

Grade 6 checklist

298 skills. Tick each one when you can do it. For grade 6 you need the skills for the grades below it too.

Biology

- ☐ **Write cell sizes in standard form** Use $1\text{ }\mu\text{m} = 10^{-6}\text{ m}$ and $1\text{ nm} = 10^{-9}\text{ m}$, e.g. $4\text{ }\mu\text{m} = 4 \times 10^{-6}\text{ m}$.
(Eukaryotes and prokaryotes)
- ☐ **Link a cell's structures to its function** e.g. a cell that needs a lot of energy has many mitochondria for respiration. (Animal and plant cells)
- ☐ **Explain how each adaptation helps the cell** Give the feature and what it does, e.g. the root hair gives a large surface area for absorbing water. (Cell specialisation)
- ☐ **Explain the importance of cell differentiation** It produces the different specialised cells a multicellular organism needs to carry out different functions. (Cell differentiation)
- ☐ **Convert units in magnification calculations** Put the image size and the real size in the same unit, usually μm , before dividing. (Microscopy)
- ☐ **Explain why body cell chromosomes are paired** One chromosome of each pair came from each parent, in the egg and the sperm. (Chromosomes)
- ☐ **Link genes to proteins** A gene is a small section of DNA that codes for a particular protein. (Chromosomes)
- ☐ **Describe therapeutic cloning and its advantage** An embryo is made with the same genes as the patient, so its stem cells are not rejected. (Stem cells)
- ☐ **Calculate surface area to volume ratios** Work out the total surface area and the volume, then write the ratio as $x : 1$. (Diffusion)
- ☐ **Explain how exchange surfaces are adapted** Large surface area, thin membrane, good blood supply and ventilation, e.g. alveoli and villi. (Diffusion)
- ☐ **Calculate a rate of change in mass** Change in mass $\div$ time, e.g. in g per minute. (Osmosis)
- ☐ **Explain gains and losses in mass** Tissue gains mass when the solution is more dilute than the cell contents, and loses mass when it is more concentrated. (Osmosis)
- ☐ **Explain osmosis in animal and plant cells** Animal cells can burst in water or shrivel in concentrated solutions; a plant cell wall stops the cell bursting. (Osmosis)
- ☐ **Compare diffusion, osmosis and active transport** Compare what moves, which way it moves relative to the concentration gradient, and whether energy is needed. (Active transport)
- ☐ **Explain why root hair cells have many mitochondria** More respiration releases more energy for the active transport of mineral ions. (Active transport)
- ☐ **Explain why a structure is an organ** Say that it is made of several different tissues that work together to carry out a specific function. (Principles of organisation)
- ☐ **Explain enzyme action using lock and key** The substrate fits the specifically shaped active site, so each enzyme catalyses only one reaction. (The human digestive system)

