

Grade 5 checklist

131 skills. Tick each one when you can do it. For grade 5 you need the skills for the grades below it too.

Energy

- ☐ **Describe energy changes in common situations** Say which store decreases and which increases, e.g. a braking car: kinetic store down, thermal store of the brakes up. (Energy stores and systems)
- ☐ **Calculate kinetic energy** Square the speed first, then multiply by the mass and by 0.5. (Changes in energy)
- ☐ **Calculate elastic potential energy of a spring** Use $E_e = \frac{1}{2} k e^2$ with the extension in metres, as long as the limit of proportionality is not exceeded. (Changes in energy)
- ☐ **Calculate energy using $\Delta E = m c \Delta \theta$** Find the temperature change first, then multiply mass $\times$ specific heat capacity $\times$ temperature change. (Energy changes in systems)
- ☐ **Compare the power of two machines** If two motors do the same work, the one that takes less time has the greater power. (Power)
- ☐ **Explain how lubrication reduces wasted energy** Oil reduces friction between moving parts, so less energy is dissipated by heating. (Energy transfers in a system)
- ☐ **Explain how insulation reduces energy transfer** Thermal insulation lowers the rate of energy transfer by heating, e.g. loft insulation in a house. (Energy transfers in a system)
- ☐ **Give efficiency as a decimal or percentage** Multiply the decimal by 100 to get a percentage; efficiency is never more than 1 (100%). (Efficiency)
- ☐ **Calculate efficiency from power values** Divide the useful power output by the total power input. (Efficiency)
- ☐ **Explain why some resources are more reliable** Wind, solar and waves depend on the weather (and solar on the time of day); fossil fuels and nuclear do not. (National and global energy resources)

Electricity

- ☐ **Recognise thermistor and LDR symbols** Both start from the resistor box: the thermistor has a line with a flat tail through it, the LDR has two arrows pointing in. (Standard circuit diagram symbols)
- ☐ **Place ammeters and voltmeters correctly** Draw an ammeter in series with a component and a voltmeter in parallel across it. (Standard circuit diagram symbols)
- ☐ **State that current is the same around a loop** In a single closed loop the current has the same value at every point. (Electrical charge and current)
- ☐ **Rearrange $V = I R$ for I or R** Use $I = V \div R$ and $R = V \div I$, converting $k\Omega$ and mA first. (Current, resistance and potential difference)
- ☐ **Identify an ohmic conductor from its graph** At constant temperature, current is directly proportional to pd, so the I - V graph is a straight line through the origin. (Resistors)
- ☐ **Describe how a diode controls current** Current flows in one direction only; the diode has a very high resistance in the reverse direction. (Resistors)

- ☐ **Find a missing current or pd** e.g. the supply pd equals the sum of the pds in series; the total current equals the sum of the branch currents. (Series and parallel circuits)

- ☐ **Explain the difference between dc and ac** A direct pd acts in one direction only; an alternating pd keeps reversing direction. (Direct and alternating potential difference)

- ☐ **State the potential of each wire** Live is about 230 V (compared with earth); neutral is at or close to 0 V; earth is at 0 V. (Mains electricity)

- ☐ **Rearrange $P = VI$** Use $I = P \div V$, e.g. to find the current an appliance takes from the mains. (Power)

- ☐ **Calculate energy using $E = QV$** Charge in coulombs $\times$ pd in volts gives energy in joules. (Energy transfers in everyday appliances)

- ☐ **Explain charging using electron transfer** Electrons move from one material to the other; the gainer becomes negative, the loser positive. (Static charge)

- ☐ **Describe evidence for forces between charges** A charged rod hanging freely turns towards or away from another charged rod that is not touching it. (Static charge)

- ☐ **Describe how field strength changes with distance** The field is strongest close to the charged object and weaker further away. (Electric fields)

- ☐ **Draw the field of a charged sphere** Straight radial lines: arrows point outwards for a positive sphere and inwards for a negative sphere. (Electric fields)

