Read your book C3 Chemistry Chapter 2.1 – 2.3 pages 72-77, and P3 Chapter 2.6 pgs 126-127, and below.

1. Atom: the smallest particle of an element that can take part in a chemical reaction
2. Molecule: a collection of two or more atoms held together by chemical bonds. The fundamental unit of compounds.
3. Compound: a substance formed by the chemical combination of two or more elements in fixed proportions
4. Matter: anything that occupies space and has mass
5. Substance: A material with a constant composition
6. SI Unit: The International System of Units (French: Système international d'unités, SI) is the modern form of the metric system, and is the most widely used system of measurement.
7. Element: A substance which cannot be further divided into simpler substances by chemical methods; all the atoms of an element contain the same number of protons
8. Dalton: Dalton performed a number of experiments that eventually led to the acceptance of the idea of atoms. He deduced that all elements are composed of atoms. Atoms are indivisible and indestructible particles. Atoms of the same element are exactly alike. Atoms of different elements are different. Compounds are formed by the joining of atoms of two or more elements.
9. Democritus: A Greek philosopher (400 BC) Came up with the idea that The smallest piece of matter that exists is the ATOM (ATOMOS: UNCUTTABLE or INDIVISIBLE)
10. Dalton Model: Dalton's 1807 "Billiard Ball Model" pictured the atom as a tiny indivisible, uniformly dense, solid sphere.
11. Rutherford Model: Pictured an atom as having positively charged particles that were contained in a dense nucleus, and negatively charged particles scattered outside the nucleus around the atom's edge.
12. Thompson Model: Thompson's "Plumb Pudding Model" pictured atoms as made from a positively charged substance with negatively charged electrons scattered about, like raisins in a pudding.
13. Electron: a subatomic particle with negligible mass and a charge of -1; electrons are present in all atoms, located in energy levels outside the nucleus.
14. Proton: a subatomic particle with a relative mass of 1 and a charge of +1, found in the nucleus of all atoms.
15. Neutron: an uncharged subatomic particle present in the nuclei of atoms - a neutron has a mass of 1 relative to a proton
16. Ion: charged particles made from an atom of groups of atoms (polyatomic ions), by the loss or gain of electrons
17. Nucleus: (of an atom) the central region of an atom that is made up of the protons and neutrons of the atom; the electrons orbit around the nucleus in different 'shells' or 'energy levels'
18. Atomic Structure: the concept of an atom as a central positively charged nucleus consisting of protons and neutrons surrounded by a number of electrons. The number of electrons is equal to the number of protons: the whole entity is thus electrically neutral
19. Charge: The electromagnetic force of a particle that defines it's behavior.
20. Periodic Table: An organizing of all the elements in which elements with similar properties are grouped together.

21. Dmitri Mendeleev: Russian chemist who looked for common properties in elements then arranged them by atomic mass. He noticed elements with similar (reactivity) properties appeared at regular intervals; "periodic"

22. Atomic Mass: (Mass Number or Nucleon number) The total number of protons and neutrons present in the nucleus of an atom.

23. Atomic Number: (or proton number) The number of protons at the nucleus of an atom; it is also the number of electrons present in an atom and the position of the element in the periodic table

24. Sub-atomic: particles which are smaller than an atom from which all atoms are built; i.e. protons, neutrons, and electrons

25. Isotope: atoms of the same element which have different numbers of neutrons in their nuclei: they differ in their mass (nucleon) numbers; some isotopes are radioactive because their nuclei are unstable (radio-isotopes)

Mystery Boxes:

1. In this activity students have to work out what’s inside six Mystery Boxes without opening them. A mock science conference is held to discuss different groups’ ideas and build a consensus about the content of each box, based on the students’ evidence. Students will want to know what is in the boxes, but this is never revealed.
   a. The boxes are an analogy for science – scientists are unable to ‘open the box’ to find a definitive answer as to whether or not their ideas are correct but instead form theories based on evidence from their research, which are open to further revision.
   b. Learning outcomes
      i. Skills used: discussion, developing an argument, observation, negotiation and teamwork
      ii. Scientists generate scientific theories based on evidence, but they do not find definitive answers.
      iii. Scientific knowledge and ideas change over time and are open to further revision as our understanding of the world around us evolves.
      iv. Science is a social and creative activity.

