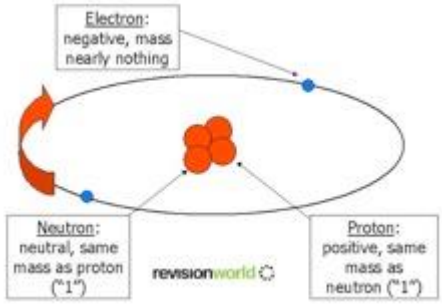
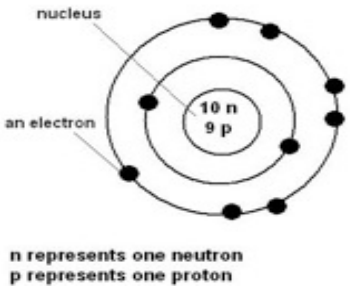
Unit 1. Atomic structure.

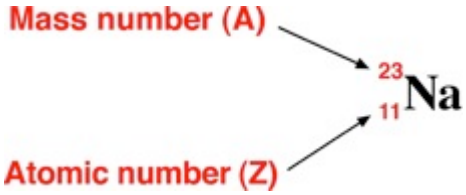
1.The atom.

Atoms are the smallest particles of matter whose properties we study in Chemistry.
However from experiments done in the late 19th and early 20th century it was deduced that atoms are made up of three fundamental sub-atomic particles, protons, neutrons and electrons, which are listed below with their relative masses and electrical charges.





An atom has a nucleus surrounded by shells of electrons.
The electrons are found in shells around the nucleus.
The nucleus is found at the centre of the atom and contains neutrons and protons.



The atomic number (Z)= number of protons in the nucleus.

The mass number (A)= number of protons + number of neutrons

Activity.

1.Listen to the teacher and complete the text:
-Protons have a positive ..... and a ..... of 1.
-..... have no charge and a mass ..... .
-Electrons have a ..... charge and a negligible mass.
-In all .... there is no overall charge, so the .....
of protons is ..... to the number of electrons.
-The .... is the number of protons added to the
number of neutrons.
-The .... is the number of protons.

2.Isotopes.

Isotopes are atoms of the same element with different numbers of neutrons and therefore different masses (different nucleon/mass numbers). This gives each isotope of a particular element a different mass or nucleon number, but, being the same element they have the same atomic or proton number and are identical chemically.

$^{1}_{1}H$ $^{2}_{1}H$ $^{3}_{1}H$,

and are the three isotopes of hydrogen with mass numbers of 1, 2 and 3, with 0, 1 and 2 neutrons respectively. All have 1 proton, since all are hydrogen! **Hydrogen-1** is the most common, there is a trace of **hydrogen-2** (sometimes called deuterium) naturally but **hydrogen-3** (sometime called tritium) is very unstable and is used in atomic bombs - nuclear fusion weapons.

Activities.

1. Write the sodium symbol using the information given below:
Sodium has an atomic number of 11 and its mass number is 23.

How many protons does it have?
How many electrons does it have?
How many neutrons does it have?

2. Chlorine has 17 electrons and 18 neutrons:
What is its atomic number?
What is its mass number?
Write its symbol:

3. Nuclear reactions.

You have to prepare a summary of this part of the unit. Use the following web page, read the information, and write down the summary
http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/radiation/nuclearfissionrev1.shtml

Activity.

1.Copy the test you'll find on that web page and mark the correct answers.

