Student Number	
Theory Mark / 46	

Chemistry

2010 Half Yearly Year 11 Examination

Theory and Data Processing

General Instructions

- Reading time – 5 minutes
- Working time – 80 minutes
- Write using black or blue pen
- Write your Student Number at the top of this page and on the response sheet on page 9.
  A data sheet and a periodic table are provided at the back of the paper and may be removed for student convenience.

Theory

Total Marks – 46

Part A – 12 marks
Attempt Questions 1 – 12

Part B – 34 marks
Attempt Questions 13-23

Data Processing

Total Marks – 15 marks
Attempt Questions 1-3

Part A- Multiple Choice 12 marks
Attempt Questions 1-12
Allow about 15 minutes for this part

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

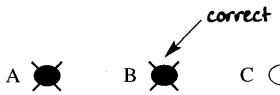
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



▸ **Mark your answers for Questions 1- 12 in the Answer Box on page 8**

1. A mixture of oil, salt, sawdust and water are to be separated into their individual components, each component being collected separately. What sequence of steps should be followed to do this separation and collection?

(A) decantation→ filtration → separating funnel → evaporation

(B) filtration → separating funnel → distillation

(C) fractional distillation →filtration → decantation

(D) filtration → separating funnel →evaporation

2. If the formula for sodium chlorotitanate is Na_2TiCl_6, what is the correct formula for zinc chlorotitanate?

(A) $ZnTiCl_6$

(B) Zn_2TiCl_6

(C) $Zn(TiCl_6)_2$

(D) $Zn_2(TiCl_6)_3$

3. Consider the following substances: calcium, neon, chlorine, oxygen and carbon dioxide. Which of the above substances exist as molecules in nature?

(A) all the substances

(B) chlorine, oxygen and carbon dioxide only

(C) neon, chlorine, oxygen and carbon dioxide only

(D) neon, chlorine and oxygen only

4. Sodium is not normally mined as sodium metal but is obtained by electrolyzing molten sodium chloride. What is the most likely reason for using this method of extraction?

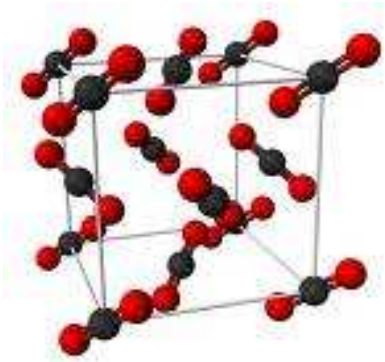
(A) it requires less energy to electrolyse molten sodium chloride than to dig up sodium metal from the ground.

(B) sodium is too reactive to handle while being mined

(C) sodium chloride is readily available than is sodium metal

(D) sodium is too reactive to exist in nature as a native element

5. The diagram below represents the structure of a solid chemical substance.



Which of the following is the solid most likely to be?

(A) silver

(B) carbon dioxide

(C) graphite

(D) sodium chloride

6. Which of the following is an empirical formula?

(A) N_2O_4

(B) NH_4NO_3

(C) Na_4O_2

(D) Na_2O

7. Which of the following descriptions best explains the electrical conductivity of metals?

(A) mobile ions transfer charge

(B) mobile valence electrons transfer charge

(C) mobile cations transfer charge

(D) mobile anions transfer charge

8. The uses of metals through history are categorised as follows:

Stone Age	Up to 3000 BC
Copper Age	3200 – 2300 BC
Bronze Age	2300 – 700 BC
Iron Age	700 BC – 1 AD
Modern Age	1 AD – present time

Which reason best accounts for this sequence?

(A) Bronze is harder than copper, is easily melted and is more malleable than copper.

(B) Iron can be extracted by heating copper ores with charcoal.

(C) The extraction of iron from its ores is easier than copper and aluminium.

(D) The extraction of metals depends upon the energy and extraction methods available at the time.

9. Consider the properties of the following substances M, Q, R and T.

Substance	MP (^{0}C)	Electrical conductivity	
		Solid state	Liquid state
M	-102	Nil	Nil
Q	1423	Nil	Conducts
R	3600	Nil	Nil
T	1535	Conducts	Conducts

Which of the following correctly identifies M, Q, R and T as covalent molecular, metallic, covalent network or ionic?

	M	Q	R	T
A	network covalent	ionic	covalent molecular	metallic
B	covalent molecular	metallic	network covalent	ionic
C	network covalent	metallic	covalent molecular	ionic
D	covalent molecular	ionic	network covalent	metallic

10. Which statement describes the trend for metals in Groups 1 and 2 of the Periodic Table with respect to their chemical reactivity?

(A) Reactivity decreases up the group.

(B) Reactivity increases down the group.

(C) Group 1 metals are less reactive than Group 2 metals.

(D) There is no difference between the reactivity of the Group 1 and Group 2 metals.

11. Which substances may be combined to make the common alloy, bronze?

(A) copper and carbon

(B) Iron and brass

(C) Copper and tin

(D) Zinc and oxygen

12. What is the name of the product when solid lead is heated with air?

(A) Lead (II) oxide

(B) Lead (III) oxide

(C) Lead (II) hydroxide

(D) Hydrogen

This page left deliberately blank

Student number	

Part A: Answer grid for multiple choice questions.

1.	A O	B O	C O	D O
2.	A O	B O	C O	D O
3.	A O	B O	C O	D O
4.	A O	B O	C O	D O
5.	A O	B O	C O	D O
6.	A O	B O	C O	D O
7.	A O	B O	C O	D O
8.	A O	B O	C O	D O
9.	A O	B O	C O	D O
10.	A O	B O	C O	D O
11.	A O	B O	C O	D O
12.	A O	B O	C O	D O

Mark	

Part B. 34 marks
Attempt Questions 13 - 23
Allow about 40 minutes for this part
Show all relevant working in questions involving calculations.

Question 13 (2 marks)

Use the particle theory to explain the difference between nitrogen and nitrogen dioxide.

.....

.....

.....

.....

.....

.....

Question 14 (3 marks)

Use Lewis electron dot structures to show the formation of magnesium chloride from elemental magnesium and chlorine.

Question 15 (5 marks)

Shown below is a simplified periodic table showing only the main group elements (no transition elements). The group numbers are given on top of each corresponding group. Fictitious names for the elements are given.

I							**VIII**
Q	***II***	***III***	***IV***	***V***	***VI***	***VII***	*Fg*
Wf	*A*	*Bg*	*X*	*Av*	*Pj*	*Yk*	*De*
E	*Sk*	*Ns*	*Cq*	*Zx*	*Kj*	*Rt*	*Ws*
R	*D*	*M*	*Vu*	*So*	*Lh*	*Tm*	*Ak*
T	*Fn*	*Kc*	*Qc*	*Ah*	*Gw*	*Pm*	*Hy*
Y	*Hz*	*L*	*Ws*	*Fb*	*Eg*	*Mp*	*Ed*
Ua	*J*	*Z*	*Uv*				

(a) Write the electronic configuration of *Av* and the period to which it belongs.(2 marks)

Electronic configuration ……..... Period …….....