Skills:

- Sensing*
- Weight
- Movement
- Sound
- Testing
- Making notes

<table>
<thead>
<tr>
<th>Sensing</th>
<th>Perseverance</th>
<th>Creativity</th>
<th>Drawing conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis</td>
<td>Visualisation</td>
<td>Reasoning</td>
<td></td>
</tr>
<tr>
<td>Prior/existing</td>
<td>Curiosity</td>
<td>Context (e.g. items are limited by size of tin)</td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>Cooperation</td>
<td>Negotiating</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>Observations</td>
<td>Systematic approach</td>
<td></td>
</tr>
</tbody>
</table>
Topics:

i. First I gave you a little HISTORY to help you understand the philosophy that created this world of Chemistry.
   a. Question: If you wanted to know what the basic unit of matter is, how would you do it?
   b. What is Matter?
      i. Everything that makes up the Universe.
      ii. Anything that occupies space (takes up volume) and has mass.

1. Mass is theoretical and relative, and helps to define things that we experience like weight and density. For Example:
   a. Weight = \text{Mass} \times \text{gravity}
   b. Density = \frac{\text{Mass}}{\text{Volume}}
   c. Mass = \frac{\text{Weight/ gravity}}{\text{Density x Volume}}

   i. We experience weight and density, mass is a factor of each

2. SI Unit for Mass is the Kilogram

3. SI: The International System of Units (French: Système international d’unités, SI) is the modern form of the metric system, and is the most widely used system of measurement.

ii. Second I told you that Philosophy allowed scientists (years later) to think about and define the ATOM, which we defined as the smallest unit of matter able to take place in a chemical reaction (or actually I think I said the smallest particle of an element). Next, I stated that atoms come together to form MOLECULES, which I defined as two or more BONDED atoms.

Atom: All elements are made of atoms. An atom consists of a nucleus containing protons and neutrons, surrounded by electrons.

i. The word atom comes from \textit{atomos}, an ancient Greek word meaning indivisible. The Greek philosopher Demokritos (460-370 BCE) maintained that all matter could be divided and sub-divided into smaller and smaller units, and eventually there would be a tiny particle that could not be divided any further - an atom. This was remarkable because there was no way ancient Greeks could support this theory by observation or experiment.

Dalton’s atomic theory

ii. John Dalton: Understanding of atoms didn’t progress much beyond Demokritos’ theory until the English chemist John Dalton (1766 - 1844) started to look at it in the 1800s. Dalton did experiments, worked out some atomic weights, and invented symbols for atoms and molecules, the fundamental unit of compounds. His most important conclusions are summarised below.
   a. molecules: a collection of two or more atoms held together by chemical bonds.
   b. all matter is made of atoms, and atoms are indestructible and cannot be broken down into pieces
   c. all the atoms of a particular element are identical to each other and different from the atoms of other elements
   d. atoms are rearranged in a chemical reaction
e. compounds are formed when two or more different kinds of atoms join together
f. Dalton's theory was developed and changed as new evidence was discovered.

**JJ Thomson's discovery of the electron**

iii. JJ Thompson discovered the electron in 1897. This showed that the atom contained smaller pieces, whereas Dalton had thought that atoms could not be broken down into anything simpler.

**Rutherford's nuclear atom**

iv. In 1911 Ernest Rutherford used experimental evidence to show that an atom must contain a central nucleus. This was further evidence that an atom contained smaller pieces.

