) and an alkali, a pupil reused the same titration flask after the first titre. He rinsed the flask with distilled water, and then with an alkali.



What possible result will he observe?

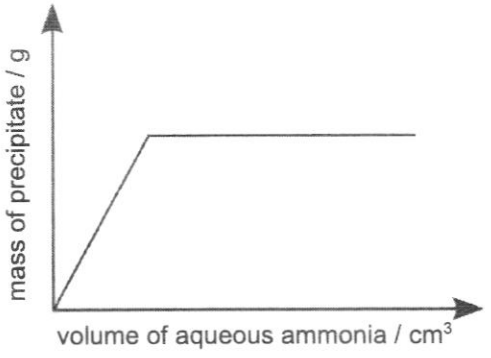
A an accurate result as the procedure is correct

B a higher concentration of acid calculated

C a lower concentration of acid calculated

D a lower volume of acid used

27 An aqueous solution of a salt was placed in a test tube and aqueous ammonia was gradually added from a burette. The mass of the precipitate was obtained when various volumes of aqueous ammonia were added, and a graph was obtained as shown.



Which salt would show this behaviour?

A copper(II) nitrate

B iron(II) sulfate

C sodium nitrate

D zinc chloride

28 Which of the following is numerically equal to the Avogadro's constant?

A number of atoms in 1 mole of hydrogen gas, H_2

B number of electrons in 1 mole of helium gas, He

C number of ions in 1 mole of sodium chloride, NaCl

D number of molecules in 1 mole of oxygen gas, O_2

29 10 g of X_3O_4 contains 7.5 g of unknown element X.

How many moles of X is present in 10 g of X_3O_4?

A $\frac{2.5}{16} \times \frac{3}{4}$ **B** $\frac{7.5}{16} \times \frac{3}{4}$ **C** $\frac{2.5}{16} \times \frac{4}{3}$ **D** $\frac{10}{16} \times \frac{4}{3}$

30 How many moles of hydrogen atoms does 3.2 g of methane, CH_4, contain?

A 0.20 mol

B 0.02 mol

C 0.40 mol

D 0.80 mol

31 When 0.002 mol of a metal X was reacted with an excess of dilute acid, 48 cm^3 of hydrogen was given off, measured at room temperature and pressure.

Which one of the following is the correct ionic equation for the reaction?

A $X + 2H^+ \rightarrow X^{2+} + H_2$

B $X + 2H^+ \rightarrow X^{2+} + 2H$

C $2X + 2H^+ \rightarrow 2X^+ + H_2$

D $2X + 6H^+ \rightarrow 2X^{3+} + 3H_2$

32 The concentration of hydroxide ions, OH^-, can be determined by titration with sulfuric acid, H_2SO_4, or ethanoic acid, CH_3COOH. An analyst found that a sample of hydroxide solution required 20.0 cm^3 of 0.1 mol/ dm^3 of sulfuric acid for complete reaction.

If the analysis had been carried out with 0.2 mol/ dm^3 of ethanoic acid, what volume of ethanoic acid would have been required for complete reaction with the hydroxide solution?

A 5 cm^3

B 10 cm^3

C 15 cm^3

D 20 cm^3

33 20 cm^3 of hydrogen is reacted with 20 cm^3 of oxygen to form steam.

What is the volume of gases remaining at the end of the reaction?

[All volumes are measured at room temperature and pressure.]

A 10 cm^3

B 20 cm^3

C 30 cm^3

D 40 cm^3

34 Which metal atom provides the most electrons per mole of atoms?

A aluminium

B calcium

C sodium

D zinc

35 Element U displaces element V from the aqueous nitrate of V.
Element W reacts with cold water to give hydrogen.
Element U only reacts with steam to give hydrogen.

What could elements U, V and W be?

	U	V	W
A	calcium	copper	silver
B	copper	zinc	sodium
C	silver	copper	calcium
D	zinc	copper	calcium

36 The position of metal X in the reactivity series is shown.

K, Na, Ca, Mg, Al, X, Fe, Pb, Cu, Ag

What is the best method used to extract X from its ore?

A thermal decomposition

B electrolysis of its molten oxide

C reduction of its oxide by heating with coke

D reduction of its oxide by heating with hydrogen

37 Which of the following does **not** match the type of steel to its use?

	type of steel	use
A	low carbon steel	car bodies
B	low carbon steel	knives
C	stainless steel	cutlery
D	stainless steel	surgical instruments

38 Which statements are reasons for recycling iron?

1 Iron, when obtained by a recycling process, produces less carbon dioxide than the blast furnace process.
2 Scrap steel contains a higher percentage of iron than iron ore.
3 Scrap steel, if not recycled, would cause environmental problems due to its disposal by landfill.

