

Grade 4 skills checklist

97 skills that set grade 4 apart. Do the lists for the grades below first. Tick each one when you can do it.

Energy

- ☐ **Name the ways energy is transferred** Mechanically (a force doing work), electrically (a current doing work), by heating and by radiation such as light. (Energy stores and systems)
- ☐ **Calculate gravitational potential energy** Multiply mass (kg) $\times$ gravitational field strength (N/kg) $\times$ height (m) to get the energy in joules. (Changes in energy)
- ☐ **Define specific heat capacity** The amount of energy needed to raise the temperature of 1 kg of a substance by 1 °C. (Energy changes in systems)
- ☐ **Define power** Power is the rate at which energy is transferred, or the rate at which work is done. (Power)
- ☐ **Calculate power from energy and time** Divide the energy transferred (J) by the time taken (s). (Power)
- ☐ **Give examples of energy being dissipated** Friction heats moving parts, air resistance heats the air, and a motor makes sound. (Energy transfers in a system)
- ☐ **Calculate efficiency from energy values** Divide the useful output energy by the total input energy. (Efficiency)
- ☐ **Sort resources into renewable and non-renewable** Coal, oil, gas and nuclear fuel are non-renewable; all the others are renewable. (National and global energy resources)
- ☐ **Link energy resources to their uses** The three main uses are transport, electricity generation and heating. (National and global energy resources)

Electricity

- ☐ **Draw a simple series circuit correctly** Use a ruler, straight wires and the correct symbols, with no gaps in the loop. (Standard circuit diagram symbols)
- ☐ **Recognise diode, LED, fuse and variable resistor** Tell apart symbols that look alike, such as the diode and the LED, or the resistor and the fuse. (Standard circuit diagram symbols)
- ☐ **State what a circuit needs for current** A closed circuit (complete loop) that includes a source of potential difference, such as a cell. (Electrical charge and current)
- ☐ **Calculate charge using $Q = I t$** Multiply the current in amps by the time in seconds to get the charge in coulombs. (Electrical charge and current)
- ☐ **Describe how resistance affects current** For a given potential difference, the greater the resistance, the smaller the current. (Current, resistance and potential difference)
- ☐ **Calculate pd using $V = I R$** Multiply the current in amps by the resistance in ohms to get the pd in volts. (Current, resistance and potential difference)
- ☐ **Recall that a thermistor's resistance falls when hot** The resistance of a thermistor decreases as temperature increases. (Resistors)

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- ☐ **State the series and parallel rules** Series: same current, pd shared. Parallel: same pd across each branch, branch currents add up. (Series and parallel circuits)
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- ☐ **Add resistances in series** Use $R_{\text{total}} = R_1 + R_2$. (Series and parallel circuits)
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- ☐ **Name a source of direct pd** Cells and batteries supply a direct potential difference. (Direct and alternating potential difference)
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- ☐ **State the job of each wire** Live carries the alternating pd from the supply, neutral completes the circuit, earth is a safety wire. (Mains electricity)
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- ☐ **Explain what power means** Power is the rate of energy transfer: the energy transferred each second. (Power)
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- ☐ **Calculate power using $P = VI$** Multiply the pd in volts by the current in amps to get the power in watts. (Power)
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- ☐ **State what affects the energy transferred** The power of the appliance and how long it is switched on for. (Energy transfers in everyday appliances)
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- ☐ **Calculate energy using $E = Pt$** Power in watts $\times$ time in seconds gives energy in joules. (Energy transfers in everyday appliances)
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- ☐ **State what a step-up transformer does** It increases the potential difference from the power station to the transmission cables. (The National Grid)
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- ☐ **State what a step-down transformer does** It decreases the potential difference to a much lower value for domestic use. (The National Grid)
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- ☐ **Describe charging by rubbing insulators** Rubbing certain insulating materials together makes them electrically charged. (Static charge)
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- ☐ **Describe what an electric field is** The region around a charged object where another charged object experiences a force. (Electric fields)
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Particle model of matter

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- ☐ **Recall and use density = mass $\div$ volume** Substitute into $\rho = m / V$ with mass in kg and volume in m^3 to get a density in kg/m^3 . (Density of materials)
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- ☐ **State that mass is conserved** When a substance changes state the number of particles stays the same, so its mass does not change. (Changes of state)
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- ☐ **Define internal energy** The total kinetic energy and potential energy of all the particles (atoms and molecules) that make up a system. (Internal energy)
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- ☐ **Define specific heat capacity** The amount of energy needed to raise the temperature of 1 kg of a substance by 1 $^{\circ}\text{C}$. (Specific heat capacity)
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- ☐ **Substitute into $\Delta E = mc\Delta\theta$** Calculate the change in thermal energy with m in kg, c in $\text{J}/\text{kg } ^{\circ}\text{C}$ and $\Delta\theta$ in $^{\circ}\text{C}$. (Specific heat capacity)
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- ☐ **Know temperature stays constant during state changes** While a substance melts, boils, freezes or condenses, its temperature does not change. (Specific latent heat)
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- ☐ **Link gas temperature to molecules' kinetic energy** The higher the temperature, the greater the average kinetic energy of the molecules, so the faster they move on average. (Particle motion in gases)
- ☐ **State the direction of gas pressure forces** The pressure of a gas produces a net force at right angles to the wall of its container (or any surface). (Pressure in gases)