**Bohr's electron orbits**

v. Niels Bohr further developed Rutherford's nuclear atom model. He used experimental evidence to support the idea that electrons occupy particular orbits or shells around the nucleus of an atom.

vi. The development of the theory of atomic structure is an example of:
   a. How a theory may change as new evidence is found
   b. How a scientific explanation is provisional but may become more convincing when predictions based on it are confirmed later on.

**Atomic structure**

i. Atoms contain three sub-atomic particles
   a. proton: A proton is a small particle with a positive charge found in the nucleus of the atom.
   b. electron: An electron is a very small negatively-charged particle found in an atom in the space surrounding the nucleus
   c. Neutrons: A small particle with no charge that serves to stabilize the nucleus.
   d. This means the nucleus of an atom is always positively charged

ii. Isotopes are atoms that have the same number of protons, but different numbers of neutrons.

iii. The protons and neutrons are found in the nucleus at the centre of the atom. The nucleus is very much smaller than the atom as a whole. The electrons are arranged in energy levels around the nucleus.

**Properties of sub-atomic particles**

<table>
<thead>
<tr>
<th>Particle</th>
<th>Relative Mass</th>
<th>Relative Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton</td>
<td>1</td>
<td>+1</td>
</tr>
<tr>
<td>Neutron</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Electron</td>
<td>0.0005 (Almost zero)</td>
<td>-1</td>
</tr>
</tbody>
</table>

iv. The number of electrons in an atom is always the same as the number of protons, so atoms are electrically neutral overall. Atoms can lose or gain electrons. When they do, they form charged particles called ions
   a. If an atom loses one or more electrons, it becomes a **positively** charged ion
   b. If an atom gains one or more electrons, it becomes a **negatively** charged ion
Evidence for atomic structure: You should be able to interpret information about Rutherford’s scattering experiment.

i. An early model of the atom was the plum pudding model. It was disproved by Rutherford’s scattering experiment and replaced by the nuclear model.
   a. plum pudding model: The scientific idea that an atom is a sphere of positive charge, with negatively-charged electrons in it.

ii. Rutherford’s scattering experiment:
   a. A scientist called Ernest Rutherford designed an experiment to test the plum pudding model. It was carried out by his assistants Hans Geiger and Ernest Marsden.
   b. A beam of alpha particles was aimed at very thin gold foil and their passage through the foil detected. The scientists expected the alpha particles to pass straight through the foil, but something else also happened.
   c. Some of the alpha particles emerged from the foil at different angles, and some even came straight back. The scientists realised that the positively charged alpha particles were being repelled [repel: Push apart] and deflected [deflect: To cause an object to change direction. The object is 'deflected']. by a tiny concentration of positive charge in the atom.
   d. As a result of this experiment, the plum pudding model was replaced by the nuclear model of the atom.
**Atomic number and mass number**

a. The **atomic number** (also called the proton number) is the number of protons in an atom.

b. The **mass number** (also called the nucleon number) is the total number of protons and neutrons in an atom.

c. The elements are arranged in the periodic table in ascending order of atomic number so it's easy to find the name or symbol for an atom if you know the atomic number.

---

**The Periodic Table (History): Before the development of the modern periodic table, there were other attempts to arrange the elements in a useful way, by scientists such as Döbereiner, Newlands and Mendeleev.**

i. **Dalton** calculated and organized elements by calculated atomic weights with respect to each other, using combinations of compounds to order elements in a sequence.

ii. **Avagadro** used ratios to organize elements relativistically.

iii. In 1858 **Stanislao Cannizzaro** expanded on Avagadro’s method calculating relative molecular weights of molecules by ratios.

iv. An English scientist called John Newlands put forward his law of octaves in 1864. He arranged all the elements known at the time into a table in order of relative atomic mass: The relative atomic mass is the number of times heavier an atom is compared to one twelfth of a carbon-12 atom. When he did this, he found that each element was similar to the element eight places further on. For example, starting at Li, Be is the second element, B is the third and Na is the eighth element.

