

Grade 7 checklist

234 skills. Tick each one when you can do it. For grade 7 you need the skills for the grades below it too.

Biology

- ☐ **Compare sizes using orders of magnitude** Put both sizes in the same unit, divide, and write the ratio as a power of ten: 1000 times bigger is 3 orders of magnitude. (Eukaryotes and prokaryotes)
- ☐ **Estimate sizes of sub-cellular structures** Compare the structure with the whole cell, e.g. a nucleus a quarter of the width of a 20 µm cell is about 5 µm across. (Animal and plant cells)
- ☐ **Suggest adaptations of unfamiliar specialised cells** Use the same ideas (surface area, mitochondria, shape, missing structures) for a cell you have not studied. (Cell specialisation)
- ☐ **Suggest how a cell changes as it differentiates** It gains the sub-cellular structures its function needs, e.g. more mitochondria or ribosomes, and may change shape. (Cell differentiation)
- ☐ **Explain how electron microscopes improved understanding** Their much higher resolution revealed small sub-cellular structures, such as ribosomes, and the detail inside mitochondria and chloroplasts. (Microscopy)
- ☐ **Explain why the new cells are identical** The DNA is copied exactly, and one copy of every chromosome goes to each new cell. (Mitosis and the cell cycle)
- ☐ **Interpret data on dividing cells** e.g. use the percentage of cells in mitosis to estimate how long mitosis lasts. (Mitosis and the cell cycle)
- ☐ **Evaluate the use of stem cells** Weigh possible treatments against risks such as viral infection, and against ethical or religious objections, then give a conclusion. (Stem cells)
- ☐ **Explain why large organisms need exchange surfaces** Their small surface area to volume ratio and long diffusion distances mean diffusion through the body surface is too slow. (Diffusion)
- ☐ **Estimate cell concentration from a graph** Read the concentration where the line of best fit crosses 0% change in mass. (Osmosis)
- ☐ **Explain how oxygen affects active transport** Less oxygen means less aerobic respiration, so less energy is released and active transport slows. (Active transport)
- ☐ **Explain why large organisms need organ systems** Large organisms have a small surface area to volume ratio, so they need specialised exchange organs and a transport system to supply every cell. (Principles of organisation)
- ☐ **Explain denaturing by high temperature or pH** The active site changes shape, so the substrate no longer fits and the rate of reaction falls. (The human digestive system)
- ☐ **Calculate rates from the amylase practical** Use the equation given, such as $\text{rate} = 1000 \div \text{time taken for the starch to be digested}$, and compare rates at each pH. (The human digestive system)
- ☐ **Explain how alveoli are adapted for gas exchange** Millions of alveoli give a large surface area, with thin walls and a rich capillary network keeping a steep concentration gradient. (The heart and blood vessels)
- ☐ **Explain why the left ventricle wall is thicker** It pumps blood at a higher pressure all round the body, while the right ventricle only pumps blood to the nearby lungs. (The heart and blood vessels)

