Physical science notes

All the objects and substances that we see in the world are made of matter. • This matter can be classified according to whether it is a mixture or a pure substance. • A mixture is a combination of two or more substances, where these substances are not bonded (or joined) to each other and no chemical reaction occurs between the substances. Examples of mixtures are air (a mixture of different gases) and cereal in milk.

The main characteristics of mixtures are that the substances that make them up are not in a fixed ratio, these substances keep their physical properties and these substances can be separated from each other using mechanical means. • A heterogeneous mixture is one that consists of two or more substances. It is non-uniform and the different components of the mixture can be seen. An example would be a mixture of sand and water. • A homogeneous mixture is one that is uniform, and where the different components of the mixture cannot be seen.

An example would be salt in water. • Pure substances can be further divided into elements and compounds. • An element is a substance that cannot be broken down into other substances through chemical means. • All the elements are found on the periodic table. Each element has its own chemical symbol. Examples are iron (Fe[pic] [pic]), sulphur (S[pic] [pic]), calcium (Ca[pic] [pic]), magnesium (Mg[pic] [pic]) and fluorine (F[pic] [pic]). • A compound is a A substance made up of two or more different elements that are joined together in a fixed ratio. Examples of ompounds are sodium chloride (NaCl[pic] [pic]), iron sulphide (FeS[pic] [pic]), calcium carbonate (CaCO[pic]3[pic][pic] [pic]) and water (H[pic]2[pic]O[pic] [pic]). • When naming compounds and writing their chemical formula, it is important to know the elements that are in the compound, how many atoms of each of these elements will combine in the compound and where the elements are in the periodic table.

A number of rules can then be followed to name the compound. • Another way of classifying matter is into metals (e. g. iron, gold, copper), metalloids (e. g. ilicon and germanium) and non-metals (e. g. sulphur, phosphorus and nitrogen). • Metals are good electrical and thermal conductors, they have a shiny lustre, they are malleable and ductile, and they have a high melting point. Metals also have a high density. These properties make metals very useful in electrical wires, cooking utensils, jewellery and many other applications. • Matter can also be classified into electrical conductors, semi-conductors and insulators. • An electrical conductor allows an electrical current to pass through it. Most metals are good electrical conductors. An electrical insulator is a non-conducting material that does not carry any charge. Examples are plastic, wood, cotton material and ceramic. • Materials may also be classified as thermal conductors or thermal insulators depending on whether or not they are able to conduct heat. • Materials may also be magnetic or non-magnetic.

Magnetism is a force that certain kinds of objects, which are called “ magnetic” objects, can exert on each other without physically touching. A magnetic object is surrounded by a magnetic “ field” that gets weaker as one moves further away rom the object. States of matter and the kinetic molecular theory • There are three states of matter: solid, liquid and gas. • Diffusion is the movement of particles from a high concentration to a low concentration. Brownian motion is the diffusion of many particles. • Melting point is the temperature at which a solid changes its phase to become a liquid. The process is called melting. • Freezing point is the temperature at which a liquid changes its phase to become a solid. The process is called freezing. • Evaporation is the process of going from a liquid to a gas.

Evaporation from a liquid's surface can happen at a wide range of temperatures. • Boiling point is the temperature at which a liquid changes phase to become a gas. The process is called evaporation. The reverse process (change in phase from gas to liquid) is called condensing. • Sublimation is the process of going from a solid to a gas. • The kinetic theory of matter attempts to explain the behaviour of matter in different phases. • The kinetic theory of matter says that all matter is composed of particles which have a certain amount of energy which allows them to move at different speeds depending on the temperature (energy).

There are spaces between the particles and also attractive forces between particles when they come close together. The atom • Some of the scientists who have contributed to the theory of the atom include J. J. Thomson (discovery of the electron, which led to the Plum Pudding Model of the atom), Marie and Pierre Curie (work on radiation), Ernest Rutherford (discovery that positive charge is concentrated in the centre of the atom) and Niels Bohr (the arrangement of electrons around the nucleus in energy levels). Because of the very small mass of atoms, their mass is measured in atomic mass units (u). 1 u = 1, 67 ? 10? 24 g. • The relative atomic mass of an element is the average mass of all the naturally occurring isotopes of that element. The units for relative atomic mass are atomic mass units.