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- ☐ **Explain how bile speeds up fat digestion** Bile is alkaline, so it neutralises stomach acid, and it emulsifies fat into small droplets with a larger surface area for lipase. (The human digestive system)
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- ☐ **Explain how blood vessels suit their functions** Arteries have thick muscular, elastic walls for high pressure, veins have valves, and capillary walls are one cell thick for diffusion. (The heart and blood vessels)
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- ☐ **Calculate the rate of blood flow** Rate of blood flow = volume of blood ÷ time, e.g. in cm³ per minute. (The heart and blood vessels)
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- ☐ **Explain how red blood cells are adapted** A biconcave shape gives a large surface area, and having no nucleus leaves more room for haemoglobin, which carries oxygen. (Blood)
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- ☐ **Describe how white blood cells defend the body** They engulf pathogens (phagocytosis), produce antibodies and produce antitoxins. (Blood)
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- ☐ **Explain how CHD damages the heart muscle** Less blood flows through the narrowed coronary arteries, so the heart muscle gets less oxygen for respiration. (Coronary heart disease: a non-communicable disease)
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- ☐ **Explain the consequences of a faulty valve** A valve that does not open fully or that leaks makes the heart pump blood less efficiently, so less oxygen reaches the body. (Coronary heart disease: a non-communicable disease)
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- ☐ **Describe how different diseases can interact** Immune defects increase infections, viruses can trigger cancers, immune reactions can trigger allergies, and severe physical illness can lead to depression. (Health issues)
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- ☐ **Calculate and interpret values from disease data** Read values from tables and graphs, calculate rates per 1000 people or percentages, and describe trends. (Health issues)
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- ☐ **Describe a correlation shown in a scatter diagram** Say whether the correlation is positive or negative and quote data from the graph. (The effect of lifestyle on some non-communicable diseases)
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- ☐ **Discuss human and financial costs of disease** Consider suffering and early death as well as treatment costs and lost work, for individuals, communities, nations and the world. (The effect of lifestyle on some non-communicable diseases)
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- ☐ **Explain how a secondary tumour forms** Cells break off a malignant tumour, travel in the blood to another part of the body and divide there to form a new tumour. (Cancer)
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- ☐ **Explain genetic risk factors for cancer** Some people inherit alleles, such as faulty BRCA alleles, that increase their risk of certain cancers. (Cancer)
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- ☐ **Explain how the mesophyll layers are adapted** Palisade cells are packed with chloroplasts near the top of the leaf; spongy mesophyll has air spaces for gases to diffuse through. (Plant tissues)
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- ☐ **Describe what guard cells and stomata do** Guard cells open and close the stomata to control gas exchange and water loss. (Plant tissues)
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- ☐ **Explain factors affecting the rate of transpiration** Higher temperature, lower humidity, more air movement and higher light intensity all increase the rate. (Plant organ system)
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- ☐ **Calculate the rate of transpiration** Rate = volume (or mass) of water lost or taken up ÷ time, e.g. from a potometer. (Plant organ system)
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- ☐ **Explain how a control method stops spread** Link the method to the route, e.g. washing hands removes pathogens, so they are not passed on by direct contact. (Communicable (infectious) diseases)
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- ☐ **Explain why TMV reduces plant growth** The discoloured parts of the leaves have less chlorophyll, so there is less photosynthesis and less glucose for growth. (Viral diseases)
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- ☐ **Explain why gonorrhoea is harder to treat now** Many strains are resistant to penicillin, so penicillin no longer kills them and other antibiotics must be used. (Bacterial diseases)
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- ☐ **Explain how vaccinating poultry protects people** Vaccinated chickens are not infected, so their meat and eggs are less likely to carry the bacteria. (Bacterial diseases)
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- ☐ **Explain why black spot reduces growth** Spotted, yellow and fallen leaves mean less photosynthesis, so less glucose is made for growth. (Fungal diseases)
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- ☐ **Explain how each control method reduces spread** Fewer mosquitoes, or fewer bites, means the protist is passed to fewer people. (Protist diseases)
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- ☐ **Explain how antibodies and antitoxins work** Antibodies bind to specific antigens on pathogens; antitoxins bind to the toxins made by bacteria and neutralise them. (Human defence systems)
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- ☐ **Explain how vaccination reduces spread in populations** If most people are immune, the pathogen is unlikely to reach unvaccinated people, so it spreads much less. (Vaccination)
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- ☐ **Explain why antiviral drugs are hard to develop** Viruses reproduce inside body cells, so drugs that kill them are likely to damage body tissues too. (Antibiotics and painkillers)
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- ☐ **Explain why a placebo is used** A placebo contains no drug, so comparing the two groups shows whether the drug itself has an effect. (Discovery and development of drugs)
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- ☐ **Explain why results are peer reviewed** Other experts check the method, results and conclusions before publication, so false or biased claims are less likely to be published. (Discovery and development of drugs)
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- ☐ **Explain the results of a leaf starch test** Only parts of a leaf that had light and chlorophyll made glucose, which was stored as starch and turns iodine solution blue-black. (Photosynthetic reaction)
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- ☐ **Explain why plants store starch, not glucose** Starch is insoluble, so it does not affect the movement of water by osmosis and it stays inside the cells. (Uses of glucose from photosynthesis)
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- ☐ **Explain why plants need nitrate ions** Plants use glucose and nitrate ions to make amino acids, which are joined to make proteins. (Uses of glucose from photosynthesis)
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- ☐ **Compare aerobic and anaerobic respiration** Compare the need for oxygen, the products and the amount of energy transferred. (Aerobic and anaerobic respiration)
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- ☐ **Explain muscle fatigue in long exercise** Lactic acid builds up from anaerobic respiration, and over long vigorous exercise muscles stop contracting efficiently. (Response to exercise)
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- ☐ **Explain why metabolism needs respiration and enzymes** Building new molecules uses energy transferred by respiration, and each reaction is controlled by enzymes. (Metabolism)
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- ☐ **Describe what happens to excess protein** Excess proteins are broken down to form urea, which is excreted. (Metabolism)
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- ☐ **Apply the control system to new contexts** Pick out the stimulus, receptor, coordination centre, effector and response in an unfamiliar example. (Homeostasis)
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- ☐ **Explain how impulses cross a synapse** A chemical is released, diffuses across the gap and binds to receptors on the next neurone, starting a new impulse. (The human nervous system)
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- ☐ **Explain how neurones are adapted** Long axons carry impulses a long way, branched endings connect to many neurones, and a fatty sheath speeds impulses up. (The human nervous system)
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- ☐ **Explain why the pituitary is the 'master gland'** Its hormones act on other glands, stimulating them to release their own hormones. (Human endocrine system)
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- ☐ **Interpret blood glucose graphs** Describe and explain the rise and fall of glucose after a meal, with and without diabetes. (Control of blood glucose concentration)
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- ☐ **Interpret hormone graphs of the menstrual cycle** Match each hormone's peak to events such as ovulation and the build-up of the uterus lining. (Hormones in human reproduction)
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- ☐ **Evaluate different methods of contraception** Compare effectiveness, side effects, STI protection, convenience and whether the method is reversible. (Contraception)
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- ☐ **Describe the main stages of IVF** Give FSH and LH, collect eggs, fertilise them in the lab, then insert one or two embryos. (The use of hormones to treat infertility (HT only))
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- ☐ **Define negative feedback** A change away from normal triggers a response that reverses the change, returning the level to normal. (Feedback systems (HT only))
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- ☐ **Explain why sexually produced offspring vary** Genetic information from two parents is mixed, so each offspring gets a different combination of alleles. (Sexual and asexual reproduction)
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- ☐ **Explain why asexual offspring are clones** There is no fusion of gametes and no mixing of genetic information, and only mitosis is involved. (Sexual and asexual reproduction)
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- ☐ **Explain why gametes have half the chromosomes** So that fertilisation restores the normal number of chromosomes. (Meiosis)
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- ☐ **Describe development after fertilisation** The new cell divides by mitosis, the number of cells increases and the cells differentiate as the embryo develops. (Meiosis)
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- ☐ **Explain how a gene makes a protein** Each gene codes for a particular sequence of amino acids, which makes a specific protein. (DNA and the genome)
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- ☐ **Give three uses of the human genome** Finding genes linked to disease, understanding and treating inherited disorders, and tracing past human migration. (DNA and the genome)
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- ☐ **Extract information from family trees** Use the key and the phenotypes of parents and children to work out genotypes. (Genetic inheritance)
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- ☐ **Predict disorder risks using Punnett squares** For example, two carriers of cystic fibrosis have a 0.25 probability of an affected child. (Inherited disorders)
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- ☐ **Explain the 0.5 chance of a boy** All eggs carry an X chromosome and half of sperm carry X, half carry Y. (Sex determination)
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- ☐ **Describe how mutations affect phenotype** All variants arise from mutations: most have no effect on the phenotype, some influence it and very few determine it. (Variation)
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- ☐ **Explain how a feature evolved** Link variation to survival and reproduction, and the allele becoming more common over many generations. (Evolution)
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- ☐ **Explain when populations become separate species** When they can no longer interbreed to produce fertile offspring. (Evolution)
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- ☐ **Explain the problems caused by inbreeding** Breeds become prone to disease or inherited defects because variation is reduced. (Selective breeding)
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- ☐ **Give benefits and concerns of GM crops** Higher yields, against concerns about wild flowers, insects and effects on human health. (Genetic engineering)
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- ☐ **Explain how fossils support evolution** Fossils from rocks of different ages show how organisms have changed over millions of years. (Evidence for evolution)
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- ☐ **Explain why the fossil record is incomplete** Early soft-bodied organisms left few traces, and most traces were destroyed by geological activity. (Fossils)
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- ☐ **Explain uncertainty about how life began** So few traces of early life remain that scientists cannot be certain how life began. (Fossils)
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- ☐ **Explain how a factor leads to extinction** Link the factor to fewer individuals surviving and reproducing until none are left. (Extinction)
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- ☐ **Explain how resistant strains develop** A mutation makes some bacteria resistant; they survive the antibiotic and reproduce, so the resistant population rises. (Resistant bacteria)
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- ☐ **Explain why the three-domain system was introduced** Evidence from chemical analysis showed that some organisms are more different than their structure suggests. (Classification of living organisms)
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- ☐ **Define a stable community** All the species and environmental factors are in balance, so population sizes stay fairly constant. (Communities)
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- ☐ **Explain how an abiotic change affects a species** Link the factor to a life process, e.g. less light means less photosynthesis, so slower growth. (Abiotic factors)
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- ☐ **Explain effects of new predators or pathogens** Prey may not be adapted to escape a new predator and organisms may have no resistance to a new pathogen, so numbers can fall fast. (Biotic factors)
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- ☐ **Explain adaptations to hot, cold and dry environments** Link each feature to heat loss or water loss, e.g. spines instead of leaves reduce water loss. (Adaptations)
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- ☐ **Estimate population size from quadrat data** Mean number per m² × total area in m². (Levels of organisation)
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- ☐ **Use a transect to investigate distribution** Place quadrats at regular intervals along a line and measure the factor at each point. (Levels of organisation)
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- ☐ **Explain the role of decomposers in cycling** Microorganisms break down dead matter and waste, respire and release carbon dioxide, and return mineral ions to the soil. (How materials are cycled)
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- ☐ **Explain why high biodiversity makes ecosystems stable** Species depend less on any one other species for food, shelter and maintaining the physical environment. (Biodiversity)
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- ☐ **Explain the effects of acidic gases** Gases such as sulfur dioxide dissolve in rain to make acid rain, which damages trees and makes lakes acidic. (Waste management)
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- ☐ **Explain how destroying peat bogs affects biodiversity** Less bog habitat means fewer of the plants, animals and microorganisms that live there can survive, so biodiversity falls. (Land use)
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- ☐ **Explain how deforestation increases atmospheric carbon dioxide** Burning releases carbon dioxide, microorganisms respire as the wood decays, and fewer trees remove carbon dioxide by photosynthesis. (Deforestation)
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- ☐ **Explain why species distributions change** As temperature or rainfall changes, species survive and breed in new areas and die out where conditions no longer suit them. (Global warming)
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- ☐ **Describe positive and negative human interactions** For example, replanting hedgerows is positive, while removing them to make bigger fields is negative. (Maintaining biodiversity)
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Chemistry