   a. Regular repeats

      i. Newlands’ table showed a repeating or periodic pattern of properties, but it had problems. For example, he put iron in the same group as oxygen and sulphur, which are two non-metals. As a result, his table was not accepted by other scientists.

v. In 1869, just five years after John Newlands put forward his law of octaves, a Russian chemist called **Dmitri Mendeleev** published a periodic table. Mendeleev also arranged the elements known at the time in order of relative atomic mass, but he did some other things that made his table much more successful.

   a. He realised that the **physical and chemical properties** of elements were related to their atomic mass in a ‘periodic’ way, and arranged them so that **groups of elements with similar properties** fell into vertical **columns** in his table.
Gaps and predictions
   b. Sometimes this method of arranging elements meant there were gaps in his horizontal rows or 'periods'. But instead of seeing this as a problem, Mendeleev thought it simply meant that the elements which belonged in the gaps had not yet been discovered.
   c. He was also able to work out the atomic mass of the missing elements, and so predict their properties. And when they were discovered, Mendeleev turned out to be right.

Chemical symbols
   i. The atoms of each element are represented by chemical symbols. These usually consist of one or two different letters, but sometimes three letters are used for newly-discovered elements. The first letter in a chemical symbol is always an UPPERCASE letter, and the other letters are always lowercase. So, the symbol for magnesium is Mg and not mg, MG or mG.

Modern Periodic Table
   i. There are more than 100 different elements. The vertical columns in the periodic table are called groups. Each group contains elements that have similar properties.

Isotopes:
   i. Isotopes are the atoms of an element with different numbers of neutrons. They have the same proton number, but different mass numbers.

Calculating Relative Atomic Mass

\[
\text{Relative Atomic Mass (R.A.M.)} = \frac{\text{Abundance} \times \text{Atomic weight}}{100} + \frac{\text{Abundance} \times \text{Atomic weight}}{100}
\]

Radioactive decay:
   i. The nuclei of some isotopes are unstable. They can split up or 'decay' and release radiation. Such isotopes are called radioactive isotopes or radioisotopes. When a radioactive isotope decays, it forms a different atom, its nucleus changes, with a different number of protons.

Charge: Electromagnetic force of a particle that defines its behaviour
   ii. A substance that gains electrons becomes negatively charged, while a substance that loses electrons becomes positively charged. Atoms or molecules that become charged are ions.
   iii. When a charged object comes near to another object they will either attract or repel each other
      a. If the charges are the same - they repel
      b. If the charges are opposite - they attract
      c. If one is charged and the other is not - they attract.
   iv. Like charges repel, and unlike charges attract.

Most Abundant Elements:
   i. Universe: Hydrogen
   ii. Earth
      a. Crust: Oxygen
      b. Whole Earth: Iron
c. Atmosphere: Nitrogen

iii. Human Body: Oxygen

**Types of Radiation:** Radioactive substances give out radiation all the time. There are three types of nuclear radiation - alpha, beta and gamma. Alpha is the least penetrating, while gamma is the most penetrating.

i. Radiation: Energy carried by particles from a radioactive substance, or spreading out from a source. It is all around us. Some of it comes from natural sources and some comes from artificial sources.

a. **Alpha Radiation:** Alpha radiation consists of alpha particles. An alpha particle is identical to the nucleus of a helium atom, which comprises two protons and two neutrons.

b. **Beta radiation** consists of high energy electrons emitted from the nucleus. These electrons have not come from the electron shells or energy levels around the nucleus. Instead, they form when a neutron splits into a proton and an electron. The electron then shoots out of the nucleus at high speed.

c. **Gamma radiation** is very short wavelength - high frequency - electromagnetic radiation. This is similar to other types of electromagnetic radiation such as visible light and x-rays, which can travel long distances.

ii. Penetrating properties of radiation: The three types of radiation penetrate materials in different ways.

