HOMEWORK WORKSHOP

WHAT IS IT?

Workshops are additional support sessions in the form of Q&A. Tutors provide individual assistance to students who have difficulties with Work Booklet questions. Students can also check the accuracy of their answers by referring to the online homework solutions.

Workshops are not alternative for make-up for missed lessons. However, if you review the Theory Booklet and flag any questions you may have, then the tutors will do their best to help you with your learning.

WHEN IS IT?

Week 2 to 9 during the term. Each session is 60 minutes long. Refer to the Notice Board for the Workshop schedule.

WHAT DO I NEED TO DO TO ATTEND?

Students must attempt all the Work Booklet questions before attending the Workshop. Students must book at the service desk as spaces are limited.
CHEMISTRY RESOURCES LIBRARY

WHAT IS IT?
The Matrix Chemistry Resources Library contains a collection of Workbook solutions, Educational Videos, First-Hand Investigation Reports, Research Assignments and Exam papers.

WHERE IS IT?
Online Resources and discussions are available on Matrix LMS (Schoology) through the website www.online.matrix.edu.au or the Schoology App (Android or IOS).

HOW CAN I ACCESS IT?
1. Log in to Matrix LMS.
2. Click on “Courses”
3. Click on your subject (e.g. ‘12 Chemistry: CM12’)
4. Click on the term folder to access resources
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YEAR 11 CHEMISTRY

METALS

LESSON 1: EXTRACTION AND USE OF METALS
PART A: MULTIPLE CHOICE QUESTIONS

QUESTION 1.
Which statement best relates the historical use of a metal?
(a) Iron to make aircraft
(b) Gold for ornaments and coins
(c) Aluminium to make spears
(d) Sodium to make cooking pot bases

QUESTION 2.
Alloys are mixtures of metals and are useful because of their properties. Which statement describes this correctly?
(a) Stainless steel resists electricity so it is used in light bulbs
(b) Solder has a high melting point so it can be used in rockets
(c) Brass is easy to cast into shapes like door handles
(d) Magnesium/aluminium alloy is used for car wheels because it burns easily

QUESTION 3.
Some metals were the first elements discovered. These include copper, lead, silver and gold. The best reason for this is:
(a) Copper produced a green flame so it was readily found
(b) Lead is a hard metal used for spear heads and arrows in ancient times
(c) Silver never tarnishes (discolours) so it was always shiny on the ground
(d) Gold is very unreactive and does not form compounds easily

QUESTION 4.
Solder is a common alloy used in plumbing. Which metals are present in solder?
(a) Brass and copper
(b) Zinc and lead
(c) Lead and tin
(d) Tin and zinc
QUESTION 5.
Why has the number of pure metals available to industry increased over the last 200 years?
(a) New synthetic metals have been produced
(b) Mining methods have improved
(c) Nuclear reactions in the lithosphere have created new metallic elements
(d) Methods of extraction have improved

QUESTION 6.
The most common reason why iron is alloyed with various other metals is to improve its:
(a) Appearance
(b) Electrical conductivity
(c) Strength
(d) Reactivity

QUESTION 7.
In Queensland, a recently discovered body of copper ore contains a high proportion of native (uncombined) copper. Which property of copper relates most closely to its occurrence as an element?
(a) Copper has low reactivity
(b) Copper is a transition metal
(c) Copper has no reaction with water
(d) Copper forms insoluble compounds

QUESTION 8.
Aluminium is very abundant in the Earth’s crust yet did not become a useful metal until the twentieth century because:
(a) Its ores are found deep in the Earth’s crust and are difficult to mine
(b) New types of coal powered furnaces need to be developed
(c) Most aluminium deposits are not economical due to the wide dispersion of the mineral
(d) Considerable amounts of energy are needed to extract the metal from its ore because aluminium is so reactive it is found in its compound form
QUESTION 9.
Energy is needed to extract a metal from its ore because:
(a) Heat, electricity and light are different forms of energy which can be changed to chemical energy
(b) It takes energy to break the bonds which hold metal ions to the other ions in the ore
(c) The metal compound in the ore has higher energy than the uncombined metal
(d) Heat can melt the uncombined metal from which the ore is made

QUESTION 10.
Which alloy and property matches its common use?
(a) Solder – high melting point
(b) Brass – hardness
(c) Steel – strength
(d) Bronze – low density

QUESTION 11.
The energy input necessary to extract a metal from its ore may be affected by serveral factors…
(i) The reactivity of the metal
(ii) The density of the metal
(iii) The magnetic property of the metal
(iv) The chemical composition of the ore
Which factor(s) will have the greatest effect on the size of the energy input?
(a) (i), (ii), (iii) only
(b) (i) and (ii) only
(c) (i) and (iv) only
(d) (i) only

QUESTION 12.
In the history of metal use, aluminium is a late entry. Which of the following statements best explains the difficulty of extracting a metal like aluminium?
(a) The metal has a low abundance in the earth’s crust
(b) The metal has a high reactivity
(c) The metal has a low density
(d) The metal has a high melting point
QUESTION 13.
Which of the following was the first alloy to be used by man?
(a) Brass
(b) Bronze
(c) Solder
(d) Steel

QUESTION 14.
Aluminium, gold, iron and tin are metals of great importance in modern technology. Historically, they were discovered in the order of gold, tin, iron, and aluminium.
(a) Aluminium is the most abundant metal in the earth’s crust
(b) Iron is the most reactive of the metals
(c) Gold is the most expensive of the metals
(d) Unreactive metals are easier to extract from compounds.

QUESTION 15.
The most common reason why iron is alloyed with various other metals is to improve its:
(a) Appearance
(b) Electrical conductivity
(c) Strength
(d) Reactivity

QUESTION 16.
Why has the number of pure metals available to industry increased over the last 200 years?
(a) New synthetic metals have been produced
(b) Mining methods have improved
(c) Nuclear reactions in the lithosphere have created new metallic elements
(d) Methods of extraction have improved.
QUESTION 17.
The less reactive a metal is –
(a) The less expensive it will be
(b) The less chance of it being discovered early in human history
(c) The less energy is required to extract it from its ore
(d) The more chance there is of it occurring as part of a compound in nature

QUESTION 18.
The diagram below shows the uses of one common element

Which element best fits this pattern of use?
(a) Aluminium
(b) Copper
(c) Lead
(d) Sodium
PART B: SHORT ANSWER QUESTIONS

QUESTION 19.

Lead is not found as a native metal. Galena is a common lead sulfide mineral. It has a very metallic looking appearance, and was likely to attract the attention of early metalworkers. It has been suggested that lead may have first been found in the bottom of a campfire where it may have formed, flowed and collected. Assess this suggestion.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifies lead as a relatively unreactive metal</td>
<td></td>
</tr>
<tr>
<td>Recognizes that unreactive metals do not need as much energy as reactive metals to extract from its ore</td>
<td></td>
</tr>
<tr>
<td>Describes that lead could potentially be extracted from its ore at temperatures of campfires</td>
<td></td>
</tr>
<tr>
<td>Recognizes the properties of lead that would allow it to be easily identifies in ancient times</td>
<td>4</td>
</tr>
</tbody>
</table>
QUESTION 20.

Explain why energy input is necessary to extract a metal from its ore.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifies that ores contain compounds more stable than pure metals</td>
<td></td>
</tr>
<tr>
<td>Identifies that energy is required to break the stable chemical bonds</td>
<td></td>
</tr>
<tr>
<td>Recognizes that the energy required is dependent on the reactivity of the metal</td>
<td>3</td>
</tr>
</tbody>
</table>
QUESTION 21.
Explain, using specific examples, how the variety of metals available for human use has increased over time. Include at least one balanced equation in your answer.

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

QUESTION 22.
a) Suggest two relevant characteristics required for a metal used in a knee implant.

____________________________________________________________________________
____________________________________________________________________________

b) Suggest two relevant characteristics required for a metal used in an exterior door of an aircraft.

____________________________________________________________________________
____________________________________________________________________________
QUESTION 23.

a) Explain why brass, which consists of copper and zinc, is not considered a compound.

1

b) Calcium is the third most abundant metal in the earth’s crust. Explain why calcium is not used as a metal.

1

c) Steel and solder are both alloys, but with very different properties.

a. For each alloy describe one of its characteristic properties

1

b. Identify a use of each alloy which relates to the property described in a.

1

d) The engine block (the outside casing) of modern cars is usually made of aluminium rather than traditional cast iron. Aluminium is significantly more expensive than iron. Identify a reason why car makers would use aluminium despite its higher cost

1
Copper has continued to be an important metal in modern times.

Match the properties of copper with its uses.

<table>
<thead>
<tr>
<th>Properties of Copper Metals</th>
<th>Uses of Copper</th>
<th>Properties of Copper That Suit the Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>excellent thermal conductor</td>
<td>Electrical cables and wiring</td>
<td>- malleable</td>
</tr>
<tr>
<td>excellent electrical conductor</td>
<td>Refrigeration systems</td>
<td>- ductile</td>
</tr>
<tr>
<td>low reactivity (resists corrosion)</td>
<td>Castings eg. bronze statues, brass fittings</td>
<td>- readily forms alloys (brass: copper and zinc, bronze: copper and tin)</td>
</tr>
<tr>
<td>malleable</td>
<td>Water pipes</td>
<td></td>
</tr>
<tr>
<td>ductile</td>
<td>Radiators</td>
<td></td>
</tr>
<tr>
<td>readily forms alloys (brass: copper and zinc, bronze: copper and tin)</td>
<td>Sheathing over iron hulls of ships</td>
<td></td>
</tr>
</tbody>
</table>
QUESTION 25.
Outline why copper was discovered before iron

QUESTION 26.
Stainless steel and wrought iron are two different types of alloys or iron available in society today. Define the term “alloy” and describe two alloys you have studied this year and relate their properties to their usage.
QUESTION 27.

