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| Knowledge organiser – Atomic Structure | | | | | |
| **The History of the Atom**  In 500 BC the atom was suggested by Greek philosopher Leucippus and his pupil Democritus. But people still only believed in **four** elements, earth, fire, air and water.  **J.J Thomson Plum Pudding Model**  As the atom is so small, people found it hard to understand the way it was structured.  The first person who discovered electrons, **Sir J.J Thomson,** put forth his 'Plum Pudding' Model of an atom. He believed that the atom was a sphere with a positive charge and had electrons stuck inside it. He could explain why the atom was neutral, but not how it was arranged.  raisin-pudding-thomson-atom-model.jpg  **Rutherford's Atomic Model**  **Ernst Rutherford** was studying radioactive substances. Through his experiment of hitting gold foil with alpha particles he found that most of the alpha particles passed through the gold foil – he suggested that the atom was mostly made up of empty space.  Next he observed that some alpha particles were deflected through small and large angles. This proved that there was a 'centre of positive charge' in an atom. Rutherford proved that the nucleus was **positively charged**. The nucleus is very small, dense and hard when compared to the whole atom. The mass of an atom is found in the nucleus. Electrons go round the nucleus at high speeds. | But there are still problems with his model.  rutherford-atom-nuclear-model.jpg  **Bohr's Model of the Atom**  In 1913, Neil Bohr explained that the electrons were not in a cloud, but on energy levels orbiting the nucleus at different distances (a bit like the solar system model we have).   Bohr's Idea - The electrons are in orbit around the nucleus kept in orbit by the pull of the protons.  **James Chadwick and Discovery of Neutrons**  With the discovery of protons, neutrons and electrons, physicists could put forth a diagram of an atom. They could explain that an atom is made up of electrons, neutrons and protons.  The centre of an atom is the nucleus that contains protons and neutrons. This makes the nucleus positively charged. The electrons are present on different shells or orbits that revolve around the nucleus. This helps in determining the size of an atom. | **The Development of the Periodic Table**  Historically, relative atomic masses were used by scientists trying to organise the elements. This was mainly because the idea of atoms being made up of smaller sub-atomic particles had not been developed.  **Antoine Lavoisier**  The earliest attempt to classify the elements was in 1789, when Antoine Lavoisier grouped the elements based on their properties into gases, non-metals, metals and earths.  **Johan Dobereiner**  In 1829, Johann Döbereiner recognised triads of elements with chemically similar properties, such as lithium, sodium and potassium, and showed that the properties of the middle element could be predicted from the properties of the other two.  **John Newlands**  Newlands noticed that there were similarities between elements with atomic weights that differed by seven.  He called this The Law of Octaves, The noble gases were not discovered until much later, which explains why there was a periodicity of 7 and not 8 in Newlands table.  Newlands did not leave any gaps for undiscovered elements in his table, and sometimes had to cram two elements into one box in order to keep the pattern. | | **Dmitri Mendeleev**  Mendeleev discovered the periodic table while attempting to organise the elements in February of 1869. He did it by writing the properties of the elements on pieces of card and arranging and rearranging them until he realised that, by putting them in order of increasing atomic weight, certain types of element regularly occurred.  Not only did Mendeleev arrange the elements in the correct way, but if an element appeared to be in the wrong place due to its atomic weight, he moved it to where it fitted with the pattern he had discovered. For example, iodine and tellurium should be the other way around, based on atomic weights, but Mendeleev saw that iodine was very similar to the rest of the halogens, and tellurium similar to the group 6 elements, so he swapped them over.  The real genius of Mendeleev’s achievement was to leave gaps for undiscovered elements. He even predicted the properties of five of these elements and their compounds. And over the next 15 years, three of these elements were discovered and Mendeleev’s predictions shown to be incredibly accurate.  Image result for periodic table | |
| **Electronic Configuration**  By looking at the periodic table we know how many protons, neutrons and electrons each element has.  In Chemistry, we need to know where we find the electrons.  Electronic configuration – are the diagrams we draw to show where the electrons are. These are important in helping us to understand how the atoms bond together to make compounds.  Surrounding the positive nucleus are the **negative electrons**.  However, they are not randomly placed, but have specific places they can occupy.  These are called electron shells, levels or orbitals – they all mean the same thing – the place where electrons are found.  The electron levels can only hold a set number of electrons.  The first – closest to the nucleus – fills first and can hold up to **2**.  The second – fills next and can hold up to **8**.  The third – fills next and can hold up to **8**.  The fourth – fills next and can hold up to **18**.  (Luckily for us we only put on 2!)  If you look there are:  2 on the first  8 on the second  8 on the third  2 on the fourth  We can write this as  2, 8, 8, 2  It tells us the information above, without the need for a diagram.  