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

39 Which of the following is **not** a redox reaction?

A $2SO_2 + O_2 \rightarrow 2SO_3$

B $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$

C $CuO + H_2 \rightarrow Cu + H_2O$

D $Mg \rightarrow Mg^{2+} + 2e^-$

40 When hydrogen peroxide is added to acidified potassium dichromate(VI), the following reaction occurs:

$$Cr_2O_7^{2-} + 3H_2O_2 + 8H^+ \rightarrow 2Cr^{3+} + 3O_2 + 7H_2O$$

Which of the following statements is correct?

A Hydrogen ions are reduced to water.

B Hydrogen peroxide acts as an oxidising agent.

C The colour of the solution changes from green to orange.

D Chromium ions in potassium dichromate(VI) are oxidised.

- End of Paper -

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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

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CANDIDATE NAME

CLASS | | | | INDEX NUMBER | | |

CHEMISTRY

6092/02

Paper 2

7 October 2022

Secondary 3 Express

1 hour 45 minutes

Setter: Ms Nur Diyana

80 marks

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions. The last question is in the form either/or.
Answer all questions in the spaces provided.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is provided on page 21.
The use of an approved scientific calculator is expected, where appropriate.

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

This document consists of **21** printed pages.

[Turn over

Section A

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

A1 Select substance from the list to answer the following questions below.

You may use each substance once, more than once, or not at all.

ammonium sulfate	carbon monoxide
calcium oxide	iron(III) nitrate
carbon dioxide	hydrogen
oxygen	sodium hydroxide

(a) Which substance is a neutral oxide?

..... [1]

(b) Which substance is a compound that increases the pH of soil?

..... [1]

(c) Which two substances are soluble bases?

..... [1]

(d) Which two substances are salts?

..... [1]

(e) Which substance is an oxidizing agent?

..... [1]

(f) Which compound exists as a diatomic molecule?

..... [1]

[Total: 6]

A2 A student added 1.0 g of granulated limestone, $CaCO_3$, to excess aqueous hydrochloric acid. The volume of carbon dioxide evolved was collected over water and its volume was recorded every 60 seconds. Fig. 2.1 shows how the volume of carbon dioxide produced varies with time.

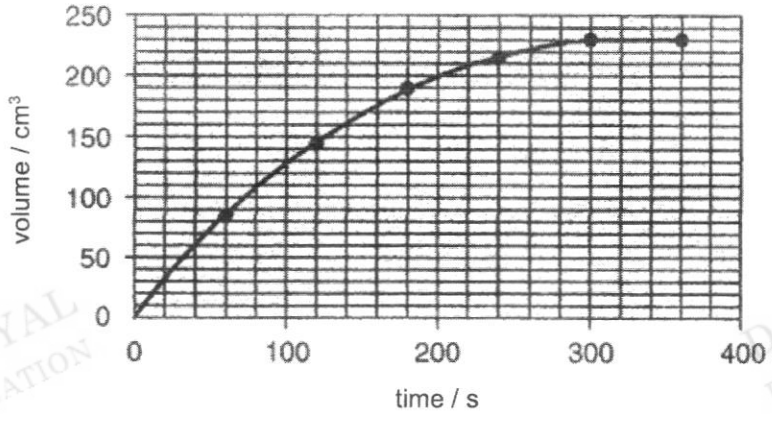


Fig. 2.1

(a) Write a chemical equation, with state symbols, for the reaction.

..... [2]

(b) What is the total volume of carbon dioxide given off in this experiment?

..... [1]

(c) Calculate the maximum possible volume of carbon dioxide that can be obtained on complete reaction of the limestone.

[2]

(d) Suggest a reason for the difference between your answers in **(b)** and **(c)**.

.....

..... [1]

(e) Why is there no change in the volume of carbon dioxide collected after 300 s?

.....

..... [1]

[Total: 7]

[Turn over

A3 Sodium reacts with chlorine to form sodium chloride. When 2.99 g of sodium is burnt in 3.4 dm^3 of chlorine, 7.3 g of sodium chloride was obtained.

..... Na + ... Cl_2 → ..... NaCl

(a) Fill in the blanks to balance the equation for the reaction above. [1]

(b) Identify the limiting reagent in the reaction above.
Show all workings clearly.

[3]

(c) Calculate the percentage yield of sodium chloride.

[2]

(d) Draw a 'dot and cross' diagram to show the bonding in sodium chloride.
Show only the outermost electrons.

[2]

[Total: 8]

A4 Fig. 4.1 shows a series of reactions involving an unknown solution, **A**.

