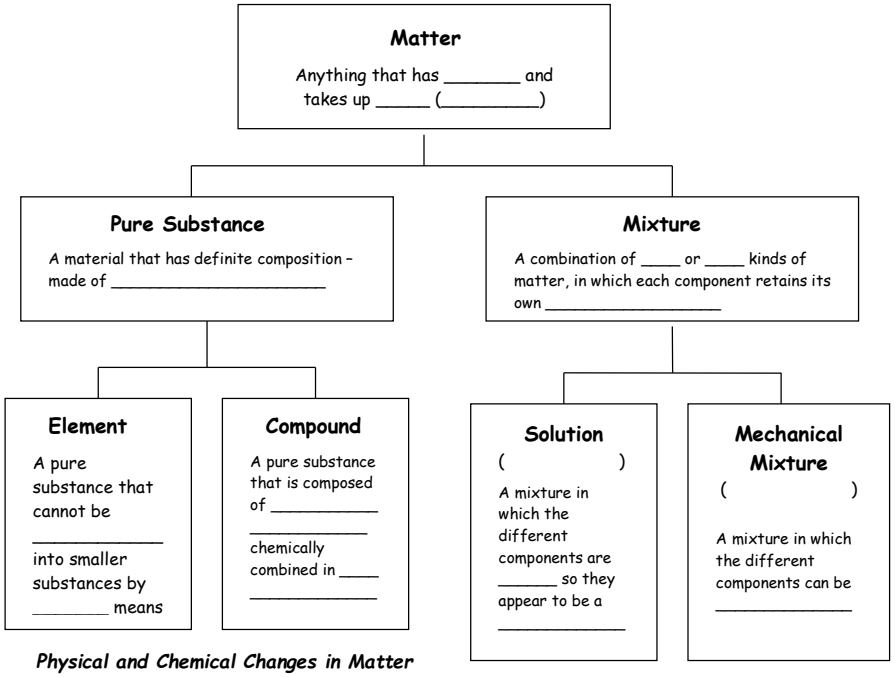
Classifying Matter

What is Science?

Science is a way of gaining _____ and _____ about our natural world.
Whenever we ask _____ or _____ something happens we are dealing with science.

What is Chemistry?

Chemistry is the study of _____ and the _____ it undergoes.



Physical and Chemical Changes in Matter

Physical Change –

Chemical Change –

Five Clues that a Chemical Change has occurred:

1.
2.
3.
4.
5.

An Introduction to the Periodic Table

During the mid 1800's, Russian scientist _____ invented the modern periodic table after noticing a relationship between the _____ and _____ _____ of the elements. He placed the elements in order of increasing _____. At the time approximately ____ elements had been identified.

The modern periodic table, which is comprised of over _____ elements, _____ of which are naturally occurring, is organized by _____ and makes use of element _____ that are the same throughout the entire world.

Metals are located on the _____ and throughout the _____ of the Periodic Table. Metals are one kind of element that have certain _____ in common – _____, _____, have _____, _____ conductors of _____ and _____. All metals are ____ except for _____ (Hg), which is a _____.

Non-metals are located on the _____ of the Periodic Table. Non-metals are _____, not _____, not very _____ and _____ conductors of _____ and _____. At room temperature non-metals may be _____ or _____ and one, _____ (Br), is a liquid.

A division line known as the "_____" separates metals and non-metals. On either side of the staircase are a group of elements known as _____ that show _____ of both metals and non-metals.

The name for each _____ row of the Periodic Table is a _____. There are _____ periods.

The _____ columns in the periodic table are called _____ and range from 1-18 (these are typically written as Roman Numerals). Some groups are given special names because they form a _____ of elements with _____.

There are four families within the periodic table:

Group 1 –
Group 2 –
Group 17 –
Group 18 –

Periodic Chart of the Elements

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca					25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn					35 Br	36 Kr
										47 Ag			50 Sn			53 I	54 Xe
										79 Au	80 Hg		82 Pb				86 Rn

Atoms and Their Composition

Elements are the basic substances that make up all _____.

An atom is the smallest particle of an element that still retains the _____ and _____ of the element.

Atoms are made up of even smaller particles. These _____ particles are _____, _____ and _____.