The relative atomic mass is written under the elements' symbol on the periodic table. • An atom is made up of a central nucleus (containing protons and neutrons), surrounded by electrons. Most of the atom is empty space. • The atomic number (Z) is the number of protons in an atom. The atomic mass number (A) is the number of protons and neutrons in the nucleus of an atom. • The standard notation that is used to write an element, is ?[pic]A[pic]Z[pic]X[pic] [pic], where X is the element symbol, A is the atomic mass number and Z is the atomic number. • The isotope of a particular element is made up of atoms which have the same number of protons as the atoms in the original element, but a different number of neutrons. This means that not all atoms of an element will have the same atomic mass. • Within each energy level, an electron may move within a particular shape of orbital.

An orbital defines the space in which an electron is most likely to be found. • The electron configuration is the arrangement of electrons in an atom, molecule or other physical structure. • Energy diagrams such as Aufbau diagrams are used to show the electron configuration of atoms. • The electron configuration of an atom can be given using spectroscopic notation. • Different orbitals have different shapes: s orbitals are spherically shaped and p orbitals are dumbbell shaped. • The electrons in the outermost energy level are called valence electrons. The electrons in an atom that are not valence electrons are called core electrons. • Atoms whose outermost energy level is full, are less chemically reactive and therefore more stable, than those atoms whose outermost energy level is not full. The periodic table • Elements are arranged in periods and groups on the periodic table. The elements are arranged according to increasing atomic number. • A group is a column on the periodic table containing elements with similar properties. A period is a row on the periodic table. •

The atomic radius is a measure of the size of the atom. The first ionisation energy is the energy needed to remove one electron from an atom in the gas phase. • Electronegativity is the tendency of atoms to attract electrons. • Across a period the ionisation energy and electronegativity increase. The atomic radius decreases across a period. • The groups on the periodic table are labelled from 1 to 18. Group 1 is known as the alkali metals, group 2 is known as the alkali earth metals, group 17 is known as the halogens and the group 18 is known as the noble gases. The elements in a group have similar properties. The atomic radius and the density both increase down a group. The ionisation energy, electronegativity, and melting and boiling points all decrease down a group. Chemical bonding • A chemical bond is the physical process that causes atoms and molecules to be attracted to each other and held together in more stable chemical compounds. • Atoms are more reactive, and therefore more likely to bond, when their outer electron orbitals are not full. Atoms are less reactive when these outer orbitals contain the maximum number of electrons.

This explains why the noble gases do not react. • Lewis notation is one way of representing molecular structure. In Lewis notation, dots and crosses are used to represent the valence electrons around the central atom. • When atoms bond, electrons are either shared or exchanged. • Covalent bonding occurs between the atoms of non-metals and involves a sharing of electrons so that the orbitals of the outermost energy levels in the atoms are filled. • A double or triple bond occurs if there are two or three electron pairs that are shared between the same two atoms. The valency is the number of electrons in the outer shell of an atom which are able to be used to form bonds with other atoms. • Covalent compounds have lower melting and boiling points than ionic compounds. Covalent compounds are also generally flexible, are generally not soluble in water and do not conduct electricity. • An ionic bond occurs between atoms where there is a large difference in electronegativity.

An exchange of electrons takes place and the atoms are held together by the electrostatic force of attraction between the resulting oppositely-charged ions. Ionic solids are arranged in a crystal lattice structure. • Ionic compounds have high melting and boiling points, are brittle in nature, have a lattice structure and are able to conduct electricity when in solution. • A metallic bond is the electrostatic attraction between the positively charged nuclei of metal atoms and the delocalised electrons in the metal. • Metals are able to conduct heat and electricity, they have a metallic lustre (shine), they are both malleable (flexible) and ductile (stretchable) and they have a high melting point and density. We can work out the relative molecular mass for covalent compounds and the formula mass for ionic compounds and metals.