Historically, the “Bronze Age” occurred before the “Iron Age”. Explain how the relative activity of copper and iron is related to this fact.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognizes that less reactive metals are easier to extract</td>
<td>3</td>
</tr>
<tr>
<td>Identifies that copper was more easily identified and extract than iron due to its chemical nature</td>
<td></td>
</tr>
<tr>
<td>Outlines the difficulties of extracting iron from its ore with reference to chemical activity</td>
<td></td>
</tr>
</tbody>
</table>
QUESTION 28.

“The methods used to extract metals from their ores depend, to a large extent, on the activity of the metal”

Assess this statement, referring to the methods used for extraction of aluminium and copper.

___________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

5
QUESTION 29.

Giving examples to support your answer, explain why in many cases the use of alloys is preferred to using the pure metal. Your answer should refer to at least two different properties.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Gives a correct definition of an alloy AND</td>
<td></td>
</tr>
<tr>
<td>• Identifies and explains TWO advantageous properties of an alloy AND</td>
<td>5</td>
</tr>
<tr>
<td>• Gives examples</td>
<td></td>
</tr>
</tbody>
</table>

---

Our Students Come First!
QUESTION 30.
The following table compares the properties of a variety of gold alloys.

<table>
<thead>
<tr>
<th>Type of Alloy</th>
<th>Gold % Weight</th>
<th>Silver % Weight</th>
<th>Copper % Weight</th>
<th>Colour</th>
<th>Tensile strength N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 carat</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>Yellow</td>
<td>200</td>
</tr>
<tr>
<td>22 carat</td>
<td>91.6</td>
<td>8.4</td>
<td>-</td>
<td>Yellow</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>91.6</td>
<td>3.3</td>
<td>5.1</td>
<td>Deep Yellow</td>
<td>390</td>
</tr>
<tr>
<td></td>
<td>91.6</td>
<td>-</td>
<td>8.4</td>
<td>Deep Pink</td>
<td>600</td>
</tr>
<tr>
<td>18 carat</td>
<td>75</td>
<td>25</td>
<td>-</td>
<td>Green-Yellow</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>12.5</td>
<td>12.5</td>
<td>Yellow</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>5</td>
<td>20</td>
<td>Red</td>
<td>880</td>
</tr>
</tbody>
</table>

Use the information in the table to answer the following questions.

a) Describe the effects of increasing the percentage of copper in a gold alloy

b) Jewellers have recently been accused of selling 12 carat gold for the price of 18 carat gold. Outline a simple procedure that you could use to prove that you had actually purchased an inferior product from your local jeweller.
c) Of the three main metals used in gold alloys (gold, zinc and copper), which metal was the first to be used in human history and which was the most recent? Explain your answer.
YEAR 11 CHEMISTRY

METALS

LESSON 2: REACTIONS OF METALS I
PART A: MULTIPLE CHOICE QUESTIONS

QUESTION 1.

A student performing a first-hand investigation to test the activity of metals made the following observations.

“When a metal was dropped into water a colourless gas slowly bubbled off. The gas was collected and tested with a flame. The test produced a small explosion.”

The metal used by the student was most likely:
(a) Potassium
(b) Copper
(c) Zinc
(d) Calcium

QUESTION 2.

A student reacted 4 metals with a dilute acid and recorded the following results:

<table>
<thead>
<tr>
<th>Metal</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Slow but consistent bubbling</td>
</tr>
<tr>
<td>Q</td>
<td>Burst into flames</td>
</tr>
<tr>
<td>R</td>
<td>No reaction</td>
</tr>
<tr>
<td>S</td>
<td>Bubbled and dissolved quickly</td>
</tr>
</tbody>
</table>

The metals most likely to be sodium and copper are respectively:
(a) Q and R
(b) P and S
(c) Q and S
(d) R and Q
QUESTION 3.
Which series of metals is in order from most reactive to least reactive?
(a) Zinc, magnesium, lead, sodium
(b) Lead, zinc, magnesium, sodium
(c) Sodium, zinc, magnesium, lead
(d) Sodium, magnesium, zinc, lead

QUESTION 4.
Which of the following properties is NOT true of a highly reactive metal?
(a) High ionisation energy
(b) Produces hydrogen gas in cold dilute acid
(c) Reacts readily with oxygen to form a metal oxide
(d) Reacts with cold water to produce a metal hydroxide

QUESTION 5.
Which of the following statements generally describes the activity series?
(a) Transition metals are the most reactive metals
(b) Group 1 and 2 metals are the most reactive metals
(c) Precious metals are the most reactive metals
(d) Passivating metals are the most reactive metals
PART B: SHORT ANSWER QUESTIONS

The steps for completing the following equations are the same as those shown in the theory booklets, irrespective of whether the substances involved are metals.
- In equations where the formulae are given, the formulae are correct.

QUESTION 6.
Balance the following equations. 2

a) \( \text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightarrow \text{HI}(\text{g}) \)

b) \( \text{Al}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{Al}_2\text{O}_3(\text{s}) \)

c) \( \text{Na}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{NaCl}(\text{s}) \)

d) \( \text{CaCO}_3(\text{s}) \rightarrow \text{CO}_2(\text{g}) + \text{CaO}(\text{s}) \)

QUESTION 7.
Balance the following equations. 3

a) \( \text{HI}_{(\text{aq})} + \text{NaOH}_{(\text{aq})} \rightarrow \text{NaI}_{(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \)

b) \( \text{Ba(NO}_3)_2_{(\text{aq})} + \text{H}_2\text{S}_{(\text{g})} \rightarrow \text{BaS}_{(\text{aq})} + \text{HNO}_3_{(\text{aq})} \)

c) \( \text{CH}_4(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}_{(\text{g})} \)

d) \( \text{C}_4\text{H}_10(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}_{(\text{g})} \)

e) \( \text{Fe}(\text{s}) + \text{CO}_2(\text{g}) \rightarrow \text{Fe}_2\text{O}_3(\text{s}) + \text{CO}_{(\text{g})} \)

f) \( \text{Al}(\text{s}) + \text{HBr}_{(\text{s})} \rightarrow \text{AlBr}_3_{(\text{aq})} + \text{H}_2(\text{g}) \)
QUESTION 8.
Balance the following equations.  

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correctly balances the equation</td>
<td>0.5 (each)</td>
</tr>
</tbody>
</table>

a) $\text{Al}_\text{(s)} + \text{O}_2\text{(g)} \rightarrow \text{Al}_2\text{O}_3\text{(s)}$

b) $\text{Na}_\text{(s)} + \text{O}_2\text{(g)} \rightarrow \text{Na}_2\text{O}_2\text{(s)}$

c) $\text{Fe}_\text{(s)} + \text{Cl}_2\text{(g)} \rightarrow \text{FeCl}_3\text{(aq)}$

d) $\text{H}_2\text{O}_\text{(l)} + \text{CO}_2\text{(g)} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6\text{(aq)} + \text{O}_2\text{(g)}$

e) $\text{Fe}_\text{(s)} + \text{O}_2\text{(g)} \rightarrow \text{Fe}_2\text{O}_3\text{(s)}$

f) $\text{CO}_\text{(g)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$

g) $\text{Na}_\text{(s)} + \text{H}_2\text{O}_\text{(l)} \rightarrow \text{NaOH}_\text{(aq)} + \text{H}_2\text{(g)}$

h) $\text{Al}_\text{(s)} + \text{H}_2\text{O}_\text{(l)} \rightarrow \text{Al(OH)}_3\text{(s)} + \text{H}_2\text{(g)}$

i) $\text{P}_2\text{O}_5\text{(s)} + \text{H}_2\text{O}_\text{(l)} \rightarrow \text{H}_3\text{PO}_4\text{(aq)}$

j) $\text{NaHCO}_3\text{(s)} \rightarrow \text{Na}_2\text{CO}_3\text{(s)} + \text{H}_2\text{O}_\text{(l)} + \text{CO}_2\text{(g)}$

k) $\text{HNO}_3\text{(aq)} + \text{CaCO}_3\text{(s)} \rightarrow \text{Ca(NO)}_3\text{2(aq)} + \text{CO}_2\text{(g)} + \text{H}_2\text{O}_\text{(l)}$

l) $\text{H}_2\text{SO}_4\text{(aq)} + \text{Al(OH)}_3\text{(s)} \rightarrow \text{Al}_2\text{(SO}_4\text{)}_3\text{(s)} + \text{H}_2\text{O}_\text{(l)}$

m) $\text{HCl}_\text{(aq)} + \text{Ca(OH)}_2\text{(s)} \rightarrow \text{CaCl}_2\text{(aq)} + \text{H}_2\text{O}_\text{(l)}$

n) $\text{H}_3\text{PO}_4\text{(aq)} + \text{CaCO}_3\text{(s)} \rightarrow \text{Ca}_3\text{(PO}_4\text{)}_2\text{(s)} + \text{CO}_2\text{(g)} + \text{H}_2\text{O}_\text{(l)}$
QUESTION 9.
In some of the following equations a reactant or product has been omitted. Add the missing substance (where applicable) and balance each of the equations.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correctly balances the equation and includes the omitted substance</td>
<td>0.5 (each)</td>
</tr>
</tbody>
</table>

a) \( \text{Cl}_2\text{O}_7(g) + \text{H}_2\text{O}(l) \rightarrow \text{HClO}_4(aq) \)

b) \( \text{Br}_2(l) + \text{H}_2\text{O}(l) \rightarrow \text{HBr}(aq) + \text{HBrO}(aq) \)

c) \( \text{Ca}_3(\text{PO}_4)_2(s) + \text{H}_2\text{SO}_4(aq) \rightarrow \text{CaSO}_4(s) + \text{H}_3\text{PO}_4(aq) \)

d) \( \text{Fe}_3\text{O}_4(s) + \text{H}_2(g) \rightarrow \text{________}_2(g) + \text{H}_2\text{O}(l) \)

e) \( \text{KClO}_3(s) \rightarrow \text{KCl}(s) + \text{O}_2(g) \)

f) \( \text{H}_2\text{O}(g) + \text{C}(s) \xrightarrow{\Delta} \text{H}_2(g) + \text{CO}(g) \)

g) \( \text{V}_2\text{O}_4(s) + \text{HClO}_4(aq) \rightarrow 2\text{VO(ClO}_4)_2(aq) + \text{H}_2\text{O}(l) \)

h) \( \text{H}_2\text{O}_2(aq) \rightarrow \text{H}_2\text{O}(l) + \text{________}(g) \)

i) \( \text{Cl}_2(aq) + 2\text{KI}(aq) \rightarrow \text{________}(aq) + \text{I}_2(aq) \)

j) \( \text{NH}_4\text{HSO}_4(s) \rightarrow \text{NH}_3(g) + \text{H}_2\text{SO}_4(l) \)

k) \( 2\text{NaI}(aq) + \text{Br}_2(aq) \rightarrow \text{________}(aq) + \text{I}_2(s) \)

l) \( \text{Zn(NO}_3)_2(aq) + \text{Na}_2\text{S}(aq) \rightarrow \text{________}(s) + 2\text{NaNO}_3(aq) \)

m) \( 2\text{HAuCl}_4(aq) \rightarrow \text{________}(s) + \text{Cl}_2(g) + 2\text{HCl}(aq) \)

n) \( \text{Xe}(g) + \text{F}_2(g) \rightarrow \text{XeF}_4(s) \)
QUESTION 10.
Complete and balance the following equations.  