- ☐ **Balance symbol equations** Change only the large numbers in front of formulae until every element has the same number of atoms on each side. (Atoms, elements and compounds)
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- ☐ **Choose a method from given data** Use information about solubility and boiling points to choose and justify a separation technique. (Mixtures)
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- ☐ **Compare plum pudding and nuclear models** Positive charge and mass spread out, compared with concentrated in a tiny nucleus with mostly empty space around it. (The development of the model of the atom)
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- ☐ **Work out a particle's overall charge** Charge = protons – electrons, e.g. 12 protons and 10 electrons gives a 2+ ion. (Relative electrical charges of subatomic particles)
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- ☐ **Find protons, neutrons and electrons in ions** Protons and neutrons as in the atom; one electron fewer for each + charge, one more for each – charge. (Size and mass of atoms)
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- ☐ **Decide which isotope is more abundant** The A_r is closer to the mass number of the more abundant isotope. (Relative atomic mass)
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- ☐ **Give the electronic structure of simple ions** Remove or add outer electrons, e.g. Na^+ is 2,8 and Cl^- is 2,8,8. (Electronic structure)
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- ☐ **Explain why it is called 'periodic'** Similar properties occur at regular intervals as the atomic number increases. (The periodic table)
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- ☐ **Explain why Mendeleev's table was accepted** Elements were later discovered that filled the gaps and had the properties he predicted. (Development of the periodic table)
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- ☐ **Classify an element using data** Use melting point, conductivity, appearance and the type of oxide as evidence. (Metals and non-metals)
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- ☐ **Predict a property from a trend** Estimate a missing value in a table so that it fits the pattern. (Group 0)
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- ☐ **Explain why helium is also unreactive** Its only shell is the first shell, which is full with 2 electrons. (Group 0)
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- ☐ **Explain their similar reactions using electrons** They all have one electron in their outer shell, which they lose to form 1+ ions. (Group 1)
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- ☐ **Predict properties of rubidium and caesium** Use the trends: even more vigorous reactions and similar products, e.g. RbOH and RbCl . (Group 1)
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- ☐ **Write equations for displacement reactions** e.g. $\text{Cl}_2 + 2\text{NaBr} \rightarrow 2\text{NaCl} + \text{Br}_2$, with the colour change. (Group 7)
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- ☐ **Describe what the electrons do in each bond** Electrons are transferred (ionic), shared in pairs (covalent) or delocalised (metallic). (Chemical bonds)
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- ☐ **Work out the formula of an ionic compound** Balance the charges so the total is zero, e.g. Ca^{2+} and Cl^- give CaCl_2 . (Ionic bonding)
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- ☐ **Work out an empirical formula from a diagram** Count the ions of each type and simplify the ratio, e.g. 8 : 16 gives XY_2 . (Ionic compounds)
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- ☐ **Draw molecules with double and triple bonds** Oxygen, O_2 , has a double bond (two shared pairs); nitrogen, N_2 , has a triple bond (three shared pairs). (Covalent bonding)
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- ☐ **Deduce a molecular formula from a diagram** Count every atom of each element in one molecule, e.g. C_2H_6 for ethane. (Covalent bonding)
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- ☐ **Explain why the metal particles are positive ions** Each atom has lost its outer electrons to the delocalised electrons, so it has more protons than electrons. (Metallic bonding)
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- ☐ **Link melting and boiling points to forces** The stronger the forces between the particles, the more energy is needed and the higher the melting and boiling points. (The three states of matter)
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- ☐ **Recognise that single atoms lack bulk properties** One atom does not have properties such as colour, melting point or conductivity; these come from huge numbers of particles. (The three states of matter)
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- ☐ **Tell (l) apart from (aq)** Water itself and molten substances are (l); substances dissolved in water are (aq). (State symbols)
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- ☐ **Explain conduction in terms of moving ions** When molten or dissolved, the ions are free to move and carry charge; in the solid they are held in fixed positions. (Properties of ionic compounds)
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- ☐ **Say which forces are overcome on boiling** The intermolecular forces are overcome; the covalent bonds inside the molecules do not break. (Properties of small molecules)
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- ☐ **Explain why polymers are solids at room temperature** Their large molecules have relatively strong intermolecular forces, which need more energy to overcome than those between small molecules. (Polymers)
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- ☐ **Recognise giant covalent structures from diagrams** A network of atoms all joined by covalent bonds, continuing in all directions, with no separate molecules. (Giant covalent structures)
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- ☐ **Explain why alloys are harder than pure metals** Atoms of different sizes distort the layers, so the layers cannot slide over each other as easily. (Properties of metals and alloys)
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- ☐ **Explain thermal conduction in metals** Energy is transferred through the metal by the delocalised electrons. (Metals as conductors)
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- ☐ **Explain why diamond does not conduct electricity** All four outer electrons of each carbon atom are used in bonds, so there are no delocalised electrons. (Diamond)
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- ☐ **Explain why graphite conducts electricity** One electron from each carbon atom is delocalised and can move through the structure, carrying charge. (Graphite)
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- ☐ **Explain graphite's very high melting point** The many strong covalent bonds within the layers must be broken. (Graphite)
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- ☐ **Explain the properties of graphene** Strong covalent bonds make it very strong; delocalised electrons let it conduct electricity. (Graphene and fullerenes)
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- ☐ **Write balanced equations from word equations** Write the correct formula for each substance (e.g. O₂, H₂, HCl, MgCl₂) and then balance it. (Conservation of mass and balanced chemical equations)
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- ☐ **Calculate percentage by mass of an element** Divide the total A_r of that element in the formula by the M_r, then multiply by 100. (Relative formula mass)
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- ☐ **Use an equation to predict the mass change** Look for (g): a gas reactant means the mass goes up, a gas product means it goes down. (Mass changes when a reactant or product is a gas)
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- ☐ **Calculate the uncertainty from the range** Uncertainty = ± half the range, e.g. a range of 0.4 g gives ± 0.2 g. (Chemical measurements)
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- ☐ **Calculate moles from mass** moles = mass (g) ÷ M_r. (Moles (HT only))
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- ☐ **Calculate the masses shown in an equation** For each substance, mass = balancing number × M_r, e.g. 2H₂O is 36 g. (Amounts of substances in equations (HT only))
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- ☐ **Convert each reacting mass into moles** Divide each mass by its M_r, using O₂, H₂, Cl₂ or N₂ for gaseous elements. (Using moles to balance equations (HT only))
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- ☐ **Explain why a reactant is used in excess** To make sure that all of the other reactant is used up. (Limiting reactants (HT only))
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- ☐ **Predict how the limiting reactant affects product** The amount of product is proportional to the amount of limiting reactant; extra excess reactant makes no more product. (Limiting reactants (HT only))
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- ☐ **Calculate the mass of solute in a solution** Mass = concentration (g/dm³) × volume (dm³). (Concentration of solutions)
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- ☐ **Balance equations for metals reacting with oxygen** Write correct formulae first, then balance with numbers in front, e.g. 4Na + O₂ → 2Na₂O. (Metal oxides)
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- ☐ **Write equations for displacement reactions** For example, zinc + copper sulfate → zinc sulfate + copper. (The reactivity series)