a. Alpha radiation is the least penetrating. It can be stopped - or absorbed - by just a sheet of paper.

b. Beta radiation can penetrate air and paper. It can be stopped by a thin sheet of aluminium.

c. Gamma radiation is the most penetrating. Even small levels can penetrate air, paper or thin metal. Higher levels can only be stopped by many centimetres of lead or many metres of concrete.

iii. Hazards of radiation: When radiation collides with molecules in living cells it can damage them. If the DNA in the nucleus of a cell is damaged, the cell may become cancerous. The cell then goes out of control, divides rapidly and causes serious health problems.

iv. The degree to which each different type of radiation is most dangerous to the body depends on whether the source is outside or inside the body.

- **If the radioactive source is inside the body**, Alpha radiation is the most dangerous because it is easily absorbed by cells.
- **If the radioactive source is inside the body**, Beta and gamma radiation are not as dangerous because they are less likely to be absorbed by a cell and will usually just pass right through it.
- **If the radioactive source is outside the body**, Alpha radiation is not as dangerous because it is unlikely to reach living cells inside the body.
- **If the radioactive source is outside the body**, Beta and gamma radiation are the most dangerous sources because they can penetrate the skin and damage the cells inside.
Matter

i. For purposes of organization it has been decided that all matter be broken down into categories. Those are Substances (or “Pure Substances”) and Mixtures.

ii. There are different states of Matter: Solid, Liquid, Gas (Plasma, Einstein-Bose Condensate).

   a. Solid: Particles in a solid are fixed in position, they vibrate, but don’t move freely about. A solid maintains its shape.

   b. Liquid: Particles move around each other freely but not apart from each other. A liquid has no definite shape, taking the shape of whatever container it is in.

   c. Gas: Particles move about most freely, pushing against and being acted on by every surface of its container.

   d. Remember: changes between states of matter are controlled by energy in the environment. The more energy added, the more active and fluid the molecules of substances become. The more energy taken away, the less active and fluid matter becomes. There are many different types of energy but energy that we experience as HEAT, or “thermo”, energy is what we most
associate with changes in the state of matter (hence the term Thermodynamics: how particles act in the presence of energy).

iii. Matter can be classified or separated into categories: Pure substances, compounds, and Mixtures.

iv. A pure substance is made up of only one element. Examples are: pure gold, pure silver, pure oxygen, etc (every element on the periodic table, can exist as a pure substance). These DO NOT decompose (break down into different parts).

v. Remember that an element is one type of atom, like carbon, gold or chlorine. There is more than one way that atoms can exist.

a. Single Atoms:
   i. The atoms of some elements do not join up with other atoms. They stay as single atoms.
   ii. The element helium is like this (left). Helium is an unreactive gas. Helium atoms do not join up with each other or any other element.

b. Molecules of elements:
   i. When atoms of the same element join together we get a molecule of that element.

   ii. Oxygen is like this. Two oxygen atoms join together to make an oxygen molecule. Most of the oxygen in the air is in this form.

   iii. Hydrogen and chlorine also have molecules with two atoms.

   iii. Some elements have molecules with more than two atoms. Sulfur atoms can make molecules of eight atoms joined together.

c. Compounds:
i. A compound is made when atoms of different elements join together by chemical bonds.

ii. This means that compounds will always exist as molecules, not separate atoms. The diagrams show some molecules of common compounds.

![Molecules of Water, Ethanol, Carbon Dioxide](image)

vi. A **compound substance** can also be “pure” substance (see flowchart above) but these substances are made up of more than one element. Examples include pure water (hydrogen and oxygen), pure sugar (Carbon, Hydrogen, and oxygen), pure bleach (Sodium, Chlorine, and Oxygen). These CAN **decompose**.

a. It’s important to note that when elements combine to form a compound, the compound substance has different properties than the elements they contain.