Particle model of matter

- ☐ **Rearrange the density equation** Use $m = \rho \times V$ to find a mass and $V = m \div \rho$ to find a volume. (Density of materials)

- ☐ **Describe the density required practical** Measure mass on a balance and find volume from measured dimensions or by displacement of water. (Density of materials)

- ☐ **Describe particle changes during melting and boiling** Describe how the arrangement, spacing and motion of the particles change. (Changes of state)

- ☐ **Explain why a change of state is physical** No new substance is made: if the change is reversed, the material recovers its original properties. (Changes of state)

- ☐ **State the two possible effects of heating** Heating either raises the temperature of the system or produces a change of state. (Internal energy)

- ☐ **Link temperature to the particles' kinetic energy** A higher temperature means the particles have a higher average kinetic energy: they move or vibrate faster. (Internal energy)

- ☐ **Work out the temperature change $\Delta\theta$** $\Delta\theta$ is the difference between the final and starting temperatures, not the final temperature. (Specific heat capacity)

- ☐ **Define specific latent heat** The amount of energy needed to change the state of 1 kg of a substance with no change in temperature. (Specific latent heat)

- ☐ **Use $E = mL$** Calculate the energy for a change of state with E in J, m in kg and L in J/kg. (Specific latent heat)

- ☐ **Find changes of state on heating graphs** Flat sections show a change of state at the melting or boiling point; sloping sections show a temperature change. (Specific latent heat)

- ☐ **Explain how a gas exerts pressure** Molecules collide with the walls of the container and exert a force on them; the force on each unit area is the pressure. (Particle motion in gases)
- ☐ **Describe how volume affects gas pressure** At constant temperature, increasing the volume of a gas decreases its pressure, and decreasing the volume increases it. (Pressure in gases)
- ☐ **Define work as energy transferred by a force** Work done = force $\times$ distance moved along the line of action of the force: $W = F s$. (Increasing the pressure of a gas)

Atomic structure

- ☐ **Compare the sizes of atom and nucleus** The nucleus has a radius less than 1/10 000 of the atom's radius, yet contains almost all of its mass. (The structure of an atom)
- ☐ **Work out protons, neutrons and electrons** Protons = atomic number; neutrons = mass number – atomic number; electrons = protons in a neutral atom. (Mass number, atomic number and isotopes)
- ☐ **Describe the nuclear model** A tiny, positively charged nucleus containing most of the mass, with electrons around it. (Development of the model of the atom)
- ☐ **Compare plum pudding and nuclear models** Charge and mass spread out, compared with concentrated in a nucleus with empty space around it. (Development of the model of the atom)
- ☐ **Describe what each radiation is** Alpha: 2 protons and 2 neutrons; beta: a fast electron from the nucleus; gamma: electromagnetic radiation. (Radioactive decay and nuclear radiation)
- ☐ **State how alpha decay changes a nucleus** The mass number falls by 4 and the atomic number falls by 2. (Nuclear equations)
- ☐ **State how beta decay changes a nucleus** The mass number stays the same and the atomic number goes up by 1. (Nuclear equations)
- ☐ **Explain why gamma emission changes neither number** Gamma is electromagnetic radiation with no mass and no charge. (Nuclear equations)
- ☐ **Explain what random decay means** You cannot predict which nucleus will decay or when, but a large sample decays in a predictable way. (Half-lives and random decay)
- ☐ **Find a half-life from a graph** Read the time for the activity or count rate to fall to half of any starting value. (Half-lives and random decay)
- ☐ **State that irradiation does not cause radioactivity** An irradiated object does not become radioactive. (Radioactive contamination)
- ☐ **Correct a count rate for background** Subtract the background count rate from the measured count rate. (Background radiation)
- ☐ **Link half-life to how fast activity falls** A short half-life means the activity falls quickly; a long half-life means it falls slowly. (Different half-lives of radioactive isotopes)
- ☐ **Describe how a medical tracer is used** A gamma emitter is swallowed or injected and detected outside the body by a gamma camera. (Uses of nuclear radiation)
- ☐ **Describe the products of fission** Two smaller nuclei of similar size, two or three neutrons and gamma rays, all with kinetic energy. (Nuclear fission)