a) \( \text{Li}(s) + \text{H}_2\text{O}(l) \rightarrow \)  
b) \( \text{Sr}(s) + \text{H}_2\text{O}(l) \rightarrow \)  
c) \( \text{Ag}(s) + \text{H}_2\text{O}(l) \rightarrow \)  
d) \( \text{Ca}(s) + \text{O}_2(g) \rightarrow \)  
e) \( \text{Zn}(s) + \text{O}_2(g) \rightarrow \)  
f) \( \text{Ca}(s) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \)  
g) \( \text{Ca}(s) + \text{HCl}(\text{aq}) \rightarrow \)  
h) \( \text{Ni}(s) + \text{HNO}_3(\text{aq}) \rightarrow \)  

QUESTION 11.
For the following chemical reactions write word equations AND balanced formulae equations.  

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Correctly completes the word equation AND provides a balanced chemical equation</td>
<td>1</td>
</tr>
</tbody>
</table>

a) Hydrochloric acid + zinc \( \rightarrow \)  
b) Hydrochloric acid + iron \( \rightarrow \)
c) Sulfuric acid + aluminium →

d) Sulfuric acid + magnesium →

**QUESTION 12.**
For the following chemical reactions write word equations AND balanced formulae equations.

[General equation for each reaction: acid + metal oxide/metal hydroxide → salt + water]

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correctly completes the word equation AND provides a balanced chemical equation</td>
<td>2 (each)</td>
</tr>
</tbody>
</table>

a) Hydrochloric acid + magnesium oxide →

b) Sulfuric acid + magnesium oxide →

c) Sulfuric acid + copper oxide →

d) Nitric acid + calcium oxide →

e) Nitric acid + copper oxide →
QUESTION 13.
For the following chemical reactions write balanced formulae equations. 2
[Heating metals with sulfur or chlorine produces the sulfide or the chloride of that metal.]

a) Heating aluminium with sulfur →

b) Heating tin(II) and sulfur →

c) Heating copper with chlorine →

d) Heating aluminium with chlorine →

QUESTION 14.
For the following chemical reactions write word AND balanced formulae equations. 6
["Burning" means that combustion occurs. Combustion reactions of hydrocarbons produce carbon dioxide and water.]

a) Burning calcium

b) Combustion of sodium

c) Combustion of iron (steel wool)
d) Combustion of carbon (coal or coke)

________________________________________________________________________

________________________________________________________________________

e) Combustion of sulfur

________________________________________________________________________

________________________________________________________________________

f) Burning hydrogen

________________________________________________________________________

________________________________________________________________________

QUESTION 15.

a) What metals are at the top of the activity series?  

________________________________________________________________________

________________________________________________________________________

b) What group(s) do they come from?  

________________________________________________________________________

________________________________________________________________________

c) Why do you think it is easier for them to lose their electron(s)?  

________________________________________________________________________

________________________________________________________________________
QUESTION 16.
A factory manufactures and supplies dilute sulfuric acid. Of the common metals available (Fe, Al, Cu, Zn, Pb, Sn, Mg, Ag):

a) Which would you use for the containers for moving this sulfuric acid? Give reasons for your answer.  

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Correctly identifies the metal(s)</td>
<td>2</td>
</tr>
<tr>
<td>• Provides correct justification</td>
<td></td>
</tr>
</tbody>
</table>

b) Which would you NOT use for the containers for moving this sulfuric acid? Give reasons for your answer.  

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Correctly identifies the metal(s)</td>
<td>2</td>
</tr>
<tr>
<td>• Provides correct justification</td>
<td></td>
</tr>
</tbody>
</table>
QUESTION 17.

Use the activity series to predict whether or not the following reactions will occur. Explain your answer.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>States whether a reaction will occur AND gives an appropriate justification</td>
<td>1 (each)</td>
</tr>
</tbody>
</table>

a) \( \text{Fe}(s) + \text{Mg}^{2+}(aq) \rightarrow \text{Mg}(s) + \text{Fe}^{2+}(aq) \)

b) \( \text{Ni}(s) + \text{Cu}^{2+}(aq) \rightarrow \text{Ni}^{2+}(aq) + \text{Cu}(s) \)

c) \( \text{Cu}(s) + 2\text{H}^+(aq) \rightarrow \text{Cu}^{2+}(aq) + \text{H}_2(g) \)

d) \( \text{Mg}(s) + \text{H}_2\text{O}(g) \rightarrow \text{MgO}(s) + \text{H}_2(g) \)

e) \( \text{Sn}(s) + \text{Ba}^{2+}(aq) \rightarrow \text{Sn}^{2+}(aq) + \text{Ba}(s) \)

f) \( \text{Al}_2\text{O}_3(s) + 3\text{H}_2(g) \xrightarrow{\Delta} 2\text{Al}(s) + 3\text{H}_2\text{O}(g) \)

g) \( \text{Ca}(s) + \text{Pb}^{2+}(aq) \rightarrow \text{Ca}^{2+}(aq) + \text{Pb}(s) \)

h) \( \text{Cu}(s) + \text{Pb}^{2+}(aq) \rightarrow \text{Cu}^{2+}(aq) + \text{Pb}(s) \)
QUESTION 18.

A group of elements have the following properties:

<table>
<thead>
<tr>
<th>Substance</th>
<th>MP (°C)</th>
<th>BP (°C)</th>
<th>Electrical Conductivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>232</td>
<td>2270</td>
<td>Good</td>
</tr>
<tr>
<td>X</td>
<td>-39</td>
<td>357</td>
<td>Good</td>
</tr>
<tr>
<td>Y</td>
<td>-7</td>
<td>59</td>
<td>Poor</td>
</tr>
<tr>
<td>Z</td>
<td>217</td>
<td>685</td>
<td>Fair</td>
</tr>
</tbody>
</table>

a) Suggest a reason why substance W is most suitable for use as an electrical conductor.  

______________________________________________________________________  
______________________________________________________________________  
______________________________________________________________________

b) Which substance is a liquid metal at room temperature? Justify your answer.  

______________________________________________________________________  
______________________________________________________________________  
______________________________________________________________________  
______________________________________________________________________

c) Suggest a use for the substance named in b).  

______________________________________________________________________
QUESTION 19.

Some reactions of metals Q, R, and S are given below.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Reaction in air</th>
<th>Reaction with water</th>
<th>Reaction with dilute hydrochloric acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>Burns to form metallic oxide</td>
<td>Reacts with steam to form hydrogen</td>
<td>Hydrogen is formed</td>
</tr>
<tr>
<td>R</td>
<td>Reacts slowly to form metallic oxide</td>
<td>Does not react</td>
<td>Does not react</td>
</tr>
<tr>
<td>S</td>
<td>Reacts to form metallic oxide</td>
<td>Does not react</td>
<td>Hydrogen is formed</td>
</tr>
</tbody>
</table>

List the metals in order of decreasing reactivity. Give reasons for your choice.  

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correctly lists metals in order of decreasing reactivity</td>
<td>2</td>
</tr>
<tr>
<td>Correct justification</td>
<td></td>
</tr>
</tbody>
</table>
YEAR 11
CHEMISTRY

METALS

LESSON 3: REACTIONS OF METALS II
PART A: MULTIPLE CHOICE QUESTIONS

QUESTION 1.
Which statement describes the transfer of electrons when zinc reacts with dilute sulfuric acid?
(a) From sulfate ion to zinc
(b) From zinc to hydrogen ion
(c) From zinc to hydrogen gas
(d) From hydrogen gas to zinc

QUESTION 2.
Which of the following list of metals has them arranged in increasing order of metal activity?
(a) Zinc, magnesium, copper and calcium
(b) Copper, zinc, magnesium and calcium
(c) Copper, magnesium, calcium and zinc
(d) Copper, magnesium, zinc and calcium

QUESTION 3.
If two electrons are transferred from an atom of X to an atom of Y to form a compound, then:
(a) The formula of the compound would be X₂Y₂
(b) The compound will be composed of X²⁺ ions and Y²⁻ ions
(c) The solid compound will conduct electricity
(d) The compound will be composed of X²⁻ ions and Y²⁺ ions

QUESTION 4.
When ionic compounds dissolve in water:
(a) they produce electrically conductive solutions due to the presence of dissociated ions
(b) they remain discrete molecules and do not conduct electricity
(c) they dissociate into their ions and do not conduct electricity
(d) they produce electrically conductive solutions due to the presence of discrete molecules
QUESTION 5.
Which of the following equations shows the precipitation of copper(I) chloride?