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- ☐ **Identify what is oxidised and reduced** The metal oxide loses oxygen so it is reduced; carbon gains oxygen so it is oxidised. (Extraction of metals and reduction)
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- ☐ **Identify the species oxidised and reduced** An atom that becomes a positive ion is oxidised; a positive ion that becomes an atom is reduced. (Oxidation and reduction in terms of electrons (HT only))
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- ☐ **Write balanced symbol equations for these reactions** For example, Zn + H₂SO₄ → ZnSO₄ + H₂. (Reactions of acids with metals)
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- ☐ **Work out salt formulae from ion charges** Balance the charges so they add to zero, e.g. Ca²⁺ and NO₃⁻ give Ca(NO₃)₂. (Neutralisation of acids and salt production)
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- ☐ **Describe the full method for a salt** Warm acid, add solid until in excess, filter, evaporate some water, crystallise, then dry the crystals. (Soluble salts)
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- ☐ **Write the ionic equation for neutralisation** H⁺(aq) + OH⁻(aq) → H₂O(l). (The pH scale and neutralisation)
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- ☐ **Define strong and weak acids** A strong acid is completely ionised in aqueous solution; a weak acid is only partially ionised. (Strong and weak acids (HT only))
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- ☐ **Explain the terms dilute and concentrated** They describe the amount of acid in a given volume of solution, not how much it ionises. (Strong and weak acids (HT only))
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- ☐ **Explain why solid ionic compounds do not conduct** In a solid the ions are held in fixed positions in a lattice, so they cannot move to carry charge. (The process of electrolysis)
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- ☐ **Explain how each product forms** Metal ions are attracted to the cathode and gain electrons; non-metal ions are attracted to the anode and lose electrons. (Electrolysis of molten ionic compounds)
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- ☐ **Explain why cryolite is used** Mixing aluminium oxide with cryolite lowers the melting point, so less energy is needed. (Using electrolysis to extract metals)
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- ☐ **Explain where hydrogen and hydroxide ions come from** A small number of water molecules break down into hydrogen ions and hydroxide ions. (Electrolysis of aqueous solutions)
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- ☐ **Describe tests for the gases produced** Hydrogen gives a squeaky pop, oxygen relights a glowing splint and chlorine bleaches damp litmus paper. (Electrolysis of aqueous solutions)
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- ☐ **Write cathode half equations for metal ions** For example, $\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}$. (Representation of reactions at electrodes as half equations (HT only))
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- ☐ **Write anode half equations for halide ions** For example, $2\text{Cl}^{-} \rightarrow \text{Cl}_2 + 2\text{e}^{-}$. (Representation of reactions at electrodes as half equations (HT only))
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- ☐ **Describe the temperature change required practical** Mix measured amounts in a polystyrene cup, stir, and record the starting and the highest (or lowest) temperature. (Energy transfer during exothermic and endothermic reactions)
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- ☐ **Evaluate uses of exothermic and endothermic reactions** Judge hand warmers, self-heating cans and cold packs using given data on temperature change, cost, safety and reuse. (Energy transfer during exothermic and endothermic reactions)
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- ☐ **Draw a reaction profile** Show the reactants and products at the correct relative heights, a curve with a peak above both, and labelled arrows. (Reaction profiles)
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- ☐ **Count the bonds in displayed formulae** Find how many of each type of bond there are, e.g. H–O–H has two O–H bonds and O=C=O has two C=O bonds. (The energy change of reactions (HT only))
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- ☐ **Explain exothermic or endothermic using bond energies** Compare the energy needed to break the bonds with the energy released when the new bonds form. (The energy change of reactions (HT only))
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- ☐ **Draw a tangent to a rate curve** Draw a straight line that touches the curve at the chosen time; its slope is a measure of the rate at that time. (Calculating rates of reactions)
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- ☐ **Sketch rate curves for changed conditions** A faster reaction has a steeper start and levels off sooner, at the same height if the amounts of reactants are the same. (Factors which affect the rates of chemical reactions)
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- ☐ **Identify and control the variables** Independent: concentration; dependent: time taken or volume of gas; control: temperature, volumes, and mass and size of solid. (Factors which affect the rates of chemical reactions)
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- ☐ **Explain the effect of temperature fully** Particles move faster, so collisions are more frequent and more energetic, and more of them have at least the activation energy. (Collision theory and activation energy)
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- ☐ **Explain how a catalyst increases the rate** It provides a different pathway for the reaction that has a lower activation energy. (Catalysts)
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- ☐ **Draw a reaction profile with a catalyst** Show a lower peak between the same reactant and product energy levels. (Catalysts)
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- ☐ **Explain how conditions change the direction** Changing a condition such as temperature can make the forward or the reverse reaction happen. (Reversible reactions)
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- ☐ **Use observations as evidence of reversibility** E.g. a white solid re-forming at the cool top of a heated tube shows the reverse reaction happening. (Reversible reactions)
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- ☐ **Link the colour changes to energy changes** Blue to white takes in energy (endothermic); white to blue gives out energy (exothermic). (Energy changes and reversible reactions)
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- ☐ **Give the energy change for the reverse reaction** Same amount, opposite direction: e.g. forward takes in 50 kJ, reverse gives out 50 kJ. (Energy changes and reversible reactions)
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- ☐ **Explain why the equilibrium is dynamic** Both the forward and reverse reactions are still happening, at the same rate. (Equilibrium)
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- ☐ **Find when equilibrium is reached from data** Equilibrium starts when the amounts or concentrations stop changing (the lines become horizontal). (Equilibrium)
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- ☐ **Explain what shifting right or left means** Shifting right gives more products at equilibrium; shifting left gives more reactants. (The effect of changing conditions on equilibrium (HT only))
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- ☐ **Know a catalyst does not move equilibrium** A catalyst speeds up both reactions equally, so equilibrium is reached faster but its position does not change. (The effect of changing conditions on equilibrium (HT only))
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- ☐ **Predict the effect of removing a product** More reactants react until equilibrium is reached again, so more product forms. (The effect of changing concentration (HT only))
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- ☐ **Predict the effect of adding more product** The position shifts to the left, so more reactants form. (The effect of changing concentration (HT only))
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- ☐ **Predict heating an endothermic reaction** Raising the temperature increases the relative amount of products at equilibrium. (The effect of temperature changes on equilibrium (HT only))
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- ☐ **Predict the effect of increasing the pressure** The position shifts towards the side with the smaller number of molecules. (The effect of pressure changes on equilibrium (HT only))
-
- ☐ **Predict the effect of decreasing the pressure** The position shifts towards the side with the larger number of molecules. (The effect of pressure changes on equilibrium (HT only))
-
- ☐ **Describe the features of a homologous series** Same general formula, each member differs from the next by CH_2 , similar chemical reactions and a gradual trend in physical properties. (Crude oil, hydrocarbons and alkanes)
-
- ☐ **Explain fractional distillation using evaporation and condensation** Crude oil is evaporated; the vapours rise and each hydrocarbon condenses where the temperature falls below its boiling point. (Fractional distillation and petrochemicals)
-
- ☐ **Balance complete combustion equations** Balance C, then H, then O; if you need half an O_2 , double every number. (Properties of hydrocarbons)
-
- ☐ **Balance cracking equations** The total numbers of carbon and hydrogen atoms must be the same on both sides, e.g. $\text{C}_{10}\text{H}_{22} \rightarrow \text{C}_8\text{H}_{18} + \text{C}_2\text{H}_4$. (Cracking and alkenes)
-