Protons and neutrons make-up the _____ or core of an atom and contribute to the _____ of an atom, while electrons are _____ and occupy the _____ that surround the nucleus of the atom (_____). Electrons are so _____ and _____ that they essentially contribute no overall weight to the atom.

Subatomic Particle	Charge	Symbol	Mass (g)	Radius (m)
Electron			9.02×10^{-28}	Smaller than 10^{-18}
Proton			1.67×10^{-24}	10^{-15}
Neutron			1.67×10^{-24}	10^{-15}

Since subatomic particles are so light, chemists use a unit called an _____ for their measurement. Both protons and neutrons have a mass of _____.

Every Element has a unique:

- **Name**
- **Symbol**
- **Atomic number (Z)**
- **Atomic Mass (A)**

Atomic Number **Z**

Element Name

X

atomic symbol

Atomic Mass **A**

The _____ of an atom can be determined by _____ the _____ on the Periodic Table.

Examples:

Mass Number:

We can use this information to calculate the number of neutrons by means of the following equation:

Number of neutrons =

Examples:

You will notice that an element reports an _____ (a decimal number) instead of a mass number on the Periodic Table. The atomic mass represents a "_____" of all the _____ for a particular atom.

Isotopes are atoms of an element that have the same number of _____ in their nucleus, but a different number of _____.

Isotopes have very similar _____ properties, but they differ in _____ properties.

Example:

"Light" Lithium "Heavy" Lithium

How to Draw Atoms

Draw Bohr-Rutherford Diagrams

Ernest Rutherford and Niels Bohr developed the planetary model of the _____ in 1913. In this model, the nucleus, containing the _____ and _____, takes the central place just like the Sun takes the central place in our solar system. The electrons spin around the nucleus in orbits similar to the path of the planets around the Sun. The orbits represent the different amounts of _____ that the _____ can have. Electrons in the first orbit have the _____ energy, whereas electrons in the last orbital have the _____ energy. The first orbit holds up to _____ electrons. The second and third orbits contain up to _____ electrons. As you fill the orbits, always fill the _____ energy orbit first, then fill up the next one and the next and so on.

When you draw Bohr-Rutherford diagrams of an element, you identify the _____ of _____ and _____ in the centre of the atom and place _____ to represent the _____ in their orbits. Since electrons have a _____ charge, and according the law of _____, _____ charged particles _____ and _____ charges _____; you must place the first _____ electrons in the orbit as far apart as possible. For reasons beyond the scope of this course, the next _____ electrons in the orbit (if there are any) pair up with the electrons already there.

Step 1: Determine the number of protons

This is equal to the atomic number of the element

Step 2: Determine the number of electrons

This is equal to the number of protons.

Step 3: Determine the number of neutrons.

Subtract the atomic number (Z) from the mass number (M) of the element. Just a reminder that the mass number is the _____ rounded to the nearest _____.

Step 4: Draw a nucleus and write in the number of protons and neutrons.

Step 5: Draw electron shells around the nucleus and fill them with the appropriate number of electrons. Always fill the inner shells to their maximum before moving to the outer shells.

Lewis (Electron) Dot Diagrams

Lewis Dot Diagrams are a short way to show the _____ energy shell (_____ shell) for an atom. These are the electrons on the outer perimeter of an atom and generally the ones that will be involved in _____.

The element _____ is used to represent, the _____, _____ and all _____. Just like when drawing B/R Diagrams, the first four valence electrons (dots) should be drawn as far apart as possible, one on each side of the _____. The remaining four electrons (if present) can then be paired up.

Classifying Chemical Compounds

A compound is a _____ composed of two or more elements, chemically bonded in fixed proportions. Chemical bonds are _____ that _____ atoms to each other. Bonding involves the interaction between the _____ of atoms and is the driving force of _____.

While there are only _____ naturally occurring elements, there are _____ of different compounds. To help organize these compounds, chemists classify them into two main groups based on the _____ of bond that they form, and according to their _____.

Ionic Bond

A chemical bond between _____ charged **ions** that arise from the _____ of _____. It usually involves a _____ and a _____.

Covalent Bond

A chemical bond in which _____ are _____ by two atoms. It usually involves two _____.

