Atoms

What subatomic particles make up the atom?	Atoms are tiny particles that consist of a nucleus of positively charged protons and neutral (uncharged) neutrons, with negatively charged electrons surrounding the nucleus.
What are the masses of the subatomic particles?	Protons and neutrons have the same mass; electrons are about 1/2000 of the mass. Most of the mass of the atom is therefore concentrated in the nucleus.
What do atomic and mass number represent?	The atomic number of an element is the # of protons (and number of electrons) whereas the mass number is the number of protons PLUS neutrons.
What does $^{7}_{3}Li$ represent?	$^{7}_{3}Li$ has 3 protons, 3 electrons and 4 neutrons.
How are elements arranged in the periodic table?	Atoms are placed in the periodic table in order of increasing atomic number; columns are called groups and rows are called periods.
What can the groups and periods tell us about an atom?	The group number gives the number of valence electrons (for some groups) e.g. group 2 elements have 2 valence electrons, group 16 elements have 6. The period number indicates the number of energy levels of electrons e.g. Mg in period 3 has electrons arranged in 3 energy levels. 2,8,2

Summary

Atoms are made up of protons, neutrons and electrons and the number of these can be found from the atomic and mass number. The periodic table arranges atoms in order of increasing atomic number in rows called periods and columns called groups.

Electrons arrangement and ion formation	
How are electrons arranged around the nucleus?	Electrons (-negatively charged) surround the nucleus in energy levels; 1st level (closest to nucleus can hold 2, 2nd level 8, 3rd level 8. An energy fills before a new one starts to fill.
Write the electron arrangement for Na, atomic # 11.	The shorthand way to write an electron arrangement e.g. for Na with 11 electrons is 2,8,1 The outermost energy level is called the valence shell.
What do some atoms do to become stable when they react?	When (some) atoms react, they form ions by losing or gaining electrons, to achieve full valence shells, because this is a stable arrangement.
Explain the charges formed by atoms such as $_{11}Na$ and $_{8}O$ when they form ions.	E.g. sodium 2,8,1 loses one electron and forms a 1+ ion, written Na^{+}. With 11 protons and 10 electrons it has a net charge of 1+. Oxygen, 2,6, gains two electrons. With 8 protons and 10 electrons it has a net charge of 2- and oxide ion is written O^{2-}.
Give a definition of an ion using the words "charged particle".	Ions are charged PARTICLES formed when atoms lose or gain electrons to achieve full valence shells because this is a stable arrangement.

Summary

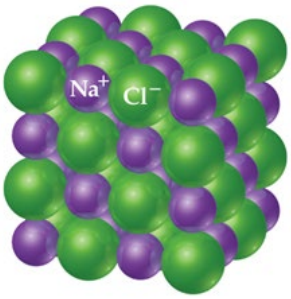
Some atoms lose or gain electrons to form charged particles called ions. The ions have full valence shells and this is a stable arrangement. The net charge (overall charge) on the ion depends on the number of protons and the number of electrons the ion now has. In the exam state exactly how many protons and electrons the ion has and explain the net charge.

Ions

What ions do metals form?	Metal atoms lose electron(s) and are called cations. $_{20}Ca$ (electron arrangement 2,8,8,2) loses 2 valence electrons, has a net charge of 2+; it forms the calcium ion, Ca^{2+}. Fe^{2+} and Fe^{3+} are distinguished by naming them as iron(II) and iron(III) ions
What ions do non-metals form? How are non-metal ions made from one atom named?	Non-metal atoms gain electron(s) and are called anions. Ions made from one atom usually have names ending in -ide. E.g. $_{17}Cl$ (2,8,7) gains 1 electron, has a net charge of 1-; it forms the chloride ion, Cl^-.
What polyatomic ions names must I memorise? (There are six) Do I need to memorise formulae and charges?	Some important polyatomic (many atom) ions to know are: NH_4^+ ammonium, OH^- hydroxide, NO_3^- nitrate, HCO_3^- hydrogen carbonate, sulfate SO_4^{2-}, and carbonate CO_3^{2-}. The formulae for the ions and their charges will be supplied in the Resource booklet but not their names.