(a) \( \text{Cu(s)} + \frac{1}{2} \text{Cl}_2(g) \rightarrow \text{CuCl(s)} \)
(b) \( \text{Cu(s)} + \text{Cl}^-(aq) \rightarrow \text{CuCl(s)} \)
(c) \( \text{Cu}^+(aq) + \text{Cl}^-(aq) \rightarrow \text{CuCl(s)} \)
(d) \( \text{Cu}^+(aq) + \frac{1}{2} \text{Cl}_2(g) \rightarrow \text{CuCl(s)} \)
PART B: SHORT ANSWER QUESTIONS

QUESTION 6.
Write balanced formulae equations for the following reactions. 5

[Many substances are decomposed by heating thus forming two or more products.]

a) Heating mercury(II) oxide

b) Heating calcium carbonate forming carbon dioxide gas

c) Heating ammonium carbonate forms ammonia \( \text{NH}_3 \) and two other chemicals in gaseous form

d) Heating magnesium carbonate

e) Heating calcium hydroxide forming calcium oxide as one of the products

f) Heating copper carbonate

g) Heating silver oxide

h) Heating copper nitrate forming \( \text{NO}_2 \) and \( \text{O}_2 \) as well as copper oxide

i) Heating sodium bicarbonate forming sodium carbonate and two other common chemicals
QUESTION 7.
Write a net ionic equation for each of the following reactions. 6

Hints: *The given formulae are correct.
*If the substance is ionic and has the subscript (aq), it is present as ions.
*The charge of unfamiliar ions can be derived from the formula.

a) \[2\text{NaIO}_3(aq) + 6\text{NaHSO}_3(aq) \rightarrow 2\text{NaI}(aq) + 3\text{Na}_2\text{SO}_4(aq) + 3\text{H}_2\text{SO}_4(aq)\]

b) \[\text{BrCl}(g) + \text{H}_2\text{O}(l) \rightarrow \text{HCl}(aq) + \text{HBrO}(aq)\]

c) \[\text{PCl}_5(g) + 4\text{H}_2\text{O}(l) \rightarrow \text{H}_3\text{PO}_4(aq) + 5\text{HCl}(aq)\]

d) \[2\text{Na}_2\text{S}_2\text{O}_3(aq) + \text{I}_2(s) \rightarrow \text{Na}_2\text{S}_4\text{O}_6(aq) + 2\text{NaI}(aq)\]

e) \[\text{Al}(s) + \text{NaOH}(aq) + 3\text{H}_2\text{O}(l) \rightarrow \text{Na}[\text{Al(OH)}_3]_2(aq) + 3/2\text{H}_2(g)\]

f) \[\text{K}_2\text{Cr}_2\text{O}_7(aq) + 6\text{KBr}(aq) + 14\text{HBr}(aq) \rightarrow 2\text{CrBr}_3(aq) + 3\text{Br}_2(aq) + 7\text{H}_2\text{O}(l) + 8\text{KBr}(aq)\]
QUESTION 8.
Write half equations for the following.

a) \[ \text{Zn(s)} \quad + \quad \text{H}_2\text{SO}_4(aq) \quad \rightarrow \quad \text{ZnSO}_4(aq) \quad + \quad \text{H}_2(g) \]

b) \[ \text{Cu(s)} \quad + \quad \text{H}_2\text{SO}_4(aq) \quad \rightarrow \quad \text{CuSO}_4(aq) \quad + \quad \text{H}_2(g) \]

c) \[ \text{Mg(s)} \quad + \quad 2\text{HCl}(aq) \quad \rightarrow \quad \text{MgCl}_2(aq) \quad + \quad \text{H}_2(g) \]

d) \[ \text{Cu(s)} \quad + \quad 2\text{HCl}(aq) \quad \rightarrow \quad \text{CuCl}_2(aq) \quad + \quad \text{H}_2(g) \]
QUESTION 9.
In the following questions, indicate whether a reaction occurs; if a reaction does occur, write a chemical equation for the reaction.

a) Calcium placed in a solution of sodium sulfate

_________________________________________________________________________
_________________________________________________________________________

b) Magnesium placed in a solution of iron chloride

_________________________________________________________________________
_________________________________________________________________________

c) Copper placed in a solution of silver nitrate

_________________________________________________________________________
_________________________________________________________________________
QUESTION 10. (FOR REVISION)

Four unknown metals were placed in a number of different liquids and observed. The results are given in the table. [Note: X = No reaction]

<table>
<thead>
<tr>
<th>Unknown Metal</th>
<th>Reaction of Metal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cold Water</td>
</tr>
<tr>
<td>P</td>
<td>X</td>
</tr>
<tr>
<td>R</td>
<td>X</td>
</tr>
<tr>
<td>S</td>
<td>X</td>
</tr>
<tr>
<td>T</td>
<td>X</td>
</tr>
</tbody>
</table>

a) Use the data in the table to determine the order of activity of the unknown metals.  

b) One of the unknown metals was later identified as iron. Explain which one it was likely to be.  

c) Assess the possibility that two of the unknown metals were copper and silver.
d) Assess the possibility that one of the unknown metals was sodium.

QUESTION 11.
Write a pair of half equations for the following reactions.

(a) Aluminium + dilute nitric acid

(b) Potassium + dilute sulfuric acid

(c) Barium + dilute hydrochloric acid
YEAR 11 CHEMISTRY

METALS

LESSON 4: THE MOLE CONCEPT
PART A: MULTIPLE CHOICE QUESTIONS

QUESTION 1.
The mass of \(3.01 \times 10^{23}\) molecules of carbon dioxide is:
(a) 12 g  
(b) 22 g  
(c) 32 g  
(d) 44 g

QUESTION 2.
Two molecules of ethanol, \(\text{CH}_3\text{CH}_2\text{OH}\), contain a total of:
(a) 6 atoms  
(b) 9 atoms  
(c) 18 atoms  
(d) 24 atoms

QUESTION 3.
The formula mass of \(\text{Na}_2\text{SO}_4.10\text{H}_2\text{O}\) is (to one decimal place)
(a) 322.2  
(b) 142.4  
(c) 161.1  
(d) 80.6

QUESTION 4.
Two molecules of glucose (\(\text{C}_6\text{H}_{12}\text{O}_6\)) contain:
(a) 6 oxygen atoms  
(b) 6 carbon atoms  
(c) 24 hydrogen atoms  
(d) 24 oxygen atoms

QUESTION 5.
Given that there are \(6.02 \times 10^{23}\) particles in one mole of any substance, calculate the mass of water containing \(3.3 \times 10^{23}\) atoms
(a) 9.9 g  
(b) 3.3 g  
(c) 6.6 \(\times 10^{23}\) g  
(d) 5.2 \(\times 10^{2}\) g
QUESTION 6.
Methane gas (CH₄) was burnt with a limited supply of oxygen in a sealed container. One of the products was solid carbon (soot). The solid carbon was carefully scraped from the inside of the container and was found to weigh 54g. Assume the carbon is pure carbon-12. How many carbon atoms would there be in the weighed sample?
(a) 4.5 atoms
(b) 5.4 x 10² atoms
(c) 2.7 x 10²³ atoms
(d) 2.7 x 10²⁴ atoms

QUESTION 7.
Given that there are 6.02 x 10²³ particles in one mole of any substance, calculate the mass of water containing 3.3 x 10²³ atoms.
(a) 9.9g
(b) 3.3g
(c) 6.6 x 10²³
(d) 5.2 x 10²

QUESTION 8.
How many atoms are there in 2.50 grams of pure carbon-12?
(a) 1.25 x 10²³
(b) 2.50 x 10²³
(c) 2.5
(d) 5

QUESTION 9.
What is the mass of 2 moles of oxygen atoms?
(a) 8.0 grams
(b) 16 grams
(c) 32 grams
(d) 64 grams
### PART B: SHORT ANSWER QUESTIONS

**QUESTION 10.**

Calculate the molar mass of:

<table>
<thead>
<tr>
<th>Chemical Formula</th>
<th>Molar Mass g/mol</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Cl₂</td>
<td></td>
</tr>
<tr>
<td>b) Fr</td>
<td></td>
</tr>
<tr>
<td>c) P₄</td>
<td></td>
</tr>
<tr>
<td>d) N₂</td>
<td></td>
</tr>
<tr>
<td>e) He</td>
<td></td>
</tr>
<tr>
<td>f) KCl</td>
<td></td>
</tr>
<tr>
<td>g) Na₃PO₄</td>
<td></td>
</tr>
<tr>
<td>h) Fe(OH)₂</td>
<td></td>
</tr>
<tr>
<td>i) Sucrose, C₁₂H₂₂O₁₁</td>
<td></td>
</tr>
<tr>
<td>j) NaAl(SO₃)₂</td>
<td></td>
</tr>
<tr>
<td>k) Al₂(SO₄)₃</td>
<td></td>
</tr>
<tr>
<td>l) (NH₄)₂CO₃</td>
<td></td>
</tr>
</tbody>
</table>
QUESTION 11.

Determine the number of molecules in:

a) A mole of ammonia gas (NH₃) 1

b) 0.5 moles of CO₂ 1

c) 2 moles of ethane (C₂H₆) 1

QUESTION 12.

The formula for aluminium sulfate is Al₂(SO₄)₃. In 1 mole of Al₂(SO₄)₃, there are: 3

a) ______ moles of oxygen atoms.

b) ______ moles of aluminium atoms.

c) ______ moles of sulfur atoms.

QUESTION 13.

Use this equation: \( \text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3 \), for the following problems. 4

a) If you used 1 mole of \( \text{N}_2 \), how many moles of \( \text{NH}_3 \) could be produced? ______

b) If 10 moles of \( \text{NH}_3 \) were produced, how many moles of \( \text{N}_2 \) would be required? ______

c) If 3.00 moles of \( \text{H}_2 \) were used, how many moles of \( \text{NH}_3 \) would be made? ______

d) If 0.600 moles of \( \text{NH}_3 \) were produced, how many moles of \( \text{H}_2 \) are required? ______
QUESTION 14.