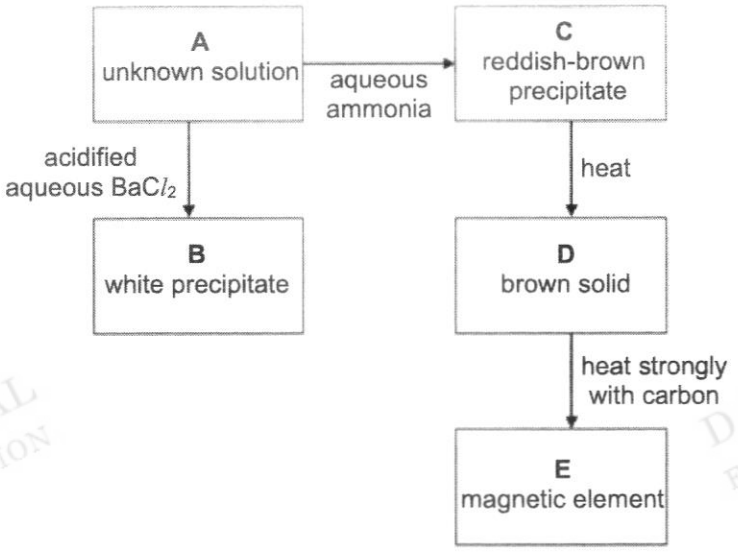


Fig. 4.1

(a) Identify **A**, **B**, **C**, **D** and **E**.

A .....

B .....

C .....

D .....

E .....

[5]

(b) Write an ionic equation for the formation of **B**.

..... [1]

(c) Identify the role of carbon in the reaction of **D** to **E**.

Explain your answer.

.....

.....

..... [2]

[Total: 8]

[Turn over

A5 Sulfur dioxide is a sulfur–containing compound and is commonly used as a refrigerant. The refrigerant flows in the refrigerator in the following stages.

Stage 1 : In the refrigerator, the refrigerant flows through the compressor which raises the pressure of the refrigerant.

Stage 2 : The refrigerant flows through the condenser, giving out heat in the process.

Stage 3 : After the condenser, the refrigerant goes through the expansion valve, where it experiences a pressure drop.

Stage 4 : Finally, the refrigerant goes to the evaporator, absorbing heat from the evaporator and goes back to the compressor to restart the cycle.

(a) From Stage 2 to 4, describe what happens to the arrangement and movement of the sulfur dioxide particles in the refrigerant.

changes to arrangement

.....

changes to movement

.....

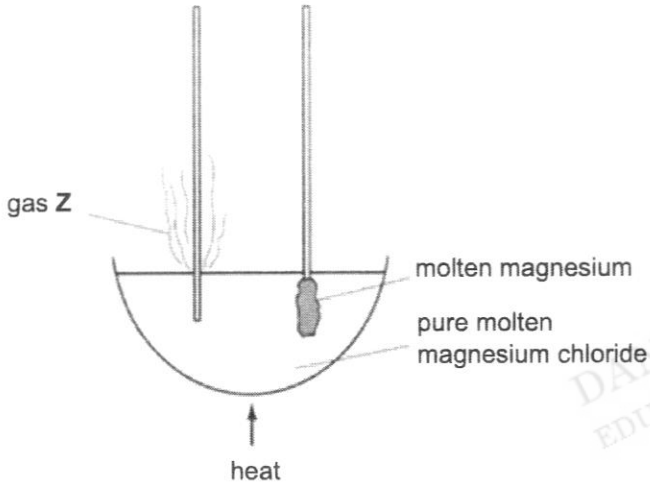
[2]

(b) Suggest the physical state of sulfur dioxide particles at the start of the cycle.

..... [1]

[Total: 3]

A6 Electrolysis is the process of using electricity to break down or decompose a compound. The diagram below shows the electrolysis of pure molten magnesium chloride. Molten magnesium and gas **Z** are formed during this electrolysis.



(a) Complete the table to show the electronic configuration of magnesium ion and chloride ion.

ion	electronic configuration
Mg^{2+}	
Cl^-	

[1]

(b) Molten magnesium chloride can be electrolysed as it can conduct electricity but solid magnesium chloride cannot.

Using ideas of bonding and structure, explain why solid magnesium chloride cannot be electrolysed.

.....

.....

.....

..... [2]

(c) Gas **Z** extinguishes a lighted splint with a 'pop' sound.

Write the chemical formula of gas **Z**.

.....

.....[1]

[Turn over

(d) Magnesium chloride can be prepared in the Science laboratory.

(i) Suggest **two** reactants that can be used to prepare magnesium chloride in the Science laboratory.

..... and ..... [2]

(ii) Describe in four steps, how a pure sample of magnesium chloride can be prepared safely in the Science laboratory.

Step 1 : .....

.....

Step 2 : .....

.....

Step 3 : .....

.....

Step 4 : .....

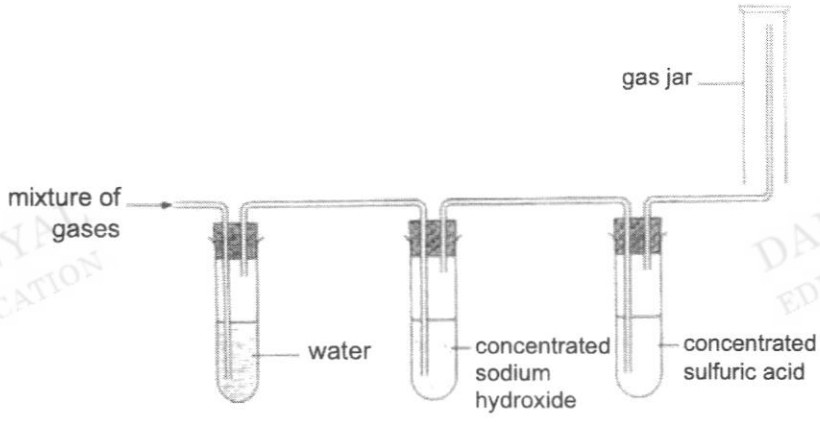
.....[4]

[Total: 10]

A7 A mixture of gases consists of the following components:

ammonia, hydrogen, sulfur dioxide and carbon dioxide

The mixture of gases is passed through the set-up shown below and a pure sample of gas is collected in the gas jar.