<table>
<thead>
<tr>
<th>Element</th>
<th>Element</th>
<th>Compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>sulphur</td>
<td>iron sulphide</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>colour</th>
<th>silvery grey</th>
<th>yellow</th>
<th>black</th>
</tr>
</thead>
<tbody>
<tr>
<td>is it attracted to a magnet?</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>reaction with hydrochloric acid</td>
<td>hydrogen formed</td>
<td>no reaction</td>
<td>smelly hydrogen sulphide formed</td>
</tr>
</tbody>
</table>

The table compares the properties of iron and sulfur (the two elements), and iron sulfide (the compound)

b. Chemical bonds: the atoms in a compound are chemically joined together by strong forces called bonds. You can only separate the elements in a compound using another chemical reaction, or electrolysis.

![Diagram of Chemical Reaction](image)

Compounds form when atoms join together in a chemical reaction

vii. A **Mixture** has different properties from compounds. A mixture is made from different substances that are not chemically joined. For example powdered iron and powdered sulphur (sulfur) mixed together makes a mixture of iron and sulphur (sulfur). They can be separated from each other without a chemical reaction, in the way that different coloured sweets can be picked out from a mixed packet and put into separate piles.
Mixture | Compound
--- | ---
**Composition** | Variable composition – you can vary the amounts of each substance in a mixture | Definite composition – you cannot vary the amount of each element in a compound

**Joined/ Separate** | Separate: The different substances are **not** chemically joined together. | The different elements are chemically joined together.

**Properties** | Each substance in the mixture keeps its own properties. | The compound has properties different from the elements it contains.

**Separation** | Each substance is easily separated from the mixture (using physical means). | It can only be separated into its elements using chemical reactions.

**Examples** | Air, sea water, most rocks. | Water, carbon dioxide, magnesium oxide, sodium chloride.

i. **Chemical reaction:** Is a process that changes one substance into a different substance. This involves the breaking of chemical bonds between atoms and the rearrangement of the atoms in a molecule and between molecules resulting in formation of a new substance. A complete reaction means the number of atoms of each going into a chemical reaction is equal to the number of atoms of each element that are produced in the reaction. This is because of the Law of Conservation of Matter.
   a. Matter can not be created or destroyed.

ii. **Balancing Chemical Equations:**
   a. A CHEMICAL EQUATION tells you which chemicals react together and what new chemicals are formed in the reaction.
   b. Chemical Equations can be represented a number of ways:
      - **Word Equation:** carbon dioxide + water → light energy → carbohydrates + oxygen
      - **Symbol Equation:** CO₂ + H₂O → light energy → M₆H₁₂O₆ + O₂
      - **Balanced Equation:** 6CO₂ + 6H₂O → light energy → C₆H₁₂O₆ + 6O₂
   c. In a chemical equation, we usually know what our reactants and products are (qualitative), but not how much of each is needed to make a complete reaction.
   d. Reactants represent the substances before their chemical change.
e. Products represent the new substances created from the chemical reaction (like a cooking recipe).

Butter + sugar + eggs + flour + chocolate chips \[\overset{375 \text{ F} \text{ & 18-10 minutes}}{\Rightarrow} \text{chocolate chip cookies}\]

f. Subscripts tell how many atoms of each element there are in each molecule. This gives the mass of the molecule (which we can now calculate).

g. The coefficient in a chemical equation tells us how many of each molecule there is in the equation.

Steps to Balancing a chemical equation:

a. Remember we cannot change subscripts. The number of atoms and how they are arranged in a molecule, defines the molecules chemical nature.

b. We CAN change the number of molecules of each substance involved in the reaction (the coefficient). These numbers represent ratios to each other.