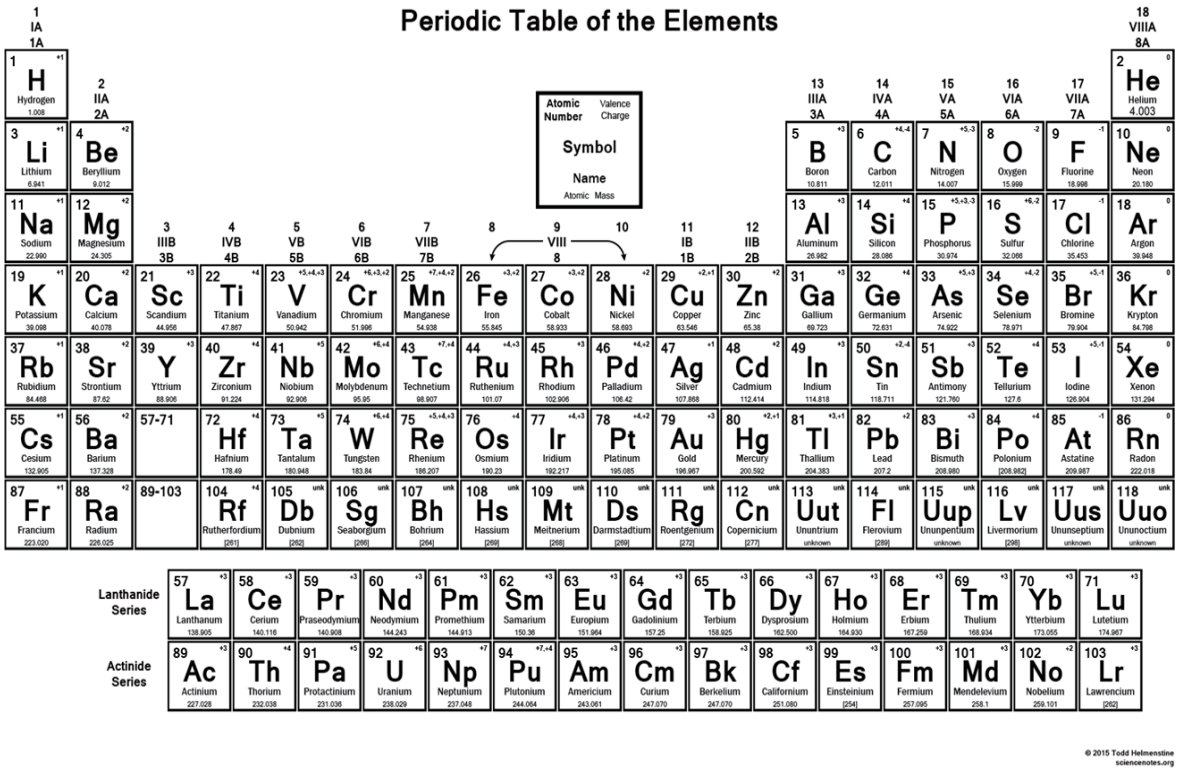
Final activities.

1.Answer the following questions:
a)What does the nucleus contain?
b)What are found in shells around the nucleus?
c)What is the charge and mass of a proton?
d)What is the charge and mass of an electron?
e)What is the charge and mass of a neutron?
f)What is the mass number of an atom?
g)What is the atomic number of an atom?
h)What is the same about the atoms of two isotopes of an element?
i)What is different about the atoms of two isotopes of an element?

2. Do the following test:
1. Which of the following does the nucleus contain?
a) protons and electrons.
b) protons and neutrons.
c)neutrons and electrons.
2. If the relative mass of a proton is 1, what is the relative mass of a neutron?
a) negligible
b) 0
c)1
3. Which one of the following statements is correct?
a) Protons are positively charged and neutrons are negatively charged.
b) Protons are negatively charged and electrons are positively charged.
c)Protons are positively charged and electrons are negatively charged.
4. What is the mass number of an atom?
a) the number of electrons and protons in the atom.
b) the number of neutrons and protons in the atom.
c) the number of neutrons in the atom.
5. What is the atomic number of an atom?
a) the number of atoms it contains.
b) the number of protons it contains.
c)the number of neutrons it contains.
6. Which of the following statements is true of an atom?
a) The number of protons is always equal to the number of neutrons.
b) The number of protons is always equal to the number of electrons.
c)The number of neutrons is always equal to the number of electrons.
7. Isotopes of an element have.
a) the same number of protons.
b) the same number of neutrons.
c)different chemical properties.
8. Lithium atoms have 3 protons and 4 neutrons. Which of the following is correct?
a) The mass number is 3.
b) The mass number is 4.
c) The mass number is 7.
3.Complete the table (use the periodic table):

Symbol	**Element**	**Z**	**A**	**p+**	**n^0**	**e-**
$_{1}^{1}H$						
	Magnesium		24			
		16			16	
				6		8
			39		19	

Unit 2. The periodic table.



1. The periodic table.

The elements are arranged in order of increasing atomic number (the atomic number is the number of protons in the nucleus). The vertical columns in the table are called groups, and the horizontal rows are called periods. The block in the middle is known as the transition metals. The blocks at the bottom are known as the lanthanides and actinides. This arrangement puts the metals towards the left and the non-metals on the right of the table.

Activities.