Comparing Ionic and Covalent Compounds

Property	Ionic Compound	Covalent Compound
State at room temperature		
Melting point		
Electrical conductivity as a liquid (melted)		
Solubility in water		
Conducts electricity when dissolved in water		

Writing Chemical Formulas

Chemical formulas are a useful way to convey information about a compound such as:

-
-

The chemical formula has different meanings depending on the type of _____ holding the compound together.

Covalent Compounds – Covalent compounds form _____. The chemical formula of a covalent compound represents exactly _____ of each type of _____ are found in each individual molecule.

Example: H_2O_2 is a molecule with exactly _____ atoms and _____ atoms per molecule.

Ionic Compounds – Ionic compounds form _____ and make a _____ structure. The chemical formula of an ionic compound represents a _____ rather than a discrete particle. Ionic compounds are always _____.

Example: MgO is an ionic compound that has _____ magnesium atom attached to every _____ oxygen atom in the _____.

When writing chemical formula, they are typically written such that the element found furthest to the _____ on the Periodic Table is written first.

Making Observations and Describing Matter

Observations

To notice with your _____. Senses may be aided by instruments such as rulers, microscopes, balances etc…

Inferences

To use _____ and _____ to make sense of your observations.

Example: The street is wet (_____). It rained last night (_____).

Observation - The fire alarm is going off.

Inference –

Observation – When a burning splint is placed in an unknown gas, the flame goes out.

Inference -

Types of Observations

Qualitative Observations:

Observations _____ the nature of something _____.
For example: colour, taste, texture etc…

DOES NOT INVOLVE NUMBERS!

Quantitative Observations:

Observations describing the _____ or _____ of something.
For example: how fast, how hot, how much etc…

ALWAYS INVOLVE THE USE OF NUMBERS!

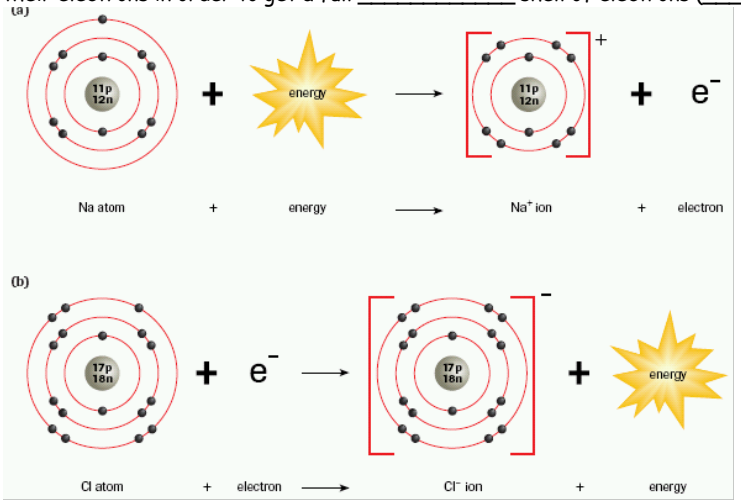
Describing matter

The properties that we can observe with our senses are called _____. The following is a list of some physical properties of matter that help us tell one thing from another.

Physical Property	Explanation or Meaning
	Solid, liquid or gas
	Black, white, colourless, greenish-blue, yellow
	Odourless, spicy, sharp, flowery
	Sweet, sour, salty, bitter
	1. Clear (transparent) 2. Cloudy (translucent) 3. Opaque (no transmission)
	Ability to reflect light (shiny → dull)
	1. Crystalline (regular shape, ex. salt) 2. Amorphous (irregular shape, ex. pepper)
	Feel - fine, coarse, smooth, gritty
	Scale [1 (soft, baby powder) → 10 (very hard, diamond)]
	Ability to shatter easily (not flexible)
	Can it be hammered into a sheet?
	Can it be stretched into a wire?
	The resistance of a liquid to flowing. Syrup is viscous, water is not.

Ionic Compounds

In order for an ionic compound to form, an atom must first become an _____. To do this, an atom will either _____ to become an _____ or _____ to become a _____. An anion has a _____ charge and a cation has a _____ charge. Anions and cations will _____ to one another, forming an _____. Atoms will _____ their electrons in order to get a full _____ shell of electrons (_____).