How many:

a) Moles of O atoms are there in 18.1 moles of formaldehyde, $\text{H}_2\text{CO}_3$?

__________________________________________________________________________
__________________________________________________________________________

b) Moles of Br atoms are there in 0.41 moles of bromoform, $\text{CHBr}_3$?

__________________________________________________________________________
__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

d) Moles of Hg atoms are there in 87 g of $\text{HgO}$?

__________________________________________________________________________
__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

e) Moles of N atoms are there in $2.1 \times 10^{-3}$ g of $\text{K}_3\text{Fe(CN)}_6$?

__________________________________________________________________________
__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
QUESTION 15.
Determine the:

a) Number of oxygen atoms in 30 g of quartz sand (silicon dioxide).  

b) Number of atoms in 8.0 g of oxygen gas.  

c) Number of atoms in 0.5 moles of oxygen gas.  

d) Number of atoms in $3 \times 10^{23}$ molecules of oxygen.  

e) Number of atoms in 36 g of water.  

QUESTION 16.

How many:

a) Moles of CO₂ are there in 83.2 g of CO₂?  
_________________________________________________________________________  
_________________________________________________________________________  
_________________________________________________________________________  
_________________________________________________________________________  

1

b) Moles of glycerol, C₃H₆O₃, are there in 428 g of glycerol?  
_________________________________________________________________________  
_________________________________________________________________________  
_________________________________________________________________________  
_________________________________________________________________________  

1

c) Moles of NaH₂PO₄ are there in 14 g of NaH₂PO₄?  
_________________________________________________________________________  
_________________________________________________________________________  
_________________________________________________________________________  
_________________________________________________________________________  

1

d) Moles of quinine, C₂₀H₂₄N₂O₂, are there in 51.6 g of quinine?  
_________________________________________________________________________  
_________________________________________________________________________  
_________________________________________________________________________  
_________________________________________________________________________  

1
QUESTION 17.
How many:

a) Grams of nitrogen dioxide, NO\textsubscript{2}, are there in 1.77 moles of NO\textsubscript{2}?  

b) Grams of 2-propanol, C\textsubscript{3}H\textsubscript{8}O (rubbing alcohol), are there in 0.84 mole of 2-propanol?  

c) Grams of WCl\textsubscript{5} are there in 3.69 moles of WCl\textsubscript{5}?  

d) Grams of galactose, C\textsubscript{6}H\textsubscript{12}O\textsubscript{6}, are there in 0.348 mole of galactose?  

e) Grams of vitamin C, C\textsubscript{6}H\textsubscript{8}O\textsubscript{6}, would correspond to \(4.9 \times 10^{-2}\) mole of vitamin C?
QUESTION 18.

How many:

a) Moles of Ag\(^+\) ions are there in 3.71 moles of AgNO\(_3\)?

b) Moles of Na\(^+\) ions are there in 1.44 g of Na\(_2\)CO\(_3\)?

c) Moles of SO\(_4^{2-}\) ions are there in 84 g of Al\(_2\)(SO\(_4\))\(_3\)?
QUESTION 19.

How many:

a) Molecules of TNT, C₇H₅N₃O₆, are there in 2.9 moles of TNT?

b) Molecules are in one drop (0.0500 g) of water?
QUESTION 20.

A student was given a sample of 4.4 g of the compound CO$_2$. How many:

a) Moles were in the sample provided? 1

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

b) Molecules were in the sample provided? 1

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

c) Atoms were in the sample provided? 1

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

d) Atoms of oxygen were in the sample provided? 1

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

e) How many moles of oxygen were in the sample provided? 1

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
QUESTION 21.
The metal zinc reacts with hydrochloric acid to produce hydrogen gas.

a) Write TWO half-equations and an overall ionic equation to represent this reaction.  

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

b) Calculate the mass of zinc required to produce 7.5g of hydrogen.  

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
YEAR 11
CHEMISTRY
METALS
LESSON 5: MOLE CALCULATIONS
PART A: MULTIPLE CHOICE QUESTIONS

[Refer to this equation for Question 1-3]

\[ \text{CH}_4(g) + 2\text{O}_2(g) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(l) \]

QUESTION 1.
The equation above shows the combustion of methane.
100 mL of methane was mixed with 100 mL of oxygen and allowed to react, and the products restored to room temperature and pressure.
What is the composition of the gases present after the reaction?
(a) 100 mL of CO₂
(b) 50 mL CH₄, 50 mL CO₂
(c) 50 mL O₂, 100 mL CO₂, 50 mL H₂O
(d) 50 mL CH₄, 50 mL O₂, 50 mL CO₂, 100 mL H₂O

QUESTION 2.
For the combustion of methane (above) determine the volume of 32.0 g of methane at 101.3 kPa and 298 K
(a) 45.3 L
(b) 49.5 L
(c) 90.6 L
(d) 1.99 L

QUESTION 3.
If 50 g of methane and 2.0 moles of oxygen are reacted, determine the mass of carbon dioxide produced (NB: Not all the reactants are used up!)
(a) 22 g
(b) 44 g
(c) 66 g
(d) 88 g
QUESTION 4.
Which one of the following is true for mole of oxygen, at 100 kPa and 25 °C?
(a) It has a mass of 16.0 grams
(b) It has a volume of 24.79 L
(c) It has a mass of $2.7 \times 10^{-23}$ grams
(d) It has one quarter the mass of a germanium atom

QUESTION 5.
Which of the following will occupy the largest volume at one atmosphere of pressure and at 25 °C?
(a) 10 grams of water
(b) 10 grams of lead
(c) 10 grams of krypton
(d) 10 grams of silver nitrate

QUESTION 6.
The boiling points of carbon dioxide, sulfur dioxide and nitrogen dioxide are -57 °C, -10 °C and 21 °C, respectively.
Which of the following will occupy the largest volume at 100 kPa and 25 °C, carbon dioxide, nitrogen dioxide or sulfur dioxide?
(a) carbon dioxide since it has the lowest molecular mass
(b) sulfur dioxide since it has the greatest molecular mass
(c) nitrogen dioxide since it has the highest boiling point
(d) they will have the same volume since they are gases

QUESTION 7.
Photosynthesis can be represented by the equation:
$$6\text{CO}_2(g) + 6\text{H}_2\text{O}(l) + \text{energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(aq) + 6\text{O}_2(g)$$
Calculate the mass of glucose produced when 54g of water reacts with excess carbon dioxide during photosynthesis.
(a) 30 g
(b) 90 g
(c) 180 g
(d) 1080 g
QUESTION 8.
What is the mass of magnesium oxide (MgO) produced by burning 6.075g of magnesium?
(a) 0.250g
(b) 6.075g
(c) 10.075g
(d) 40.300g

QUESTION 9.
What is the number of molecules present in 22g of CO₂ at 298K and 100kPa?
(a) 3.0 x 10^{23}
(b) 6.0 x 10^{23}
(c) 12 x 10^{23}
(d) 6.0 x 10^{11.5}

QUESTION 10.
What is the whole number mass ratio of metal to non-metal in barium chloride?
(a) 1:2
(b) 2:1
(c) 1:1
(d) 4:1
PART B: SHORT ANSWER QUESTIONS

QUESTION 11.

For the reaction

\[ 2N_2(g) + 3O_2(g) \rightarrow 2N_2O_3(g) \]

a) How many moles of \( N_2 \) are required to react completely with 1 mole of \( O_2 \)? 1

\[ \text{b) How many moles of } N_2O_3 \text{ are produced from the complete reaction of 1 mole of } O_2? 1 \]

\[ \text{c) How many moles of } O_2 \text{ are required to produce 8 moles of } N_2O_3? 1 \]

QUESTION 12.

a) For the reaction

\[ 2Al(s) + 6HCl(g) \rightarrow 2AlCl_3(s) + 3H_2(g) \]

How many moles of \( H_2 \) are produced by the complete reaction of 132 g of Al? 2

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculates the number of moles of Al AND determines the number of moles of ( H_2 ) by applying mole ratios</td>
<td>2</td>
</tr>
</tbody>
</table>
b) Ethyl alcohol, C\textsubscript{2}H\textsubscript{6}O, can be added to gasoline to produce “gasohol”, a fuel for automobile engines. The equation for the combustion of ethyl alcohol is

\[
\text{C}_2\text{H}_6\text{O}(l) + 3\text{O}_2(g) \rightarrow 2\text{CO}_2(g) + 3\text{H}_2\text{O}(g)
\]

How many grams of O\textsubscript{2} are required for the combustion of 421 g of C\textsubscript{2}H\textsubscript{6}O?

---

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculates the number of moles of C\textsubscript{2}H\textsubscript{6}O AND Determines the number of moles of O\textsubscript{2} AND Converts this to grams</td>
<td>3</td>
</tr>
</tbody>
</table>
c) In the process called photosynthesis, plants convert CO$_2$ and H$_2$O to glucose, C$_6$H$_{12}$O$_6$, by the reaction

$$6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g})$$

How many grams of CO$_2$ are required to produce 5.1 g of glucose? 3

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculates the number of moles of glucose AND</td>
<td></td>
</tr>
<tr>
<td>Determines the number of moles of CO$_2$ AND</td>
<td>3</td>
</tr>
<tr>
<td>Converts this to grams</td>
<td></td>
</tr>
</tbody>
</table>
QUESTION 13.

a) Iron ore is converted to iron by a process that can be represented as

\[ 2Fe_2O_3(s) + 6C(s) + 3O_2(g) \rightarrow 4Fe(s) + 6CO_2(g) \]

If the process is run until 3940 g of Fe is produced, how many grams of CO\(_2\) will also be produced?

