AMOUNT OF SUBSTANCE

Cue	Notes
Calculating volumes	$\text{volume (cm}^3\text{)} = \frac{\text{number of moles} \times 1000}{\text{concentration}}$
Empirical formula	The simplest whole number ratio of atoms of each element in a compound
Molecular formula	Gives the actual numbers of atoms in a molecule
How to calculate molecular formula given empirical formula and the relative molecular mass	-Find the empirical mass - (add up the relative atomic mass values of all the atoms in the empirical formula -Divide the relative molecular mass by the empirical mass -Multiply the empirical formula by that number to find the molecular formula.
Calculating empirical formulas from the percentages of different elements	-Assume you've got 100g of the compound - turn percentages straight into masses, then work out how many moles of each element are in 100g of the compound -Divide each number of moles by the smallest number of moles you found in step 1, this gives the ratio of elements in the compound. -Apply the numbers from the ratio to the formula
How to calculate theoretical yield	-Work out how many moles of reactant you have -Use the equation to work out how many moles of product you would expect that much reactant to make -Calculate the mass of that many moles of product
Calculating percentage yield	$\text{Percentage Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$
How to calculate mass	-Write out the balanced equation for the reaction -Work out how many moles of the reactant you have -Use the molar ratio from the balanced equation to work out the number of moles of product that will be formed from that much reactant -Calculate the mass of that many moles of product
Define atom economy	Atom economy is a measure of the proportion of reactant atoms that become part of the desired product (rather than by-products) in the balanced chemical equation.
Advantages of high atom economy	-Economic advantages – will make more efficient use of its raw materials, also less waste to deal with. -Environmental and ethical advantages – Processes that use fewer raw materials and produce less waste are better for the environment, and more sustainable.
Calculating atom economy	$\%\ \text{atom economy} = \frac{\text{molecular mass of desired product}}{\text{sum of molecular masses of all reactants}} \times 100$

Summary

$$\%\ \text{atom economy} = \frac{\text{molecular mass of desired product}}{\text{sum of molecular masses of all reactants}} \times 100$$

$$\text{volume (cm}^3\text{)} = \frac{\text{number of moles} \times 1000}{\text{concentration}} \qquad \text{Percentage Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

-Having a high atom economy has a number of benefits to both the economy and the environment.
-Calculate empirical formula by assuming you've got 100g and turn the percentages into masses.

BONDING

Cue	Notes
Ionic formulas of Ammonium, Carbonate, Hydroxide, Nitrate and Sulfate	Ammonium → NH_4^+ Carbonate → CO_3^{2-} Hydroxide → OH^- Nitrate → NO_3^- Sulfate → SO_4^{2-}
Electrostatic attraction	Holds positive and negative ions together – is very strong
Electrical conductivity of ionic compounds	Ionic compounds conduct electricity when they're molten or dissolved but not when they're solid, because the ions in a liquid are free to move and can carry a charge.
Melting point of ionic compounds	Have high melting points, as the giant ionic lattices are held together by strong electrostatic forces, which take a lot of energy to overcome
Solubility of ionic compounds	Ionic compounds tend to dissolve in water, water molecules are polar and pull the ions away from the lattice and cause it to dissolve
Molecules	Form when two or more atoms bond together, they are held together by strong covalent bonds.
Simple covalent compounds	Compounds that are made up of lots of individual molecules are called simple covalent compounds. The atoms in the molecules are held together by strong covalent bonds, but the molecules within the compound are held together by weaker intermolecular forces, its these that determine the properties of the compounds. In general, they have low melting and boiling points and are electrical insulators
Giant covalent structures	Are a type of crystal structure – have a huge network of covalently bonded atoms (aka macromolecular structures)
Graphite	The carbon atoms are arranged in sheets of flat hexagons covalently bonded with three bonds each. The fourth outer electron of each carbon is delocalised. The sheets are bonded together by weak van der Waals forces
Graphite's properties	-Slippery, can be used as a dry lubricant in pencils as the weak bonds between layers can be easily broken -Electric current can flow due to delocalised electrons -Low density so used to make lightweight sports equipment as the layers are quite far apart compared to the length of the covalent bonds -Very high melting points because of the strong covalent bonds in the hexagon sheets -Insoluble in any solvent as the covalent bonds in the sheets are too strong
Diamond	Each carbon atom is covalently bonded to four other carbon atoms, the atoms arrange themselves in a tetrahedral shape – its crystal lattice structure.
Diamonds properties	-High melting point -Extremely hard – used in diamond tipped drills and saws -Good thermal conductor as vibrations travel easily through the stiff lattice -Can't conduct electricity -Wont dissolve in any solvent
Co-ordinate (dative covalent) bonds	Where one of the atoms provides both of the shared electrons