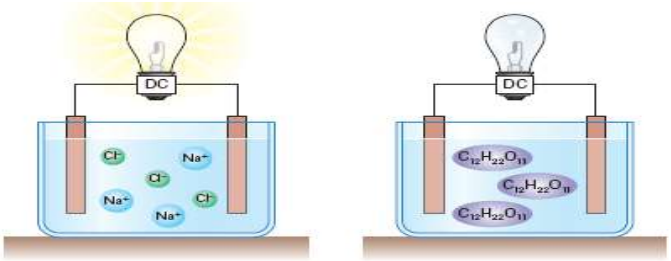


Predict the type of ion that each of the following atoms would form:

Atom	Gain or Lose Electrons	Number of Electrons	Ion Formed	Cation or Anion
Potassium				
Magnesium				
Bromine				
Calcium				
Nitrogen				
Sulphur				
Argon				

All metals tend to form _____ and all non-metals _____. Therefore, ionic compounds form when a _____ and a _____ combine. When these positive and negative particles come together they form what is called a _____ _____; a _____, _____ pattern of ions. This is why all ionic compounds appear as _____.

The reason that ionic compounds are capable of _____ is because they are composed of _____. Electricity is the movement of _____ particles. Ionic solids are **NOT** able to conduct electricity because the ions are held in place in a _____ _____. When _____ or _____ in water, the ions will split apart from each other (_____) and are then free to move around. A substance that can conduct electricity is termed an _____.



Some atoms will react more intensely than others when trying to get a full outer shell of electrons.

Which of the following metals is more reactive – lithium, sodium or potassium? Can you suggest why?

Do you think the non-metals will follow the same pattern? For example, fluorine, chlorine and bromine? Can you suggest why?

The following is how you can draw atoms exchanging their electrons to become ions and therefore form an ionic bond and thus becoming stable.

Bonding Atoms	EDD 1st element	EDD 2nd element	Formation of Bond (Movement of Electrons)	Ions formed	Chemical Formula
Lithium and Bromine					
Magnesium and Oxygen					
Beryllium and fluorine					
Aluminium and Sulphur					

Covalent Compounds

Covalent compounds typically form when two or more _____ bond together. During a covalent bond, valence electrons are ____ exchanged, but rather are _____ between atoms. Atoms can share _____ of electrons, creating a _____ bond; _____ of electrons, creating a _____ bond; or _____ of electrons resulting is a _____ bond. Atoms will share as many electrons as they need in order to achieve a stable octet.

Multiple Covalent Bonds				***Compound E.D.D***	***Lewis Structure***
One pair of electrons shared	→	Single bond	→		
Two pairs of electrons shared	→	Double bond	→		
Three pairs of electrons shared	→	Triple bond	→		

A unique type of interaction occurs when electrons are shared between atoms of the _____. There are only seven such elements that occur naturally; they are called _____ molecules: _____

Covalent compounds come in a variety of _____, solid, liquid and gas, and seem to have a wide range of _____ when compared to ionic compounds. This is due to the fact that when atoms are sharing their electrons, the sharing can occur _____ or _____ and the molecules that covalent compounds form can come in a variety of _____. These variations within molecules create the differences we see in covalent compounds.

Covalent compounds DO NOT typically conduct electricity when _____ or _____ in water. The atoms that make-up covalent molecules do not _____ _____ when they melt or boil, but rather remain as _____. Thus, there are no _____ charges to move around to create electricity.

The following is how you can draw atoms sharing their electrons to form covalent compounds.

Covalent Molecule	EDD 1st element	EDD 2nd element	Compound EDD	Lewis Structural Diagram	Chemical Formula
Oxygen and Iodine					
Phosphorous and Iodine					
Nitrogen and Fluorine					
Carbon and Bromine					
Try for a challenge: Nitrogen and Oxygen					

Chemical Reactions

A chemical reaction can be written in a number of different forms:

Chemical Equation

A description of a chemical reaction using _____, not _____, where:

- The _____ are written first
- The _____ are written second
- The state for each element or compound is indicated in brackets – _____ (s), _____ (l), _____ (g), _____ (aq)
- Reactants and products are separated by an arrow (→) – read as "_____"

Example:

Word Equation

The elements and compounds that are reacting are written first followed by the products. States are included in the description.