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- ☐ **Apply blood functions to unfamiliar situations** For example, explain the effects of having too few platelets or too few red blood cells. (Blood)
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- ☐ **Evaluate drugs, devices and transplants** Weigh up how well and how quickly each works, risks, side effects, recovery, cost and the need for donors or lifelong drugs, then give a justified conclusion. (Coronary heart disease: a non-communicable disease)
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- ☐ **Evaluate how representative a sample is** Large, random samples that include a range of people give data you can apply to the whole population. (Health issues)
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- ☐ **Explain why correlation does not prove causation** Another factor might explain the link, so a causal mechanism is needed before saying one factor causes a disease. (The effect of lifestyle on some non-communicable diseases)
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- ☐ **Explain how several factors combine to cause disease** Many diseases result from several risk factors interacting, e.g. smoking, poor diet and no exercise together raise heart disease risk. (The effect of lifestyle on some non-communicable diseases)
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- ☐ **Link cancer to the cell cycle** Changes to the genes that control cell division make cells divide by mitosis in an uncontrolled way. (Cancer)
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- ☐ **Explain how leaf structure suits photosynthesis** Link the thin, broad shape, transparent epidermis, chloroplast position, air spaces, stomata and veins to supplying light, carbon dioxide and water. (Plant tissues)
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- ☐ **Explain how guard cells control water loss** Guard cells become turgid to open the stomata and flaccid to close them, balancing gas exchange against water loss. (Plant organ system)
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- ☐ **Explain how water moves through the plant** Water evaporates from leaf cells and diffuses out through the stomata, and more water is drawn up the xylem to replace it. (Plant organ system)
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- ☐ **Interpret data on the spread of a disease** Describe trends in case numbers, calculate percentage changes and use the way the pathogen spreads to explain the pattern. (Communicable (infectious) diseases)
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- ☐ **Explain how HIV leads to AIDS** HIV attacks immune cells; when the immune system is badly damaged, the body cannot deal with other infections or cancers. (Viral diseases)
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- ☐ **Explain why infected leaves must be destroyed** Infected leaves, including fallen ones, still carry the fungus, which can spread to healthy leaves by water or wind. (Fungal diseases)
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- ☐ **Explain why controlling mosquitoes controls malaria** The protist's life cycle includes the mosquito, so it is normally passed between people only by mosquito bites. (Protist diseases)
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- ☐ **Explain why antibodies are specific** Each antibody fits only one antigen, so it binds to only one type of pathogen. (Human defence systems)
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- ☐ **Explain effects of damage to a defence** E.g. smoke stops cilia beating, so mucus and pathogens build up in the airways and infections are more likely. (Human defence systems)
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- ☐ **Interpret graphs of antibody concentration** After a second exposure, antibodies are made faster and in much larger amounts than after the first. (Vaccination)
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- ☐ **Explain why antibiotic resistance is a concern** Resistant strains are not killed by the antibiotic, so infections become hard to treat and the strains can spread. (Antibiotics and painkillers)
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- ☐ **Explain why double blind trials are used** Neither doctors nor patients know who has the drug, so their expectations cannot bias the results. (Discovery and development of drugs)
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- ☐ **Explain plant gas exchange in light and dark** Plant cells respire all the time, so a plant gives out carbon dioxide in the dark but takes it in overall when photosynthesis is faster than respiration. (Photosynthetic reaction)
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- ☐ **Find the limiting factor on multi-factor graphs (HT)** Compare curves: if raising the second factor raises the curve, that factor was limiting the lower curve. (Rate of photosynthesis)
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- ☐ **Use the inverse square law (HT)** Light intensity is proportional to $1 \div \text{distance}^2$, so doubling the distance gives a quarter of the light intensity. (Rate of photosynthesis)
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- ☐ **Explain how nitrate shortage reduces growth** Less nitrate means fewer amino acids and less protein, so fewer new cells are made and the plant grows less. (Uses of glucose from photosynthesis)
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- ☐ **Explain why anaerobic respiration transfers less energy** The oxidation of glucose is incomplete, so much of the energy stays in the lactic acid or ethanol. (Aerobic and anaerobic respiration)
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- ☐ **Describe how lactic acid is removed (HT)** Blood carries lactic acid from the muscles to the liver, where it is converted back into glucose. (Response to exercise)
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- ☐ **Define oxygen debt (HT)** The extra oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from the cells. (Response to exercise)
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- ☐ **Explain the importance of the small building blocks** Sugars, amino acids, fatty acids and glycerol are what large molecules are built from and broken down into, so they can be reused. (Metabolism)
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- ☐ **Analyse and evaluate reaction time data** Calculate means, spot anomalies, judge conclusions and suggest control variables. (The human nervous system)
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- ☐ **Describe how glucagon raises blood glucose** Glucagon causes glycogen to be converted into glucose, which is released into the blood. (Control of blood glucose concentration)
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- ☐ **Explain how the four hormones interact** E.g. oestrogen inhibits FSH and stimulates LH; progesterone inhibits FSH and LH. (Hormones in human reproduction)
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- ☐ **Give the disadvantages of fertility treatment** It is emotionally and physically stressful, success rates are not high, and multiple births are risky. (The use of hormones to treat infertility (HT only))
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- ☐ **Explain how thyroxine levels are controlled** High thyroxine inhibits TSH release from the pituitary, so less thyroxine is released, and the reverse. (Feedback systems (HT only))
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- ☐ **Compare meiosis with mitosis** Compare the number of divisions, the number of cells made, the chromosome number and whether the cells are identical. (Meiosis)
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- ☐ **Discuss the importance of the human genome** Explain how each use could benefit people, especially in medicine. (DNA and the genome)
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- ☐ **Construct a genetic cross to make predictions** From the information given, work out the genotypes and gametes, draw the Punnett square and give probabilities. (Genetic inheritance)
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- ☐ **Discuss the issues of embryo screening** Give economic, social and ethical arguments for and against, using the information provided. (Inherited disorders)
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- ☐ **Explain why the sperm determines sex** Eggs always carry X, so the sex depends on whether the sperm carries an X or a Y. (Sex determination)
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- ☐ **Use twin or clone data** Identical twins and clones have the same genes, so differences between them are caused by the environment. (Variation)
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- ☐ **Explain how a mutation can change a species** A rare new phenotype that suits an environmental change can spread relatively quickly by natural selection. (Variation)
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- ☐ **Compare selective breeding with natural selection** In selective breeding humans choose which individuals breed; in natural selection the environment decides which survive to breed. (Selective breeding)
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- ☐ **Evaluate the impact of selective breeding** Weigh benefits such as more food against inbreeding and reduced variation. (Selective breeding)
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- ☐ **Describe the main steps of genetic engineering** Enzymes isolate the gene, it is inserted into a vector, and the vector puts the gene into the required cells. (Genetic engineering)
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- ☐ **Explain how resistant bacteria show evolution** Bacteria reproduce so quickly that natural selection of resistant strains can be seen over a short time. (Evidence for evolution)
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- ☐ **Interpret an evolutionary tree** Organisms sharing the most recent common ancestor are the most closely related. (Fossils)
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- ☐ **Explain why variation reduces extinction risk** Some individuals are more likely to have characteristics that let them survive the change. (Extinction)
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- ☐ **Suggest causes from information given** Use clues in a description or data to name the factor and explain its effect. (Extinction)
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- ☐ **Explain why resistant strains spread** People are not immune to the new strain and there is no effective treatment. (Resistant bacteria)
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- ☐ **Explain why new antibiotics won't solve it** Developing new antibiotics is costly and slow, so it is unlikely to keep up with new resistant strains. (Resistant bacteria)
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- ☐ **Interpret evolutionary trees** Organisms that share the most recent common ancestor are the most closely related. (Classification of living organisms)
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- ☐ **Explain how new evidence changed classification** Better microscopes revealed internal structures, and biochemistry revealed chemical differences, leading to new models. (Classification of living organisms)
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- ☐ **Predict knock-on effects of changes in food webs** Follow every arrow into and out of the changed species, give a reason for each effect and allow for other food sources. (Communities)
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- ☐ **Explain knock-on effects through a community** Show how a change that affects plants then affects the animals that eat them or shelter in them. (Abiotic factors)
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- ☐ **Explain how competition can make a species decline** If one species outcompetes another, the other's numbers can fall until too few are left to breed. (Biotic factors)
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- ☐ **Explain adaptations using surface area to volume ratio** A large, compact body has a small surface area to volume ratio, so it loses heat more slowly. (Adaptations)
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- ☐ **Explain predator–prey cycles from a graph** Prey rise first, giving predators more food; predators rise and eat more prey, so prey fall, then predators fall. (Levels of organisation)
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- ☐ **Explain why the carbon and water cycles matter** They return carbon dioxide for photosynthesis and supply fresh water on land, so organisms can grow and survive. (How materials are cycled)
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- ☐ **Compare the stability of two ecosystems** Use the numbers of species to explain which is more likely to be badly affected by a change. (Biodiversity)
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- ☐ **Explain how fertiliser run-off kills aquatic life** Algae grow, block light, plants die, decomposers respire and use up oxygen, so fish die. (Waste management)