Summary

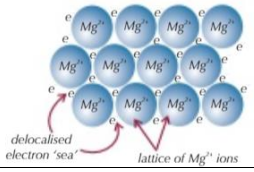
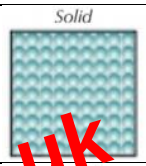
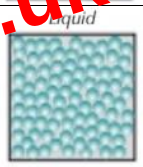
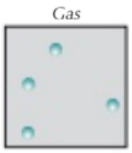
Bonding	Mp/Bp	State (standard c)	Conduct electricity	Soluble in water
Ionic	High	Solid	Molten/dissolved	Yes
Simple covalent	Low	Usually fluid	No	Depend how polar
Giant covalent	High	Solid	No (Ex graphite)	No

BONDING

Cue	Notes
Electronegativity	The ability to attract the bonding electrons in a covalent bond. Its measured on the Pauling Scale (higher number = more electronegative).
Polarity of diatomic gases (e.g. H_2, Cl_2)	Non-polar because the atoms have equal electronegativities so the electrons are equally attracted to both nuclei.
Polarity with two atoms of different electronegativities	The bonding electrons are pulled towards the more electronegative atom, this makes the bond polar, the greater the difference in electronegativity the more polar the bond
Dipole	In a polar bond, the difference in electronegativity between two atoms causes a dipole. This is the difference in charge between the two atoms caused by a shift in the electron density in the bond
Polar molecules	If a charge is distributed unevenly over a whole molecule, then the molecule will have a permanent dipole. Whether or not a molecule is polar depends on whether it has any polar bonds and its overall shape.
Polar bonds arranged symmetrically	Dipoles cancel each other out, so the molecule has no permanent dipole and is non-polar
Polar bonds all point in roughly the same direction	The charge will be arranged unevenly across the whole molecule, this results in a polar molecule which has a permanent dipole
What are intermolecular forces?	They're forces that exist between molecules and are much weaker than covalent, ionic or metallic bonds.
Van der Waals Forces	Cause all atoms and molecules to be attracted to each other. Electrons in charge clouds are always moving really quickly so at any particular moment the electrons are more likely to be on one side than the other, so the atom would have a temporary dipole. This dipole can cause a temporary dipole in the opposite direction on a neighbouring atom, the two dipoles are the attracted to each other.
Strength of van der Waals forces	-Larger molecules have larger electron clouds, meaning stronger van der Waals forces -Long, straight molecules can lie closer together than branched ones, the closer the molecules the stronger the forces.
Permanent dipole-dipole forces	In a substance made up of molecules that have permanent dipoles, there will be weak electrostatic forces of attraction between the δ+ and δ- charges on neighbouring molecules
Testing for permanent dipoles	If you put an electrostatically charged rod next to a jet of polar liquid, the liquid will move towards the rod.
Hydrogen bonding	The strongest intermolecular force, only happens when hydrogen is covalently bonded to fluorine, nitrogen or oxygen. They are very electronegative so draw the bonding electrons away from the hydrogen atom. The bond is so polarised, and hydrogen has such a high charge density because its so small, that the hydrogen atoms form weak bonds with the lone pairs of electrons on the F, N O atoms of other molecules

Summary
-Electronegativity is the ability to attract bonding electrons in a covalent bond -The three types of intermolecular forces are Van der Waals, dipole-dipole and hydrogen bonding (in order of strength)