-
- ☐ **Explain why cracking is needed using data** The supply of long-chain fractions is greater than demand, and the demand for short-chain fuels is greater than supply. (Cracking and alkenes)
-
- ☐ **Calculate masses and percentages in formulations** Mass of component = percentage ÷ 100 × total mass, and the reverse. (Formulations)
-
- ☐ **Name the stationary and mobile phases** The paper is the stationary phase; the solvent is the mobile phase that moves through it. (Chromatography)
-
- ☐ **Give R_f values to suitable significant figures** R_f has no units; give it to the significant figures asked for, usually 2. (Chromatography)
-
- ☐ **Explain the pop with an equation** Hydrogen reacts rapidly with oxygen in the air: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$. (Test for hydrogen)
-
- ☐ **Explain why the splint relights** The gas has a much higher concentration of oxygen than air (about 20%), so the splint burns fast enough to relight. (Test for oxygen)
-
- ☐ **Identify gases using all four tests** Match each result to hydrogen, oxygen, carbon dioxide or chlorine. (Test for chlorine)
-
- ☐ **Use ratios and fractions for gases in air** Nitrogen : oxygen is about 80 : 20, which simplifies to 4 : 1, and four-fifths is the same as 80%. (The proportions of different gases in the atmosphere)
-
- ☐ **Explain how the oceans removed carbon dioxide** Carbon dioxide dissolved in the oceans and carbonates were precipitated, forming sediments. (The Earth's early atmosphere)
-
- ☐ **Explain why evidence about it is limited** The time scale is about 4.6 billion years, so no one could measure it and little evidence survives. (The Earth's early atmosphere)
-
- ☐ **Describe how the percentage of oxygen increased** Over the next billion years plants evolved and oxygen gradually increased to a level that let animals evolve. (How oxygen increased)
-
- ☐ **Explain two effects of photosynthesis on air** Photosynthesis adds oxygen to the atmosphere and removes carbon dioxide from it at the same time. (How oxygen increased)
-
- ☐ **Describe how crude oil and natural gas formed** Remains of plankton buried in mud on the sea bed were changed by heat and pressure over millions of years. (How carbon dioxide decreased)
-
- ☐ **Describe the greenhouse effect using wavelengths** The warm surface emits long wavelength radiation, which greenhouse gases absorb and re-emit in all directions. (Greenhouse gases)
-
- ☐ **Explain why peer review matters** Other experts check the methods, data and conclusions before publication, which reduces errors and bias. (Human activities which contribute to an increase in greenhouse gases in the atmosphere)
-
- ☐ **Describe trends in carbon dioxide data** Quote values from a graph or table and calculate changes, e.g. the increase or percentage increase over a period. (Human activities which contribute to an increase in greenhouse gases in the atmosphere)
-
- ☐ **Explain how warming causes sea levels to rise** Ice on land melts and flows into the sea, and sea water expands as it warms. (Global climate change)
-
- ☐ **Give reasons why actions may be limited** Scientific disagreement, lack of public information and education, lifestyle changes, economic considerations and incomplete international cooperation. (The carbon footprint and its reduction)
-