(b) Construct a formula for the compound formed from *Zx* and *Lh* (1 mark)

.....

(c) Describe a possible use for *Ns* based on a physical property and state this property. (2 marks)

.....

.....

Question 16 (4 marks)

Elemental iron is strongly magnetic but iron bonded in a compound is not. A student found a lump of a substance containing iron and iron oxide. He wanted to determine how much elemental iron was present in the sample. Suggest a step by step procedure to determine the percentage of iron in the sample by physical means only using equipment found in the school laboratory.

.....

.....

.....

.....

.....

.....

.....

.....

.....

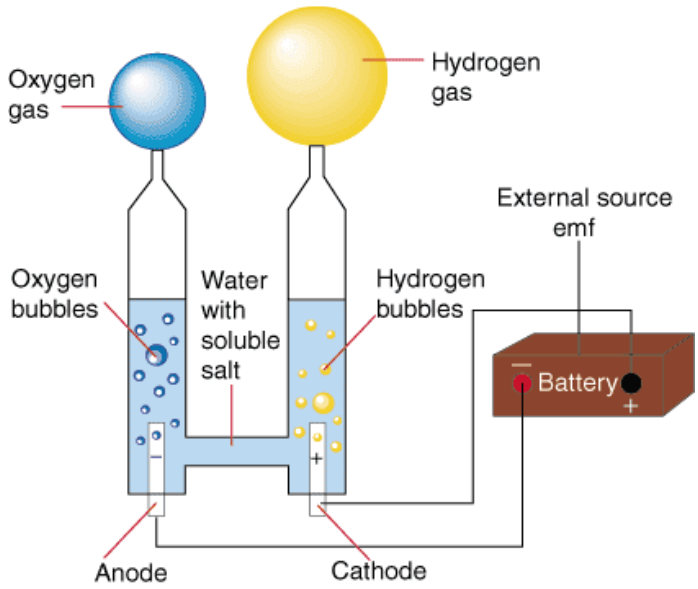
Question 17 (3 marks)

Complete the table by giving the names or formulae of the following substances.

Name	*Formula*
Ammonium sulfate	
Aluminium carbonate	
Nitrogen dioxide	
	KNO_3
	Na_2O
	CuS

Question 18 (3 marks)

Consider the diagram for the electrolysis of water.



Identify the electrolysis of water as a physical or chemical process and give reasons for answer.

.....

.....

.....

.....

.....

.....

Question 19 (4 marks)

During your practical work you performed a first- hand investigation to show the decomposition of a carbonate by heat.

(a) Give a balanced chemical equation for the decomposition reaction of a carbonate. (1 mark)

.....

(b) Outline two observations that indicated that a reaction had taken place. (2 marks)

.....

.....

.....

(c) Outline one test you performed to determine the nature of one of the products formed. (2 marks)

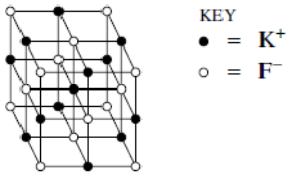
.....

.....

.....

Question 20 (5 marks)

The arrangement of potassium ions and fluoride ions in potassium fluoride is represented in the following diagram. The arrangement extends in three dimensions to represent a crystal.



(a) Would it be possible for magnesium fluoride to have the same structure as potassium fluoride? Give a reason for your answer. (1 mark)

.....

.....

(b) In terms of the bonds involved, explain why potassium fluoride has a much higher melting point (857^0C) than carbon tetra fluoride (-184^0C). (2 marks)

.....

.....

.....

(c) Explain why aqueous potassium fluoride is a good conductor of electricity while solid potassium fluoride is not. (2 marks)

.....

.....

.....

.....

Question 21 (2 marks)

Calcium reacts vigorously with dilute sulfuric acid at room temperature.

Write half-equations to describe the electron transfer associated with this reaction. (2 marks)

.....

.....

Question 22 (1 mark)

Potassium reacts violently with water at room temperature.

Write balanced formulae equation to describe the reaction between potassium and water at room temperature. (1 mark)

.....

Question 23 (2 marks)

The observations made by a group of students when adding several common metals to water, steam (water gas) and an acid are presented in the table. The metals are represented fictitiously by the symbols, W, X, Y and Z. The metals are listed in no particular order.

	W	X	Y	Z
Dilute HCl (aq)	N	small amount of bubbling, metal slowly disappears	large amount of bubbling, no metal remains	large amount of bubbling, no metal remains
H_2O (l) at 25^oC	N	N	bubbles, no metal remains	N
H_2O (g) (steam)	N	N	no metal remains	no metal remains

Note. N = no observable reaction.

(a) In the space below list the metals in order from most active to least active. (1 mark)

Most active → Least active

Metal list: ....

(b) Describe the relationship between the relative reactivity of these metals and their first ionisation energy. (1 mark)

.....

.....

End of Theory Test – Continue with the Data Processing……

Student Number	
Mark / 15	

Chemistry

2009 Half Yearly Year 11 Examination

Data Processing

General Instructions

- Write using black or blue pen
- Draw diagrams using pencil
- Data source material is included in this task