- ☐ **Explain how using peat releases carbon dioxide** Burning peat, or its decay by microorganisms once it is exposed to oxygen, releases carbon dioxide. (Land use)

- ☐ **Evaluate a decision about land use** Weigh people's needs for homes, jobs and materials against the loss of habitats and biodiversity. (Land use)

- ☐ **Explain how cattle and rice fields add methane** Cattle release methane from digestion, and microorganisms in flooded rice fields release methane. (Deforestation)

- ☐ **Evaluate clearing forest for crops or cattle** Weigh food, income and renewable fuel against habitat loss and the carbon dioxide released. (Deforestation)

- ☐ **Explain how global warming reduces biodiversity** Species that cannot adapt or move to suitable areas quickly enough may become extinct. (Global warming)

- ☐ **Explain conflicting pressures on maintaining biodiversity** Conservation costs money and uses land that people also need for food, homes, jobs and income. (Maintaining biodiversity)

Chemistry

- ☐ **Write ionic equations (Higher tier)** Show only the particles that change and leave out spectator ions, e.g. $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$. (Atoms, elements and compounds)

- ☐ **Plan a separation with several steps** Combine methods in a sensible order, e.g. dissolve, filter, then crystallise to get pure salt from rock salt. (Mixtures)

- ☐ **Explain what alpha scattering showed** Link each observation (most straight through, some deflected, very few bounced back) to its conclusion about the atom. (The development of the model of the atom)

- ☐ **Compare sizes using standard form** Divide one size by the other, e.g. $1 \times 10^{-10} \div 1 \times 10^{-14} = 10\,000$, and relate the scale to everyday objects. (Size and mass of atoms)

- ☐ **Calculate A_r for three isotopes** Same method with three terms; check that the abundances add up to 100%. (Relative atomic mass)

- ☐ **Predict reactions from an element's position** Use the group's typical reactions and trends, e.g. caesium reacts with water like sodium, but more vigorously. (The periodic table)

- ☐ **Explain why atomic weight order failed** Atomic weight depends on isotopes, so it does not always follow atomic number, e.g. argon and potassium. (Development of the periodic table)

- ☐ **Describe the whole development in order** Early tables, their problems, Mendeleev's changes, the discoveries that confirmed them, then isotopes and atomic number. (Development of the periodic table)

- ☐ **Explain properties using electronic structure** Metal atoms have few outer electrons, which they lose; non-metal atoms gain or share electrons. (Metals and non-metals)

