Atoms and Molecules
Discussion....

- What does the word Chemistry mean?
- Where does the word Chemistry come from?
- Who is the man on the front cover?
- What does the diagram in Arabic tell you about Arabs and Science?

For the teacher, please visit:
http://www.muslimheritage.com/topics/default.cfm?TaxonomyTypeID=18&TaxonomySubTypeID=77&TaxonomyThirdLevelID=221&ArticleID=1004
http://forum.khurram.ca/viewtopic.php?t=972
Standards:

8.12.1 Know that the smallest particle of an element is an atom and that atoms of one element are of one kind and are different from atoms of every other element.

8.12.2 Know that elements join together chemically to form compounds, that the smallest particle of a compound is a molecule, and that all molecules of a compound are made up of the same fixed number of atoms of the constituent elements.

8.12.3 Know that all elements can be represented by a symbol, compounds by formulae and reactions by equations.

8.12.4 Know that mass is conserved during a chemical reaction and that the number of atoms of each element taking part in the reaction remains unchanged.

Objectives

1. Know that the smallest part of an element is an atom.
2. Know that elements join together chemically to form compounds.
3. Define the molecule and understand that it is made of fixed number of atoms.
4. Know how to represent the elements and compounds.

KEY WORDS

<table>
<thead>
<tr>
<th>Atom</th>
<th>الذرة</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>رمز</td>
</tr>
<tr>
<td>Element</td>
<td>عنصر</td>
</tr>
<tr>
<td>Compound</td>
<td>مركب</td>
</tr>
<tr>
<td>Molecule</td>
<td>جزيء</td>
</tr>
<tr>
<td>Formula</td>
<td>صيغة</td>
</tr>
</tbody>
</table>
Atoms

More than 2400 years ago, Greek philosophers suggested that it is possible to divide a sample of matter into smaller and smaller pieces but eventually, you would not be able to cut anymore. You would have only one particle left. They named these particles atoms, a term that means "can not be divided".

Atoms

Everything is made from atoms, including you. Atoms are tiny particles that are too small to see, even with a microscope.
We usually imagine atoms as being like tiny balls, to make diagrams simpler we often draw atoms as circles.

نتخيل عادةً شكل الذرات مثل كرات صغيرة، ولتبسيط نرسمها عادةً على شكل دوائر.

**Atom:** is the smallest particle of an element that cannot be split.

الذرة: أصغر جزء في العناصر المختلفة و الذي لا يمكن تقسيمه أكثر.

**Elements**

There are over a hundred different types of atom, and these are called elements. Each element has a special name. For example carbon, oxygen and hydrogen are all elements.

هناك المئات من الأنواع المختلفة من الذرات و تسمى العناصر. لكل عنصر اسم خاص به، فمثلًا الكربون، الهيدروجين والأكسجين تعد كلها من العناصر.

Lead and gold are elements too. A piece of pure gold contains only gold atoms. A piece of pure lead contains only lead atoms.

الرصاص والذهب كذلك من العناصر. قطعة من الذهب الخالص تتكون فقط من ذرات عنصر الذهب. كما تتكون قطعة الرصاص من ذرات عنصر الرصاص فقط.

Some substance cannot be broken down into anything simpler. This is because all the atoms inside them have the same type. These substances are called elements.

بعض المواد لا يمكن تقسيمها أكثر إلى جزيئات أصغر وذلك لأن جميع الذرات في هذه المادة من نفس النوع.
Elements: Molecules that are made up of the same type of atoms
العناصر: هي جزيئات تتكون من نفس النوع من الذرات.

Look at the examples of elements:
في الشكل 4 الحديد هو عنصر صلب يتكون فقط من ذرات عنصر الحديد، وفي شكل 5 الكلور هو غاز يتكون فقط من ذرات عنصر الكلور.

Symbols
الرموز
Each element is given its own chemical symbol, like O for oxygen and Cl for chlorine.
كل نوع من الذرات اسم ورمز كيميائي.
Chemical symbols are usually one or two letters long, but sometimes three letters are used. For example, Uut is Ununtrium.
يتكون الرمز الكيميائي من حرف أو حرفين ولكن في بعض الأوقات يتكون من 3 أحرف.