3 marks

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculates the number of moles of iron AND</td>
<td></td>
</tr>
<tr>
<td>Determines the number of moles of CO(_2) AND</td>
<td>3</td>
</tr>
<tr>
<td>Converts this to grams</td>
<td></td>
</tr>
</tbody>
</table>

b) How much C (in grams) is necessary to react completely with 0.58 g of Fe\(_2\)O\(_3\)?

2 marks
QUESTION 14.

a) Aspirin can be made in the laboratory by the reaction

\[ C_7H_6O_3(s) + C_2H_3ClO(l) \rightarrow C_9H_8O_4(s) + HCl(g) \]

How many grams of aspirin (C₉H₈O₄) are produced if 85.0 g of salicylic acid (C₇H₆O₃) is treated with excess acetyl chloride (C₂H₃ClO)?

Criteria | Marks
--- | ---
Calculates the number of moles of salicylic acid AND | 3
Determines the number of moles of aspirin AND | 3
Converts this to grams | 3

b) The compound aniline reacts with chlorine as follows:

\[ C_6H_7N(l) + 3Cl_2(g) \rightarrow C_6H_4Cl_3N(l) + 3HCl(g) \]

How many grams of trichloroaniline are produced if 34.7 g of aniline is treated with excess Cl₂?

QUESTION 15.
Two 1.0L containers are each filled with chlorine gas and helium gas at the same temperature (25°C) and pressure (100 kPa).

(a) Construct a table to compare the volume, the number of molecules and the number of atoms in each of the container.

<table>
<thead>
<tr>
<th>Volume</th>
<th>Chlorine</th>
<th>Helium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) State the law that allows you to make this comparison.
QUESTION 16.

If 29.7 g of N₂ is added to 3.31 g of H₂ in the reaction:

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) \]

a) Which reactant is completely used up?

b) How many grams of the other reactant are left over?

c) How many grams of NH₃ are formed if the reaction goes to completion?
QUESTION 17.

1.38 g of hydrogen reacts with chlorine to form hydrogen chloride.

\[ \text{H}_2(g) + \text{Cl}_2(g) \rightarrow 2\text{HCl}(g) \]

a) Find the number of moles of hydrogen. 

______________________________________________________________________

b) Find the number of moles of chlorine needed to react with hydrogen completely.

______________________________________________________________________

c) Find the mass of chlorine that will combine with 1.38 g of hydrogen to form hydrogen chloride.

______________________________________________________________________

d) Find the number of moles of hydrogen chloride gas produced.

______________________________________________________________________

e) Find the volume of hydrogen chloride gas produced at 1 atm and 25 °C.

______________________________________________________________________

f) What is the mass of hydrogen chloride gas produced?

______________________________________________________________________
QUESTION 18.

The table shows the percentage composition (volume/volume) of dry air.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>78.08%</td>
</tr>
<tr>
<td>Oxygen</td>
<td>20.95%</td>
</tr>
<tr>
<td>Argon</td>
<td>0.93%</td>
</tr>
</tbody>
</table>

a) Calculate the volume of oxygen in a 100mL sample of air 1

b) Calculate the number of moles of oxygen in 100mL of air at STP 1

c) Calculate the percentage of oxygen in air in terms of moles, i.e. mole %/total moles of gas 2

d) Identify the chemical law used to calculate your result in (c). 1
QUESTION 19.

Gaseous chlorine and gaseous fluorine undergo a combination (synthesis) reaction to form the interhalogen compound \( \text{ClF}_2 \).

a) Write the chemical equation for this reaction.  

\[
\text{Cl}_2(g) + \text{F}_2(g) \rightarrow \text{ClF}_2(g)
\]

1

b) Calculate the mass of fluorine needed to react with 3.27 g of \( \text{Cl}_2 \).  

2

c) Calculate the volume of \( \text{ClF} \) produced at 100 kPa and 25 °C.  

2
QUESTION 20.

Dinitrogen pentoxide, $\text{N}_2\text{O}_5$, undergoes a decomposition reaction to form nitrogen dioxide, $\text{NO}_2$, and oxygen. 0.165 g of $\text{O}_2$ was produced by the reaction

a) Write the chemical equation for this reaction.

b) What is the number of moles of $\text{O}_2$ produced?

c) How many moles of $\text{NO}_2$ are produced?

d) What volume of $\text{NO}_2$ is produced at 100 kPa and 0°C?
QUESTION 21.

Sodium reacts with water to produce sodium hydroxide and hydrogen gas.

\[ 2\text{Na}(s) + 2\text{H}_2\text{O}(l) \rightarrow 2\text{NaOH}(aq) + \text{H}_2(g) \]

Calculate the mass of sodium required to produce 80.0 g of sodium hydroxide when reacted with water, and the volume of hydrogen produced at room temperature and 100 kPa. 4

(This reaction is rather dangerous because the hydrogen can form an explosive mixture with the oxygen in the air and bits of molten sodium metal may be released and start a fire.)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculates the moles of sodium hydroxide</td>
<td>4</td>
</tr>
<tr>
<td>Determines the number of moles of sodium required and converts this to mass</td>
<td></td>
</tr>
<tr>
<td>Determines the number of moles of hydrogen gas produced</td>
<td></td>
</tr>
<tr>
<td>Calculates the volume of hydrogen gas produced using molar volumes</td>
<td></td>
</tr>
</tbody>
</table>

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YEAR 11
CHEMISTRY

METALS
LESSON 6: EMPIRICAL & MOLECULAR FORMULAE
PART A: MULTIPLE CHOICE QUESTIONS

QUESTION 1.
Identify the molar ratios of reactants to products in the reaction represented by the unbalanced equation:

\[ \text{Al}(s) + \text{H}_2\text{SO}_4(aq) \rightarrow \text{Al}_2(\text{SO}_4)_3(aq) + \text{H}_2(g) \]

<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) 1:1</td>
<td>1:1</td>
</tr>
<tr>
<td>(b) 2:3</td>
<td>1:3</td>
</tr>
<tr>
<td>(c) 3:2</td>
<td>3:1</td>
</tr>
<tr>
<td>(d) 3:2</td>
<td>1:2</td>
</tr>
</tbody>
</table>

QUESTION 2.
A sample of sulfide contains 6.70 g of iron and 3.84 g of sulfur. The empirical formula of the sulfide is:

(a) \( \text{Fe}_7\text{S}_4 \)
(b) \( \text{Fe}_4\text{S}_7 \)
(c) \( \text{Fe}_2\text{S}_3 \)
(d) \( \text{FeS} \)

QUESTION 3.
One mole of an oxide of iron was found to contain 64 g of oxygen and 168 g of iron. The correct formula for this compound is:

(a) \( \text{FeO} \)
(b) \( \text{FeO}_2 \)
(c) \( \text{Fe}_2\text{O}_3 \)
(d) \( \text{Fe}_3\text{O}_4 \)

QUESTION 4.
The relative atomic mass of chlorine is 35.45. This value tells us that:

(a) Chlorine has several different allotropes
(b) Chlorine has several different isotopes
(c) Each chlorine atom contains at least 35 neutrons
(d) Each chlorine atom weighs 35.45 g
QUESTION 5.
Which of the following compounds has a molecular formula which is identical to its empirical formula?
(a) Methane
(b) Ethane
(c) Propane
(d) Butane

QUESTION 6.
How many empirical units are there in a molecule of glucose (C₆H₁₂O₆)?
(a) 1
(b) 4
(c) 6
(d) 12

QUESTION 7.
How many empirical units are there in a molecule of sucrose (C₁₂H₂₂O₁₁)?
(a) 1
(b) 4
(c) 6
(d) 12

QUESTION 8.
One mole of an oxide of iron was found to contain 64 g of oxygen and 168 g of iron. The correct formula for this compound is:
(a) FeO
(b) FeO₂
(c) Fe₂O₃
(d) Fe₃O₄
PART B: SHORT ANSWER QUESTIONS

QUESTION 9.

a) Calculate the percentage composition of each element in:

(i) KClO

(ii) KClO₃

(iii) KClO₄

b) What mass of oxygen is contained in 5.5 g of KClO₃?

c) A 0.2360 g sample of a white compound was analysed and found to contain 0.0944 g of Ca, 0.0283 g of C and 0.1133 g of O. What is the percentage composition of this compound?
d) What mass of silver is contained in:
   (i) 0.263 g of AgF
   _____________________________________________________________

   (ii) 5.92 g of AgCl
   _____________________________________________________________

   (iii) 136.9 g of AgBr
   _____________________________________________________________

QUESTION 10.

a) What is the empirical formula of a compound of bismuth and chlorine, which is 66% (w/w) bismuth?
   _____________________________________________________________
   _____________________________________________________________

b) If a sample of this compound contained 2g of bismuth, what would be the total mass of the sample?
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________
QUESTION 11.

A compound of copper and chlorine contains 1.902 g of copper and 1.048 g of chlorine. Calculate its empirical formula.

QUESTION 12.

Determine the empirical formula of the following:

a) A hormone with percentage composition: 56.8 % C, 6.56 % H, 28.4 % O, and 8.28 % N.

b) Copper(II) tartrate with percentage composition: 30.3 % Cu, 22.70 % C, 1.91 % H and 45.37 % O.
c) Nitrosyl fluoroborate with percentage composition: 11.99 % N, 13.70 % O, 9.25 % B and 65.06 % F.

QUESTION 13.

A compound containing 52.2 % C, 13.0 % H and 34.8 % O has an observed molar mass of 91.6 g.

Determine:

a) The empirical formula

b) The molecular formula

c) The exact molar mass of the compound.
QUESTION 14.

A compound containing 12.3% N, 3.5% H, 28% S and 56.1% O has an observed molar mass of 228 g.