- ☐ **Explain why reactivity increases down Group 1** The outer electron is further from the nucleus, so it is less strongly attracted and more easily lost. (Group 1)

- ☐ **Explain why reactivity decreases down Group 7** The outer shell is further from the nucleus, so an electron is attracted less strongly and gained less easily. (Group 7)

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- ☐ **Tell chemical bonds from intermolecular forces** Chemical bonds hold atoms or ions together and are strong; intermolecular forces are weak forces between separate molecules. (Chemical bonds)
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- ☐ **Describe electron transfer when the ratio is 2 : 1** For example, in lithium oxide two lithium atoms each transfer one electron to one oxygen atom. (Ionic bonding)
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- ☐ **Give limitations of each type of diagram** For example, ball and stick models show gaps and sticks that are not really there; 2D diagrams do not show the 3D arrangement. (Ionic compounds)
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- ☐ **Classify covalent substances as small, large or giant** Small molecules (e.g. CH₄), very large molecules (polymers) and giant covalent structures (e.g. diamond, silicon dioxide). (Covalent bonding)
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- ☐ **Draw and label a diagram of metallic bonding** Regular rows of positive ions with electrons between them, labelled 'delocalised electrons'. (Metallic bonding)
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- ☐ **Give limitations of the particle model (HT)** The model shows particles as solid spheres with no forces between them; real particles are not like this. (The three states of matter)
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- ☐ **Use data and observations to choose state symbols** Use melting and boiling points, or words such as 'bubbles', 'precipitate' and 'solution', to decide each state. (State symbols)
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- ☐ **Explain boiling point trends using molecule size** Larger molecules have stronger intermolecular forces, so they have higher melting and boiling points. (Properties of small molecules)
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- ☐ **Compare intermolecular forces with covalent bonds** Covalent bonds are strong and intermolecular forces are weak, which explains the bulk properties of molecular substances. (Properties of small molecules)
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- ☐ **Tell polymers from giant covalent structures** Polymers are separate chain molecules with forces between them; a giant covalent structure is one continuous network of covalent bonds. (Polymers)
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- ☐ **Contrast giant covalent and small molecular substances** Melting a giant structure breaks covalent bonds; melting small molecules only overcomes intermolecular forces. (Giant covalent structures)
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- ☐ **Interpret diagrams of pure metals and alloys** Regular layers of identical atoms compared with layers disrupted by atoms of a different size. (Properties of metals and alloys)
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- ☐ **Compare conduction in metals and ionic compounds** Metals conduct when solid because electrons move; ionic compounds conduct only when molten or dissolved, because ions move. (Metals as conductors)
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- ☐ **Link diamond's properties to its uses** Its hardness and very high melting point make it useful for cutting tools and drill tips. (Diamond)
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- ☐ **Describe carbon nanotubes and their properties** Cylindrical fullerenes with a very high length to diameter ratio; very strong and conduct electricity. (Graphene and fullerenes)
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- ☐ **Balance equations with brackets in formulae** Count atoms inside brackets carefully, e.g. Ca(OH)₂ + 2HNO₃ → Ca(NO₃)₂ + 2H₂O. (Conservation of mass and balanced chemical equations)
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- ☐ **Show that M_r values balance in equations** The total M_r of the reactants (using balancing numbers) equals the total M_r of the products. (Relative formula mass)
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- ☐ **Explain mass changes using the particle model** Gas particles move quickly and randomly and spread out, so they leave an open container or reach the reactants from the air. (Mass changes when a reactant or product is a gas)
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- ☐ **Write a mean with its uncertainty** Give the mean $\pm$ uncertainty with a unit, e.g. $24.3 \pm 0.2 \text{ cm}^3$. (Chemical measurements)
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- ☐ **Calculate mass from moles** $\text{mass (g)} = \text{moles} \times M_r$. (Moles (HT only))
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- ☐ **Calculate product mass from reactant mass** Moles of known substance $\rightarrow$ mole ratio $\rightarrow$ moles of wanted substance $\rightarrow$ mass. (Amounts of substances in equations (HT only))
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- ☐ **Find the simplest whole-number mole ratio** Divide every number of moles by the smallest one. (Using moles to balance equations (HT only))
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- ☐ **Write the balanced equation from the ratio** The whole numbers are the balancing numbers in front of each formula. (Using moles to balance equations (HT only))
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- ☐ **Identify the limiting reactant using moles** Divide the moles of each reactant by its balancing number; the smallest value is limiting. (Limiting reactants (HT only))
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- ☐ **Explain how mass and volume affect concentration (HT)** More solute in the same volume, or the same solute in less volume, gives a higher concentration. (Concentration of solutions)
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- ☐ **Explain why a reaction is a redox reaction** Show that one substance gains oxygen while another loses oxygen in the same reaction. (Metal oxides)
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- ☐ **Link reactivity to forming positive ions** The more easily a metal's atoms lose electrons to form positive ions, the more reactive the metal is. (The reactivity series)
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- ☐ **Evaluate an unfamiliar extraction method** Use the information given and the reactivity series to judge a method on energy, cost, raw materials and waste. (Extraction of metals and reduction)
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- ☐ **Write half equations for displacement reactions** For example, $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$ and $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$. (Oxidation and reduction in terms of electrons (HT only))
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- ☐ **Explain these reactions as redox reactions** The metal atoms lose electrons (oxidised) and the hydrogen ions gain electrons (reduced). (Reactions of acids with metals)
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- ☐ **Write balanced equations for neutralisation reactions** For example, $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$. (Neutralisation of acids and salt production)
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- ☐ **Choose suitable reactants for a named salt** Pick the acid with the right negative ion and an insoluble compound of the metal (or a metal that is safe to use). (Soluble salts)
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- ☐ **Explain why a stronger acid has lower pH** At the same concentration, a strong acid releases more H^+ ions, so its pH is lower. (Strong and weak acids (HT only))
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- ☐ **Explain what happens when ions are discharged** At the electrodes, ions gain or lose electrons and become atoms or molecules of elements. (The process of electrolysis)
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- ☐ **Write half equations for molten electrolysis** For example, $\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$ and $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}^-$. (Electrolysis of molten ionic compounds)
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- ☐ **Explain why the anodes must be replaced** Oxygen formed at the carbon anodes reacts with them to form carbon dioxide, so they wear away. (Using electrolysis to extract metals)
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- ☐ **Plan the required practical investigation** Use inert electrodes and a d.c. supply, identify each product, and compare solutions to test a hypothesis. (Electrolysis of aqueous solutions)