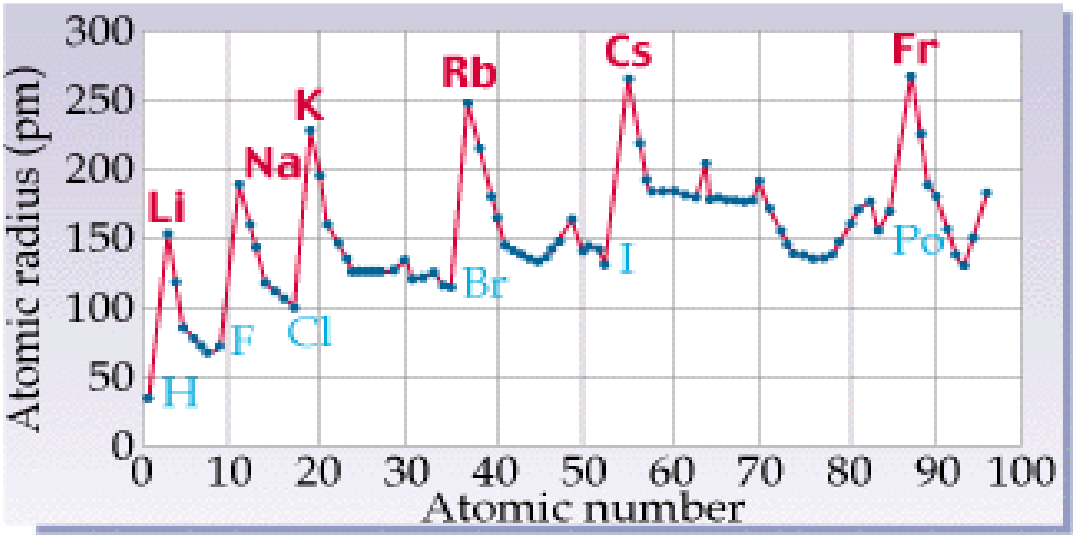
Data Processing

Total Marks – 15

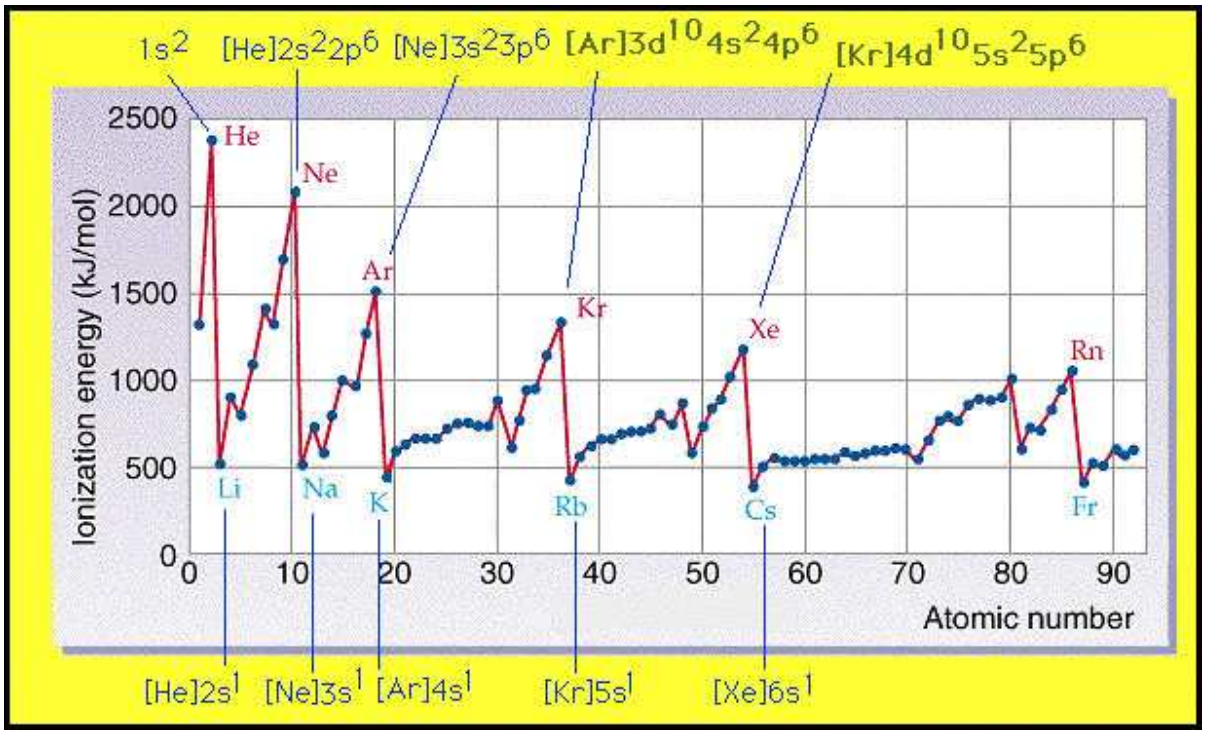
Allow about 25 minutes for this part

Question 1 (4 marks)
Use graph A and graph B below to answer Question 1.

Graph A – Atomic Radius vs Atomic Number



Graph B – First Ionisation energy of Elements



Compare and contrast four significant features of Graph A and Graph B above. (4 marks)

……

……

……

……

……

……

Continued over the page

Question 2 (7 marks)Use the diagram below and the table on page 21 to answer the following questions.

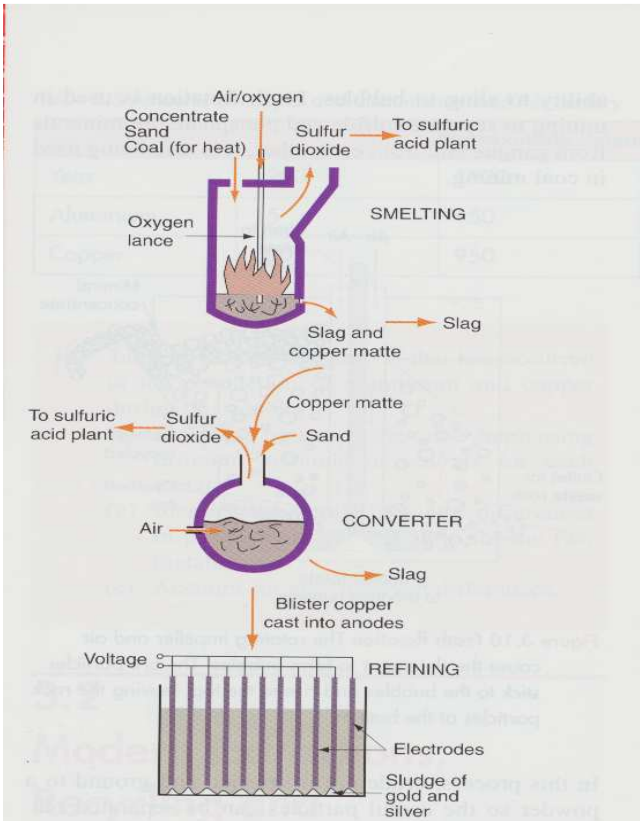


Figure 3.11 Producing copper In the Isasmelt process, copper ore is first smelted in a modern furnace before being sent to the converter

The main copper ores contain chalcopyrites ($CuFeS_2$) .
After a series of physical separation processes, the copper mineral must be treated chemically to extract copper from the compounds present in the ores. A common method used in the chemical separation process involves mixing the mineral concentrate($CuFeS_2$) with sand(SiO_2) and coal and placing into a furnace. Oxygen is added and the intense heat causes the ore to be smelted.

The chemical equations below show the reactions which occur :

$2CuFeS_{2(s)} + 4O_{2(g)} \rightarrow Cu_2S_{(l)} + 2FeO_{(s)} + 3SO_{2(g)}$

$FeO_{(s)} + SiO_{2(s)} \rightarrow FeSiO_{3(l)}$

The copper(I) sulfide is heated in a converter with oxygen blown through to extract the copper from the copper(I) sulfide. Sand is added to remove the remaining iron oxide.