(a) State the purpose of passing the mixture of gas through water, concentrated sodium hydroxide and concentrated sulfuric acid.

(i) water

..... [1]

(ii) concentrated sodium hydroxide

..... [1]

(iii) concentrated sulfuric acid

..... [1]

(b) **(i)** Name the gas collected in the gas jar.

..... [1]

(ii) What property does the gas have, to enable it to be collected by upward delivery?

..... [1]

[Total: 5]

A8 Fig. 8.1 shows the arrangement of atoms in pure iron.

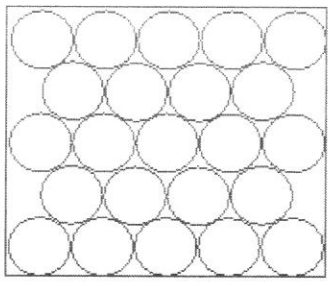


Fig. 8.1

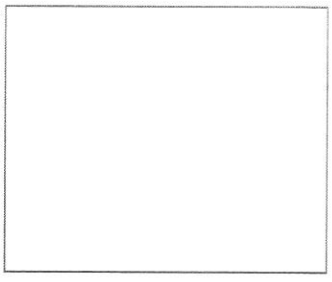


Fig. 8.2

(a) Draw a labelled diagram, in Fig. 8.2 to show the arrangement of atoms in steel. [1]

(b) Based on your answer in **(a)**, describe and explain the difference in strength between steel and pure iron.

.....

.....

..... [2]

[Total: 3]

- End of Section A -

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.

B9 Solubility of Compounds

The solubility of a compound, at a certain temperature, is the maximum number of grams of the compound which dissolve in 100 grams of water at that temperature.

The relationship between solubility and temperature can be expressed by a solubility curve.

The solubility curves of some compounds are shown in Fig. 9.1.