- ☐ **Compare a reactor with a nuclear weapon** In a reactor the chain reaction is controlled; in a weapon it is uncontrolled, causing an explosion. (Nuclear fission)
- ☐ **State where fusion happens naturally** In the cores of stars, e.g. hydrogen nuclei fuse to form helium in the Sun. (Nuclear fusion)
- ☐ **State where the energy comes from** Some of the mass is converted into the energy of radiation. (Nuclear fusion)

Forces

- ☐ **Represent a vector with an arrow** The length of the arrow shows the magnitude and the way it points shows the direction. (Scalar and vector quantities)
- ☐ **Identify the forces acting in a situation** For example, a book on a table has its weight acting down and a normal contact force acting up. (Contact and non-contact forces)
- ☐ **Show forces as vector arrows** Draw each arrow from the object, in the direction of the force, with its length showing the size. (Contact and non-contact forces)
- ☐ **Find mass or g from a weight** $m = W \div g$ and $g = W \div m$. (Gravity)
- ☐ **Describe how to measure weight** Hang the object from a calibrated spring-balance (a newtonmeter). (Gravity)
- ☐ **Recognise balanced forces (zero resultant)** If the resultant force is zero, the object stays at rest or keeps moving at a steady velocity. (Resultant forces)
- ☐ **Find force or distance from work done** $F = W \div s$ and $s = W \div F$. (Work done and energy transfer)
- ☐ **Convert between joules and newton-metres** $1 \text{ J} = 1 \text{ N m}$, so 250 N m of work is 250 J. (Work done and energy transfer)
- ☐ **Calculate force or extension with $F = ke$** For example, $k = 40 \text{ N/m}$ and $e = 0.15 \text{ m}$ give $F = 6.0 \text{ N}$. (Forces and elasticity)
- ☐ **Describe the spring extension required practical** Hang known weights on a spring, measure its length each time, calculate the extension and plot force against extension. (Forces and elasticity)
- ☐ **Find a force or distance from a moment** $F = M \div d$ and $d = M \div F$. (Moments, levers and gears)
- ☐ **Calculate pressure using $p = F \div A$** For example, 600 N on an area of 0.20 m^2 gives 3000 Pa. (Pressure in a fluid ($p = F/A$))
- ☐ **State that liquid pressure increases with depth** The deeper a point is below the surface, the greater the pressure there. (Pressure with depth and upthrust)
- ☐ **Explain what causes atmospheric pressure** Air molecules collide with a surface, and each collision exerts a force on it. (Atmospheric pressure)
- ☐ **Calculate distance and displacement along a line** 40 m east then 15 m west: distance 55 m, displacement 25 m east. (Distance and displacement)
- ☐ **Explain why displacement can be zero** After a round trip back to the start, the displacement is zero although the distance travelled is not. (Distance and displacement)
- ☐ **Find speed or time using $s = vt$** $v = s \div t$ and $t = s \div v$. (Speed)

- ☐ **Calculate average speed for a whole journey** Average speed = total distance $\div$ total time. (Speed)

- ☐ **Use + and – signs for velocity** Along a line, e.g. +4 m/s to the right and –4 m/s to the left. (Velocity)

- ☐ **Calculate speed from the gradient** Speed = change in distance $\div$ change in time for a straight section. (Distance–time graphs)

- ☐ **Find acceleration from a velocity–time graph** Acceleration = gradient = change in velocity $\div$ time taken. (Acceleration and velocity–time graphs)

- ☐ **Explain steady motion using balanced forces** A zero resultant force means there is no change in speed or direction. (Newton's First Law)

- ☐ **Find mass or acceleration using $F = ma$** $a = F \div m$ and $m = F \div a$. (Newton's Second Law)

- ☐ **Describe how acceleration depends on force and mass** Acceleration is proportional to the resultant force and inversely proportional to the mass. (Newton's Second Law)

- ☐ **Identify Third Law partner forces** If a boy pushes a wall with 150 N, the wall pushes the boy with 150 N in the opposite direction. (Newton's Third Law)