Atomic structure

- ☐ **Give the relative charge of each particle** Proton +1, neutron 0, electron -1, so the nucleus is positively charged. (The structure of an atom)
- ☐ **Recall the size of an atom** The radius of an atom is about 1×10^{-10} m. (The structure of an atom)
- ☐ **State what mass number means** The mass number is the total number of protons and neutrons in the nucleus. (Mass number, atomic number and isotopes)
- ☐ **Explain why atoms have no overall charge** An atom has equal numbers of protons and electrons, and their charges are equal and opposite. (Mass number, atomic number and isotopes)
- ☐ **Describe the plum pudding model** The atom is a ball of positive charge with negative electrons embedded in it. (Development of the model of the atom)
- ☐ **Define radioactive decay and activity** Unstable nuclei give out radiation to become more stable; activity is decays per second, in becquerels (Bq). (Radioactive decay and nuclear radiation)
- ☐ **State what absorbs each radiation** Alpha: paper; beta: a few mm of aluminium; gamma: reduced by thick lead or concrete. (Radioactive decay and nuclear radiation)
- ☐ **Recall the symbols for alpha and beta** Alpha is ${}^4_2\text{He}$ and beta is ${}^0_{-1}\text{e}$. (Nuclear equations)
- ☐ **Define half-life** The time for the number of unstable nuclei in a sample, or its count rate, to halve. (Half-lives and random decay)
- ☐ **Define contamination and irradiation** Contamination: unwanted radioactive material on or in something; irradiation: exposure to radiation from outside. (Radioactive contamination)
- ☐ **Name natural sources of background radiation** Rocks (including radon gas released from rocks) and cosmic rays from space. (Background radiation)
- ☐ **Name man-made sources of background radiation** Fallout from nuclear weapons testing and from nuclear accidents. (Background radiation)
- ☐ **State that half-lives vary widely** Half-lives range from fractions of a second to billions of years. (Different half-lives of radioactive isotopes)
- ☐ **Name two medical uses of nuclear radiation** Exploring internal organs with tracers; destroying unwanted tissue such as tumours. (Uses of nuclear radiation)
- ☐ **Define nuclear fission** The splitting of a large, unstable nucleus into two smaller nuclei. (Nuclear fission)
- ☐ **Name nuclear fuels used for fission** Uranium (e.g. uranium-235) and plutonium (e.g. plutonium-239). (Nuclear fission)
- ☐ **Define nuclear fusion** Two light nuclei join to form a heavier nucleus. (Nuclear fusion)

Forces

- ☐ **Sort common quantities into scalars and vectors** Distance, speed, mass, time, energy and temperature are scalars; displacement, velocity, acceleration and force are vectors. (Scalar and vector quantities)

- ☐ **Name examples of non-contact forces** Gravitational, electrostatic and magnetic forces act even when the objects are physically separated. (Contact and non-contact forces)

- ☐ **Calculate weight using $W = m g$** For example, $60 \text{ kg} \times 9.8 \text{ N/kg} = 588 \text{ N}$. (Gravity)

- ☐ **Find the resultant of forces along a line** Add forces acting in the same direction; subtract forces acting in opposite directions. (Resultant forces)

- ☐ **Calculate work done using $W = F s$** For example, $50 \text{ N} \times 3.0 \text{ m} = 150 \text{ J}$. (Work done and energy transfer)

- ☐ **Distinguish elastic and inelastic deformation** An elastically deformed object returns to its original shape when the forces are removed; an inelastically deformed one does not. (Forces and elasticity)

- ☐ **Calculate a moment using $M = F d$** Moment (N m) = force (N) $\times$ perpendicular distance from the pivot (m). (Moments, levers and gears)

- ☐ **State that fluid pressure acts normal to surfaces** The force caused by the pressure in a fluid acts at right angles to any surface. (Pressure in a fluid ($p = F/A$))

- ☐ **Describe a simple model of the atmosphere** The atmosphere is thin compared with the size of the Earth and gets less dense with increasing altitude. (Atmospheric pressure)

- ☐ **State that displacement is a vector** Displacement is the straight-line distance from the start point to the finish point, with the direction of that line. (Distance and displacement)

- ☐ **Calculate distance using $s = v t$** For example, 1.5 m/s for 60 s gives 90 m . (Speed)

- ☐ **Recall typical speeds of everyday motion** Walking $\sim 1.5 \text{ m/s}$, running $\sim 3 \text{ m/s}$, cycling $\sim 6 \text{ m/s}$, sound in air $\sim 330 \text{ m/s}$. (Speed)