Summary

Metal atoms form positively charged ions, named after the atom they were formed from. Non-metals form negatively charged ions and some are named -ide (made from one atom) and others are -ate (ion made from atom and oxygen atoms) e.g. sulfate, SO_4^{2-}. Memorise the names of NH_4^+ ammonium, OH^- hydroxide, NO_3^- nitrate, HCO_3^- hydrogen carbonate, sulfate SO_4^{2-}, and carbonate CO_3^{2-}.

Ions, ionic bond and ionic compounds.	
What are cations and anions?	Positive ions = cations; formed from metal atoms Negative ions = anions; formed from non-metal atoms
What is the ionic bond?	The force of attraction between oppositely charged ions is called an ionic bond. It is a strong electrostatic attraction between oppositely charged ions.
What type of atoms from ionic compounds?	When metals react with non-metals ionic compounds are formed. (Metal ions attracted to non-metal ions).
What is a lattice?	The ionic compound is a 3D lattice, with ions arranged in a regular pattern. 
Why are ionic compounds, which are made from charged ions, uncharged overall?	Ionic compounds have no overall electrical charge because the ions combine in such a way that the positive and negative charges cancel out. E.g. Mg^{2+} ions and O^{2-} ions form the ionic compound MgO. Cu^{2+} ions and Cl^- ions form the ionic compound $CuCl_2$

Summary

Metal cations are held to non-metal anions by strong electrostatic forces of attraction between oppositely charged ions. The attraction is called the ionic bond, and the compound made is called an ionic compound.

The ionic compound has no electrical charge because the ions combine in such a way (ion ratio) that the charges cancel out.

Writing and explaining ionic formula	
Why must I write neatly?	$CaCo3$ is not the same as $CaCO_3$!! Numbers after atoms are written as subscripts.
Why is there a difference in the formulae for MgO and Al_2O_3?	The magnesium ion has a charge of +2 and the oxide ion has a charge of -2, so the ratio of the two ions is one to one in order to have a neutral ionic compound overall, MgO The aluminium ion has a charge of +3 and the oxide ion has a charge of -2, the ratio of aluminium ions to oxide ions is 2:3 in order to have a neutral compound overall. Al_2O_3 ($2 \times 3+ = 6+$ and $3 \times 2- = 6-$)
When are brackets needed in formulae?	Brackets are needed if a polyatomic ion* is used more than once in a formula. E.g. $Cu(OH)_2$ which is made from $1 \times Cu^{2+}$ ion and $2 \times OH^-$ ions. If you wrote $CuOH_2$ you would only have <u>one</u> oxygen atom * NH_4^+ ammonium, OH^- hydroxide, NO_3^- nitrate, HCO_3^- hydrogen carbonate, sulfate SO_4^{2-}, and carbonate CO_3^{2-}. The small subscript associated with many polyatomic ions is part of the ion and must never be altered.

Summary

Ionic compounds are neutrally charged overall and so the ions combine in an ion ratio so that the sum of the charges equals zero e.g. sodium oxide has sodium ions Na^+ and oxide ions O^{2-} in a 2:1 ratio . $(2 \times 1+) + (1 \times 2-) = 0$. The charge on the ions arose as sodium lost one electron to have a full outer shell and got a charge of +1, and oxygen gained two electrons to have a full outer shell and got a charge of -2. Brackets are used only when

polyatomic ions are used more than once and the subscript numbers are never altered.

Word equations and balanced chemical equations	
What is important in word equations?	Write all the chemicals as words, and don't be tempted to write H_2O for water. Use a $\rightarrow$ (not =) to separate reactants from products.
Why and how do we balance equations?	Matter cannot be created nor destroyed so this means we need the same number of each atom on either side of an arrow in an equation. We show this by balancing equations with (full sized) numbers in front of atoms or compounds. E.g. $Mg + 2HCl \rightarrow MgCl_2 + H_2$
What are the three general equations I must memorise?	Metal + acid $\rightarrow$ salt + hydrogen Base + acid $\rightarrow$ salt + water Carbonate + acid $\rightarrow$ salt + water + carbon dioxide Note: A base is a metal oxide or metal hydroxide. Carbonates and hydrogen carbonates both react the same way with acid
What are the three acids I must memorise?	Sulfuric acid H_2SO_4 forms salts called sulfates Hydrochloric acid HCl forms salts called chlorides Nitric acid HNO_3 forms salts called nitrates

Summary

Metal + acid $\rightarrow$ salt + hydrogen

Base + acid $\rightarrow$ salt + water

Carbonate + acid $\rightarrow$ salt + water + carbon dioxide

To balance an equation: first write all the correct formulae for the reactants and products. Then balance by placing numbers in front of atoms / compounds. Never change the formula e.g. HCl into HCl$_2$

Reactions with acids- what we see and how we test for it

What is the general reaction for metal + acid? What is the test for hydrogen gas?