The chemical equations for these reactions in the converter are shown below :

$Cu_2S_{(s)} + O_{2(g)} \dashrightarrow 2Cu_{(l)} + SO_{2(g)}$

$FeO_{(s)} + SiO_{2(s)} \rightarrow FeSiO_{3(l)}$

The overall reaction is :

$2CuFeS_{2(s)} + 5O_{2(g)} \rightarrow 2Cu_{(s)} + 2FeO_{(s)} + 4SO_{2(g)}$

(a) At various stages of the production of copper from its ore, the percentages of the elements present change as shown in the Table below :

Percentage of elements present

Stage	Copper %	Iron %	Sulfur %	Sand %
Concentrate (copper)	25	33	32	3
Slag	0.6	36	0.1	34
Blister copper	98	0.1	0.2	0
Pure copper	99.99	0	0	0

i. Identify the process used to convert concentrate (copper) to blister copper. (1 mark)

……

ii. Identify the process used to convert blister copper to pure copper. (1 mark)

……..

(b) Distinguish between concentrate (copper) and blister copper using information given in the table above. (2 marks)

……

……

(c) Calculate the mass of copper metal that could be extracted from 50 kg of concentrate (copper). (3 marks)

……..

……

……

Question 3 (4 marks)

Use the flow chart diagram below, showing the Extraction of Aluminium, to answer the following questions.

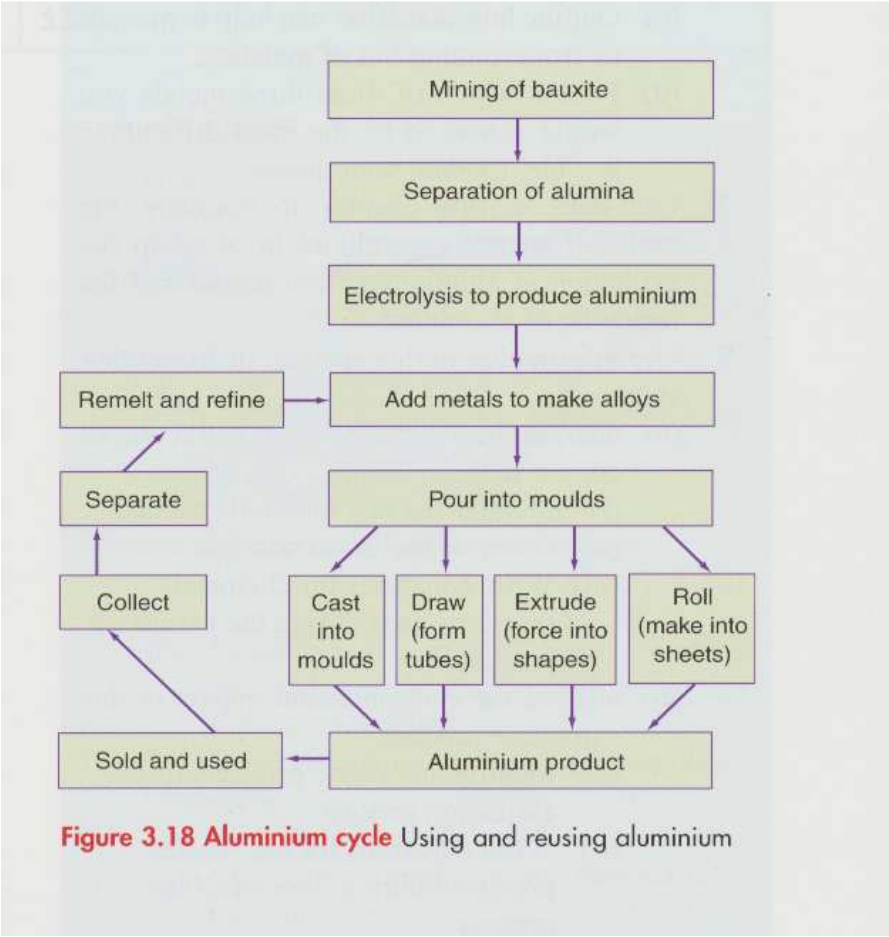
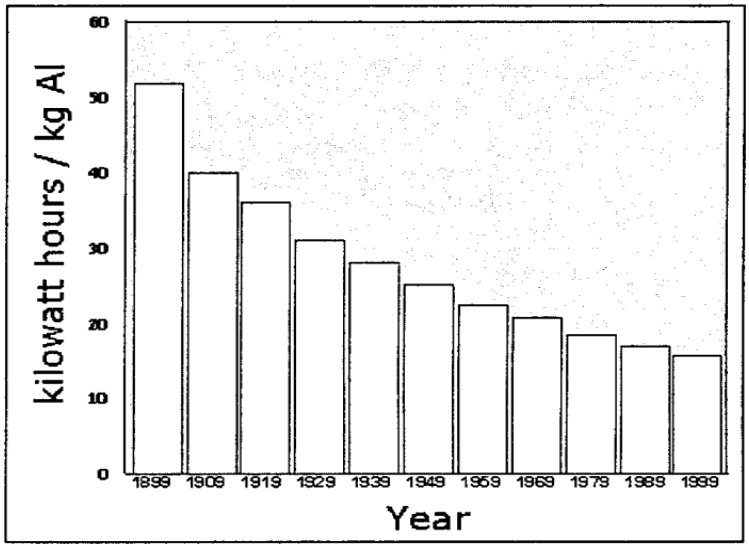


Figure 3.18 Aluminium cycle Using and reusing aluminium

Energy Usage for the Production of Aluminium over time



(a) Identify the trend in energy usage in the production of Aluminium, shown in the graph above. (1 mark)

……..

(b) Account for the trend in energy usage using information in the diagram above. (3 marks)

……..

……..

……..

……..

……..

End of Data Processing
End of Test

2010 Year 11 Chemistry Half Yearly Answers

Part A: Answer grid for multiple choice questions.

1.	A O	B √	C O	D O
2.	A √	B O	C O	D O
3.	A O	B O	C √	D O
4.	A O	B O	C O	D √
5.	A O	B √	C O	D O
6.	A O	B O	C O	D √
7.	A O	B √	C O	D O
8.	A O	B √	C O	D O
9.	A O	B O	C O	D √
10.	A O	B O	C O	D √
11.	A O	B O	C √	D O
12.	A √	B O	C O	D O

1. A mixture of oil, salt, sawdust and water are to be separated into their individual components, each component being collected separately. What sequence of steps should be followed to do this separation and collection?

(A) decantation→ filtration → separating funnel → evaporation

(B) filtration → separating funnel → distillation

(C) fractional distillation →filtration → decantation

(D) filtration → separating funnel →evaporation

OUTCOME(S) P13,P11,P15

2. If the formula for sodium chlorotitanate is Na_2TiCl_6, what is the correct formula for zinc chlorotitanate?

(A) $ZnTiCl_6$

(B) Zn_2TiCl_6

(C) $Zn(TiCl_6)_2$

(D) $Zn_2(TiCl_6)_3$

OUTCOME(S) P13,

3. Consider the following substances: calcium, neon, chlorine, oxygen and carbon dioxide. Which of the above substances exist as molecules in nature?