- ☐ **Calculate thinking distance using $s = vt$** Thinking distance = speed $\times$ reaction time. (Stopping distance)

- ☐ **Calculate thinking distance from reaction time** Thinking distance = speed $\times$ reaction time. (Reaction time)

- ☐ **Describe the ruler-drop reaction time test** Catch a dropped ruler; the further it falls before you catch it, the longer your reaction time. (Reaction time)

- ☐ **Explain the effects of worn tyres and brakes** Worn tyres grip the road less; worn brakes produce a smaller friction force. (Factors affecting braking distance)

- ☐ **Calculate the work done by a braking force** $W = Fs$, where s is the braking distance. (Braking forces and deceleration)

- ☐ **Link braking force to deceleration** The greater the braking force, the greater the deceleration ($F = ma$). (Braking forces and deceleration)

- ☐ **Recall the momentum equation $p = mv$** Momentum (kg m/s) = mass (kg) $\times$ velocity (m/s). (Momentum of moving objects)

Waves

- ☐ **Describe how transverse and longitudinal waves differ** Compare the direction of the oscillations with the direction of energy transfer: perpendicular for transverse, parallel for longitudinal. (Transverse and longitudinal waves)

- ☐ **Identify compressions and rarefactions** In a longitudinal wave, compressions are where the particles are close together and rarefactions are where they are spread out. (Transverse and longitudinal waves)

- ☐ **Use $T = 1/f$** Find the period from the frequency, or the frequency from the period, e.g. $f = 50$ Hz gives $T = 1 \div 50 = 0.02$ s. (Properties of waves)

- ☐ **Draw a ray diagram for reflection** Draw the normal at 90° to the surface, then the reflected ray at an equal angle on the other side, with arrows on both rays. (Reflection of waves)

- ☐ **State what happens to absorbed wave energy** When a wave is absorbed, its energy is transferred to the material, usually heating it. (Reflection of waves)

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- ☐ **Describe how sound makes solids vibrate** Sound waves can travel through solids: a sound wave reaching a solid makes it vibrate, and the vibrations travel through it. (Sound waves)
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- ☐ **Describe how the ear detects sound** Sound waves make the eardrum vibrate; the vibrations are passed on to other parts of the ear, causing the sensation of sound. (Sound waves)
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- ☐ **Give uses of ultrasound and echo sounding** Medical scans (e.g. of a foetus), finding flaws inside metal, and measuring the depth of water. (Waves for detection and exploration)
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- ☐ **Compare P-waves and S-waves** P-waves are longitudinal and travel through solids and liquids; S-waves are transverse and cannot travel through liquids. (Waves for detection and exploration)
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- ☐ **State that all EM waves travel equally fast** All EM waves travel at the same speed through a vacuum (space) or air: 3.0×10^8 m/s. (Types of electromagnetic waves)
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- ☐ **Give examples of EM waves transferring energy** E.g. infrared from a fire warming your skin, or microwaves heating food in an oven. (Types of electromagnetic waves)
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- ☐ **Draw a ray diagram for refraction** Draw the normal; a ray that slows down (e.g. air into glass) bends towards the normal. (EM waves: refraction and absorption)
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- ☐ **State which surfaces emit and absorb infrared best** Matt black surfaces are the best emitters and absorbers of infrared; shiny silver surfaces are the worst. (EM waves: refraction and absorption)
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- ☐ **State the effects of X-rays and gamma rays** They are ionising radiation and can cause mutation of genes and cancer. (EM waves: production and hazards)
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- ☐ **State where gamma rays come from** Gamma rays come from changes in the nucleus of an atom. (EM waves: production and hazards)
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- ☐ **Give uses of visible light and ultraviolet** Visible light: fibre optic communications. Ultraviolet: energy-efficient lamps and sun tanning. (Uses and applications of EM waves)
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- ☐ **Calculate magnification** magnification = image height ÷ object height, with both heights in the same unit; it has no units. (Lenses)
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- ☐ **Describe an image in three words** Say whether it is real or virtual, upright or inverted, and magnified or diminished. (Lenses)
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- ☐ **Describe specular and diffuse reflection** Specular: from a smooth surface in a single direction. Diffuse: from a rough surface, scattered in many directions. (Visible light)
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- ☐ **Explain how a colour filter works** A filter transmits certain wavelengths (its own colour) and absorbs the others. (Visible light)
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- ☐ **Identify good and poor emitters and absorbers** Dark, matt surfaces are good emitters and absorbers; shiny surfaces are poor emitters and absorbers because they reflect radiation. (Emission and absorption of infrared radiation)
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- ☐ **Describe how emission changes with temperature** A hotter body emits more radiation at every wavelength, and relatively more at shorter wavelengths. (Perfect black bodies and radiation)
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Magnetism and electromagnetism