Every chemical symbol starts with a capital letter, with the second or third letters written in lower case.
يبدأ كل رمز كيميائي بحرف كبير بينما يكون الحرف الثاني و الثالث بأحرف صغيرة.
For example, \( \text{Mg} \) is the correct symbol for magnesium, but \( \text{mg}, \text{mG} \) and \( \text{MG} \) are wrong.

Take care to write chemical symbols correctly

Most symbols resemble their English name. Some are based on their original Latin names.

Look at the table in Figure 6

- Which atoms have symbols based on Latin names?
- Why is the symbol for helium \( \text{He} \) and not \( \text{H} \)?

Notice that you always use capital letter for the first letter of symbol. If the symbol has a second letter, it is always a small letter. Refer to examples in Figure 6.

\textbf{Molecules}

Atoms are nature's building blocks. A molecule is formed when two or more \textbf{atoms} join together chemically.

Molecular \textit{hydrogen} (\( \text{H}_2 \)), molecular \textit{oxygen} (\( \text{O}_2 \)) and molecular \textit{nitrogen} (\( \text{N}_2 \)) are not compounds because each is composed of a single element.

Water (\( \text{H}_2\text{O} \)), carbon dioxide (\( \text{CO}_2 \)) and methane (\( \text{CH}_4 \)) are compounds because each is made from more than one element.
The smallest bit of each of these substances would be referred to as a molecule. For example, a single molecule of molecular hydrogen is made from two atoms of hydrogen while a single molecule of water is made from two atoms of hydrogen and one atom of oxygen.

There are only 92 elements in nature and therefore 92 different types of atoms. However, there are millions of different substances.

Compounds
There are only 92 elements in nature and therefore 92 different types of atoms. However, there are millions of different substances.

\[ \text{Compounds} \]

المركبات
هناك فقط 92 نوع من العناصر في الطبيعة تتكون من 92 نوع من الذرات. ولكن هناك الملايين من المواد المختلفة.
Most matter or substances is made of more than one element. Substances that is made of more than one element is called a compound. Some examples of compounds are water (H₂O), table salt NaCl, table sugar C₆H₁₂O₆, and chalk (CaCO₃).

A compound is a substance formed when two or more elements are chemically joined.

Note that even in the figure 6, Methane, which is very small, is called both a molecule and a compound.

A compound is two or more different atoms bonded. A molecule is two or more of the same atoms or different elements bonded.

A molecular compound is a small number of different atoms that are commonly bonded.

Chemical Formula

Chemists used a kind of shorthand to describe molecules. It is called the chemical formula.

Formulas tell you which atoms are in the molecule by looking at the symbols.
It also tells you how many atoms there are by small numbers after each symbol. The smaller number is called the subscript. For Example: $CO_2$ means 1 Carbon atom and 2 Oxygen atoms.

Notice that, if there is just one atom it is not numbered.

Example: $H_2O$ is the chemical formula for _______________. It has ___ Hydrogen atom(s) and _______ oxygen atom(s).

Table 1 shows some common molecules.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Molecular element</th>
<th>Molecular element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>$H_2O$</td>
<td>Hydrogen $H_2$</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>$CO_2$</td>
<td>Oxygen $O_2$</td>
</tr>
<tr>
<td>Glucose</td>
<td>$C_6H_{12}O_6$</td>
<td>Ozone $O_3$</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>$NaCl$</td>
<td>Chlorine $Cl_2$</td>
</tr>
<tr>
<td>Magnesium sulfate</td>
<td>$MgSO_4$</td>
<td>Sulfur $S_8$</td>
</tr>
</tbody>
</table>

Table 1

Other examples are shown in Table 2.
Worksheets

1 Look at the three diagrams.

A B C

a i One diagram represents solid iron. Which one?

ii Explain why you chose your answer.

iii Why is this substance an element?

2 Copy the table and write the substances into the correct column.

<table>
<thead>
<tr>
<th>Element</th>
<th>Molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td>copper</td>
<td>NaCl</td>
</tr>
<tr>
<td>gold</td>
<td>carbon dioxide</td>
</tr>
<tr>
<td>water</td>
<td>carbon</td>
</tr>
<tr>
<td>carbon</td>
<td>methan</td>
</tr>
<tr>
<td>helium</td>
<td></td>
</tr>
</tbody>
</table>
3 - Define the following: (CS 8.12.1,8.12.2) 

عرف المصطلحات العلمية التالية:

Atom:

Element:

4 - Write the symbols of these elements:

اكتب الرمز الكيميائي للعناصر التالية:

<table>
<thead>
<tr>
<th>Atom</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td></td>
</tr>
<tr>
<td>Helium</td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td></td>
</tr>
<tr>
<td>Neon</td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td></td>
</tr>
<tr>
<td>Carbon</td>
<td></td>
</tr>
<tr>
<td>Chlorine</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td></td>
</tr>
<tr>
<td>Sulphur</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td></td>
</tr>
</tbody>
</table>
5- Choose the correct answer:

a) Which is the symbol for carbon?
   a) Co
   b) C
   c) Ca
   d) Cr

b) Which of these is an element?
   a) Magnesium
   b) Water
   c) Carbon dioxide
   d) Zinc oxide

c) Which is the chemical symbol for the element zinc?
   a) ZnO
   b) Zn
   c) ZrC
   d) ZnS
6- Complete the sentences, using words from the list below.

 أكمل الجمل باستخدام الكلمات في القائمة :

<table>
<thead>
<tr>
<th>Atom</th>
<th>broken atom</th>
<th>simpler compound</th>
<th>element atoms</th>
</tr>
</thead>
</table>

1. When 2 or more ________ bond together, we get a ________.

2. If a substance is made up of 2 or more different types of ________, it is called a ____________________.

3. An ________ is a substance made up of only one type of ________, they can't be ________ down into ________ substances.

7- The diagrams below show the particles in some substances.

تمثل الرسوم التوضيحية التالية اشكال الجزيئات في بعض المواد

a Which substances are compounds?

أي المواد تمثل مركبات؟

b Which substances are elements?

أي المواد تمثل عناصر؟

c Explain below how you could tell the difference.

فسر سبب هذه الإجابات
8- Complete the following table:

<table>
<thead>
<tr>
<th></th>
<th>Formula</th>
<th>Write down the symbols of each atom in the molecule</th>
<th>Write down the number of each kind of atom in the molecule</th>
<th>Write down the name of each element in the molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H₂O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CH₄</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Na₂SO₄</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>NH₄OH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Mg₃(PO₄)₂</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
H.W.

- The chemical formula of carbon dioxide is $CO_2$.

$CO_2$

- Explain why carbon dioxide is a compound and not an element.

فسر لماذا يعتبر ثاني اكسيد الكربون مركب وليس عنصر

- How many carbon atoms are there in one molecule of carbon dioxide?

كم عدد ذرات الكربون في جزئ واحد من ثاني اكسيد الكربون

9- Complete the table below by writing the chemical formula for the compound. The first one is done for you.

أكمل الجدول التالي بكتابة الصيغة الكيميائية المناسبة كما في المثال الأول

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Question</th>
<th>Chemical formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium chloride is a compound which has 1 Sodium atom and 1 chlorine atom</td>
<td>Sodium chloride is a compound which has 1 Sodium atom and 1 chlorine atom</td>
<td>NaCl</td>
</tr>
<tr>
<td>Calcium fluoride, 1 Calcium, 2 Fluorine</td>
<td>Calcium fluoride, 1 Calcium, 2 Fluorine</td>
<td></td>
</tr>
<tr>
<td>Nitrogen dioxide, 1 nitrogen, 2 oxygen</td>
<td>Nitrogen dioxide, 1 nitrogen, 2 oxygen</td>
<td></td>
</tr>
<tr>
<td>Methane, 1 carbon, 4 hydrogen</td>
<td>Methane, 1 carbon, 4 hydrogen</td>
<td></td>
</tr>
<tr>
<td>Ammonia, 1 nitrogen, 3 hydrogen</td>
<td>Ammonia, 1 nitrogen, 3 hydrogen</td>
<td></td>
</tr>
</tbody>
</table>
Standard:

8.12.4 Know that mass is conserved during a chemical reaction and that the number of atoms of each element taking part in the reaction remains unchanged.

Objectives:

Know that the mass is conserved during a chemical reaction.

Key Words

<table>
<thead>
<tr>
<th>Chemical Reaction</th>
<th>تفاعل كيميائي</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equation,</td>
<td>معادلة</td>
</tr>
<tr>
<td>Reactant</td>
<td>متفاعلات</td>
</tr>
<tr>
<td>Product</td>
<td>نواتج</td>
</tr>
<tr>
<td>Balance.</td>
<td>متوزن</td>
</tr>
<tr>
<td>Mass</td>
<td>كتلة</td>
</tr>
</tbody>
</table>
Chemical reactions

Chemical reactions produce new substances that have properties different from those of the original substances. The rust on a bike’s handlebars, for example, has properties different from those of the metal around it. A process that produces chemical change is a chemical reaction.