- ☐ **Describe actions to reduce methane emissions** For example, collect methane from landfill to use as a fuel, send less waste to landfill, and reduce livestock numbers. (The carbon footprint and its reduction)

- ☐ **Describe how oxides of nitrogen form** At the high temperatures in engines, nitrogen and oxygen from the air react together. (Atmospheric pollutants from fuels)

- ☐ **Explain how particulates cause global dimming** Particulates reflect sunlight back into space, so less sunlight reaches the Earth's surface. (Properties and effects of atmospheric pollutants)

- ☐ **Describe the health effects of these pollutants** Sulfur dioxide and oxides of nitrogen cause respiratory problems, and particulates can damage the lungs. (Properties and effects of atmospheric pollutants)

- ☐ **Classify a resource as finite or renewable** Use the information given: compare how quickly the resource forms or regrows with how quickly it is used. (Using the Earth's resources and sustainable development)

- ☐ **Describe the water purification required practical** Test the pH, find the mass of dissolved solids by evaporation, and purify the water by distillation. (Potable water)

- ☐ **Describe what happens at each stage** For example, in sedimentation solids settle to form sludge, leaving the liquid effluent on top. (Waste water treatment)

- ☐ **State what industrial waste water needs** Removal of organic matter and harmful chemicals. (Waste water treatment)

- ☐ **Describe how bioleaching works** Bacteria are used to produce leachate solutions that contain metal compounds. (Alternative methods of extracting metals (HT only))

- ☐ **Name ways to get copper from solutions** Displacement using scrap iron, or electrolysis. (Alternative methods of extracting metals (HT only))

- ☐ **Calculate totals from LCA data tables** Add up the values for each stage, and compare products per item or per use. (Life cycle assessment)

- ☐ **Explain why separation is needed for recycling** The amount of separation depends on the material and the properties required of the final product. (Ways of reducing the use of resources)

Physics

- ☐ **Include wasted energy in your descriptions** Say that friction or air resistance dissipates some energy to the thermal store of the surroundings. (Energy stores and systems)

- ☐ **Convert units before you substitute** Change grams to kilograms, centimetres to metres and kilojoules to joules first. (Changes in energy)

- ☐ **Rearrange to find c, m or $\Delta\theta$** E.g. $c = \Delta E \div (m \times \Delta\theta)$ or $\Delta\theta = \Delta E \div (m \times c)$. (Energy changes in systems)

- ☐ **Describe the specific heat capacity practical** Heat a metal block of known mass with an electric heater, measuring the energy supplied and the temperature rise. (Energy changes in systems)

- ☐ **Convert kW, kJ and minutes first** Change kilowatts to watts, kilojoules to joules and minutes to seconds before you substitute. (Power)

- ☐ **Rearrange to find energy or time** $E = P \times t$ and $t = E \div P$. (Power)

- ☐ **Link thermal conductivity to rate of transfer** The higher the thermal conductivity, the higher the rate of energy transfer by conduction through a material. (Energy transfers in a system)

- ☐ **Describe how walls affect a building's cooling** Thicker walls made of a material with a lower thermal conductivity make a building cool more slowly. (Energy transfers in a system)

- ☐ **Find the wasted or useful energy** Wasted energy = total input – useful output, so useful output = total input – wasted energy. (Efficiency)

- ☐ **Describe the environmental impact of each resource** E.g. burning fossil fuels releases carbon dioxide; hydro-electric dams flood valleys. (National and global energy resources)