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- ☐ **Write the half equation for hydrogen** $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$. (Representation of reactions at electrodes as half equations (HT only))
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- ☐ **Suggest and explain improvements to the practical** For example, a lid and extra insulation reduce energy transfer to the surroundings, and repeats let you calculate a mean. (Energy transfer during exothermic and endothermic reactions)
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- ☐ **Explain why some reactions need heating to start** Particles must collide with at least the activation energy, so energy (e.g. a spark or flame) must be supplied at first. (Reaction profiles)
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- ☐ **Calculate the energy change for a simple reaction** Overall energy change = energy to break bonds – energy released making bonds, e.g. for $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$. (The energy change of reactions (HT only))
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- ☐ **Calculate the gradient of a tangent (HT)** Rate at that time = change in y ÷ change in x, using two points far apart on the tangent. (Calculating rates of reactions)
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- ☐ **Calculate a mean rate in mol/s (HT)** Convert a mass to moles with moles = mass ÷ M_r (or A_r), then divide by the time in seconds. (Calculating rates of reactions)
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- ☐ **Calculate surface area to volume ratio** For a cube, surface area = $6 \times \text{side}^2$ and volume = side^3 ; smaller pieces have a larger ratio. (Collision theory and activation energy)
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- ☐ **Link catalysis to successful collisions** With a lower activation energy, more collisions have enough energy to react, so successful collisions are more frequent. (Catalysts)
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- ☐ **Explain how the rates change before equilibrium** The forward rate falls as reactants are used up and the reverse rate rises as products build up, until they are equal. (Equilibrium)
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- ☐ **Predict the effect of a change in conditions** Use the information given (equation, energy change, numbers of molecules) to say which way the position shifts. (The effect of changing conditions on equilibrium (HT only))
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- ☐ **Explain shifts using Le Chatelier's principle** The system counteracts the change by using up an added substance or replacing a removed one. (The effect of changing concentration (HT only))
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- ☐ **Explain temperature effects using Le Chatelier** Increasing the temperature favours the endothermic direction, which takes in energy. (The effect of temperature changes on equilibrium (HT only))
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- ☐ **Deduce the energy change from yield data** If the yield falls as the temperature rises, the forward reaction is exothermic. (The effect of temperature changes on equilibrium (HT only))
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- ☐ **Recognise when pressure has no effect** If both sides have the same number of gas molecules, changing the pressure does not move the position. (The effect of pressure changes on equilibrium (HT only))
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- ☐ **Explain pressure effects using Le Chatelier** Fewer molecules exert a lower pressure, so shifting to that side counteracts a pressure increase. (The effect of pressure changes on equilibrium (HT only))
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- ☐ **Work out an alkane's formula from its M_r** $M_r = 14n + 2$, so solve for n: an M_r of 72 gives $n = 5$, which is C_5H_{12} . (Crude oil, hydrocarbons and alkanes)
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- ☐ **Explain why there are so many carbon compounds** Carbon atoms can bond to each other to form chains of different lengths, making families of similar compounds. (Fractional distillation and petrochemicals)
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- ☐ **Explain the boiling point trend using intermolecular forces** Larger molecules have stronger forces between the molecules, so more energy is needed to overcome them. (Properties of hydrocarbons)
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- ☐ **Compare data to rank samples by purity** The purer sample melts closer to the pure value and over a narrower range of temperatures. (Pure substances)
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- ☐ **Predict effects of changing a formulation** Changing the amount of one component changes the properties of the product, so it may no longer do its job. (Formulations)
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- ☐ **Explain how chromatography separates substances** Each substance is distributed differently between the mobile and stationary phases, so each moves a different distance. (Chromatography)
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- ☐ **Use different solvents to test purity** A pure compound gives a single spot in every solvent; a mixture may only separate in some solvents. (Chromatography)
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- ☐ **Explain why limewater turns milky** Carbon dioxide reacts with calcium hydroxide to form insoluble calcium carbonate, a white precipitate. (Test for carbon dioxide)
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- ☐ **Calculate percentage oxygen from experimental results** Divide the decrease in gas volume, when oxygen is removed by a reaction, by the starting volume and multiply by 100. (The proportions of different gases in the atmosphere)
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- ☐ **Use given evidence to evaluate a theory** Say which evidence supports the theory, which does not, and why the evidence is uncertain, then give a conclusion. (The Earth's early atmosphere)
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- ☐ **Balance the symbol equation for photosynthesis** The balanced equation is $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$. (How oxygen increased)
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- ☐ **Explain how these deposits removed carbon dioxide** The carbon in the organisms came from carbon dioxide, and burying them locked it away for millions of years. (How carbon dioxide decreased)
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- ☐ **Explain why more greenhouse gases cause warming** More long wavelength radiation is absorbed and re-emitted towards the Earth, so less escapes to space and the average temperature rises. (Greenhouse gases)
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- ☐ **Describe uncertainties in climate evidence** The climate is complex, so models are simplified, data about the past are incomplete and future emissions are unknown. (Human activities which contribute to an increase in greenhouse gases in the atmosphere)
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- ☐ **Explain effects on food production and wildlife** Changes in temperature and rainfall change where crops grow well and where species can survive. (Global climate change)
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- ☐ **Calculate and compare emissions from data** Use given data, e.g. grams of carbon dioxide per km × distance, and convert units correctly. (The carbon footprint and its reduction)
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- ☐ **Write balanced equations for combustion** For example, $2\text{CH}_4 + 3\text{O}_2 \rightarrow 2\text{CO} + 4\text{H}_2\text{O}$ for incomplete combustion of methane. (Atmospheric pollutants from fuels)
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- ☐ **Explain why carbon monoxide is toxic** It combines with haemoglobin in red blood cells, so the blood carries less oxygen. (Properties and effects of atmospheric pollutants)
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- ☐ **Interpret resource data from charts and tables** Read values, describe trends and calculate, for example how many years a reserve will last. (Using the Earth's resources and sustainable development)
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- ☐ **Compare treating ground water and salty water** Ground water only needs filtering and sterilising; salty water must be desalinated, which needs large amounts of energy. (Potable water)
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- ☐ **Calculate dissolved solids from practical results** Mass of dried residue ÷ volume of the sample, e.g. in g/dm^3 after converting cm^3 to dm^3 . (Potable water)
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- ☐ **Compare treating waste, ground and salt water** Ground water needs the least treatment; waste water needs many stages; salt water needs desalination, which uses large amounts of energy. (Waste water treatment)