Chemical reaction: Process in which new substances with new chemical and physical properties are formed.

Exploring activity:
Observing a chemical reaction:
Bring a piece of paper and matches as shown in Figure 1. Use the match to set fire to the paper. Caution: Be careful when using matches. Look for the changes will happen to the paper after the burning process.

Figure 1: burning the paper creates new substance, there for burning is a chemical change.
In any chemical reactions, the substance or substances initially involved in a chemical reaction are called reactants. Chemical reactions are characterized by a chemical change, and they yield one or more products which are, in general, different from the reactants.

في أي تفاعل كيميائي، تسمى المواد المستخدمة في بداية التفاعل بالتفاعلات بالتفاعلات الكيميائية. تتميز التفاعلات الكيميائية بتغيرات كيميائية التي تنتج ناتج أو أكثر يختلف عن المتفاعلات.

**Reactant**: substances that is changed in a chemical reaction.

المتفاعلات: هي المواد التي يطرأ عليها تغييرات في التفاعلات الكيميائية.

**Product**: substances that is formed in a chemical reaction.

النواتج: هي المواد التي تتكون نتيجة للفشلات الكيميائية.
Chemical equations:

Mini Lab:
Describing a chemical reaction:
Procedure:
Place about 1g of baking soda in an evaporating dish. Add 2ml of white vinegar.
1- Allow the mixture to dry
2- Examine the result and compare it with baking soda. Do they look the same?
Analysis:
1- What do the bubbles formed in Figure 2 tell you?

Are bubbles are the only product out of the reaction, or do some atoms from the vinegar and baking soda form something else? What goes on in the chemical reaction can be more than what you see with your eyes.

Figure 2: Bubbles are formed when baking soda is added to the vinegar.

Chemists try to find out which reactants are used and which products are formed in a chemical reaction. Then, they can write it in a shorthand form called chemical equation.
One way you can describe a chemical reaction is with an equation that uses words to name the reactants and products.

Baking soda + Vinegar $\rightarrow$ Gas + white solid

Sometimes, the word equation for the reaction can be long. That's why chemists use chemical formulas to represent the chemical names of substances in the equation.

The reaction between Iron and Sulphur can be shown by a word equation (figure 3).
The substances that we start with are called **reactants.**

The substances made in reactions are called **products.**

*In the above example Iron and Sulphur are reactants and Iron sulphide is the product.*

\[\text{Fe} + \text{S} \rightarrow \text{FeS}\]

This tells us that 1 atom of iron reacts with 1 atom of sulphur. They make iron sulphide,

This contains one iron atom for each sulphur atom.

The new compound, iron sulphide, is not like iron or sulphur at all.

It has totally different properties. A new substance has been made.

**Conservation of Mass**

What happens to the atoms in the reactants when they are converted into products? Do they disappear?

No. According to the law of conservation of mass, the mass of a closed system of substances will remain constant, regardless of the processes acting inside the system. An equivalent statement is that matter changes form, but cannot be created nor destroyed. This implies that for any chemical process in a closed system, the mass of the reactants must equal the mass of the products.

**Law of conservation of mass:** A relation stating that in a chemical reaction, the mass of the products equals the mass of the reactants.
Standard:

8.12.4 Know that mass is conserved during a chemical reaction and that the number of atoms of each element taking part in the reaction remains unchanged.

Objectives:

* Know that the number of atoms of each element taking part in the reaction is unchanged.

**Balancing chemical equations:**
Balancing Chemical Equations is absolutely essential if you want to determine quantities of reactants or products. A balanced equation assures that the Conservation Law of matter is obeyed. The total mass of reactants must equal the total mass of products. A balanced equation is like a recipe. It tells you the proportional quantities of each substance involved, Figure 4.

Figure 4: Every atom that appears on the reactant side of the reaction also appears on the product side.

**Balanced equation:** the number of atoms of each element is equal on both sides of the equation.
Balancing chemical equation

Rules for Balancing Equations:

Five steps to write a balanced equation:

1. Write the word equation for the reaction

2. Write the symbols and formulas for reactants and products.

3. Count the number of atoms of each element on each side of the arrow.

4. Balance the equation using coefficients. Put a coefficient in front of a symbol of formula, so that the same number of each type of atoms appears on both reactant side.