1. Go to this page: http://www.sheppardsoftware.com/Elementsgames.htm
On this page you can learn the periodic table using the games. Do level L (learning), just to memorize the most common elements. After that you can play level 1 (beginner) using only common elements. There are higher levels, in case you need more!

2. Answer the following questions about the periodic table, elements and compounds:

a) What is listed in the Periodic Table?

b) In the periodic table, what is a group?

c) In the periodic table, what is a period?

d) Where are the metals and the non-metals? Left or right-handed-side?

e) Using a copy of the periodic table, find the odd one out for each of the list 1 to 5 and explain why it's different from all the others.

1- Magnesium, aluminium, lead, silicon:

2-Ca, Cu, Cl, Cs:

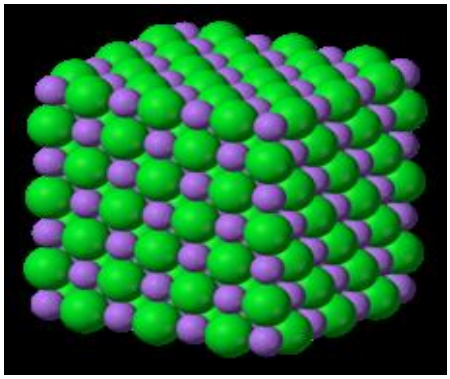
3-Helium, argon, hydrogen, krypton:

4-Li.Na, K, Fe:

5-Lithium, nitrogen, oxygen,carbon:

2. Ionic compounds.

(Remember, a **compound** is a substance that contains atoms of more than one kind joined together.)



Ionic compounds are held together by strong forces of attraction between oppositely charged ions. Ionic bonding occurs between **metals** in groups 1 and 2 and **non-metals** in groups 16 and 17.
The metal is positive and the non-metal is negative so they are attracted by strong forces.

Properties.

-The compound has a regular structure. Ions form giant structures
-They have very high melting and boiling points because we have to break the strong bonds.
-They dissolve easily in water.
-They don't conduct electricity when they are solid, because the ions can't move.
-They conduct electricity when they are dissolved or when they are melted because in these cases the ions can move.

Activities.

1. Which structure do all the ionic compounds form?
2. Why do they have high melting and boiling points?
3. Why can ionic substances conduct electricity when dissolved but not when they are solid?

3. Covalent compounds.

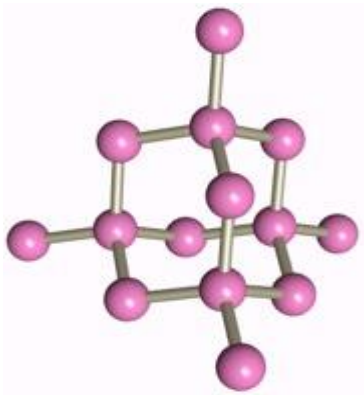
Covalent bonding occurs between non-metal atoms.
Atoms can share electrons to form **simple** molecules or **giant** covalent structures.

Simple molecular covalent structures.

Chlorine (Cl_2), oxygen (O_2), hydrogen (H_2), hydrogen iodide (HI) and water (H_2O), are examples of simple molecular covalent structures. These molecules are formed from small numbers of atoms.
There are strong covalent bonds between the atoms in each molecule, but very weak forces of attraction between these molecules.
-This means that simple molecular compounds have low melting and boiling points. Most are gases or liquids at room temperature.
-Simple molecular substances **do not conduct electricity** because they don't contain ions.
-They tend to be **insoluble** in water (although they may dissolve in other solvents)

Giant covalent substances

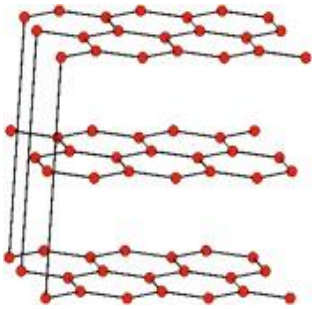
Carbon in the form of diamond or graphite are examples of these substances. These structures are formed from a **large** number of atoms. All the atoms in these structures are held together by strong covalent bonds.
-This means that these compounds have high melting and boiling points and are solid at room temperature.
-Like simple covalent structures, giant covalent structures do not conduct electricity (except graphite) nor do they dissolve in water.