(A) all the substances

(B) chlorine, oxygen and carbon dioxide only

(C) neon, chlorine, oxygen and carbon dioxide only

(D) neon, chlorine and oxygen only

OUTCOME(S) P13

4. Sodium is not normally mined as sodium metal but is obtained by electrolyzing molten sodium chloride. What is the most likely reason for using this method of extraction?

(A) it requires less energy to electrolyse molten sodium chloride than to dig up sodium metal from the ground.

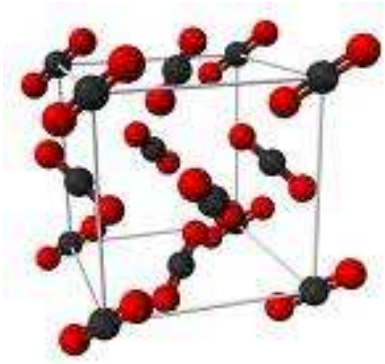
(B) sodium is too reactive to handle while being mined

(C) sodium chloride is readily available than is sodium metal

(D) sodium is too reactive to exist in nature as a native element

OUTCOME(S) P7, P8

5. The diagram below represents the structure of a solid chemical substance



Which of the following is the solid most likely to be?

(A) silver

(B) carbon dioxide

(C) graphite

(D) sodium fluoride

Outcomes : H6

6. Which of the following is an empirical formula?

(A) N_2O_4

(B) NH_4NO_3

(C) NO_2

(D) Na_2O

Outcomes : H6

7. Which of the following descriptions best explains the electrical conductivity of metals?

(A) mobile ions transfer charge

(B) mobile valence electrons transfer charge

(C) mobile cations transfer charge

(D) mobile anions transfer charge

Outcomes : H6

8. The uses of metals through history are categorised as follows:

Stone Age	Up to 3000 BC
Copper Age	3200 – 2300 BC
Bronze Age	2300 – 700 BC
Iron Age	700 BC – 1 AD
Modern Age	1 AD – present time

Which reason best accounts for this sequence?

(A) Bronze is harder than copper, is easily melted and is more malleable than copper.

(B) Iron can be extracted by heating copper ores with charcoal.

(C) The extraction of iron from its ores is easier than copper and aluminium.

(D) The extraction of metals depends upon the energy and extraction methods available at the time.

9. Consider the properties of the following substances M, Q, R and T.

Substance	MP (^{0}C)	Electrical conductivity	
		Solid state	Liquid state
M	-102	Nil	Nil
Q	1423	Nil	Conducts
R	3600	Nil	Nil
T	1535	Conducts	Conducts

Which of the following correctly identifies M, Q, R and T as covalent molecular, metallic, covalent network or ionic?

	M	Q	R	T
A	network covalent	ionic	covalent molecular	metallic
B	covalent molecular	metallic	network covalent	ionic
C	network covalent	metallic	covalent molecular	ionic
D	**covalent molecular**	**ionic**	**network covalent**	**metallic**

Outcomes : H6

10. Which statement describes the trend for metals in Groups 1 and 2 of the Periodic Table with respect to their chemical reactivity?

(A) Reactivity decreases from top to bottom of the group.

(B) Reactivity increases from top to bottom of the group.

(C) Group 1 metals are less reactive than Group 2 metals.

(D) There is no difference between the reactivity of the Group 1 and Group 2 metals.

11. Which substances may be combined to make the common alloy, bronze?

(A) copper and carbon

(B) Iron and brass

(C) Copper and tin

(D) Zinc and oxygen

12. What is the name of the product when solid lead is heated with air?

(A) Lead (II)oxide

(B) Lead (III) oxide

(C) Lead(II)hydroxide

(D) Hydrogen

Free Response

13. Use the particle theory to explain the difference between nitrogen and nitrogen dioxide (2 marks)

OUTCOME(S) P13, P7, P8,

Sample Answer:

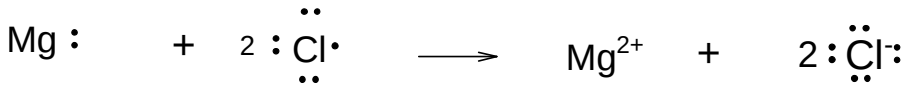
According to the particle theory substances are made of particles. In the case nitrogen, the particles are made up of only one type of atom whereas in nitrogen dioxide the particles are made up of two different types of atoms

Criteria	**Marks**
One premise of the particle theory	1
Distinction between elements and compounds on the basis of the premise	1

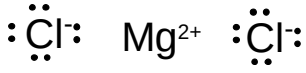
14. Use Lewis electron dot structures to show the formation of magnesium chloride crystals from elemental magnesium and atomic chlorine (3 marks)

OUTCOME(S) P13, P10

Sample Answer:



1 mark each



1 mark

Criteria	**Marks**
Correct Lewis structure for magnesium and chlorine	2
Correct Lewis structure for magnesium chloride crystals	1

15. Shown below is a simplified periodic table showing only the main group elements (no transition elements). The group numbers are given on top of each corresponding group. Fictitious names for the elements are given. (5 marks)

OUTCOMES:P6, P10,P13

I **VIII**

Q	***II***	***III***	***IV***	***V***	***VI***	***VII***	*Fg*
Wf	*A*	*Bg*	*X*	*Av*	*Pj*	*Yk*	*De*
E	*Sk*	*Ns*	*Cq*	*Zx*	*Kj*	*Rt*	*Ws*
R	*D*	*M*	*Vu*	*So*	*Lh*	*Tm*	*Ak*
T	*Fn*	*Kc*	*Qc*	*Ah*	*Gw*	*Pm*	*Hy*
Y	*Hz*	*L*	*Ws*	*Fb*	*Eg*	*Mp*	*Ed*
Ua	*J*	*Z*	*Uv*				

(a) Write the electronic configuration of *Av*, the period to which it belongs and whether it is a metal or a non-metal (2 marks)

Electronic configuration *2.5* Period *2*

Both correct 1 mark each

(b) Construct a formula for the compound formed from *Zx* and *Lh* (1 mark)

Zx_2Lh_3 1 mark for the correct answer

(c) What could be a possible use for *Ns* based on a physical property and state this property.(2 marks)

It may also be used as a structural material in aeroplanes since metals are typically strong and Ns is not very dense (lightweight).