Example:

Skeleton Equation

The Law of Conservation of Mass states that matter cannot be _____ or _____; it can only be _____ from one form to another. Therefore the _____ in the reactants must _____ the number of atoms in the products.

A skeleton equation is an unbalanced equation that _____ follow the Conservation of Mass. The number of atoms on the left side (reactants) of the chemical equation _____ equal the number of atoms on the right side (products).

Example:

$$H_2\,(g) + Cl_2\,(g) \rightarrow HCl\,(g)$$

On the reactant side there is a total of ____ atoms (____ hydrogen and ____ chlorine)
On the product side there is a total of ____ atoms (____ hydrogen and ____ chlorine)

Balanced Chemical Equation

A balanced chemical equation is an equation that follows the Law of Conservation of Mass. The number of atoms on the reactant side equals the atoms on the product side. In most chemical equations, numbers placed in front of the elements or compounds (_____) are required to balance the equation.

Example:

On the reactant side there is a total of ____ atoms (____ hydrogen and ____ chlorine)
On the product side there is a total of ____ atoms (____ hydrogen and ____ chlorine)

When there is a coefficient of "____", it is typically not written: $H_2\,(g) + Cl_2\,(g) \rightarrow 2HCl\,(g)$

Balancing Equations

All chemical equations must be balanced so that they are consistent with the Law of Conservation of Mass.

Here are some suggestions for balancing equations:

1. When balancing equations, always start with the "ugliest" molecule first (polyatomics).

2. To balance, place the desired number (coefficient) in front of the element or compound. Never split-up a compound and never change the subscripts in the chemical formula.

3. It is often useful to balance the diatomic molecules, if they are present, last.

4. Creating a chart to keep track of the type and number of each atom on the reactant and product side of the equation can make balancing easier.

5. Make sure to always recheck the final balanced equation.

Examples:

____ Mg (s) + ____ O_2 (g) → ____ MgO (s)

Atoms	Reactants	Products
Mg		
O		

____ H_2 (g) + ____ O_2 (g) → ____ H_2O (g)

Atoms	Reactants	Products
H		
O		

____ Fe (s) + ____ O_2 (g) → ____ Fe_2O_3 (s)

Atoms	Reactants	Products
Fe		
O		

____ Al_2O_3 (s) + ____ H_2 (g) → ____ H_2O (l) + ____ Al (s)

Atoms	Reactants	Products
Al		
O		
H		

____ $Pb(NO_3)_2$ (aq) + ____ BF_3 (s) → ____ $B(NO_3)_3$ (aq) + ____ PbF_2 (s)

Atoms	Reactants	Products
Pb		
NO_3		
B		
F		

Sometimes to balance an equation, fractions must be used. Fractions are not to be left in the final balanced equation, as it impossible to have part of an atom. To get rid of the fraction, multiply every element or compound in the equation by the denominator of the fraction (i.e. If you use $\frac{1}{2}$ as a coefficient, then multiply by 2).

____ NH_3 (l) + ____ O_2 (g) → ____ NO_2 (g) + ____ H_2O(s)

Atoms	Reactants	Products
N		
H		
O		

____ FeS_2 (s) + ____ O_2 (g) → ____ Fe_2O_3 (s) + ____ SO_2 (g)

Atoms	Reactants	Products
Fe		
S		
O		

Balancing chemical equations becomes increasing more difficult when you are given the reaction as a word equation. To balance the equation, you must first convert the elements and/or compounds into their correct chemical formula. Even the slightest mistake will make you equation incorrect and could possibly create an equation that is impossible to balance. Be careful, and make sure to always check your work.

Write out a balanced chemical equation for the following:

Oxygen gas reacts with solid aluminum sulfide to produce solid aluminum oxide and sulfur dioxide gas.

Balancing Word Equations

Write the appropriate formulas and symbols below the word equation and then balance each reaction.