Diamond

-Each carbon atom is bonded to four other carbon atoms by strong covalent bonds.
-Diamond is very strong and has a very **high melting point.**

Graphite



-Each carbon atom forms strong covalent bonds with three other carbon atoms in the same layer.
-However, the bonding between the layers is **weak**. The layers can pass over each other.
-The electrons in the weak bonds can move, so graphite conducts electricity.

Final activities.

1. Divide the following into two sets labelled elements and compounds by writing the name in the box below:

Sodium Chloride Magnesium Oxide Sulphur Lead Water
Propane Carbon Dioxide Oxygen Methane Helium Calcium
Sulphuric Acid Sulphur Dioxide Chlorine

Elements:

Compounds:

2. Write down how many atoms are present in the molecules written below. (e.g. CO_2 contains 1 atom of carbon C and 2 atoms of oxygen O)

a) Copper sulphate $CuSO_4$
b) Ammonia NH_3
c) Sodium chloride NaCl
d) Water H_2O
e) Sodium oxide Na_2O
f) Hydrogen H_2

3. Why can ionic substances conduct when they are molten?
4. Give an example of a simple molecular substance.
5. Give two forms of carbon which are giant covalent substances.
6. Why do giant covalent substances have high melting and boiling points?
7. Complete the table.

Substance	Type of bond	Solubility in water	Melting and boiling points	Conduction of electricity	Structure	Drawing
CO_2						
NaCl						
C						
He						
O_2						
LiCl						

8. Having Fun with Symbols

Q1 Look at the secret message below, then use the symbols you have learnt and the symbols listed below to decipher the message.

Phosphorus, uranium, phosphorus, iodine, (lithium-iodine), sulphur/ Tungsten, hydrogen, oxygen/Tungsten oxygen, (rhodium-hydrogen), potassium/ Hydrogen, argon, (dysprosium-yttrlum) / Tungsten iodine (lithium-iodine), (Lithium-iodine),/ (dysprosium-yttrium) oxygen / Tungsten, (Einsteinium-sulphur), (lithium-iodine), (lithium-iodine) / indium / sulphur, astatine, sulphur.

Actinum	Ac	Cadmium	Cd	Erbium	Er
Aluminium	Al	Caesium	Cs	Europium	Eu
Americium	Am	Calcium	Ca	Fermium	Fm
Antimony	Sb	Californium	Cf	Fluorine	F
Argon	Ar	Carbon	C	Francium	Fr
Arsenic	As	Cerium	Ce	Gadolinium	Gd
Astatine	At	Chlorine	Cl	Gallium	Ga
Barium	Ba	Chromium	Cr	Germanium	Ge
Berkelium	Bk	Cobalt	Co	Hafnium	Hf
Beryllium	Be	Copper	Cu	Helium	He
Bismuth	Bi	Curium	Cm	Holmium	Ho
Boron	B	Dysprosium	Dy	Hydrogen	H
Bromine	Br	Einstenium	Es	Indium	In

Gold	Au	Neodymium	Nd	Potassium	K
Iodine	I	Neon	Ne	Preseodymium	Pr
Iridium	Ir	Neptunium	Np	Promethium	Pm
Iron	Fe	Nickel	Ni	Protactinium	Pa
Krypton	Kr	Niobium	Nb	Radium	Ra
Lanthanum	La	Nitrogen	N	Radon	Rn
Lead	Pb	Nobelium	No	Rhenium	Re
Lithium	Li	Osmium	Os	Rhodium	Rh
Lutetium	Lu	Oxygen	O	Rubidium	Rb
Magnesium	Mg	Palladium	Pd	Ruthenium	Ru
Manganese	Mn	Phosphorous	P	Samarium	Sm
Mendelevium	Md	Platinum	Pt	Scandium	Sc
Mercury	Hg	Plutonium	Pu	Selenium	Se
Molybdenum	Mo	Polonium	Po	Silicon	Si

Silver	Ag	Thorium	Th	Zinc	Zn
Sodium	Na	Tin	Sn	Zirconium	Zr
Strontium	Sr	Titanium	Ti		
Sulphur	S	Tungsten	W		
Tantalum	Ta	Uranium	U		
Technetium	Tc	Vanadium	V		
Tellurium	Te	Xenon	Xe		
Terbium	Tb	Ytterbium	Yb		
Thallium	Tl	Yttrium	Y		

Q2 Translate the message below in the same way as you did for Question 1.
lodine / (Lutetium-uranium), oxygen vanadium, (europium- uranium) / Holmium, (manganese-nitrogen), (europium- uranium) Tungsten, oxygen, (rubidium-boron) potassium.
Molybdenum rhenium / fluorine, oxygen, (rubidium-boron) / (manganese-nitrogen) (europium-uranium)

Q3 Now translate the message below into symbol code:

Best do some work matey!