untitled.png  Image result for electronic configuration gcse  The electronic configurations shows us:  The **Group** number = number of **outer** electrons  The **Period** number = number of electron shells, levels or orbital. | | **Relative Atomic Masses**  23 is the atomic mass of sodium. This is called the **relative atomic mass**.  **Relative** is because the protons and neutrons are too small to weigh individually.  It is also an average of all the **isotopes** of sodium.  **untitled.png**  Isotope – This is an element with the same number of protons – but a different number of neutrons in its nucleus.  If you look at chlorine on the periodic table its RAM is **35.5** this is because it exists as the two isotopes of:  imagesCAG8K5TS.jpg  To calculate the RAM you need to know:   * The abundance (amount) of each isotope; * The RAM of each isotope.   If the relative abundances are  75% of Cl35 and 25% of Cl37.  The equation can then be used:  (% of Cl35 × RAM of Cl35) + (% of Cl37 × RAM of Cl37)  100  (75 × 35) + (25 × 37) = 2625 + 925 = 3550  100 = **35.5** | | **Properties of metals**  **4-1**  **Why do metals conduct electricity?**    To forma a metallic bond the metals ‘donate’ electrons to the spaces between the atoms. These atoms become positively charged (cations) and are held together by the movement of the electrons across the structure.  When the metal is placed in an electrical current – the electrons become excited and are attracted to the positive terminal. This causes a flow of electrons and therefore a flow of electricity.  **Alloys – a mixture of fused metals**  Metals are malleable as their atoms are regularly arranged in layers. These layers can easily slide over each other – making the structure less strong.  When a different sized atom is added, this prevents the layers sliding, jamming up the structure making the metal stronger. | |
| **The Transition metals**    Transition metals have been known since ancient times. Cu, Ag, Au, Pb, Fe.  The elements have typical metallic properties.  The transition elements form COLOURED compounds.  Transition elements can form ions with different charges – because they can lose differing numbers of electrons. This changes the colour of the compound they form.  Eg. Iron can be Fe3+ and forms green compounds or Fe 2+ and forms orange brown compounds (rust).  These coloured compounds are used as pigments in dyes and ceramics.      **Catalysts**  Transition metals are used to speed up chemical reactions – but not take part in them. | | | **How do the Group 1 metals react with chlorine, oxygen and water?**   |  |  |  |  | | --- | --- | --- | --- | | Reaction | Lithium | Sodium | potassium | | With oxygen | Burns red flame  White ash of lithium oxide | Burns more vigorously with yellow flame  White ash of sodium oxide | Burns violently with lilac flame  White ash of potassium oxide | | With chlorine | Burns red flame  White ash of lithium chloride | Burns more vigorously with yellow flame  White ash of sodium chloride | Burns violently with lilac flame  White ash of potassium chloride | | **With water** | Floats, fizzes producing hydrogen gas, produces colourless lithium hydroxide solution (alkali) | Floats and melts , fizzes producing hydrogen gas, produces colourless sodium hydroxide solution | Floats, hydrogen gas sets on fire with lilac flame, produces colourless potassium hydroxide solution |   What do all Group 1 elements have in common?  **They all have one outer electron.**  EE-SolidState-01.gif  The reactivity INCREASES down the group:  More shielding of the nucleus  Outer electron is easier to remove releasing more energy as heat.  **Equations:**  Lithium + oxygen 🡪 Lithium oxide  **4Li + O2  🡪 2Li2O**  Lithium + chlorine 🡪 lithium chloride  **2Li + Cl2  🡪 2LiCl**  Lithium + water 🡪 lithium hydroxide + hydrogen  **2Li + H2O 🡪 2LiOH + H2**  **This is the reaction pattern for all group 1 – just change the name and symbol ☺** | | |
| **How do the Group 7 Halogens react?**  E:\AQA CHEMISTRY 2016 onwards\AQA CHEMISTRY\Lesson 6 - Group 7 reactions\mptbptgraph.gif  The trend show an increase in the melting and boiling points of the halogens as the size of the atom increase.   |  |  |  |  | | --- | --- | --- | --- | | Halogen | Formula | State | Colour | | Fluorine | F2 | Gas | Pale yellow | | Chlorine | Cl2 | Gas | Green | | Bromine | Br2 | Liquid | Red | | Iodine | I2 | Solid | Purple | | Astatine | At2 | Solid | Grey |   Halogens will dissolve in water to produce acidic solutions  eg hydrochloric acid  Halogens will react with silver nitrate to produce coloured **precipitates.**   |  |  |  | | --- | --- | --- | |  | Colour of precipitate when silver nitrate is added | Equation | | Potassium chloride | white | AgNO3 + KCl 🡪 AgCl (s) + KNO3 | | Potassium bromide | cream | AgNO3 + KBr 🡪 AgBr (s) + KNO3 | | Potassium iodide | yellow | AgNO3 + KI 🡪 AgI (s) + KNO3 |   Halogens will displace a less reactive halogen from a solution.    **Equations**  Chlorine + potassium 🡪 Potassium + Bromine  bromide Chloride  Cl2  + 2KBr 🡪 2KCl + Br2 | | | **The Group 0 – Noble Gases**  Group 0 are all gases.    Electronic configurations for the first THREE noble gases are:  Image result for noble gases atomic structure  They all have full outer shells and as a result are INERT – unreactive with other elements. They exist as single atoms  Helium has the lowest boiling point. The trend shows that the boiling point increase down the group.  Helium: -269 degrees celsius, neon: -246, argon: -185, krypton: -153,  xenon: -108, radon: -62.  **Uses of the noble gases**  **Image result for noble gases**    Use in welding to prevent the metal reacting with oxygen in the air. | |