1. dicarbon dihydride gas reacts with oxygen gas to produce carbon dioxide gas and liquid dihydrogen monoxide

2. hydrogen iodide gas and aqueous sulfuric acid (hydrogen sulfate) react to produce aqueous hydrogen sulfide, iodine gas and liquid dihydrogen monoxide

3. Aqueous potassium sulfate reacts with aqueous barium nitrate to yield aqueous barium sulfate and aqueous potassium nitrate

Types of Chemical Reactions

It is important to be able to classify chemical reactions as it enables scientists to predict possible products or outcomes. For example, think of appropriate storage of chemicals…

Why are some chemicals stored in dark containers?

Why are some chemicals stored in glass jars?

Why is it inappropriate to store propane tanks in areas that get very hot?

Below are 4 major categories of chemical reactions:

1. Synthesis

A synthesis reaction occurs when 2 or more _____ combine to form a new _____ or _____.

The general equation for a synthesis reaction is:

Specific types of synthesis reactions:

a) **Metals** react with **oxygen** to produce a **metal oxide**

b) A **non-metal** reacts with **oxygen** to produce a **non-metal oxide**

c) A **metal** and **non-metal** combine to form a **binary ionic compound**

d) **Non-metallic oxides** react with **water** to produce an **acid**

e) **Metallic oxides** react with **water** to produce a **base**

2. Decomposition

A decomposition reaction is the reverse to a synthesis reaction, a compound _____ into _____ or other _____.

The general equation for a decomposition reaction is:

Example:

Typically, some form of _____ or type of _____ is needed to initiate a decomposition reaction.

A catalyst is a substance that controls the _____ of a reaction, without being _____ during the reaction or affecting the overall _____.

3. Single Displacement Reaction

A single Displacement reaction occurs when one _____ in a compound is _____ by another _____. This can occur in 2 ways, a _____ can replace a _____ or a _____ can replace a _____.

The general equation for a single displacement reaction is: _____ where A is a _____ or _____ where X is a _____.

Examples: a) **Al + Fe_2O_3 →**

b) **Cl_2 + $CaBr_2$ →**

c) **Cu + $AgNO_3$ →**

How do you know that a single displacement reaction can occur or do they always occur?

For example, explain why the above reactions occur but the following reaction does not?

In order to determine if an element will displace another element in a single displacement reaction you must refer to an _____:

If one element is _____ another element in the compound, it can be _____ _____ and a single displacement reaction will occur.

Non-metals, typically _____ are involved in Single Displacement Reactions. To determine who can bump out whom, you must refer to the _____ _____.

Predict if the following reactions will occur and what the products are:

Fluorine
Chlorine $I_2 + NaCl \rightarrow$ _____
Bromine
Iodine $F_2 + KBr \rightarrow$ _____

4. Double Displacement Reactions

A double displacement reaction occurs when there is an _____ of _____ between two _____ compounds.

The general equation for a double displacement reaction is:

In the general equation above, A and C are _____ (written first) and B and D are _____.

How do you know that a double displacement reaction can occur or will they always occur?

Evidence that a double displacement reaction will/has occurred:

A)
B)
C)

Example: $NaCl + AgNO_3 \rightarrow$ _____

Example: $Na_2CO_3 + HCl \rightarrow$ _____

Example: $H_3PO_4 + Ca(OH)_2 \rightarrow$ _____

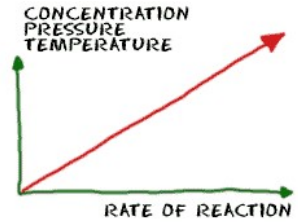
Water is evidence of an _____ reaction (_____), which is a type of double displacement reaction. Since water is a clear, colourless, liquid, it typically cannot be seen by looking at the reaction. To determine if water is present, it has to be tested using _____ or _____.

Rates of Reactions (and Energy Changes -2DW)

Rates of Reactions
The rate of reactions is defined as the:

Rates of reactions can be explained using the _____. The collision theory states that the _____ that occur between atoms or molecules, the _____ will happen. If there are a higher number of collisions in a system, more combinations of molecules will occur. The reaction will go faster, and the rate of that reaction will be higher.

Reactions happen, no matter what. Atoms are always combining or compounds breaking down. The reactions happen over and over but not always at the same speed. A few things affect the overall speed of the reaction and the number of collisions that can occur.