Unit 3. Chemical reactions.

1. Types of chemical reactions.

All chemical reactions involve a change in substances and a change in energy.

Neither matter nor energy is created or destroyed in a chemical reaction, they only change.

There are so many chemical reactions that it is helpful to classify them into four general categories which include the following:

Synthesis reaction.

In a synthesis reaction two or more simple substances combine to form a more complex substance. For example, simple hydrogen gas combined with simple oxygen gas can produce a more complex substance-----water!

The chemical equation for this synthesis reaction looks like this:

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

reactant + reactant -------> product

Decomposition reaction.

In a decomposition reaction a more complex substance breaks down into its more simple parts. Basically, synthesis and decomposition reactions are opposites.

For example, water can be broken down into hydrogen gas and oxygen gas. The chemical equation for this decomposition reaction looks like this:

$$\mathbf{H_2O(g) \rightarrow 2H_2(g) + O_2(g)}$$

reactant -------> product + product

Single replacement reaction.

In a single replacement reaction a single uncombined element replaces another in a compound. For example when zinc combines with hydrochloric acid, the zinc replaces hydrogen. The chemical equation for this single replacement reaction looks like this:

$$\mathbf{Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)}$$

reactant + reactant ---------> product + product

In a double replacement reaction parts of two compounds change places to form two new compounds. For example when silver nitrate combines with sodium chloride, two new compounds (silver chloride and sodium nitrate) are formed because the sodium and silver changed places. The chemical equation for this double replacement reaction is:

$$\mathbf{AgNO_3(aq) + NaCl(aq) \rightarrow NaNO_3(aq) + AgCl(aq)}$$

reactant + reactant ---------> product + product

You can also say that your reaction is a **combustion or oxidation**, when you need oxygen to produce it, for example:

$$\mathbf{C(s) + O_2(g) \rightarrow CO_2(g)}$$

$$\mathbf{CH_4(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)}$$

The opposite is a **reduction** when the oxygen is removed from a reactant:

$$\mathbf{H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)}$$

Activities.

1. You have some kinds of reaction in the table, match them with the explanation:

Combustion (oxidation)	A more reactive substance takes the place of a less reactive one, in a compound.
Displacement	A compound breaks down into simpler molecules (often when it is heated).
Decomposition (thermal decomposition)	When a substance reacts with oxygen.
Reduction	The oxide of a substance loses its oxygen.

2. Classify the following reaction:
a) $CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$
b) $Fe(s) + CuSO_4(aq) \rightarrow Cu(s) + FeSO_4(aq)$
c) $CH_3CH_3(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

2. Energy of chemical reactions.
Chemical reactions always involve a change in energy.

"Energy is neither created nor destroyed."

Energy is absorbed or released in chemical reactions. Chemical reactions can be described as endothermic or exothermic reactions.

Endothermic Reactions
Chemical reactions in which energy is absorbed are endothermic. Energy is required for the reaction to occur. The energy absorbed is often heat energy or electrical energy. Adding electrical energy to metal oxides can separate them into the pure metal and oxygen. Adding electrical energy to sodium chloride can cause table salt to break into its original sodium and chlorine parts.

Exothermic Reactions
Chemical reactions in which energy is released are exothermic. The energy that is released was originally stored in the chemical bonds of the reactants. Often the heat given off causes the product(s) to feel hot. Any reaction that involves combustion (burning) is an exothermic chemical reaction.

Activity.

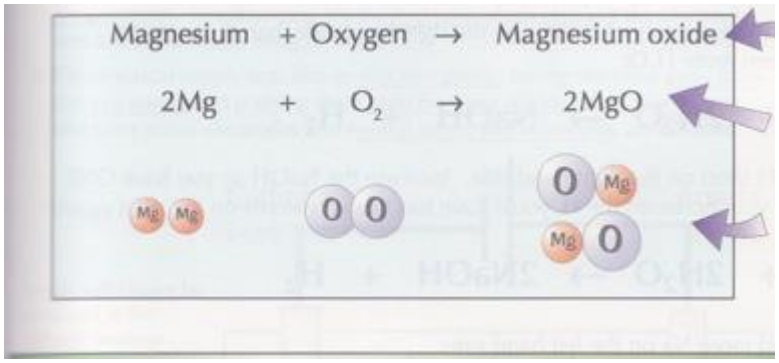
1. Translate the text above into Spanish.