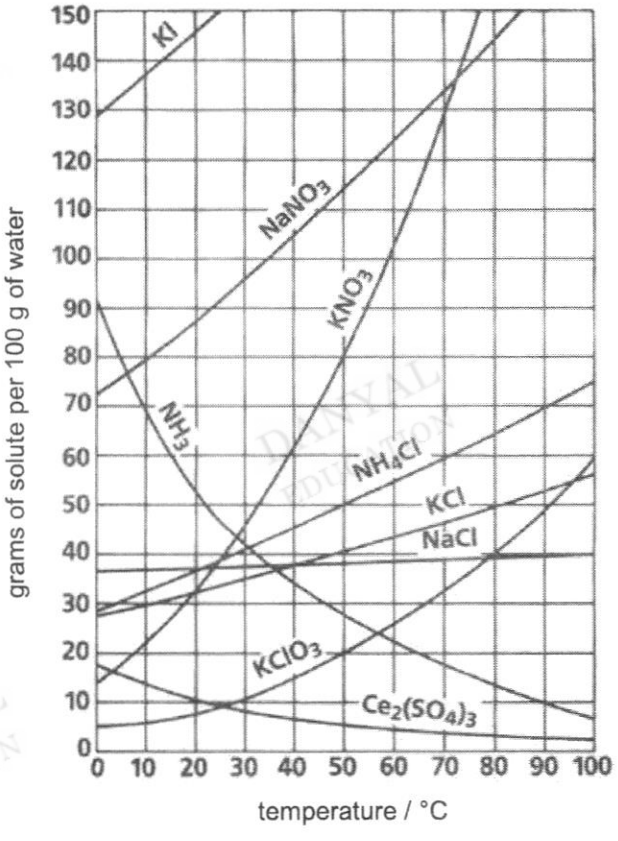


Fig. 9.1

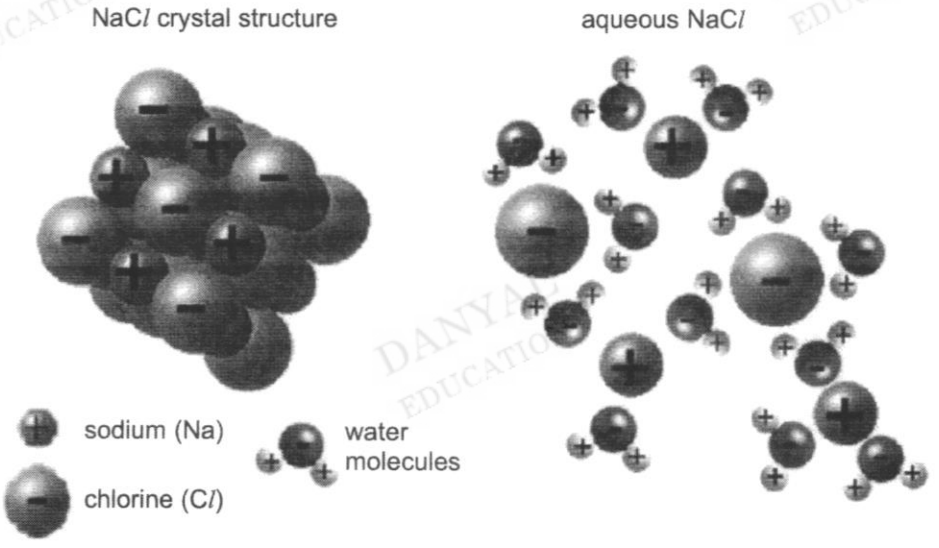
Sparingly Soluble Ionic Compounds

The dissolving and precipitating of ionic compounds are phenomena that occur both within us and around us. For example, the dissolving of enamel on teeth in acidic solutions causes tooth decay; the precipitation of certain salts in our kidneys produces kidney stones; the precipitation of calcium carbonate from underground water forms stalactites and stalagmites inside caves.

Although solids of ionic compounds are generally known to be soluble in water, some ionic solids have low solubility. Such ionic compounds are said to be sparingly soluble in water.

The solubility of ionic compounds depends on the forces of attraction between

- the cations and anions of the same solid, and
- the water molecules and the ions of the solid.



The solubility of sparingly soluble ionic compounds can be estimated from its solubility product, K_{sp}, which is a constant value at a given temperature. The higher the K_{sp} value, the more soluble the compound will be.

Table 9.1 shows the K_{sp} values of some common ionic compounds.

Table 9.1

compound	chemical formula	K_{sp} (mol^2/dm^6) at 25°C
lead(II) sulfate	$PbSO_4$	2.5×10^{-8}
calcium carbonate	$CaCO_3$	5.0×10^{-9}
calcium sulfate	$CaSO_4$	2.0×10^{-5}
silver chloride	AgCl	2.0×10^{-10}

Predicting Precipitation

The K_{sp} value can be used to predict whether precipitation will occur when two solutions are mixed. This can be done by comparing the K_{sp} value to the ionic product. Ionic product is a measure of the amount of ions present in solution in a given situation.

For instance,

$$BaSO_4\ (s) \rightarrow Ba^{2+}\ (aq) + SO_4^{2-}\ (aq)$$

Ionic product = [concentration of Ba^{2+} ions] × [concentration of SO_4^{2-} ions]

Table 9.2 provides some outcomes of the K_{sp} values when compared to the ionic product.

Table 9.2

situation	outcome
ionic product = K_{sp}	solution is just saturated, no further solute can dissolve
ionic product < K_{sp}	solution is not saturated, more solute can dissolve
ionic product > K_{sp}	solution is saturated, precipitation will occur.

(a) Why do the solubility curves not go beyond 100 °C?

..... [1]

(b) With reference to Fig. 9.1, name the compound which is the least soluble at 90 °C.

..... [1]

(c) If 200 g of a saturated solution of sodium nitrate at 50 °C was evaporated to dryness what mass of sodium nitrate would remain?

[2]

(d) Using the information provided and Table 9.1, explain why sodium chloride is very soluble in water while silver chloride is only sparingly soluble.

.....

.....

.....

..... [2]

[Turn over

(e) Suggest the relationship between temperature and K_{sp} value of an ionic compound.

..... [1]

(f) State the least soluble compound found in Table 9.1.

..... [1]

(g) Without further addition of any reagent, suggest how the amount of solid precipitated out from a saturated solution can be increased.

..... [1]

(h) 0.02 mol/dm^3 of calcium nitrate solution is added to the same volume of 0.005 mol/dm^3 of sodium sulfate solution at 25°C.

(i) Name the sparingly soluble compound that is formed.

..... [1]

(ii) Using the information provided in Table 9.1 and Table 9.2, determine, by calculation of the ionic product of the sparingly soluble compound, if precipitation will occur.

[2]

[Total: 12]

B10 Finland generates energy by burning of fossil fuels. This produces carbon dioxide which poses environmental problems. Carbon dioxide can be removed by reacting with magnesium oxide to form magnesium carbonate.

(a) Provide a positive test in identifying the carbon dioxide gas produced.

.....

..... [1]

(b) Magnesium oxide is formed from the thermal decomposition of magnesium silicate, $MgSiO_3$, a major component in mineral rocks. In this process, silicon dioxide is also produced.

Write a balanced equation for the thermal decomposition of magnesium silicate.

..... [1]

(c) During the thermal decomposition of mineral rocks, impurities like sulfur dioxide are also produced.