16. Elemental iron is strongly magnetic but iron bonded in a compound is not. A student found a lump of an impure iron compound to be strongly magnetic. He wanted to determine how much elemental iron is present in the sample. Suggest a step by step procedure to determine the percent iron in the sample by physical means only using equipment found in the school laboratory. (4 marks)

OUTCOME(S) P11, P12, P13, P14

Sample Answer:

- *Prepare the sample by grinding the lump in a mortar and pestle, mix the ground material well*
- *Weigh the ground material on a watch glass*
- *Pass a magnet over the ground solid to attract the magnetic particles. Remove the magnetic particles from the magnet and repeat the process until no more particles adhere to the magnet*
- *Weigh the remaining non-magnetic material on the watch glass. The loss in mass is the mass of the magnetic material and therefore of the elemental iron. The percent iron is obtained from the following formula:*

$$\%\ iron = \frac{loss\ in\ mass}{total\ mass} x\ 100\%$$

Criteria	**Marks**
Weighing (2 times),	1
equipment used must be given,	1
separation technique of using a magnet	1
formula for the percentage iron	1

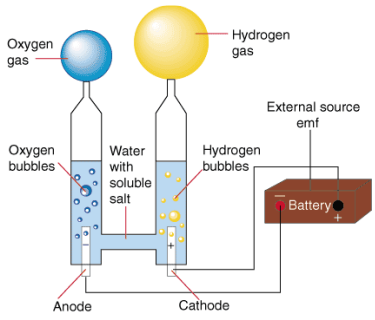
Question 17 (3 marks)

Complete the table by giving the names or formulae of the following substances.

Name	*Formula*
Ammonium sulfate	$(NH_4)_2SO_4$
Aluminium carbonate	$Al_2(CO_3)_3$
Nitrogen dioxide	NO_2
Potassium nitrate	KNO_3
Sodium oxide	Na_2O
Copper II sulfide	CuS

Outcomes : H10, H6

Question 18 (3 marks) Consider the diagram for the electrolysis of water.



Identify the electrolysis of water as a physical or chemical process and explain your answer.

Sample answer

The electrolysis of water is a chemical process as electrical energy is required to break the bonds in the water molecules and new products are formed, oxygen and hydrogen molecules.

Marking Criteria	***Marks***
• *Correctly identifies the process as chemical and explains the process*	*3*
• *Correctly identifies the process as chemical and outlines the process*	*2*
• *Correctly identifies the process as chemical*	*1*

Outcomes : P7

Question 19 (4 marks)

During your practical work you performed a first- hand investigation to show the decomposition of a carbonate by heat.

(a) Give a balanced chemical equation for the decomposition reaction. (1 mark)

$CuCO_3 \rightarrow CuO + CO_2$ *(No states required)* *(1 mark)*

(b) Outline two observations that indicated that a reaction had taken place. (2 marks)

Sample answer

The solid changed colour from green to black. *(1 mark)*

A gas was given off, seen as bubbles in lime water. *(1 mark)*

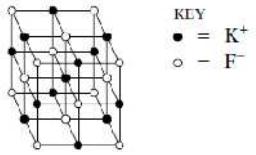
(c) Outline one test you performed to determine the nature of one of the products formed.(2 marks)

Sample answer *The gas was bubbled through lime water which turned milky demonstrating that carbon dioxide was a product of the reaction.*

Outcomes : P11, P14, P7

Question 20 (5 marks)

The arrangement of potassium ions and fluoride ions in potassium fluoride is represented in the following diagram. The arrangement extends in three dimensions to represent a crystal.



(a) Would it be possible for magnesium fluoride to have the same structure as potassium fluoride? Explain your answer. (1 mark)

Sample answer

No as there are 2 fluoride ions to one magnesium ion so the structure would be different.

(b) In terms of the bonds involved, explain why potassium fluoride has a much higher melting point (857^0C) than carbon tetra flouride (-184^0C). (2 marks)

Sample answer

The ions in potassium fluoride are held together in the solid be strong electrostatic ionic bonds which require a lot of energy to break so the melting point is high. (1 mark)The molecules in carbon tetra fluoride are only held together in the solid by weak dispersion forces that are easily overcome so the melting point is low.(1 mark)

(C) Aqueous potassium fluoride is a good conductor of electricity while solid potassium fluoride is not. Explain. (2 marks)

Sample answer

When aqueous, the ions are mobile and free to transfer charge.(1 mark) When solid, the ions are locked in the crystal lattice and cannot move and therefore cannot transfer charge.(1 mark)

Outcomes : H6

Question 21 (2 marks)

Calcium is a representative element that reacts vigorously with dilute sulfuric acid at room temperature.

Write half-equations to describe the processes of electron transfer associated with this reaction. (2 marks)

(1): $Ca(s) \rightarrow Ca^{2+}(aq) + 2e^-$

(1): $2H^+(aq) + 2e^- \rightarrow H_2(g)$

Question 22 (1 mark)

Potassium reacts violently with water at room temperature.

Write a balanced formulae equation to describe the reaction between potassium and water at room temperature. (1 mark)

$2K(s) + 2H_2O\ (l) \rightarrow 2KOH\ (aq) + H_2\ (g)$

Question 23 (2 marks)

The observations made by a group of students when adding several common metals to water, steam (water gas) and an acid are presented in the table. The metals are represented fictitiously by the symbols, W, X, Y and Z. The metals are listed in no particular order.

	W	X	Y	Z
Dilute HCl (aq)	N	small amount of bubbling, metal slowly disappears	large amount of bubbling, no metal remains	large amount of bubbling, no metal remains
H_2O (l) at 25^oC	N	N	bubbles, no metal remains	N
H_2O (g) (steam)	N	N	no metal remains	no metal remains

Note. N = no observable reaction.

(a) In the space below list the metals in order from most active to least active. (1 mark)

Most active → Least active

Metal list: *Y* *Z* *X* *W*

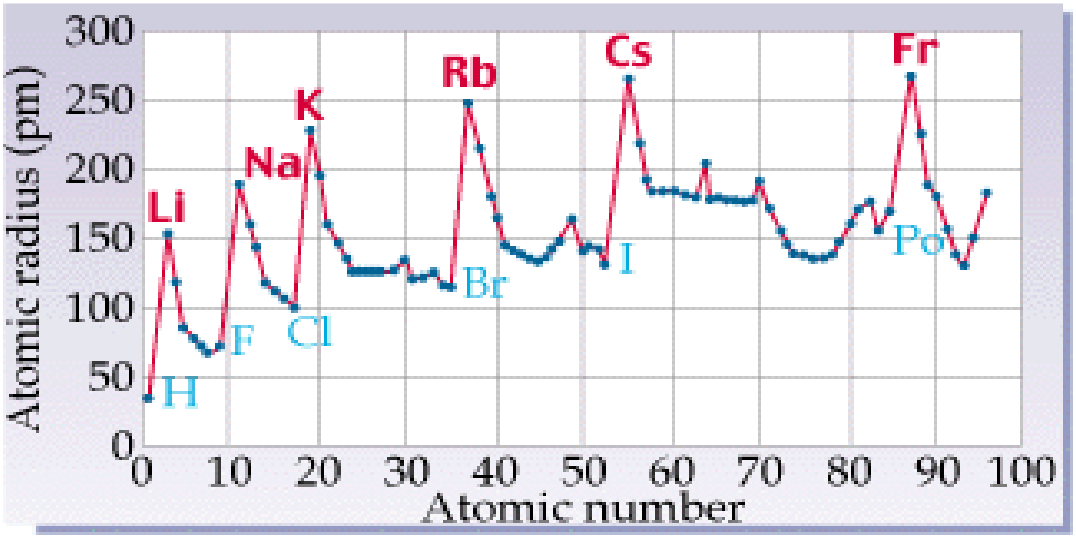
(b). Describe the relationship between the relative reactivity of these metals and their first ionisation energy. (1 mark)

The more reactive metals have a lower first ionisation energy than the least reactive metals. Hence the more reactive metals tend to lose their valence electrons more easily than the least reactive metals.