- ☐ **Interpret circuit diagrams with junctions** Work out which components are in series and which are on parallel branches. (Standard circuit diagram symbols)

- ☐ **Rearrange $Q = I t$ and convert units** Use $I = Q \div t$ or $t = Q \div I$, converting minutes to seconds and mA to A first. (Electrical charge and current)

- ☐ **Describe the resistance of a wire practical** Measure V and I for different lengths of wire and calculate $R = V \div I$ each time. (Current, resistance and potential difference)

- ☐ **Explain the filament lamp I – V graph** The line curves because the filament gets hotter as the current increases, so its resistance increases. (Resistors)

- ☐ **Describe the I – V characteristics practical** Vary the pd with a variable resistor, record V and I , then reverse the connections for negative values. (Resistors)

- ☐ **Explain how added resistors change total resistance** Series increases the total resistance; parallel decreases it. (Series and parallel circuits)

- ☐ **Interpret pd–time graphs for ac and dc** A steady dc supply is a horizontal line; ac is a wave that goes positive and negative. (Direct and alternating potential difference)

- ☐ **Explain how the earth wire keeps you safe** It stops the appliance becoming live and only carries a current if there is a fault. (Mains electricity)

- ☐ **Calculate power using $P = I^2 R$** Square the current first, then multiply by the resistance. (Power)

- ☐ **Relate power ratings to energy transferred** An appliance with a higher power rating transfers more energy each second. (Energy transfers in everyday appliances)

- ☐ **Explain why a high pd means low current** For the same power, $P = V I$, so increasing the pd decreases the current. (The National Grid)

- ☐ **Explain density differences between states using particles** Gas particles are far apart, so each cubic metre of gas contains much less mass than a cubic metre of solid or liquid. (Density of materials)

- ☐ **Convert between g/cm^3 and kg/m^3** $1 \text{ g/cm}^3 = 1000 \text{ kg/m}^3$, because $1 \text{ kg} = 1000 \text{ g}$ and $1 \text{ m}^3 = 1\,000\,000 \text{ cm}^3$. (Density of materials)

- ☐ **Explain why density changes but mass does not** The particles move closer together or further apart, so the volume changes but the number of particles does not. (Changes of state)

- ☐ **Explain mass changes in an open container** Particles can escape into the air, so the container's mass drops even though the total mass is conserved. (Changes of state)

- ☐ **Explain how temperature differs from internal energy** A large mass at a low temperature can have more internal energy than a small mass at a high temperature, because it has many more particles. (Internal energy)

-
- ☐ **Rearrange to find c, m or $\Delta\theta$** Use $c = \Delta E \div (m \Delta\theta)$, $m = \Delta E \div (c \Delta\theta)$ or $\Delta\theta = \Delta E \div (m c)$. (Temperature changes in a system and specific heat capacity)
-
- ☐ **Explain what affects a temperature rise** The rise depends on the mass heated, the material (its specific heat capacity) and the energy supplied. (Temperature changes in a system and specific heat capacity)
-
- ☐ **Distinguish latent heat of fusion and vaporisation** Fusion: changing between solid and liquid. Vaporisation: changing between liquid and vapour (gas). (Changes of state and specific latent heat)
-
- ☐ **Tell specific heat capacity from specific latent heat** Specific heat capacity is for a temperature change with no change of state; specific latent heat is for a change of state with no temperature change. (Changes of state and specific latent heat)
-
- ☐ **Explain pressure rise when heated at constant volume** Faster molecules collide with the walls more often and with more force, so the pressure increases. (Particle motion in gases)
-
- ☐ **Explain how electrons change energy level** Absorbing EM radiation moves an electron to a higher level, further out; emitting EM radiation moves it to a lower level, closer in. (The structure of an atom)
-
- ☐ **Compare sizes using standard form** Divide the larger size by the smaller one, e.g. $1 \times 10^{-10} \text{ m} \div 1 \times 10^{-14} \text{ m} = 10\,000$. (The structure of an atom)
-
- ☐ **Define and identify isotopes** Isotopes are atoms with the same number of protons but different numbers of neutrons. (Mass number, atomic number and isotopes)
-
- ☐ **Explain how an atom becomes a positive ion** Losing one or more outer electrons leaves more protons than electrons, so the particle is positive. (Mass number, atomic number and isotopes)
-
- ☐ **Explain each alpha scattering observation** Link 'straight through', 'deflected' and 'bounced back' to what each shows about the atom. (The development of the model of the atom)
-
- ☐ **Explain how a beta particle is formed** A neutron in the nucleus turns into a proton, and a high-speed electron is ejected. (Radioactive decay and nuclear radiation)
-
- ☐ **Compare penetration, range and ionising power** Alpha is the most ionising with the shortest range; gamma is the least ionising with the longest range. (Radioactive decay and nuclear radiation)
-
- ☐ **Complete a nuclear equation** Make the mass numbers and the atomic numbers balance on both sides of the arrow. (Nuclear equations)
-
- ☐ **Calculate activity after whole half-lives** Halve the activity once for each half-life that passes. (Half-lives and the random nature of radioactive decay)
-
- ☐ **Find a half-life from data** Count the number of halvings in the time given, then divide the time by that number. (Half-lives and the random nature of radioactive decay)
-
- ☐ **Explain why findings are peer reviewed** Published findings can be checked by other scientists, so the conclusions are more reliable. (Radioactive contamination)
-
- ☐ **Compare the hazards of contamination and irradiation** Contamination keeps exposing you until it is removed or decays; irradiation stops when the source is removed. (Radioactive contamination)
-
- ☐ **Draw and read vector arrows to scale** With a scale of $1 \text{ cm} = 5 \text{ N}$, a 4.0 cm arrow represents a 20 N force. (Scalar and vector quantities)
-
- ☐ **Describe the forces between interacting objects** Each object exerts a force on the other; the two forces are equal in size and opposite in direction. (Contact and non-contact forces)
-