By considering the pH values of the solutions formed when the following oxides are added to water, arrange magnesium oxide, silicon dioxide and sulfur dioxide in order of increasing acidity.

Explain your reasoning, in terms of pH values.

.....

.....

.....

..... [3]

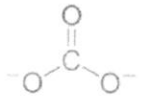
(d) Outline how magnesium oxide can be separated from a mixture of magnesium oxide and silicon dioxide.

.....

.....

..... [2]

(e) The following is a structure of the carbonate ion in magnesium carbonate.



Draw a 'dot-and-cross' diagram to show the bonding in the carbonate ion.
Show the outer shell electrons only.

[1]

[Total: 8]

EITHER

B11 Iron is extracted in a blast furnace using haematite, coke and limestone. During the extraction, waste products are formed.

(a) **(i)** Name two main waste products of this process and write equations to show their formations.

.....

.....

.....

..... [3]

(ii) Name the reducing agent in the formation of iron.

..... [1]

(iii) Calcium cannot be extracted from its metal ore using the same method as iron.

Suggest a suitable method of extraction and explain your answer.

.....

.....

..... [2]

(b) Two experiments were carried out to investigate the relative reactivity of iron and three other solid metals, **X**, **Y** and **Z**.

In experiment I, each of the oxides of the metals were heated in a test-tube.

In experiment II, metals **X**, **Y** and **Z** were placed in separate samples of aqueous green iron(II) sulfate.

(note: Sulfate solutions of **X**, **Y** and **Z** are all colourless.)

The results for both experiments were tabulated below.

experiment I	oxide of iron	oxide of **X**	oxide of **Y**	oxide of **Z**
action of heat	no change	no change	no change	metal **Z** is formed

experiment II	**X**	**Y**	**Z**
action on aqueous iron(II) sulfate	iron deposited, no gas evolved	iron deposited, gas evolved with vigorous bubbling	no change

(i) Place the metals, iron, **X**, **Y** and **Z**, in terms of increasing reactivity.

..... [1]

(ii) Predict two observations when **X** is placed in aqueous iron(II) sulfate in experiment **II.**

.....

.....

..... [2]

(iii) Name the gas that is formed when **Y** is placed in aqueous iron(II) sulfate.

..... [1]

[Total: 10]

OR

B11 Paracetamol, the active ingredient in Panadol, is commonly used to reduce fever and relief pain. Based on recommended dosages, an adult should not take more than 4 g of paracetamol daily.

(a) A sample of paracetamol was found to contain 63.6% of carbon, 5.9% of hydrogen, 9.3% of nitrogen and 21.2% of oxygen by mass.

Show, by means of calculation, that the empirical formula of paracetamol is $C_8H_9NO_2$.

[2]

(b) Paracetamol can be synthesized in the laboratory via the following equation.

$$\underset{\text{4-aminophenol}}{C_6H_7NO} + C_4H_6O_3 \rightarrow \underset{\text{paracetamol}}{C_8H_9NO_2} + \underset{\text{ethanoic acid}}{C_2H_4O_2}$$

(i) One Panadol tablet contains 500 mg of the active ingredient paracetamol.

Calculate the mass of 4-aminophenol required to synthesize **eight** Panadol tablets.

[3]

(ii) How can the purity of the synthesized paracetamol be tested?

.....

..... [1]

[Turn over

(c) Ethanoic acid is a weak acid while hydrochloric acid is a strong acid.

(i) Define weak acid.

Hence, explain the difference in electrical conductivities of ethanoic acid and hydrochloric acid of the same concentration.

.....

.....

.....

..... [3]

(ii) Ethanoic acid can be neutralised with alkalis such as sodium hydroxide.

Write a balanced ionic equation, including the state symbols, for the reaction of ethanoic acid and sodium hydroxide.

.....

..... [1]

[Total: 10]

- End of Section B -
- End of Paper 2 -

Damai Secondary School
Marking Scheme – 2022 Sec 3E Pure Chemistry End-of-Year Exam

Paper 1:

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

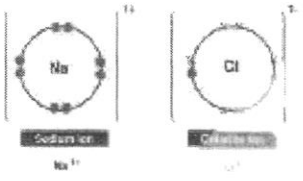
11	B
12	C
13	A
14	C
15	C
16	C
17	C
18	C
19	B
20	A

21	B
22	D
23	D
24	A
25	D
26	C
27	B
28	D
29	A
30	D

Paper 2: Section A

A1	**(a)**	Carbon monoxide	[1]
	(b)	Calcium oxide	[1]
	(c)	Calcium oxide / sodium hydroxide	[1]
	(d)	Iron(III) nitrate / ammonium sulfate	[1]
	(e)	oxygen	[1]
	(f)	Carbon monoxide	[1]
			[Total: 6]