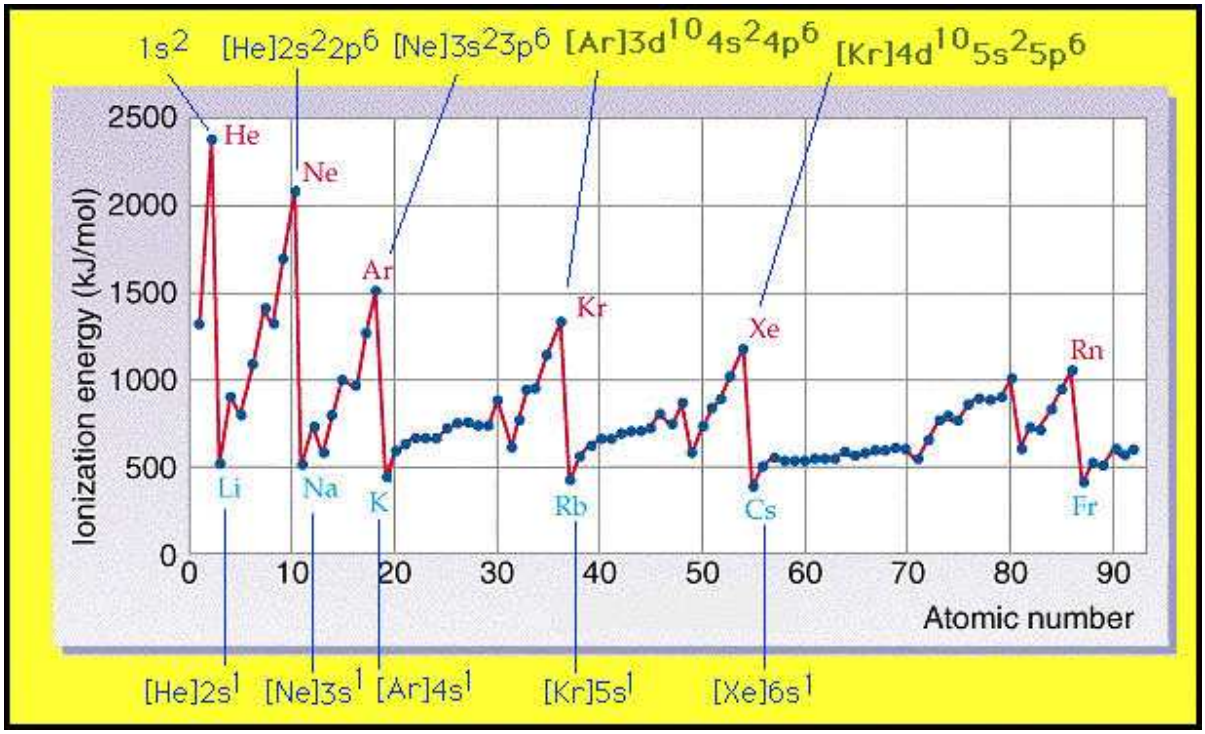
Data Processing Answers

1. Use the graphs of Atomic Radius vs Atomic Number – Graph A and the Ionisation Energy graph – Graph B below to answer the following Question.

   Graph A – Atomic Radius vs Atomic Number



   Graph B – First Ionisation energy of Elements



Compare and contrast four significant features of Graph A and Graph B above. (4 marks)

1. Marking Criteria

Criteria	Mark
Correct identification of 4 features (similarities and differences) comparing both graphs	4
Identication of 3 features comparing both graphs	3
Identification of 2 feature comparing both graphs	2
Identification of one feature comparing both graphs	1

Sample Answer :

Similarities : 1.Both graphs show a periodic rise and fall pattern across periods.

2. Both graphs show atomic number on the X-axis.

Differences : 1.Graph A has Group 1 elements at peak and Group 7 elements at the troughs while Graph B has Group 8 elements at the peaks and Group 1 elements at the troughs.

2. Graph A shows an increase in atomic radii down each Group while Graph B shows a decrease in ionization energy down each Group.

2.. Use the diagrams and Table below to answer the following questions.

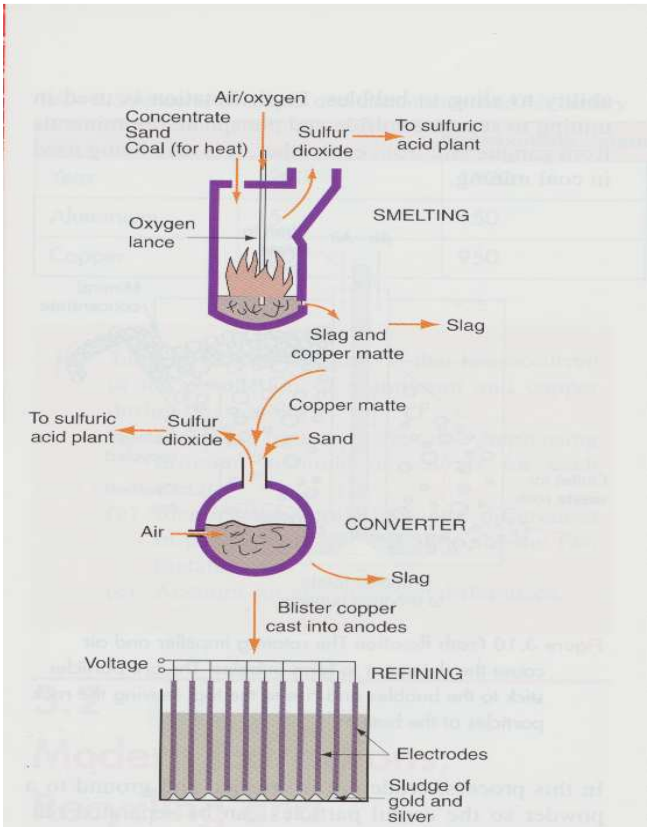


Figure 3.11 Producing copper In the Isasmelt process, copper ore is first smelted in a modern furnace before being sent to the converter

The main copper ores contain chalcopyrites ($CuFeS_2$) .

After a series of physical separation processes, the copper mineral must be treated chemically to extract copper from the compounds present in the ores. A common method used in the chemical separation process involves mixing the mineral concentrate($CuFeS_2$) with sand(SiO_2) and coal and placing into a furnace. Oxygen is added and the intense heat causes the ore to be smelted.