Metal + acid → salt + hydrogen

- You would see bubbles of colourless gas. The metal might get smaller and smaller as it reacts and there may be a temperature rise
  e.g. $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$
- Test for the gas with a lit splint / match. The gas burns with a squeaky pop showing hydrogen gas is present.

What is the general reaction for base + acid? Why is there no gas in this reaction?

Base + acid → salt + water

- No visible sign of reaction (as no gas made) ; solid may dissolve or there may be a temperature rise e.g. $CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$
  e.g. $NaOH + HNO_3 \rightarrow NaNO_3 + H_2O$

What is the general reaction for carbonate / hydrogen carbonate + acid?

What is the test for carbon dioxide gas?

Carbonate* + acid → salt + water + carbon dioxide

- You would see bubbles of colourless gas. E.g. $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$
- Test for the gas with lime water The gas turns the limewater cloudy/milky showing that carbon dioxide gas is present.

*or hydrogen carbonate

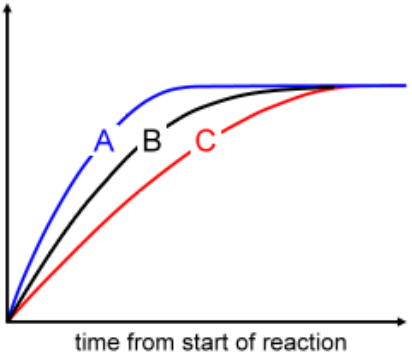
Summary

Metal + acid → salt + hydrogen Base + acid → salt + water
Carbonate + acid → salt + water + carbon dioxide
Hydrogen is identified with a lit splint (gas burns with a pop) and carbon dioxide with lime water (limewater turns milky).

Rates of Reaction and Collision Theory	
What is collision theory?	In order for a chemical reaction to occur, two or more particles must collide with sufficient energy and at the correct orientation to break bonds The minimum amount of energy required for a reaction to proceed is called the activation energy.
What is the rate of reaction?	The rate is a measure of how fast reactants become products during a chemical reaction.
What causes an increase in rate?	An increase in rate occurs whenever there are more successful collisions per unit time.
What <u>factors</u> affect the rate of reaction?	Increasing the concentration of a reactant solution (by increasing the number of particles in a given volume). Increasing the temperature (by increasing the speed and kinetic energy of the particles). Increasing the surface area of a solid reactant (by meaning more particles are exposed at any one time). Adding a catalyst, which increases rate without being used up* (by lowering the activation energy for the reaction). *Prove by measuring mass before / after experiment.
Summary	

For a reaction to occur reactant particles must collide and with sufficient energy. Factors that increase the number of collisions per time (the frequency of collisions) increase the rate of reaction. Do NOT just say "more collisions" - must be more particle collisions / s for example.
The four main factors are: concentration, temperature, surface area and catalysts.

Measuring reaction rates

How do we measure rate?	Often we measure the amount of product formed over time; measuring the volume of gas produced at time intervals is easy to do.
What does the shape of a rate of reaction investigation graph tell you?	The steeper the line, the faster the rate of reaction. A is reacting at a faster rate than B and B is reacting faster rate than C. 
Why does the rate change as the reaction proceeds?	Rate is fastest at the start — concentration of reactant particles is highest so there are more collisions/time. Rate decreases as time proceeds as the reactant concentration falls so there are less collisions/time. The reaction eventually stops when one of the reactants has run out -so no more reactant collisions can occur.
Which reactant runs out?	One reactant is usually in excess which means more than enough particles of this reactant to react with ALL the particles of the other reactant. The reaction stops when the "limiting reactant" has been used up.

Summary

At the beginning of the reaction the concentration of reactant particles is the highest so there are more successful collisions /time and a fast reaction rate. Over time the reactant particle concentrations fall and there are fewer collisions /time between reactants and a slower reaction rate. The reaction stops when the particles of one of the reactants are all used up so there is no more of it to react.