5. Check to see that the coefficients used are the smallest whole numbers that give the balanced equation.

Below is an example of how you can balance an equation

When hydrogen and oxygen react, the product is water. Write a balanced equation for this reaction.

المثال يمثل تفاعل الهيدروجين مع الاكسجين لتكوين الماء

Solution:
Since the chemical formulas of the reactants and products are known, we can write a skeleton equation.

$$H_2(g) + O_2(g) \rightarrow H_2O(l)$$

Hydrogen is balanced but oxygen is not. If we put a coefficient of 2 in front of $H_2O$, the oxygen becomes balanced.

$$H_2(g) + O_2(g) \rightarrow 2H_2O(l)$$

Now there is twice as many hydrogen atoms in the product as there are in the reactants. To correct this, put a coefficient of 2 in front of $H_2$. The equation is now balanced.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$$

Check the coefficients. They must be in their lowest possible ratio $2(H_2)$s $1(O2)$, and $2(H_2O)$.

Here we notice the mass of the reactants also remains constant.

**# of atoms in reactants = # of atoms in products**

عدد ذرات المتفاعلات = عدد الذرات في النواتج

Word equation: hydrogen + oxygen $\rightarrow$ water (hydrogen oxide)

Using formulas: $\frac{H_2}{\text{left-hand side}} + \frac{O_2}{\text{right-hand side}} \rightarrow \frac{H_2O}{\text{right-hand side}}$
Key Questions:

1- How do we represent chemical equations? Provide an example.

كيف يمكننا تمثيل المعادلة الكيميائية؟ أعط مثال على ذلك.

2- Write the word equation for each one of the following reactions:

أكتب المعادلة الكلامية لكل من التفاعلات التالية:

1. When magnesium reacts with oxygen it forms magnesium oxide.

2. When zinc reacts with oxygen it forms zinc oxide

3. Sodium reacts with hydrochloric acid (HCl) and forms sodium chloride and hydrogen gas.

4. When copper is heated in oxygen it forms a black solid called copper oxide.
   a. Write down the name of the element that the copper reacted with.
   b. Copy and complete this word equation:

   Copper + ____________ → ____________ + ____________
c Copy the table below and write the names of the substances in your word equation into the table.

<table>
<thead>
<tr>
<th>Element</th>
<th>Compound</th>
</tr>
</thead>
</table>

4. Kerry is burning some elements in oxygen.

a Kerry burns carbon in oxygen. It makes carbon dioxide. Some of these are reactants. Some are products.

Copy and complete the sentences:

I Carbon is a: ____________________

ii Oxygen is a: ____________________

Iii Carbon dioxide is the: ____________________

iv Write the word equation for this reaction.
Balancing Equations

Key Questions:

1- What happens to the mass and the number of atoms in a chemical reaction?

ماذا يحدث لكتلة وعدد ذرات العناصر في التفاعلات الكيميائية؟

2- Balance the following equations:

The first one is done for you.

1. \( 2 \text{ Mg} + \text{ O}_2 \rightarrow 2 \text{ MgO} \)

2. \( \text{ C} + \text{ O}_2 \rightarrow \text{ CO}_2 \)

3. \( \text{ Na} + \text{ MgF}_2 \rightarrow \text{ NaF} + \text{ Mg} \)
4. $\text{Mg} + \text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$

5. $\text{Cl}_2 + \text{KI} \rightarrow \text{KCl} + \text{I}_2$

6. $\text{NaCl} \rightarrow \text{Na} + \text{Cl}_2$

7. $\text{Na} + \text{O}_2 \rightarrow \text{Na}_2\text{O}$

8. $\text{Na} + \text{HCl} \rightarrow \text{H}_2 + \text{NaCl}$

9. $\text{K} + \text{Cl}_2 \rightarrow \text{KCl}$
References:

1. [http://chemistry.about.com/cs/stoichiometry/a/aa042903a.htm](http://chemistry.about.com/cs/stoichiometry/a/aa042903a.htm)

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(http://www.chem4kids.com/files/react_intro.html)


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Rules for balancing equation Taken from: *Chemistry*

Wilberham, Staley, Simpson, Matta

Addison Wesley