- ☐ **Explain displacement and electrolysis of copper compounds** Iron is more reactive than copper; at the negative electrode $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$. (Alternative methods of extracting metals (HT only))

- ☐ **Explain why LCAs are not fully objective** Giving numerical values to the effects of pollutants needs value judgements. (Life cycle assessment)

- ☐ **Evaluate a recycling scheme from given data** Balance the resources and energy saved against the energy and cost of collecting, transporting and sorting. (Ways of reducing the use of resources)

Physics

- ☐ **Use calculations to compare energy stores** Calculate the energy in each store before and after a change to show how the total energy is shared out. (Energy stores and systems)

- ☐ **Rearrange to find speed, height or extension** E.g. $h = E_p \div (m \times g)$, or $v = \sqrt{2E_k \div m}$, taking the square root last. (Changes in energy)

- ☐ **Explain why the measured value is too high** Energy is dissipated to the surroundings, so more energy is supplied than the block gains. (Energy changes in systems)

- ☐ **Combine power with work done or energy** Find the work done or gravitational potential energy gained first, then divide by the time. (Power)

- ☐ **Rearrange to find the input or output** Useful output = efficiency $\times$ total input; total input = useful output $\div$ efficiency. (Efficiency)

- ☐ **Describe ways to increase efficiency** Reduce the wasted transfers, e.g. lubricate moving parts, streamline, insulate (Higher tier only). (Efficiency)

- ☐ **Explain trends in energy resource use** Use data and reasons such as cutting carbon dioxide emissions and the falling cost of renewables. (National and global energy resources)

- ☐ **Analyse resistance against length results** A straight line through the origin shows resistance is directly proportional to length. (Current, resistance and potential difference)