What are acids and bases?	
What three acids must I memorise?	Hydrochloric acid HCl (makes salts called chlorides) Nitric acid HNO_3 (makes salts called nitrates) Sulfuric acid H_2SO_4 (makes salts called sulfates)
What makes a solution an acid?	Substances that break apart (dissociate) in water to release H^+ ions are acids.
What's the difference between a strong and weak acid?	A strong acid releases more H^+ ions than a weak acid (of the same concentration e.g. 1 mol L^{-1}) and so a strong acid is more acidic - has a lower pH.
What bases must I memorise?	Bases are usually metal oxides, metal hydroxides, metal carbonates or metal hydrogen carbonates.
What is the difference between a base and an alkali?	A base is an "acid opposite". If the base is soluble in water it is also an alkali such as sodium hydroxide NaOH.
What makes a solution an alkali?	Substances that break apart (dissociate) in water to release OH^- ions , or react with water to make OH^- ions, are alkalis. E.g. $NaHCO_3$ and NH_3 both react with water to make OH^- ions.

Summary

Acids are solutions with pH < 7 that contain a greater concentration of H^+ ions than OH^- ions.

Alkalis are solutions with pH >7 that contain a greater concentration of OH^- ions than H^+ ions.

A solution where the concentration of H^+ ions equals OH^- ions is neutral (pH 7).

What is the pH scale and what are indicators used for?	
What does the pH scale represent?	The pH scale is used to represent the concentrations of H^+ and OH^- ions and pH values generally range from 0 to 14. A pH of 7 is given to neutral solutions. Solutions with a pH less than 7 are acids, whereas solutions with a pH greater than 7 are alkaline.
What do the colours of litmus paper and solution tell us?	Litmus indicator solution turns red in acidic solutions and purple-blue in alkaline solutions. Blue litmus paper will turn red in an acidic solution and remain blue when added to an alkali solution. Red litmus paper will stay red in an acidic solution and turn blue when added to an alkali solution. Litmus does not tell you how strong the acid or alkali is. Universal Indicator - Universal indicator shows us how strongly acidic or alkaline a solution is, using the pH scale. Universal indicator has many different colour changes,: from red (strong acid), through orange and yellow to green (neutral) to blue-green, blue and to purple, (strong alkali).

Summary
Chemists use indicators to show visually whether a solution is acidic, neutral or alk-ali. Indicators change colour, depending on whether they are placed in an acid or base. Litmus does not tell you how strong the acid or alk-ali is but Universal Indicator shows us how strongly acidic or alk-aline a solution is, by matching its different colours to the pH using a colour chart.

Neutralisation	
What is neutralisation?	Neutralisation is the chemical reaction where you mix an acid and base and the base cancels out the effects of the acid (or vice versa). f just enough acid and base/alk-ali are mixed together, the concentration of H^+ ions = OH^- ions and the pH will be 7, neutral.
What equation shows neutralisation?	$H^+ + OH^- \longrightarrow H_2O$
What do different pH values tell us about the concentration of H^+ and OH^- ions?	$H^+ > OH^-$, solution is acidic (pH 0 - 6.9) $H^+ = OH^-$, solution is neutral (pH 7) $H^+ < OH^-$, solution is alk-aline (pH 7.1 -14)
What would be seen as NaOH is added to HCl, with UI added?	The UI would start off red as $H^+ >>> OH^-$, but as more NaOH is added the colour would become orange then yellow. It would be green when $H^+ = OH^-$ and the solution is neutral (pH 7). Adding more NaOH would mak-e the solution more and more alk-aline (UI turns blue then purple) as the concentration of $OH^- >> H^+$.
What would be seen as Na_2CO_3 is added	The UI would be red as $H^+ >>> OH^-$, but as Na_2CO_3 is added it would become orange, yellow and then green when $H^+ = OH^-$ (neutral, pH 7). Adding more Na_2CO_3

to HCl, with UI added?	would make the solution alkaline, UI turning blue as the concentration of OH^- > H^+. Bubbles of a colourless gas would be given off (carbon dioxide).

Summary

An acid is a substance that neutralises bases. A base is a substance that can neutralise an acid. The pH scale shows the concentration of hydrogen ions, and therefore the relative concentration of acids and bases.