3. Balancing equations.

Equations need a lot of practise if you're going to get them right.

This is just a reminder of the basics.

The symbol equation shows the atoms on both sides.



Word equation

Symbol equation

Pictorial representation of the atoms

1) There must always be the same number of atoms on both sides, they can't disappear.

2) You balance the equation by putting numbers in front of the formulae where needed.

Take this equation for reacting sodium with water:

$Na+H_2O \rightarrow NaOH+H_2$

The formulae are all correct but the number of some atoms don't match up on both sides.

You can't change formulae like H_2O to H_2O_2. You can only put numbers in front of them.

-Balance just one type of atom at a time.

-Find an element that doesn't balance and pencil in a number to try and sort it out.

-See where it gets you. It may create another imbalance but pencil in another number and see where that gets you.

Example:

$Na + H_2O \rightarrow NaOH+H_2$

1) You'll notice that there are more H atoms on the right hand side than there are on on the left. You'll need more water:

$Na + 2H_2O \rightarrow NaOH + H_2$

2) Now you're one H short on the right hand side. Increase the NaOH so you have ONE more H atom.(If you increased the H_2 you'd have too many H atoms on the right again):

$Na + 2H_2O \rightarrow 2\ NaOH + H_2$

3) But now you need more Na on the left hand side:

$2Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$

4) And suddenly there it is. Everything balances. It took a while, but by being methodical, we go there in the end.

To have a reaction well written you have to indicate the physical state of each substance.

These are easy enough, just make sure you know them, especially aq (aqueous).

(s) solid
(l) liquid
(g) gas
(aq) dissolved in water

Eg. $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

Activities.

1. How many calcium atoms are present in $CaCO_3$?

2. How many carbon atoms are present in $CaCO_3$?

3. How many oxygen atoms are present in $CaCO_3$?
4. Why must there be the same number of atoms on both sides of the equation?
5. Balance the equation: $Na(s) + Cl_2(g) \rightarrow NaCl(s)$.
6. Balance the equation: $H_2(g) + Cl_2(g) \rightarrow HCl(g)$.
7. Balance the equation: $C(s) + CO_2(g) \rightarrow CO(g)$.
8. What does the state symbol (l) indicate?
9. What does the state symbol (aq) indicate?
10. Add the state symbols to the equation for the thermal decomposition of calcium carbonate:

$$CaCO_3 \rightarrow CaO + CO_2$$

Final activities.

1. Draw "ball and stick" diagrams of the following molecules:
a) Nitrogen dioxide (NO_2).
b) Sulphur trioxide (SO_3).
c) Tetrachloromethane (CCl_4)-
d) Chlorine (Cl_2).
2. Balance the following equations:
a) $CuO + HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$
b) $Na + O_2 \rightarrow Na_2O$
c) $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$
d) $Al_2O_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$
e) $CuSO_4 + NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$
f) $Ca(NO_3)_2 \rightarrow CaO + NO_2 + O_2$

3. Match each word with the explanation

Word	**What happens in the reaction**
oxidation	a substance burns, usually in air
reduction	a compound breaks down into simpler substances, usually when heated
endothermic	a metal displaces or pushes out a less reactive metal from its compound
exothermic	energy is taken in, causing the temperature to go down
displacement	energy is given out, causing the temperature to go up
combustion	oxygen is added to a substance
decomposition	oxygen is taken away from a substance

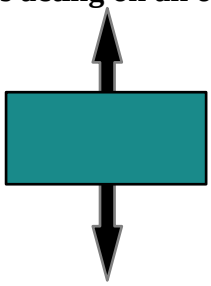
4. Which of the following is not a chemical reaction?
a) Making toast.
b) Lighting a match.
c) Boiling water.
5. In chemical reactions, the new substances made are called? .....
6. If 100g of copper oxide is formed when 80g reacts with oxygen, what mass of oxygen was needed in the reaction?.....
7. When a piece of carbon burns in air, its mass goes down. This is because.....
8. When coal burns, it gives out heat energy. This tells you that: the reaction is .....
9. What's the term for reactions that take in heat from their surroundings?
10. Balance the following equations:
a) $H_2 + O_2 \rightarrow H_2O$
b) $Mg + O_2 \rightarrow MgO$
c) $CO + O_2 \rightarrow CO_2$
d) $Ca + O_2 \rightarrow CaO$
e) $Mg + HCl \rightarrow MgCl_2 + H_2$

Unit 4. Forces.