- ☐ **Explain the difference between speed and velocity** Speed is a scalar (magnitude only); velocity is a vector (magnitude and direction). (Velocity)

- ☐ **Plot a distance–time graph from data** Time on the x-axis, distance on the y-axis, labelled axes with units and sensible scales. (Distance–time graphs)

- ☐ **Calculate acceleration using $a = \Delta v \div t$** From 4 m/s to 16 m/s in 3 s : $a = 12 \div 3 = 4 \text{ m/s}^2$. (Acceleration and velocity–time graphs)

- ☐ **Describe motion from a velocity–time graph** Horizontal line: constant velocity; sloping up: accelerating; sloping down: decelerating. (Acceleration and velocity–time graphs)

- ☐ **State Newton's First Law** If the resultant force on an object is zero, it stays at rest or keeps moving at the same velocity. (Newton's First Law)

- ☐ **Find a force from steady motion** At a steady speed in a straight line, the driving force equals the total resistive force. (Newton's First Law)

- ☐ **Calculate force using $F = m a$** For example, $1200 \text{ kg} \times 2.5 \text{ m/s}^2 = 3000 \text{ N}$. (Newton's Second Law)

- ☐ **State Newton's Third Law** Whenever two objects interact, the forces they exert on each other are equal and opposite. (Newton's Third Law)

- ☐ **Calculate stopping distance from given data** Add the thinking distance and the braking distance. (Stopping distance)

- ☐ **List factors that increase reaction time** Tiredness, drugs, alcohol and distractions (e.g. using a phone).
(Reaction time)

- ☐ **Explain how wet or icy roads affect braking** There is less friction between the tyres and the road, so the braking distance is longer. (Factors affecting braking distance)

- ☐ **Describe the energy transfer when a vehicle brakes** Energy is transferred from the kinetic store of the vehicle to the thermal store of the brakes. (Braking forces and deceleration)

Waves

- ☐ **State what waves transfer** Waves transfer energy (and can carry information) from place to place, but they do not transfer matter. (Transverse and longitudinal waves)

- ☐ **Define frequency and period** Frequency is the number of waves passing a point each second (Hz); the period is the time for one wave (s). (Properties of waves)

- ☐ **Calculate wave speed using $v = f \lambda$** Multiply the frequency in Hz by the wavelength in m to get the wave speed in m/s. (Properties of waves)

- ☐ **State the law of reflection** The angle of incidence equals the angle of reflection, both measured from the normal. (Reflection of waves)

- ☐ **Link spectrum position to wavelength and frequency** Radio waves have the longest wavelength and lowest frequency; gamma rays have the shortest wavelength and highest frequency. (Types of electromagnetic waves)

- ☐ **State the effects of ultraviolet on skin** Ultraviolet can make skin age prematurely and increases the risk of skin cancer. (EM waves: production and hazards)

- ☐ **Give two uses of microwaves** Satellite communications and cooking food. (Uses and applications of EM waves)

- ☐ **Give three uses of infrared** Electrical heaters, cooking food and infrared cameras. (Uses and applications of EM waves)

- ☐ **Define principal focus and focal length** A convex lens brings parallel rays to a focus at the principal focus; the focal length is its distance from the lens. (Lenses)

- ☐ **State why an object looks a colour** An opaque object reflects the wavelengths of its colour most strongly and absorbs the others. (Visible light)

- ☐ **Explain why objects look white or black** White objects reflect all wavelengths equally; black objects absorb all wavelengths. (Visible light)

- ☐ **Link temperature to infrared emitted** The hotter a body is, the more infrared radiation it radiates in a given time. (Emission and absorption of infrared radiation)

Magnetism and electromagnetism

- ☐ **Identify magnetic forces as non-contact forces** Magnets attract or repel each other without touching, so these are non-contact forces. (Poles of a magnet)

- ☐ **Draw the field pattern of a bar magnet** Curved lines from the north pole to the south pole, with arrows, closest together at the poles. (Magnetic fields)

- ☐ **Describe how to show a wire's magnetic field** Put plotting compasses around a vertical wire: they line up in a circle when the current is switched on. (Electromagnetism)
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Space physics

- ☐ **Describe how the Sun formed** A nebula (a cloud of dust and gas) was pulled together by gravity until fusion started. (Our solar system)
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- ☐ **State what decides a star's life cycle** The size (mass) of the star decides which path it follows after the main sequence. (The life cycle of a star)
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- ☐ **Describe the life cycle of a Sun-sized star** Main sequence star, then red giant, then white dwarf, then black dwarf. (The life cycle of a star)
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- ☐ **Tell apart planets, moons and artificial satellites** Planets orbit a star, moons orbit planets, and artificial satellites are made and launched by people. (Orbital motion and satellites)
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- ☐ **Describe what red-shift is** Red-shift is an observed increase in the wavelength of light from most distant galaxies. (Red-shift)
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