Electromagnetic radiation • Electromagnetic radiation has both a wave and a particle nature. • Electromagnetic waves travel at a speed of approximately 3 ? 108 m·s? 1 in a vacuum. • The Electromagnetic spectrum consists of the following types of radiation: radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma-rays. • Gamma-rays have the most energy and are the most penetrating, while radio waves have the lowest energy and are the least penetrating.

Covalent bonds, ionic bonds and metallic bonds are examples of chemical bonds. • A covalent bond exists between non-metal atoms. An ionic bond exists between non-metal and metal atoms and a metallic bond exists between metal atoms. • Covalent molecular structures interact and exist as separate molecules. • Network structures exist as giant repeating lattices. Network structures can consist of covalent, ionic or metallic compounds. • A chemical formula is an abbreviated (shortened) way of describing a compound. • The molecular formula is a concise way of expressing information about the atoms that make up a particular covalent molecular compound.

The molecular formula gives the exact number of each type of atom in the molecule. • The empirical formula is a way of expressing the relative number of each type of atom in a chemical compound. The empirical formula does not show the exact number of atoms, but rather the simplest ratio of the atoms in the compound. • The structure of a compound can be represented by stick, ball-and-stick or space-filling models. • A stick model use coloured sticks to represent compounds. • A ball-and-stick model is a 3-dimensional molecular model that uses “ balls” to represent atoms and “ sticks” to represent the bonds between them. • A space-filling model is also a 3-dimensional molecular model.

The atoms are represented by spheres. Physical and chemical change • Matter does not stay the same. It may undergo physical or chemical changes. • A physical change is a change that can be seen or felt, but that does not involve the break up of the particles in the reaction. During a physical change, the form of matter may change, but not its identity. • During a physical change, the arrangement of particles may change but the mass, number of atoms and number of molecules will stay the same. • Physical changes involve small changes in energy and are easily reversible. • A chemical change occurs when one or more substances change into other materials.

A chemical reaction involves the formation of new substances with different properties. For example, hydrogen and oxygen react to form water • A chemical change may involve a decomposition or synthesis reaction. During a chemical change, the mass and number of atoms is conserved, but the number of molecules is not always the same. • Chemical reactions involve large changes in energy. Chemical reactions are not easily reversible. • The law of conservation of mass states that the total mass of all the substances taking part in a chemical reaction is conserved and the number of atoms of each element in the reaction does not change when a new product is formed. The law of constant composition states that in any particular compound, all samples of that compound will be made up of the same elements in the same proportion or ratio. • Gay-Lussac's Law states that in a chemical reaction between gases, the relative volumes of the gases in the reaction are present in a ratio of small whole numbers if all the gases are at the same temperature and pressure.

Representing chemical change • A chemical equation uses symbols to describe a chemical reaction. • In a chemical equation, reactants are written on the left hand side of the equation and the products on the right. The arrow is used to show the direction of the reaction. • When representing chemical change, it is important to be able to write the chemical formula of a compound. The law of conservation of mass states that the mass of a closed system of substances will remain constant, regardless of the processes acting inside the system. Matter can change form, but cannot be created or destroyed. • In any chemical reaction, the law of conservation of mass applies. This means that the total atomic mass of the reactants must be the same as the total atomic mass of the products. This also means that the total number of atoms of the reactants must be the same as the total number of atoms of the product. • If the number of atoms of each element in the reactants is the same as the number of atoms of each element in the product, then the equation is balanced.

If the number of atoms of each element in the reactants is not the same as the number of atoms of each element in the product, then the equation is not balanced. • In order to balance an equation, coefficients can be placed in front of the reactants and products until the number of atoms of each element is the same on both sides of the equation. • The state of the compounds in a chemical reaction can be expressed in the chemical equation by using one of four symbols. The symbols are g (gas), ? (liquid), s (solid) and aq (aqueous solutions). These symbols are written in brackets after the compound. Magnetism • Magnets have two poles - North and South. Some substances can be easily magnetised. • Like poles repel each other and unlike poles attract each other. • The Earth also has a magnetic field. • A compass can be used to find the magnetic north pole and help us find our direction. • The Earth's magnetic field protects us from being bombarded by high energy charged particles which are emitted by the Sun.

• The Aurorae are an effect of the Earth's magnetic field. Electrostatics .