1. Forces in action.

Forces are PUSHES or PULLS eg. FRICTION, WEIGHT, AIR RESISTANCE.
A force can also be used to change the shape of an object, change the speed of a moving object or change its direction.
They are measured in NEWTONS (N) and may be different in SIZE and act in different directions.

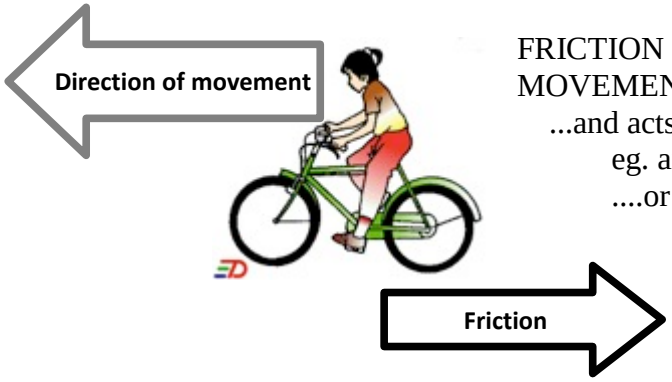
Forces acting on an object at rest.



When an object rests on a surface...
*...there is a downward force exerted by the weight of the object,...
*...and an upward force exerted by the surface.
*These two forces are EQUAL and OPPOSITE and therefore the object remains at rest.

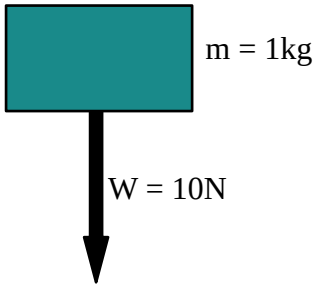
WHENEVER TWO OBJECTS INTERACT ie. ARE IN CONTACT THEY EXERT EQUAL AND OPPOSITE FORCES ON EACH OTHER.

Friction.



FRICTION is a force that OPPOSES THE DIRECTION OF MOVEMENT of an object...
...and acts when an object MOVES THROUGH A MEDIUM
eg. air, water...
....or when SURFACES SLIDE past each other.

Weight is due to the force of GRAVITY on an object.



Mass and weight are often confused. **Mass** is a measure of the amount of matter in an object and is measured in kilograms. **Weight** is the downward force acting on a mass and is caused by gravity. It is measured in Newtons (N).

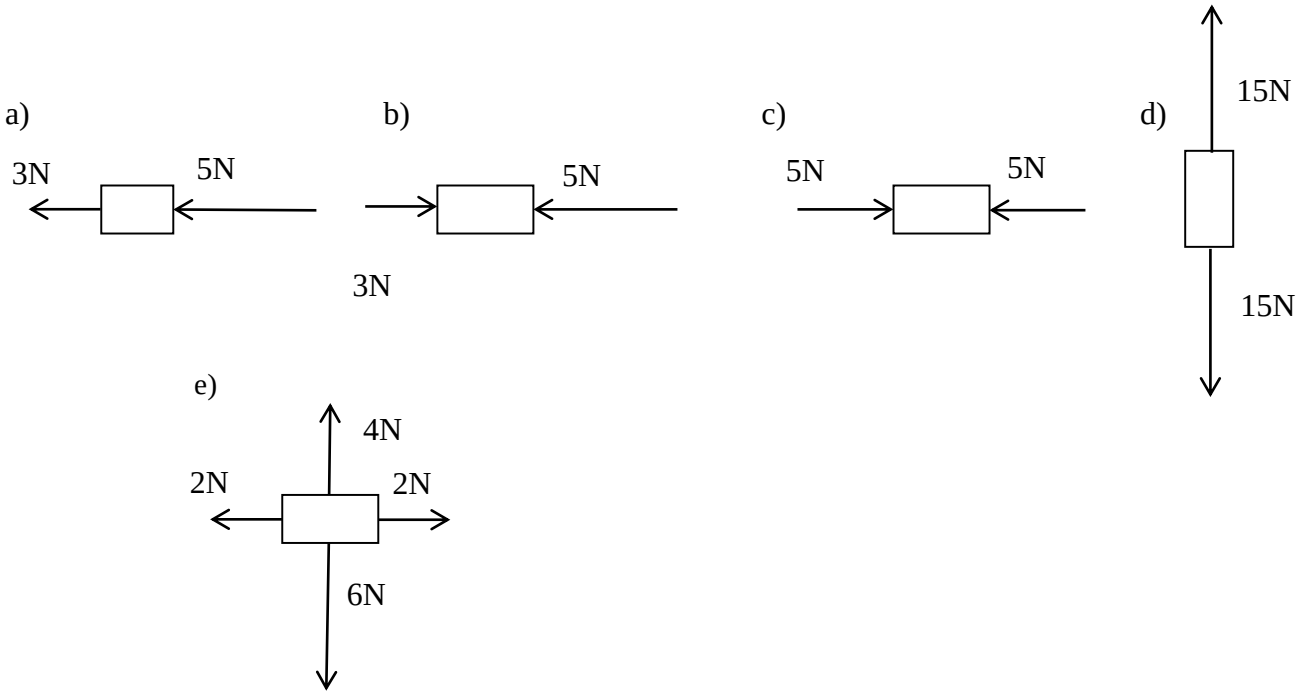
More than one force.