Determine:

a) The empirical formula

b) The molecular formula

c) The exact molar mass of the compound.
QUESTION 15.
The table shows data for the compound hydrazine

<table>
<thead>
<tr>
<th>Composition</th>
<th>Hydrazine is a compound of nitrogen and hydrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete combustion of gaseous hydrazine at 400 K and 100 kPa</td>
<td>hydrazine (g) + oxygen (g) → nitrogen dioxide (g) + water (g)</td>
</tr>
<tr>
<td>1.0 L</td>
<td>3.0 L</td>
</tr>
</tbody>
</table>

a) Explain how the data for combustion illustrates Gay-Lussac’s Law of Combining Gas Volumes. 1

b) Determine the molecular formula of hydrazine. Show all working. 2

c) What is the empirical formula for hydrazine? 1

QUESTION 16.
a) A compound of copper and chlorine contains 2.950g of copper and 1.048g of chlorine. Calculate its empirical formula. 2

b) Write a balanced chemical equation for the formation of the above compound from its constituent atoms. 2
QUESTION 17.
Chalcocite is a copper ore which has a mass composition of 20.2% sulphur and 79.8% copper.

a) Calculate the empirical formula of chalcocite

b) Copper metal is commonly extracted from chalcocite by heating the liquid ore in the presence of oxygen producing liquid copper metal and sulphur dioxide, a toxic gas.' Write a balanced chemical equation for the extraction reaction described above.

c) Calculate the volume of sulphur dioxide gas produced at STP when 10 kilograms of chalcocite is completely decomposed

d) Give two factors that justify the recycling of copper metal

QUESTION 18.

a) Classify each of the following as molecular formula or empirical formula

   a. MgCl₂.6H₂O
   b. C₄H₈
   c. H₂O₂
   d. CH₄

b) If any of the above formulas are molecular, re-write as empirical formulas
QUESTION 19.
A student performed a first-hand investigation to measure and identify the mass of the elements in magnesium oxide.

The information she recorded is as follows:

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

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

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
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_______________________________________________________________________
_______________________________________________________________________

2
b) Calculate the volume of oxygen taken from the air during this experiment. Assume the air temperature and pressure was 25°C and 100kPa respectively.  

_______________________________________________________________________  

_______________________________________________________________________  

_______________________________________________________________________  

_______________________________________________________________________
YEAR 11 CHEMISTRY

METALS

LESSON 7: TRENDS IN THE PERIODIC TABLE
PART A: MULTIPLE CHOICE QUESTIONS

QUESTION 1.
One property which is not characteristic of metals is that:
(a) metals readily lose valence electrons from their atoms
(b) metals are good conductors of electricity and heat
(c) the strength of metals is a consequence of extensive covalent bonding
(d) metals have a regularity of structure such as is found in crystals

QUESTION 2.
Which of the following statements is not possible?

When a metal forms a compound, its electronic configuration:
(a) becomes the same as the non-metal with which it bonds
(b) becomes similar to that of the noble gas in the previous period
(c) will add up to a number that is higher than its atomic number
(d) will add up to a number that is less than its atomic number

QUESTION 3.
The aspect of metallic structure which best accounts for the electrical conductivity of metals is:
(a) the presence of delocalised electrons
(b) the presence of mobile cations
(c) the formation of an ionic crystal lattice
(d) the close packing of metal cations in the crystal

QUESTION 4.
Which of the sequences arranges the elements according to increasing electronegativity?
(a) Al, H, O, F
(b) Al, O, F, H
(c) F, O, H, Al
(d) F, O, Al, H
Questions 5-8 are based on the following part of the Periodic Table. The symbols for the elements are fictitious.

Groups

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>P</td>
<td>Q</td>
<td>U</td>
<td>V</td>
<td>Y</td>
<td></td>
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<tr>
<td>R</td>
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<td></td>
<td></td>
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<tr>
<td>S</td>
<td>T</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

QUESTION 5.
Based on the position of the elements in the Periodic Table, which of the following formulae is not correct?
(a) $V_2X_3$
(b) $P_2X_2$
(c) $R_3V_2$
(d) $QY_2$

QUESTION 6.
Which of the following elements has the lowest first ionisation energy?
(a) P
(b) S
(c) Z
(d) Y

QUESTION 7.
Which of the following elements has the smallest atomic volume?
(a) P
(b) S
(c) Z
(d) Y
QUESTION 8.
Which of the following elements is the most electronegative?
(a) P
(b) S
(c) Z
(d) Y

QUESTION 9.
The first ionisation energy:
(a) is a measure of the energy required to remove the electron nearest to the nucleus
(b) is lowest for francium in the family of alkali metals
(c) is highest for the halogen of each period in the Periodic Table decreases from left to right in a period of elements in the periodic table

QUESTION 10.
If the arrows that are shown in the alternatives (a) to (d) were drawn onto a periodic table, which one would indicate the trend of increasing metallic character?

(a)  (b)  (c)  (d)

QUESTION 11.
Choose the INCORRECT statement in the following. The atomic radii of elements:
(a) increase across any given period, due to an increase in the number of electrons
(b) increase down a given group, due to the increased number shells
(c) depends upon the size of the nucleus of its atoms
(d) depends upon the electronic configuration of the element
QUESTION 12.
An imaginary element ‘bevittine’, symbol Bv with 7 outer shell electrons, is found to have an atomic weight in excess of all other elements in its group. The prediction most likely to be correct is that ‘bevittine’ would:
(a) form covalent bonds with itself, and ionic bonds with metal
(b) have a very high first ionisation energy
(c) form a compound with phosphorus with the formula PBv
(d) not be very reactive

QUESTION 13.
Which of the following series is isoelectronic?
(a) F−, C2−, O, B3−
(b) F−, C+, O+, B3−
(c) F, C−, O2+, B
(d) F+, C2+, O, B3−

QUESTION 14.
In comparing any pair of elements in Group VII of the Periodic Table, the lower element of each pair would have:
(a) monatomic molecules
(b) a lower atomic weight
(c) a higher boiling point
(d) a smaller atomic radius

QUESTION 15.
A vertical group of the periodic table consists of elements that have the:
(a) Same number of electrons in the valence shell
(b) Same number of protons in the nucleus
(c) Same number of electrons surrounding the nucleus
(d) Same number of neutrons
QUESTION 16.
The numbers 2, 8, 18 and 32 are significant in atomic structure because they represent the:
(a) Atomic number of successive noble gas elements
(b) Numbers of elements in various rows of the periodic table
(c) Maximum number of electrons contained in successive electron shells
(d) Number of shells in atoms of successive elements down a periodic table group

QUESTION 17.
Which element has the highest electronegativity?
(a) Chlorine
(b) Iodine
(c) Rubidium
(d) Sodium

QUESTION 18.
Which statement best describes Mendeleev’s theory for the classification of elements?
(a) The chemical and physical properties of elements vary in relation to their atomic weights
(b) The physical properties of elements vary in relation to their atomic weight
(c) The chemical and physical properties of elements vary in relation to their atomic number
(d) The chemical properties of elements vary in relation to their atomic number

QUESTION 19.
When Mendeleev formulated his Periodic Table in the 1860s, he studied the properties of known elements. Which property was not used by Mendeleev?
(a) Electronic configuration
(b) Melting point and boiling point
(c) Density
(d) Reactivity
QUESTION 20.

Which property of elements increases as you go down each group of the Periodic Table?

(a) Ionisation Energy
(b) Electronegativity
(c) Melting Point
(d) Atomic Radius
PART B: SHORT ANSWER QUESTIONS

QUESTION 21.

Sodium, potassium and rubidium belong to Group I of the Periodic Table and exhibit similarity in some properties and differences in others. Explain in terms of their structure of their atoms, each of the following observations:

a) Their reaction with water is similar in that hydrogen gas is produced in all cases. 2

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describes similarities in their reaction with water</td>
<td>2</td>
</tr>
<tr>
<td>Reference to their atomic structure</td>
<td></td>
</tr>
</tbody>
</table>

b) Their reaction with water is different in that the reaction involving rubidium is the most violent. 2

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describes the differences in reaction with water</td>
<td>2</td>
</tr>
<tr>
<td>Reference to their atomic structure</td>
<td></td>
</tr>
</tbody>
</table>
QUESTION 22.

The graph belows the 1st ionisation energies of the first 55 elements.

![Graph of ionisation energies vs Atomic No.](image)

**a)** Outline why the shape of the graph varies in this way.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

**b)** Explain why the elements with Atomic numbers 3, 11, 19, 37 and 55 have much lower 1st ionisation energies than the elements immediately preceding them (atomic numbers 2, 10, 18, 36 and 54).

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

1

3
QUESTION 23.

The graph below shows the trend in the first ionisation energy and atomic radius of the first 20 elements against their atomic number.

Explain the trend displayed in the graph, using specific examples to illustrate your answer.

5
QUESTION 24.

Of the eight elements in the second period of the Periodic Table, name two which:

a) Form ionic bonds with fluorine. Write the formulae for the two compounds.  

   ____________________________________________________________________________
   ____________________________________________________________________________
   ____________________________________________________________________________

b) Form covalent bonds with fluorine. Write the formulae for the two compounds.  

   ____________________________________________________________________________
   ____________________________________________________________________________
   ____________________________________________________________________________

QUESTION 25.

Explain why the second ionisation energy of Mg is only about twice as great as the first, but the third is ten times as great.  

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Explains why the second ionization energy is twice as great</td>
<td>2</td>
</tr>
<tr>
<td>• AND</td>
<td></td>
</tr>
<tr>
<td>• Explains why the third ionization energy is ten times as great</td>
<td></td>
</tr>
</tbody>
</table>
QUESTION 26.

Successive ionisation energies for the element X are given below:

<table>
<thead>
<tr>
<th></th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.E. (in kJ/mol)</td>
<td>744</td>
<td>1476</td>
<td>7834</td>
<td>10578</td>
<td>13783</td>
</tr>
</tbody>
</table>

a) To which periodic table group does this element belong?  
__________________________________________________________________________

b) Use the data to predict the formula of the chloride of X.  
__________________________________________________________________________

QUESTION 27.

Explain the implications of this trend for the relative chemical reactivity of the Group II elements.  
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
QUESTION 28.

The melting points of elements in Period 3 of the Periodic Table are given below.