Concentration: If there is _____of a substance in a system, there is a _____ that molecules will _____ and speed up the rate of the reaction. If there is _____of something, there will be _____ _____ and the reaction will probably happen at a slower speed.

Temperature: When you _____ of a system, the molecules bounce around a lot more (an increase in thermal energy). When they bounce around more, they are _____. That fact means they are also more likely to combine. When you lower the temperature, the molecules are slower and collide less. That temperature drop lowers the rate of the reaction.

Pressure: Pressure affects the rate of reaction, especially when you look at gases. When you _____, the molecules have _____ in which they can move. That greater concentration of molecules increases the number of collisions. When you _____ atoms and/or molecules _____ and don't hit each other as often. The lower pressure decreases the rate of reaction.

Surface Area: When you _____ _____, you are increasing the number of atoms/molecules that are able to collide. The more collisions that occur, the greater the opportunity of a reaction occurring.

An example of this is can be seen when comparing a pack of sugar versus a sugar cube placed in water. A pack of sugar provides a greater surface area, as every sugar crystal will be in contact with the water. With a sugar cube, only the outer layer of sugar is in contact with the water and therefore capable of reacting.

Catalyst: A catalyst is defined as _____ _____. Catalysts lower the energy required (activation energy) required to break the bonds that hold substances together.

Examples of catalysts include enzymes (biological systems), palladium (catalytic converters) and even light (hydrogen peroxide).

Energy Changes and Chemical Reactions (2DW content only)

All chemical reactions involve the **input and release of energy**. Often thermal energy is involved, but can the energy can also come in the form of light, electricity and sound.

You can classify reactions on the basis of whether they release or absorb more energy. **Energy releasing** reactions are called **exothermic**. Examples include the burning of fossil fuels and the rusting of iron.

Some reactions involve the addition of large amounts of energy to cause a chemical change (**large activation energy**). **Energy-absorbing** reactions are called **endothermic**. Cooking food, ice packs and electrolysis are all examples of endothermic reactions.

Identify the following as exothermic or endothermic:

Ice melting - _____
A match burning - _____
Frying an egg - _____
Mixing acids with water will cause a rise in temperature - _____
Hydrogen gas and chlorine gas will explode when exposed to UV light - _____

Acids and Bases

An **acid** is a substance that produces _____ in solution, __ $_{(aq)}$. For example:

i) When hydrochloric acid, HCl is placed in solution it dissociates (ionizes) into:
_____

ii) When sulfuric acid, H_2SO_4 is placed in water it dissociates (ionizes) into:
_____

A **base** is a substance that produces _____ in solution, ___ $_{(aq)}$. For example:

i) When sodium hydroxide, NaOH is placed in solution it dissociates (ionizes) into:
_____

ii) When calcium hydroxide, $Ca(OH)_2$ is placed in solution it dissociates (ionizes) into: _____

Acids and bases have _____ that are summarized in the table below:

Acids	**Bases**
	Taste bitter
Has no characteristic feel	
	Conducts electricity
Keeps red litmus red	
Turns blue litmus red	
	Bromothymol blue remains blue
Keeps phenolphthalein clear	
	Does not react with metals
Reacts with sodium carbonate to produce carbon dioxide (limewater test)	
	Reacts with ammonium chloride to produce ammonia (waft for odour)

Indicators

Most solutions of acids or bases are _____ and _____. Therefore they cannot be distinguished from ordinary water by appearance alone. The simplest way to distinguish them from water is to use an _____. An indicator is a substance that produces a _____ as the concentration of _____ and _____ changes.

Indicators can be made from _____ products such as flowers, fruit and vegetables. There are also a number of _____ indicators. These are more common as they tend to last longer and can be produced in large quantities.

Concentration of Acids and Bases (pH)

Concentration is defined as the amount of _____ per quantity of _____. The concentration of a product can easily be altered by diluting with _____ or the addition of _____. _____ is the universal solvent.

When you determine the concentration of hydrogen ions in solution (amount of H+ ions/ total solution volume) you are determining the _____ of that particular solution. pH stands for, "_____". The pH of a substance can be determined a number of different ways, such as with the use of pH paper, an electronic pH meter or mathematically. **The pH scale ranges from _____.**

Acids have a pH _____
Bases have a pH _____
Neutral substances have a pH _____

_____

While the pH scale ranges from 0 to 14 and each pH unit represents a factor of 10.