If two equal forces are applied to a stationary object in opposite directions, the object does not move. The two forces balance each other out and are called **balanced forces.**
If one force is greater than the other, the object will move in the direction of the larger force.

Activities

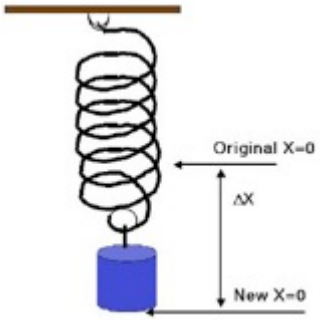
1.Give three examples of where:
a)friction is useful
b)friction is not useful.

2 .a) What is the resultant force acting on each object?
b) In which direction will each object move?



2. Hooke's law.

The English physicist Robert Hooke made many significant contributions to the development of physics, but he is most famous for the relatively simple relationship called **Hooke's law.**



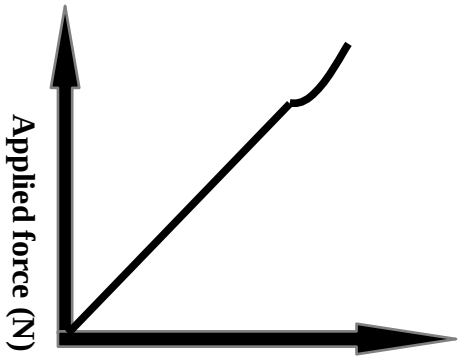
We can see Hooke's law in action when masses are hung on the end of a spring, as in the figure. Each 100g of mass hung on the spring will apply a force of 1,0N that stretches the spring. Each time an extra 1,0N force is applied, the length of the spring will increase by the same amount.

The length of the spring without any force applied to it is called the **original length.** The total increase in length of the spring is called the **extension.**

Extension = new length - original length

Hooke's law states that:

"the extension of a spring is directly proportional to the force applied to it".



Plotting an extension against the force applied produces a straight line until the spring is stretched beyond its **elastic limit**, as shown in the figure. The elastic limit is the point at which the force applied is too great for the spring and it no longer returns to its original length when the force is removed.

If the spring is stretched beyond the elastic limit, it no longer obeys Hooke's law.

Activities

1. Copy and complete the following sentences.

Hooke's law states that when a spring is stretched the ---------- is directly ---------- to the force applied to it. When stretched beyond its ---------- limit the spring will no longer obey ---------- law.

2. Juanjo y José Antonio performed a stretching experiment on a long spring. They obtained the results shown in the table.

Force (N)	1,0	2,0	3,0	4,0	5,0	6,0	7,0	8,0	9,0	10,0
Extension (cm)	1,2	2,4	3,6	5,8	6,0	7,2	8,4	10,0	12,1	16,0

a) Plot a line graph of their results.

b) Draw a cross to show where the elastic limit was reached and label it.

c) Juanjo y José Antonio made a mistake with one of their results. Which result do you think it was? Circle this result on the graph.

d) How much force is needed to extend the spring by 1,0 cm?