- ☐ **Find resistance at a point on I–V graph** Read V and I at that point and use $R = V \div I$, not the gradient. (Resistors)

- ☐ **Explain thermistor and LDR sensing circuits** Link a change in temperature or light to a change in resistance, current and the pd across each component. (Resistors)

- ☐ **Solve multi-step series circuit problems** Find the total resistance, then $I = V \div R$, then the pd across each resistor with $V = I R$. (Series and parallel circuits)

- ☐ **Find frequency from a pd–time graph** Read the time for one complete cycle and use frequency = $1 \div$ time period. (Direct and alternating potential difference)

- ☐ **Explain why touching the live wire is dangerous** Your body is at 0 V, so there is a large pd across you and a current flows through you. (Mains electricity)

- ☐ **Explain dangers even when a switch is open** The live wire is still connected to the supply, so it is still at about 230 V. (Mains electricity)

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- ☐ **Find current or resistance from $P = I^2 R$** Use $I = \sqrt{P \div R}$ or $R = P \div I^2$. (Power)
-
- ☐ **Combine $E = Q V$ with $Q = I t$** Find the charge first, then the energy, in multi-step problems. (Energy transfers in everyday appliances)
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- ☐ **Explain why the National Grid is efficient** A lower current means less heating of the cables, so less energy is wasted. (The National Grid)
-
- ☐ **Solve multi-step density problems** For example, find a volume from dimensions in cm, convert it to m^3 , then use a density in kg/m^3 to find the mass. (Density of materials)
-
- ☐ **Explain energy changes during a change of state** The energy supplied increases the potential energy of the particles, so internal energy rises but the temperature does not. (Internal energy)
-
- ☐ **Use heater power and time in calculations** Find the energy supplied with $E = P t$, then use it in $\Delta E = m c \Delta \theta$. (Temperature changes in a system and specific heat capacity)
-
- ☐ **Explain why a measured c is too high** Energy is transferred to the surroundings, so the temperature rise is smaller and $c = \Delta E \div (m \Delta \theta)$ comes out larger. (Temperature changes in a system and specific heat capacity)
-
- ☐ **Do multi-step heating and melting calculations** Work out each stage separately with $\Delta E = m c \Delta \theta$ or $E = m L$, then add the energies. (Changes of state and specific latent heat)
-
- ☐ **Apply the particle model to real situations** For example, explain why a sealed can may burst if heated, or why tyre pressure falls on a cold night. (Particle motion in gases)
-
- ☐ **Identify isotopes and ions from data** Use particle numbers in a table to decide which atoms are isotopes of the same element and which particles are charged. (Mass number, atomic number and isotopes)
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- ☐ **Explain why the plum pudding model was replaced** It predicted only tiny deflections, so large deflections needed a new model with a concentrated, charged nucleus. (The development of the model of the atom)
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- ☐ **Explain how new evidence changes models** When experiments give results a model cannot explain, scientists change or replace the model. (The development of the model of the atom)
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- ☐ **Choose the best radiation for a use** Justify the choice using penetration and ionising power, and say why the others are unsuitable. (Radioactive decay and nuclear radiation)
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- ☐ **Identify the decay type from an equation** Compare the mass and atomic numbers before and after to see what was emitted. (Nuclear equations)
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- ☐ **Correct count rates for background radiation** Subtract the background count rate from each reading before finding the half-life. (Half-lives and the random nature of radioactive decay)
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- ☐ **Explain which radiation is most hazardous where** Outside the body beta and gamma are more hazardous; inside the body alpha is most hazardous. (Radioactive contamination)
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- ☐ **Explain scalar–vector pairs such as speed and velocity** Two objects can have the same speed but different velocities if they move in different directions. (Scalar and vector quantities)
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- ☐ **Use the proportionality between weight and mass** $W \propto m$, so a graph of weight against mass is a straight line through the origin with a gradient equal to g . (Gravity)
-
- ☐ **Find a resultant using a scale drawing** Draw the two forces tip-to-tail to scale; the resultant is the arrow from the start of the first to the end of the second. (Resultant forces)
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- ☐ **Link work done to changes in energy stores** Work done by brakes equals the kinetic energy lost; work done lifting an object equals its gain in gravitational potential energy. (Work done and energy transfer)
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- ☐ **Calculate elastic potential energy stored** Use $E_e = 0.5 \times k \times e^2$, up to the limit of proportionality. (Forces and elasticity)
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- ☐ **Link work done to energy stored** If the spring is not inelastically deformed, the work done stretching it equals the elastic potential energy stored. (Forces and elasticity)
-
- ☐ **Find the displacement for a right-angled journey** Use a scale drawing (or Pythagoras): 30 m north then 40 m east is 50 m at about 53° east of north. (Distance and displacement)
-
- ☐ **Estimate speeds, distances and times** For example, walking 1 km at ~ 1.5 m/s takes about 670 s, roughly 11 minutes. (Speed)
-
- ☐ **Explain circular motion: constant speed, changing velocity** The direction of motion changes all the time, so the velocity changes even though the speed stays the same. (Velocity)