c. Method 1 [Long Method]:
   i. List the elements and count them out to make sure the same number of atoms of each element exist on either side of the chemical equation.
   ii. Change the number of molecules of each substance (coefficient) to multiply the number of atoms of each element that isn’t balanced.
   iii. Continue doing this until all elements are balanced
   iv. Order of balancing:
      a. Metals
      b. Non-metals
      c. Hydrogen and Oxygen

d. Method 2 [Algebraic method]
   i. Put unknown coefficients in front of each molecular species in the equation: \[x \text{C}_4\text{H}_{10} + y\text{O}_2 \rightarrow z\text{CO}_2 + w\text{H}_2\text{O}\]
   ii. Then we write down the balance conditions for each element in terms of the unknowns. In this case, there are are four unknowns, \(x\), \(y\), \(z\) and \(w\).
      i. From carbon balance, we have the condition: \(4x = z\)
      ii. The hydrogen balance condition is: \(2y = 2z + w\)
      iii. and the oxygen balance condition gives: \(10x = 2w\)
   iii. Make ANY coefficient equal to 1:
      i. From carbon balance, we have the condition: \(4x = z\)
      ii. The hydrogen balance condition is: \(2y = 2z + w\)
   iv. Solve for the other coefficients:
i. If $x = 1$, then in $4x = z$, $4 \times 1 = 4$, therefore $z = 4$

ii. If $x = 1$, then in $10x = 2w$, $\{10 \times 1 = 2w\} \times \frac{1}{2}$ $w = 5$

iii. If $z = 4$ and $w = 5$, then in $2y = 2z + w$

\[
2y = 8 + 5 = 13, \text{ so } y = \frac{13}{2}
\]

v. This gives us a balanced chemical equation of:

\[
C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O
\]

vi. This is a perfectly fine way of writing the equation, however, customarily, it is preferable to express all the coefficients as integers. Thus, we can multiply through the equation by 2 on both sides:

\[
2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O
\]

Final, Balanced Chemical Equation

ii. The Coefficients tell us the number of moles of each reactant and product we should expect in our reaction. With a Balanced Chemical equation you can use the molar masses of the constituent parts of your chemical equation and molar ratios to calculate Mass relationships in chemical like:

i. Percent Yield = Actual mass of product / calculated mass x 100%

ii. Concentration: Mass of solute (g / mol) / Volume of solvent (L)

ii. Read more at http://chemistry.about.com/od/lecturenotesl3/a/concentration.htm

b. A molar mass is very simple to calculate using a periodic table.

c. The mass of an atom (atomic mass: see periodic table) is ALSO equal to the mass IN GRAMS of one mole of the element

i. 1 mole = $6.02214129(27) \times 10^{23}$ mol$^{-1}$. The mole is one of the base units of the SI, and has the unit symbol mol.

d. The mol unit can be used to measure the amount of any substance in chemistry: one mole of a substance has a mass equal to its relative formula mass in grams. To find the molar mass of any substance, we count the elements present and add up their atomic masses. The total mass in amu is also equal to the mass in grams of one mole (g/mol or g mol$^{-1}$)

i. Step 0: Get the formula for your compound

ii. Step 1: Count up the number of each element

ii. Step 2: Look up the mass of each element (see periodic table)

v. Step 3: Calculate the total mass of the molecule.

v. Step 4: Convert molecular mass into molar mass

e. Now you can use the molar masses of the reactants and products to convert from moles to grams.

(Eg. 2 moles of ammonia = 34.08 grams)

(Moles)(Molar mass) → Mass, or reverse.
The following calculations are now possible:

a. The molar masses of the reactants and the products are used as conversion factors so that you can calculate the mass of product from the mass of reactant and vice versa.

Steps in Converting between Masses of Reactant and Product

a. Convert the mass of one substance (substance A) to the corresponding number of moles using its molar mass.

b. From the balanced chemical equation, obtain the number of moles of another substance (B) from the number of moles of substance A using the appropriate mole ratio (the ratio of their coefficients).

c. Convert the number of moles of substance B to mass using its molar mass. It is important to remember that some species are in excess by virtue of the reaction conditions. For example, if a substance reacts with the oxygen in air, then oxygen is in obvious (but unstated) excess.