BONDING

Cue	Notes
What is metallic bonding	 The outermost shell of electrons of a metal atom is delocalised, this leaves a positive metal ion, which is attracted to the delocalised negative electrons. They form a lattice of closely packed positive ions in a sea of delocalised electrons
Melting point (metals)	Metals have high melting points because of the strong electrostatic attraction between the positive metal ions and delocalised electrons. More delocalised electrons mean that bonding is stronger and melting point is higher.
Ability of metals to be shaped	Metals are malleable and ductile as there's no bonds holding specific ions together, so the metal ions can slide over each other
Conductivity of metals	The delocalised electrons can pass kinetic energy to each other, so they're good thermal conductors. They can also carry a charge so are good electrical conductors
Solubility of metals	Metals are insoluble, except in liquid metals, because of the strength of the metallic bonds
Properties of solid	Has its particles very close together, so has a high density and is incompressible, the particles vibrate about a fixed point and can't move about freely. 
Properties of liquid	Has a similar density to solids and is virtually incompressible, the particles move about freely and randomly allowing it to flow 
Properties of gas	Particles have lots of energy and are far apart, so the density is pretty low and it's very compressible. The particles move about freely with not a lot of attraction between them, so they'll quickly diffuse to fill a container. 
Melting and boiling simple covalent substances	To melt or boil simple covalent substances you only have to overcome the weak intermolecular forces that hold the molecules together so they have relatively low melting and boiling points
Melting and boiling giant covalent substances	To melt or boil a giant covalent substance you do need to break the covalent bonds holding the atoms together, so they have very high melting and boiling points.

Summary
-Metallic bonding involves attraction between delocalised electrons and positive ions in a lattice -Metallic lattices are one of the four types of crystal structure -Metals have high melting points, are malleable and ductile, can conduct heat and electricity and are insoluble -Melting and boiling points of a substance are determined by the strength of the attraction between its particles. -A substance will only conduct electricity if it contains charged particles that are free to move -How soluble a substance is in water depends on the type of particles that it contains. Water is a polar solvent, some substances that are polar or charged will dissolve in it well, whereas non-polar or uncharged substances won't.

REDOX

Cue	Notes
What is Oxidation?	-Increase in oxidation number -Loss of electrons -Addition of Oxygen -Loss of Hydrogen
What is Reduction?	-Decrease in oxidation number -Gain of electrons -Loss of Oxygen -Addition of Hydrogen
What is disproportionation?	Disproportionation occurs when an element is simultaneously oxidised and reduced to form two different products
What are oxidising agents? [O]	A compound which oxidises another compound (by gaining electrons and hence being reduced in the process)
What are reducing agents? [H]	A compound which reduces another compound (by losing electrons and hence being oxidised in the process)
What is the oxidation state of all atoms (including those in a diatomic molecule such as H_2)?	0
Rules for assigning oxidation numbers	1. All uncombined elements have an oxidation number of 0 2. The oxidation numbers of the elements in a compound add up to zero 3. The oxidation number of a monoatomic ion is equal to the ionic charge 4. In a polyatomic ion (CO_3^{2-}) the sum of the individual oxidation numbers of the elements adds up to the charge on the ion 5. Several elements have invariable oxidation numbers in their common compounds.
Common oxidation numbers	Group 1 metals = +1 Group 2 metals = +2 Al = +3 H = +1 (except in metal hydrides where it is –1 eg NaH) F = -1 Cl, Br, I = –1 except in compounds with oxygen and fluorine O = -2 except in peroxides (H_2O_2) where it is –1 and in compounds with fluorine.
Balancing redox equations	1. Work out oxidation numbers for element being oxidised/ reduced 2. Add electrons equal to the change in oxidation number For reduction add e's to reactants For oxidation add e's to products 3. check to see that the sum of the charges on the reactant side equals the sum of the charges on the product side
More complex half equations	Multiply the half equations to get equal electrons Add half equations together and cancel electrons Multiply the half equations to get equal Add half equations together and cancel electrons
Summary	
-Oxidation is loss of electrons -Reduction is gain of electrons -Atoms and diatomic molecules have an oxidation state of 0	