-
- ☐ **Explain why weight changes but mass does not** Weight depends on the gravitational field strength where the object is; mass is the amount of matter and stays the same. (Gravity)
-
- ☐ **State where the weight of an object acts** The weight of an object can be treated as acting at a single point called its centre of mass. (Gravity)
-
- ☐ **Draw and use free body diagrams** Show every force acting on one object as a labelled arrow drawn from the object. (Resultant forces)
-
- ☐ **Explain heating by work done against friction** Work done against friction transfers energy to the thermal store, so the temperature of the object rises. (Work done and energy transfer)
-
- ☐ **Interpret linear and non-linear force–extension graphs** A straight line through the origin shows $F \propto e$ with gradient k ; the line curves beyond the limit of proportionality. (Forces and elasticity)
-
- ☐ **Give displacement as magnitude and direction** For example 25 m east, 300 m on a bearing of 045° , or –5 m along a line. (Distance and displacement)
-
- ☐ **Convert units of distance, time and speed** km to m $\times 1000$, minutes to seconds $\times 60$, km/h to m/s $\div 3.6$. (Speed)
-
- ☐ **Explain when velocity changes** Velocity changes if the speed changes, if the direction changes, or if both change. (Velocity)
-
- ☐ **Calculate average speed from a graph** Read the total distance and total time, then divide. (The distance–time relationship)
-
- ☐ **Use the equation $v^2 - u^2 = 2as$** It is on the equations sheet and applies to uniform acceleration; rearrange it for a , s , u or v . (Acceleration)
-
- ☐ **Explain terminal velocity for a falling object** It accelerates at first; drag increases with speed until the resultant force is zero. (Acceleration)
-
- ☐ **Explain changing motion using resultant force** Velocity (speed and/or direction) only changes if a resultant force acts. (Newton's First Law)
-
- ☐ **Use the resultant force in $F = ma$** Find the resultant first, e.g. thrust minus drag, then divide by the mass. (Newton's Second Law)
-
- ☐ **Describe the acceleration required practical** Vary the force (or the mass) on a trolley and measure its acceleration, e.g. with light gates. (Newton's Second Law)
-
- ☐ **Describe the features of a Third Law pair** Same size, opposite directions, same type of force, acting on two different objects. (Newton's Third Law)
-
- ☐ **Explain motion using the Third Law** A swimmer pushes water backwards; the water pushes the swimmer forwards. (Newton's Third Law)
-
- ☐ **Explain how speed affects stopping distance** For a given braking force, a greater speed gives a greater thinking distance and a greater braking distance. (Stopping distance)
-
- ☐ **Evaluate reaction time measurements** Identify anomalies, calculate means and suggest how to make a test fairer. (Reaction time)
-
- ☐ **Explain the effect of speed on braking distance** A faster vehicle has more kinetic energy, so more work must be done to stop it. (Factors affecting braking distance 1)
-

-
- ☐ **Explain the safety implications of braking distances** Lower speeds and bigger gaps are needed in bad conditions and near hazards. (Factors affecting braking distance 1)
-
- ☐ **Link speed to the braking force needed** A faster vehicle needs a greater braking force to stop in the same distance. (Factors affecting braking distance 2)
-
- ☐ **Explain the dangers of large decelerations** The brakes may overheat, and the vehicle may skid so the driver loses control. (Factors affecting braking distance 2)
-
- ☐ **Calculate momentum** For example, $0.16 \text{ kg} \times 25 \text{ m/s} = 4.0 \text{ kg m/s}$. (Momentum is a property of moving objects)
-
- ☐ **Find mass or velocity using $p = mv$** $m = p \div v$ and $v = p \div m$. (Momentum is a property of moving objects)
-
- ☐ **State the law of conservation of momentum** In a closed system, the total momentum before an event equals the total momentum after it. (Conservation of momentum)
-
- ☐ **Calculate the total momentum of a system** Add the momentum of each object, taking direction into account. (Conservation of momentum)
-
- ☐ **Describe evidence that the medium does not travel** A floating object bobs up and down as ripples pass but does not move across the water with them. (Transverse and longitudinal waves)
-
- ☐ **Rearrange $v = f \lambda$ with unit conversions** Convert kHz, MHz, cm or mm to Hz and m first, then rearrange to find f or λ . (Properties of waves)
-
- ☐ **Describe measuring the speed of sound in air** Time a sound over a long measured distance, then use $\text{speed} = \text{distance} \div \text{time}$. (Properties of waves)
-
- ☐ **Use $v = f \lambda$ with standard form** E.g. find the wavelength of a 100 MHz radio wave using a speed of $3.0 \times 10^8 \text{ m/s}$. (Types of electromagnetic waves)
-
- ☐ **Describe the infrared radiation practical** Fill a Leslie cube with hot water and measure the infrared from each face with a detector at the same distance. (Properties of electromagnetic waves 1)
-
- ☐ **Use radiation dose data to compare risks** Compare doses in sieverts or millisieverts: the bigger the dose, the greater the risk of harm. (Properties of electromagnetic waves 2)
-
- ☐ **Explain why induced magnetism always attracts** The end of the material nearest the magnet becomes the opposite pole to the magnet's pole, so there is always attraction. (Poles of a magnet)
-
- ☐ **Define the direction of a magnetic field** It is the direction of the force that would act on a north pole placed at that point. (Magnetic fields)
-
- ☐ **Compare field strength using field-line spacing** Where the field lines are closer together, the field is stronger. (Magnetic fields)
-
- ☐ **Use the right-hand grip rule for field direction** Point your right thumb along the current (+ to -); your curled fingers show the direction of the field. (Electromagnetism)
-
- ☐ **Draw the magnetic field of a solenoid** Outside, like a bar magnet's field; inside, strong and uniform (straight, parallel, equally spaced lines). (Electromagnetism)
-
- ☐ **Calculate the force with $F = BIl$** Substitute B in tesla, I in amperes and l in metres to get F in newtons. (Fleming's left-hand rule (HT only))
-
- ☐ **Describe how to reverse or speed up motors** Reverse the current or the field to reverse it; increase the current, field strength or number of turns to speed it up. (Electric motors (HT only))
-

☐ **Find which way a motor coil turns** Use Fleming's left-hand rule on each side of the coil to find the forces, then decide clockwise or anticlockwise. (Electric motors (HT only))

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