The chemical equations below show the reactions which occur :

$2CuFeS_{2(s)} + 4O_{2(g)} \rightarrow Cu_2S_{(l)} + 2FeO_{(s)} + 3SO_{2(g)}$

$FeO_{(s)} + SiO_{2(s)} \rightarrow FeSiO_{3(l)}$

The copper(I) sulfide is heated in a converter with oxygen blown through to extract the copper from the copper(I) sulfide. Sand is added to remove the remaining iron oxide.

The chemical equations for these reactions in the converter are shown below :

$Cu_2S_{(s)} + O_{2(g)} \dashrightarrow 2Cu_{(l)} + SO_{2(g)}$

$FeO_{(s)} + SiO_{2(s)} \rightarrow FeSiO_{3(l)}$

The overall reaction is :

$2CuFeS_{2(s)} + 5O_{2(g)} \dashrightarrow 2Cu_{(s)} + 2FeO_{(s)} + 4SO_{2(g)}$

a. At various stages of the production of copper from its ore, the percentages of the elements present change as shown in the Table below

Stage	Copper	Iron	Sulfur	Sand
Copper concentrate	25	33	32	3
Slag	0.6	36	0.1	34
Blister copper	98	0.1	0.2	0
Pure copper	99.99	0	0	0

i. Identify the process used to convert copper concentrate to blister copper. (1 mark)

ii. Identify the process used to convert blister copper to pure copper. (1 mark)

b. Distinguish between copper concentrate and blister copper using information given in the Table above. (2 marks)

c. Calculate the mass of copper metal that could be extracted from 50 kg of copper concentrate. (3 marks)

Marking Criteria 2 a i

Criteria	Mark
Correct identification of smelting process	1

2 aii

Criteria	Mark
Correct identification of electrolysis process	1

2 b

Criteria	Mark
Comparison between copper concentrate and blister copper in terms of composition with information from the Table	2
Comparison but does not include information from the Table.	1

Sample Answer :

Copper concentrate had 25% copper, 33% iron, 32% sulfur and 3% sand

Blister copper had 98% copper, 0.15 iron, 0.2% sulfur, 0% sand.

2.c

Criteria	Mark
Correct calculation of the mass of copper from 50 kg of copper ore, showing percentage of Cu in ore and calculation of formula mass of copper ore	3
One of the above missing	2
Two of the above missing	1

Sample Answer :

% Cu in $CuFeS_2$ = 63.55/(63.55 + 55.85 + 2 X 32.07) X 100 = 63.55 /183.54 X100
= 34.62 %

Mass of Cu in 50 kg of copper ore = 34.62 / 100 X 50 kg = 17.31 kg of Cu metal

3. Use the flow chart diagram showing the Extraction of Aluminium below to answer the following questions.

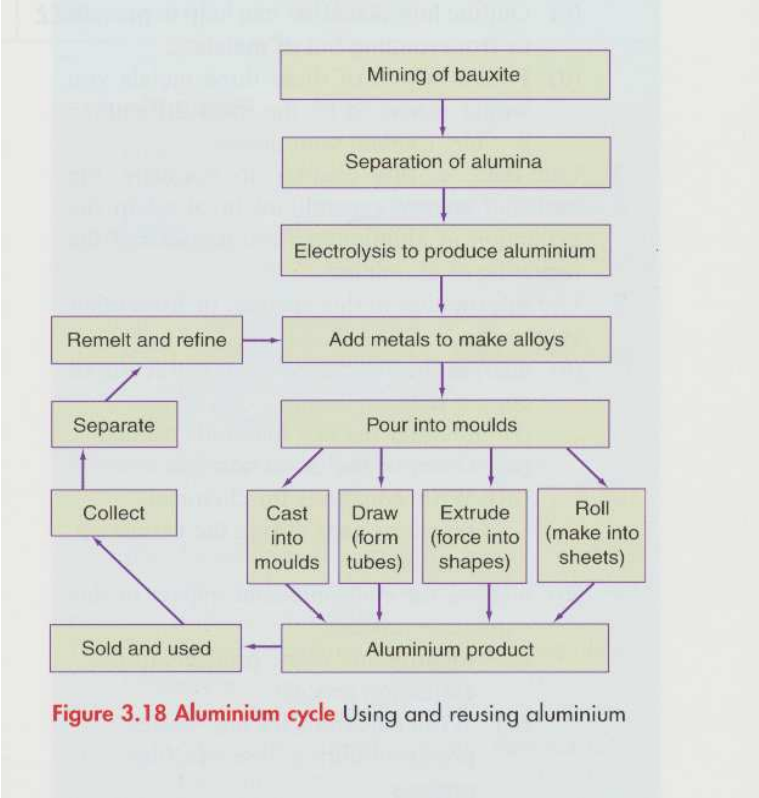
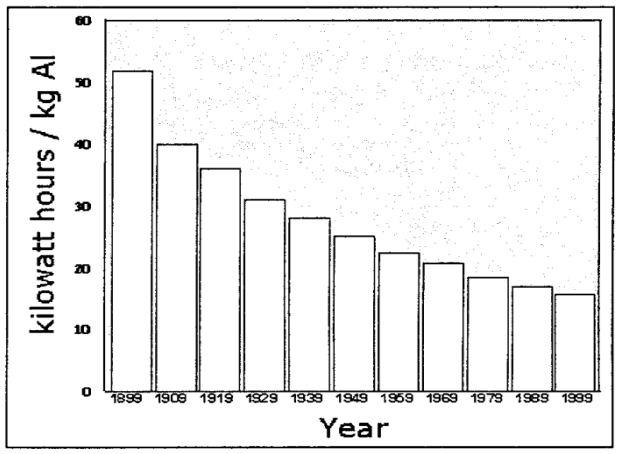


Figure 3.18 Aluminium cycle Using and reusing aluminium

Energy Usage for the Production of Aluminium over time



a. Identify the trend in energy usage shown in the graph above in the production of Aluminium. (1 mark)

3a. Marking Criteria

Criteria	Mark
Correct identification of the trend shown in the graph	1

Sample Answer :

There is a decrease in energy usage for the production of aluminium over time.

3b. Account for the trend in energy usage using information in the diagram above. (3 marks)

Marking Criteria

Criteria	Mark
Accounting for the decreasing use in energy over time due to the use of electrolysis in the early years and very little recycling. Increased recycling in later years means less energy is required to make aluminium products.	3
Brief description of the use of electrolysis and recycling	2
Identifying electrolysis Or recycling in the production of aluminium.	1

Sample Answer :

The use of electrolysis in the production of aluminium requires a large amount of electrical energy and there was no recycling in the early years of aluminum production.

Over time recycling aluminium became more prominent and this reduced the need for the raw production of aluminium using large amounts of electrical energy as the recycling process requires less energy.