A2	**(a)**	$CaCO_3$ (s) + 2HCl (aq) → $CaCl_2$ (aq) + CO_2 (g) + H_2O (l) - must be balanced - to include state symbols	[1] [1]
	(b)	230 cm^3 - With correct units	[1]
	(c)	No of moles of $CaCO_3$ = 1/100 = 0.01 mol No of moles of CO_2 = 0.01 mol Volume of CO_2 = 0.01 × 24 = 0.24dm^3	[1] [1]
	(d)	The carbon dioxide produced is slightly soluble in water. Hence, some of the carbon dioxide gas may have dissolved in water.	[1]
	(e)	The limestone has completely used up.	[1]
			[Total: 7]

A3	(a)	$2\ Na + 1\ Cl_2 \rightarrow 2\ NaCl$	[1]
	(b)	sodium is the limiting reagent. No of moles of sodium present = 2.99 / 23 = 0.13 mol No of moles of chlorine present = 3.4 / 24 = 0.1417 mol Mole ratio of Na : Cl_2 = 2 : 1 If sodium is completely used up, 0.065 moles of chlorine is needed. (sufficient) If chlorine is completely used up, 0.2834 moles of sodium is needed. (insufficient) Hence, sodium is the limiting reagent.	[1] [1] [1]
	(c)	No of moles of sodium present = 2.99 / 23 = 0.13 mol Mole ratio of Na : NaCl = 2 : 2 Hence no of moles of NaCl produced = 0.13 mol Mass of NaCl produced = 0.13 × 58.5 = 7.605g(theoretical) % yield = actual / theoretical × 100 = 7.3 / 7.61x100 = 96.0 %	[1] [1]
	(d)	 - outermost electrons only - correct charges	[1] [1]
			[Total: 8]

A4	(a)	A = iron (III) sulfate / $Fe_2(So_4)_3$ B = barium sulfate / $BaSO_4$ C = iron(III) hydroxide / $Fe(OH)_3$ D = iron (III) oxide / Fe_2O_3 E = iron metal /Fe	[1] [1] [1] [1] [1]
	(b)	$Ba^{2+}(aq) + SO_4^{2-}(aq)\ BaSO_4$ ($)	[1]
	(c)	Carbon is the reducing agent it removes the oxygen atoms from Fe_2O_3 to from Fe metal	[1] [1]
			[Total: 8]

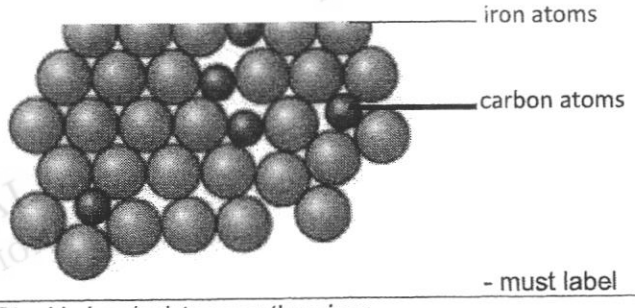
A5	(a)	Arrangement - far apart in random manner to closely packed in disorderly manner to far apart in random manner Movement – randomly at high speed to slide past / over each other to randomly at high speed.	[1] [1]
	(b)	gas	[1]
			[Total: 3]

A6	(a)		[1]

ion	electronic configuration
Mg^{2+}	2.8
Cl^-	2.8.8

		- both correct to obtain 1m		
	(b)	For electrolysis to be carried out, molten magnesium chloride must be used and not solid. Magnesium chloride is an ionic compound. In a solid state, the ions are orderly arranged in a giant ionic lattice structure with strong electrostatic forces of attraction. Hence, these ions are not able to carry electrical charges to conduct electricity and no electrolysis can be carried out.		[1] [1]
	(c)	Gas Z = H_2		[1]
	(d)	(i)	Hydrochloric acid; and Magnesium/Magnesium hydroxide/Magnesium oxide/Magnesium carbonate;	[1] [1]
		(ii)	Step 1 :Add excess magnesium/ magnesium hydroxide / magnesium oxide / magnesium carbonate to hydrochloric acid; Step 2: Filter the mixture and obtain the filtrate. Step 3: Heat the filtrate until saturated; Cool to allow crystals to form. Step 4: Filter and wash the crystals with cold distilled water.	[1] [1] [1] [1]
				[Total: 10]

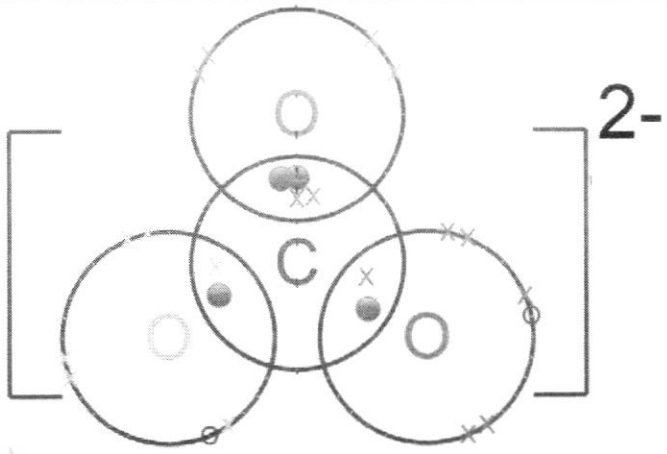
A7	**(a)**	**(i)**	To dissolve the sulfur dioxide and ammonia.	[1]
		(ii)	To react with acidic CO_2 that is slightly acidic in water.	[1]
		(iii)	To dry H_2 (and to react with remaining alkaline ammonia)	[1]
	(b)	**(i)**	Hydrogen	[1]
		(ii)	It is less dense than air.	[1]
				[Total: 5]