A change in pH from 3 to 8 is a(n) _____ increase/decrease in $[H^+]$
A change in pH from 11 to 2 is a(n) _____ increase/decrease in $[H^+]$

Strength of Acids and Bases

Strong acid –

Example: $HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$

When hydrogen chloride molecules enter an aqueous solution, 100% of the hydrogen chloride molecules dissociate. As a result the solution contains the same percent of H^+ ions and Cl^- ions: 100%

Weak acid –

Example: $CH_3COOH_{(aq)} \Leftrightarrow H^+_{(aq)} + CH_3COO^-_{(aq)} + CH_3COOH_{(aq)}$

On average, only about 1% of the acetic acid molecules dissociate at any given moment.

Notice that the arrow used in the dissociation of a weak acid points in both directions. This indicates that the reaction is _____. The products of the reaction will also react to produce the original reactants.

Strong base –

Examples: NaOH, $Mg(OH)_2$

Weak base –

Example: NH_3

Neutralization Reactions

Neutralization occurs when _____ (base) and _____ _____(acid) are mixed to make _____ and a _____. Neutralization reactions are types of _____ reactions. The general word equation for a neutralization is:

Examples:

1. *Given the full equation in words:*

Aqueous solutions of hydrobromic acid and beryllium hydroxide undergo a neutralization reaction to produce liquid water and aqueous beryllium bromide.

2. *Given the partial equation in words or in these cases, in chemical formulae, you can complete the following equations:*

___ $H_2SO_{4\,(aq)}$ + ___ $LiOH_{\,(aq)} \rightarrow$

___ $Ca(OH)_{2\,(aq)}$ + ___ $H_3PO_{4\,(aq)} \rightarrow$

3. Working backwards from the examples above, you can determine which acid and base would react together to produce the following salts:

i) KNO_3

ii) $MgCO_3$

Elements and Oxides

An oxide is any element chemically combined with oxygen. How does the element's position in the periodic table affect the ability of the oxide to form an acid or a base?

How does an element's position in the periodic table affect the ability of the element to form an acid or a base?

Reactions of Metals

Review:

- Metals are found on the **left** side of the staircase
- Metals are generally shiny, ductile, malleable, good conductors of electricity and heat, and **solid** at room temperature (except **Mercury**)

There are certain patterns of chemical behavior that metals follow:

- Form **metal oxides** when they react in oxygen
- Metal oxides are always **solids**
- Metal oxides form **bases** when they react with water

Since they form **bases**, they can be called **basic** oxides or **basic anhydrides**.

For example:

Potassium burns in oxygen to produce potassium oxide. The balanced chemical equation representing this statement is:

$$4\ K + O_2 \rightarrow 2\ K_2O$$

When the potassium oxide reacts with water the product is potassium hydroxide. The balanced chemical equation representing this statement is:

$$K_2O + H_2O \rightarrow 2\ KOH\ (aq)$$

Potassium hydroxide is used in **liquid fertilizer**, **cosmetics, paint removers**, and **making soap**.

Reactions of Non-Metals

Review:

- Non-metals are found to the right of the staircase
- Non-metals are usually brittle, dull, poor conductors of heat and electricity, and have a variety of states at **room temperature**

Non-metals also follow certain patterns of chemical behavior, such as:

- Form **non-metal** oxides when they react in **oxygen**
- Non-metal oxides are often **liquid** or **gases**
- When non-metal oxides react with water they form **acids**

Since they form **acids** they can also be called **acidic** oxides.

For example:
Nitrogen reacts with oxygen to form nitrogen dioxide. The balanced equation representing this statement is:

$$N_2 + O_2 \rightarrow 2\ NO_2$$

When the nitrogen dioxide is reacted with water, the product is nitric acid. The balanced equation representing this statement is:

$$3\ NO_2 + H_2O \rightarrow 2\ HNO_3\ (aq) + NO$$

Nitric acid contributes to our **air pollution** and is used in many **industrial reactions**.