<table>
<thead>
<tr>
<th>Element</th>
<th>Na</th>
<th>Mg</th>
<th>Al</th>
<th>Si</th>
<th>P</th>
<th>S</th>
<th>Cl</th>
<th>Ar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting Point (°C)</td>
<td>98</td>
<td>650</td>
<td>660</td>
<td>1410</td>
<td>44</td>
<td>119</td>
<td>-101</td>
<td>-189</td>
</tr>
</tbody>
</table>

a) Explain why silicon and phosphorous, which are so close to each other, have such a marked difference in their melting points.  

___________________________________________________________________  
___________________________________________________________________  
___________________________________________________________________  
___________________________________________________________________  

b) Plot a graph on the grid below to show how the melting point (in °C) changes with the atomic number of the elements across Period 3 of the Periodic Table.
QUESTION 29.

Consider the following first ionisation energy for successive elements in the periodic table denoted only by the letters P – V. All values are in kJ/mol.

<table>
<thead>
<tr>
<th>Elements</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>S</th>
<th>T</th>
<th>U</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ionisation Energy</td>
<td>1407</td>
<td>1320</td>
<td>1687</td>
<td>2087</td>
<td>502</td>
<td>744</td>
<td>584</td>
</tr>
</tbody>
</table>

a) Predict which element is likely to form an ionic compound with bromine, with the ratio of 2:1. Write the formula of this compound.

b) Predict the type of bonding present in the chloride of R.

c) Do the elements P – V all have the same number of electron shells? Justify your answer.

---

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct answer</td>
<td></td>
</tr>
<tr>
<td>Correct justification regarding ionization energies and noble gas electron configuration</td>
<td></td>
</tr>
<tr>
<td>Reference to the values in the table</td>
<td>3</td>
</tr>
</tbody>
</table>
QUESTION 30.

Consider the part of the Periodic Table given below and answer the following questions.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td></td>
<td>T</td>
<td>W</td>
<td>Y</td>
<td>X</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Using the letter given in the table, name the element with:

a) The largest first ionisation energy

______________________________________________________________________

b) The largest third ionisation energy

______________________________________________________________________

c) The highest electron affinity

______________________________________________________________________

d) The highest melting point

______________________________________________________________________

e) The highest conductivity of heat and electricity

______________________________________________________________________
QUESTION 31.

Consider the table:

<table>
<thead>
<tr>
<th>Element</th>
<th>Atomic Radius</th>
<th>Ionic Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li</td>
<td>1.52</td>
<td>0.65</td>
</tr>
<tr>
<td>F</td>
<td>0.71</td>
<td>1.36</td>
</tr>
</tbody>
</table>

Explain why lithium decreases in size when it forms its ion, while fluorine increases in size. 4

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Correctly explains the formation of a cation with reference to the change in electron structure and forces</td>
<td>3-4</td>
</tr>
<tr>
<td>• Correctly explains the formation of an anion with reference to the change in electron structure and forces</td>
<td></td>
</tr>
</tbody>
</table>

...
QUESTION 32.

In each of the following statements, cross out the incorrect alternative. Consider the halogens in order of increasing atomic weight. As the atomic weight increases:

a) The melting and boiling points [increases / decreases]

b) The atomic radius [increases / decreases]

c) The first ionisation energy [increases / decreases]

d) The colour of the elements gets [lighter / darker]

e) The reactivity of the elements [increases / decreases]

QUESTION 33.

Explain each of the following trends, referring to the processes involved.

a) The first ionisation energies and the chemical reactivities of Group VII elements decrease down the group.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explains the relationship between reactivity and electronegativity</td>
<td>3</td>
</tr>
<tr>
<td>Explains the relationship between electronegativity and the atomic radius</td>
<td></td>
</tr>
<tr>
<td>Explains how the size of the atomic radius affects first ionization energy</td>
<td></td>
</tr>
</tbody>
</table>
b) The first ionisation energies of Group I elements decrease down the group; however the chemical reactivity increases down the group.  

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Explains the relationship between reactivity and electronegativity</td>
<td>3</td>
</tr>
<tr>
<td>• Explains the relationship between electronegativity and the atomic radius</td>
<td></td>
</tr>
<tr>
<td>• Explains how the size of the atomic radius affects first ionization energy</td>
<td></td>
</tr>
</tbody>
</table>
QUESTION 34.

a) Define the term first ionisation energy using sodium as an example

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

b) Explain the importance of first ionisation energy in determining the reactivity of a metal such as sodium

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

___________________________________________________________________
QUESTION 35.

The atomic radii of period 2 elements are show in the graph.

a) Plot a new point on the graph showing the relative value for the atomic radius of sodium 1

b) Plot a new point on the graph showing the relative value for the atomic radius of a lithium ion, $\text{Li}^+$ 1

c) Sketch a curve on the graph showing the relative trend in ionisation energy values for period 2 elements 1

d) The ionisation energy for chlorine is 1260 kJ/mol, which of the following equations correctly represents the ionisation process? 1

a. $\text{Cl}(g) + 1260\text{kJ} \rightarrow \text{Cl}^+(g) + e^-$

b. $\text{Cl}_2(g) \rightarrow 2\text{Cl}^+ + 2e^- + 1260\text{kJ}$

c. $\text{Cl}_2(g) + 2e^- \rightarrow 2\text{Cl}^-(g) + 1260\text{kJ}$

d. $\text{Cl}_2(g) + 2e^- + 1260\text{kJ} \rightarrow 2\text{Cl}^-(g)$
QUESTION 36.
Explain the trend in melting points as you move across Period 2 of the Periodic Table (beginning with lithium).
As part of you answer, use the axes provided to sketch this trend.

[Diagram of a line graph with the x-axis labeled "Atomic Number" and the y-axis not labeled.]

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YEAR 11 CHEMISTRY

METALS
LESSON 8: DEVELOPMENT OF THE PERIODIC TABLE
PART A: MULTIPLE CHOICE QUESTIONS

QUESTION 1.
The idea of the atom as the smallest indivisible particle of matter was first proposed:
(a) Around 400 BC by Greek philosophers
(b) In the 1700s by Lavoisier
(c) In the 1800s by Dalton
(d) In the 1900s by Rutherford

QUESTION 2.
The idea that in forming compounds atoms of different elements combine in small whole number ratios was proposed:
(a) Around 400 BC by Greek philosophers
(b) In the 1700s by Lavoisier
(c) In the 1800s by Dalton
(d) In the 1900s by Rutherford

QUESTION 3.
A major change to the model of the atom provided by Rutherford’s gold foil experiment was the recognition that the atom contained:
(a) Electrons
(b) Electron shells
(c) Neutrons
(d) A central positive nucleus

QUESTION 4.
An incorrect statement about the periodic table devised by Dimitri Medeleev is that:
(a) A space was left for the insertion of new elements.
(b) Properties of undiscovered elements were able to be deduced.
(c) The octave arrangement was exclusively the basis of the classification.
(d) Elements were arranged in the order of increasing atomic weights.
QUESTION 5.
The patterns in properties of elements that led to their organisation the periodic table are closely linked to the structure of the atom. Which of the following discoveries best accounts for the periodic nature of those patterns?
(a) Rutherford’s discovery that the mass and positive charge are in a central nucleus
(b) Rutherford’s discovery that the atom is mostly empty space
(c) Bohr’s discovery that electrons are contained in different energy levels or shells
(d) Chadwick’s discovery of the presence of neutrons in the nucleus

QUESTION 6.
Which one of the scientists below is credited with the development of the modern Periodic Table?
(a) Dalton
(b) Rutherford
(c) Mendeleev
(d) Gay-Lussac

QUESTION 7.
Which one of the following is regarded as the originator of the periodic table?
(a) Dalton
(b) Mendeleev
(c) Gay-Lussac
(d) Avogadro
PART B: SHORT ANSWER QUESTIONS

QUESTION 8.
Write the symbols for:

a) Two lanthanide elements
b) Two transition metal elements
c) Two alkali metal elements
d) Two actinide elements

QUESTION 9.
Hydrogen is not placed in a group in the periodic table.

a) Discuss hydrogen’s possible placement in Group VII giving at least one reason for and one reason against such a placement.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least ONE reason given for placing hydrogen in group VII</td>
<td>2</td>
</tr>
<tr>
<td>At least ONE reason given against placing hydrogen in group VII</td>
<td></td>
</tr>
</tbody>
</table>

b) In what other group could hydrogen be placed? Give one reason for such placement.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>
QUESTION 10.

Name the element that fits the following descriptions:

3

a) Noble gas with less than 8 outer shell electrons.

b) A non-metal which is a liquid at room temperature.

c) A non-metal in group IV which forms allotropes.

QUESTION 11.

Identify one scientist involved with the development of the periodic table of the elements and describe their contribution. Explain the impact their contribution had on the development of the modern periodic table.

Criteria | Marks
---|---
Identifies ONE scientist | 3
Correctly describes their work on the periodic table | 
Explains the impact that their work has had on the development of the current modern periodic table | 

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QUESTION 12.

Construct a timeline to show chronologically, the scientists whose work contributed to the development of the modern periodic table. Include a phrase to indicate each scientist’s contribution.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correctly identifies a scientist involved in the development of the periodic table and briefly describes their contribution</td>
<td>1 (each)</td>
</tr>
</tbody>
</table>
QUESTION 13.

a) Identify the original data which Mendeleev used to formulate the Periodic Table

   a. Physical data 1

   b. Chemical data 1

b) Historically, Mendeleev made accurate predictions about element 32 (germanium) before it was discovered. According to the HSC periodic table, element 117 has not yet been synthesised; however, we also can make predictions about its properties in relation to its neighbouring elements based on periodic law principles.

   a. Compare the relative electronegativity of element 117 with that of ununoctium (element 118) 1

   b. Compare the valency of element 117 with that of astatine 1

   c. Compare the relative reactivity of element 117 with that of astatine 1