A8	**(a)**	 - must label	[1]
	(b)	Steel is harder/stronger than iron. The different sized carbon atoms disrupt the orderly arrangement of pure iron atoms, preventing them from sliding over one another.	[1] [1]
			[Total: 3]

Section B

B9	**(a)**		Above 100°C, the solvent which is water would have boiled off. *Reject evaporation of water.*	[1]
	(b)		Cerium(III) sulfate	[1]
	(c)		At 50°C, a 100g saturated solution of sodium nitrate will contain 115g of solute. For 200g saturated solution, mass of KNO_3 crystals at 50°C = 115g ×2g = 230g	[1] [1]
	(d)		The forces of attraction between water molecules and Na^+ and Cl^- is stronger than the forces of attraction between Na^+ and Cl^- ions. The forces of attraction between water molecules and Ag^+ and Cl^- is weaker than forces of attraction between Ag^+ and Cl^- ions.	[1] [1]
	(e)		Temperature increases the solubility of a salt. The higher the temperature, the higher the K_{sp}.	[1]
	(f)		Silver chloride	[1]
	(g)		evaporate the solvent / cool the solution.	[1]
	(h)	**(i)**	Calcium sulfate	[1]
		(ii)	Ionic product = [conc. of Ba^{2+} ions] × [conc. of SO_4^{2-}ions] $= (\frac{0.02}{2} \times \frac{0.005}{2})$ $= 2.5 \times 10^{-5} > 2.0 \times 10^{-5}$ mol/dm^3 Since IP > Ksp, precipitation would be observed.	[1] [1]
				[Total: 12]

B10	**(a)**	Bubble the gas into limewater. If carbon dioxide gas is present, white precipitate will be seen.	[1]
	(b)	$MgSiO_3 \rightarrow MgO + SiO_2$	[1]
	(c)	In order of increasing acidity: MgO, SiO_2, SO_2 MgO is a basic oxide which forms an alkaline solution with pH above 7. SiO_2 does not dissolve in water, pH remains at 7. SO_2 is an acidic oxide which forms an acidic solution with pH below 7.	[1] [1] [1]
	(d)	Add sodium hydroxide to the mixture. Filter the mixture and recover MgO as the residue.	[1] [1]
	(e)		[1]

			 Show outer electrons only. Ensure that the charge of the ion is included.	
				[Total:8]

Either

B11	**(a)**	**(i)**	Slag and carbon dioxide (both must be written) Slag: $CaO + SiO_2 \rightarrow CaSiO_3$ Carbon dioxide: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$	[1] [1] [1]
		(ii)	Carbon monoxide	[1]
		(iii)	Method: Electrolysis Calcium is a more reactive metal than iron as it lies higher than iron in the reactivity list. Hence, it is more stable, making it harder to decompose to its constituents. Thus, more energy is required to extract calcium from its ore.	[1] [1]
	(b)	**(i)**	Z, iron, X, Y	[1]
		(ii)	1. <u>Green solution becomes lighter</u> in colour / <u>green solution turns colourless</u> / <u>green solution is decolourised</u> 2. Silvery/grey deposit formed which is iron	[1] [1]
		(iii)	hydrogen	[1]
				[Total: 10]

OR

B11 (a)

	C	H	N	O
mass in 100 g/g	63.6	5.9	9.3	21.2
A_r	12	1	14	16
no of moles	63.6/12 =5.3	5.9/1 =5.9	9.3/14 = 0.664	21.2/16 =1.325
simplest ratio	8	9	1	2

Empirical formula = $C_8H_9NO_2$ [2]

(b) **(i)** Mass of paracetamol in 8 tablets = 8 × 500
= 4000g = 4g [1]

Number of moles of paracetamol = 4 / 151
= 0.026490 mol [1]

Number of moles of 4-aminophenol = 0.026490 mol

Mass of 4-aminophenol = 0.026490 × 109
= 2.8874 g
= 2.89g [1]

(ii) Check that the melting point is fixed OR
Check that the paracetamol sample produces only one spot using paper chromatography. [1]

(c) **(i)** A weak acid partially ionises in water to form H^+ ions. [1]

Ethanoic acid will have a lower electrical conductivity compared to hydrochloric acid. [1]
This is because it is due to the lower concentration of hydrogen ions present. [1]

(ii) $H^+ + (aq) + OH^- (aq) \rightarrow H_2O (l)$ [1]

[Total: 10]