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- ☐ **Recognise acceleration and deceleration on the graph** A curve getting steeper shows acceleration; a curve getting less steep shows deceleration. (The distance–time relationship)
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- ☐ **Estimate the size of everyday accelerations** For example, a car reaching 30 m/s in about 10 s accelerates at about 3 m/s^2 . (Acceleration)
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- ☐ **Find distance from area under v–t graph** Split the area into rectangles and triangles and add them. (Acceleration)
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- ☐ **Define and use the idea of inertia** Inertia is the tendency of objects to continue in their state of rest or of uniform motion. (Newton's First Law)
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- ☐ **Estimate forces in everyday road transport** For example, a car of mass ~ 1000 kg decelerating at $\sim 6 \text{ m/s}^2$ needs ~ 6000 N. (Newton's Second Law)
-
- ☐ **Distinguish Third Law pairs from balanced forces** Balanced forces act on the same object; a Third Law pair acts on two different objects. (Newton's Third Law)
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- ☐ **Apply the Third Law to equilibrium situations** A book on a table pushes down on the table, and the table pushes up on the book with an equal force. (Newton's Third Law)
-
- ☐ **Interpret stopping distance data and graphs** Thinking distance rises in proportion to speed; braking distance rises more and more steeply. (Stopping distance)
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- ☐ **Evaluate factors affecting thinking distance from data** Compare thinking distances with and without a factor, at the same speed. (Reaction time)
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- ☐ **Estimate stopping distances at typical speeds** A car on a dry road needs roughly 25 m to stop from 13 m/s and roughly 100 m from 31 m/s. (Factors affecting braking distance 1)
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- ☐ **Calculate a braking force from kinetic energy** Braking force $\times$ braking distance $= \frac{1}{2} m v^2$. (Factors affecting braking distance 2)
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- ☐ **Explain that momentum is a vector** Momentum has the same direction as the velocity; opposite directions have opposite signs. (Momentum is a property of moving objects)
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- ☐ **Compare the momentum of different objects** A slow, heavy object can have more momentum than a fast, light one. (Momentum is a property of moving objects)
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- ☐ **Calculate the velocity after objects join** Total momentum before = $(m_1 + m_2) \times v$ after. (Conservation of momentum)
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- ☐ **Explain explosions and recoil using momentum** The total momentum is zero before, so the parts move apart with equal and opposite momentum. (Conservation of momentum)
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- ☐ **Explain what a closed system is** No external forces act on the system, so its total momentum cannot change. (Conservation of momentum)
-
- ☐ **Explain how particles move in a sound wave** Air particles vibrate backwards and forwards about fixed positions, parallel to the direction of travel, passing energy on to their neighbours. (Transverse and longitudinal waves)
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- ☐ **Describe the ripple tank and string practical** Measure across several wavelengths, find the frequency, use $v = f \lambda$, and explain why the apparatus suits each measurement. (Properties of waves)
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- ☐ **Explain why higher frequency means shorter wavelength** All EM waves have the same speed, so a higher frequency means a proportionally shorter wavelength. (Types of electromagnetic waves)
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- ☐ **Explain refraction using wave fronts (HT)** The part of a wave front that reaches the slower medium first slows down first, so the wave front changes direction. (Properties of electromagnetic waves 1)
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- ☐ **Explain how radio waves are produced (HT)** Oscillations (an alternating current) in an electrical circuit produce radio waves of the same frequency. (Properties of electromagnetic waves 2)
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- ☐ **Explain why microwaves suit satellite communications (HT)** Microwaves pass through the Earth's atmosphere, so they can reach satellites in space. (Uses and applications of electromagnetic waves)
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- ☐ **Explain why X-rays suit imaging bones (HT)** X-rays pass through soft tissue but are absorbed by bone, so bones show up on the image. (Uses and applications of electromagnetic waves)
-
- ☐ **Explain how to test for a magnet** Only repulsion proves an object is a permanent magnet, because a magnetic material is attracted to both poles. (Poles of a magnet)
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- ☐ **Explain the compass evidence for Earth's magnetic core** A compass lines up in a fixed direction even far from any magnet, so the Earth must have a magnetic field, which comes from its core. (Magnetic fields)
-
- ☐ **Explain how solenoids and iron cores strengthen fields** The fields of all the turns add together inside the coil, and an iron core becomes magnetised, making the field much stronger. (Electromagnetism)
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- ☐ **Rearrange $F = BIl$ after converting units** e.g. find B in tesla when the length is given in mm or cm. (Fleming's left-hand rule (HT only))
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- ☐ **Explain the role of the split-ring commutator** It reverses the current in the coil every half turn, so the coil keeps turning in the same direction. (Electric motors (HT only))
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