- ☐ **Describe the difference between permanent and induced magnets** A permanent magnet produces its own magnetic field; an induced magnet only becomes a magnet when it is placed in a magnetic field. (Poles of a magnet)

- ☐ **Plot a magnetic field using a compass** Mark where the compass needle points, move the compass on, repeat, then join the dots from N to S. (Magnetic fields)

- ☐ **State how field strength depends on distance** The field is strongest at the poles and gets weaker further from the magnet. (Magnetic fields)

- ☐ **Draw the field around a straight wire** Circles centred on the wire, further apart further out, with arrows showing the direction. (Electromagnetism)

- ☐ **State what affects the strength of the field** The field is stronger for a bigger current, and weaker further from the wire. (Electromagnetism)

- ☐ **Recall the factors that affect the force** The force is bigger for a stronger field (greater magnetic flux density), a bigger current and a longer length of wire in the field. (Fleming's left-hand rule)

- ☐ **Use Fleming's left-hand rule to find direction** First finger = field (N to S), second finger = current (+ to -), thumb = force (motion). (Fleming's left-hand rule)

- ☐ **Explain why a current-carrying wire moves** The magnetic field of the current interacts with the field of the magnet, producing a force on the wire. (Fleming's left-hand rule)

- ☐ **Explain why the coil's sides feel opposite forces** The current is in opposite directions in the two sides, so the forces on them are in opposite directions. (Electric motors)

- ☐ **State that loudspeakers use the motor effect** The coil carries a current in a magnetic field, so there is a force on it. (Loudspeakers)

- ☐ **State when a potential difference is induced** When a conductor moves relative to a magnetic field, or the magnetic field around it changes. (Induced potential)

- ☐ **State when an induced current flows** A current is only induced if the conductor is part of a complete circuit. (Induced potential)

- ☐ **State what an alternator and a dynamo produce** An alternator generates alternating current (a.c.); a dynamo generates direct current (d.c.). (Uses of the generator effect)

- ☐ **Explain why a rotating coil induces a pd** The sides of the coil move through (cut) the magnetic field lines, so a pd is induced. (Uses of the generator effect)

- ☐ **State that microphones use the generator effect** Sound makes a coil move in a magnetic field, which induces a pd. (Microphones)

- ☐ **Describe the structure of a transformer** A primary coil and a secondary coil wound on an iron core. (Transformers)

- ☐ **Identify step-up and step-down transformers** Step-up: more turns on the secondary coil, so the output pd is bigger. Step-down: fewer turns on the secondary, so the output pd is smaller. (Transformers)

Space physics

- ☐ **State how a star releases energy** In the core of a main sequence star, hydrogen nuclei fuse to form helium, releasing energy. (Our solar system)

- ☐ **Describe the life cycle of a massive star** Main sequence star, then red super giant, then supernova, then neutron star or black hole. (The life cycle of a star)

- ☐ **Give similarities between orbiting objects** All are held in orbit by the gravity of a more massive object and move in (nearly) circular orbits. (Orbital motion and satellites)

- ☐ **Explain what red-shift shows about galaxies** A red-shifted galaxy is moving away from us, and a bigger red-shift means it is further away and moving faster. (Red-shift)

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