

Grade 6 checklist

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

Energy

- ☐ **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)

Electricity

- ☐ **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, $P = VI$, so increasing the pd decreases the current. (The National Grid)
- ☐ **Explain why the two charges are equal** The number of electrons gained by one material equals the number lost by the other. (Static charge)
- ☐ **Explain non-contact forces using fields** Each charged object is in the other's electric field, so each experiences a force. (Electric fields)

Particle model of matter

- ☐ **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 $\Delta\theta = \Delta E \div (m c)$. (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. (Specific heat capacity)
- ☐ **Distinguish latent heat of fusion and vaporisation** Fusion: changing between solid and liquid. Vaporisation: changing between liquid and vapour (gas). (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. (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 the volume–pressure link using particles** In a bigger volume, the molecules collide with the walls less often, so the pressure is lower. (Pressure in gases)

- ☐ **Use $pV = \text{constant}$ for a fixed mass** Use $p_1V_1 = p_2V_2$ to find a new pressure or volume. (Pressure in gases)
- ☐ **State how doing work affects a gas** Doing work on a gas transfers energy to it, increasing its internal energy, which can raise its temperature. (Increasing the pressure of a gas)
- ☐ **Calculate the work done on a gas** Use $W = F s$ with the force on the piston in N and the distance it moves in m. (Increasing the pressure of a gas)

Atomic structure

- ☐ **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. (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 random 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 random 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)
- ☐ **Explain how job and location affect dose** E.g. aircrew receive more cosmic rays; people in granite areas receive more radon. (Background radiation)
- ☐ **Explain the hazard of long half-lives** The material stays radioactive for a very long time, so it needs safe long-term storage. (Different half-lives of radioactive isotopes)
- ☐ **Explain the hazard of short half-lives** The material is hazardous for a short time, as its activity soon falls to a low level. (Different half-lives of radioactive isotopes)

- ☐ **Explain the choice of a tracer isotope** Gamma, so it leaves the body and is weakly ionising; short half-life, so the dose is small. (Uses of nuclear radiation)

- ☐ **Describe how radiation destroys a tumour** Gamma beams aimed at the tumour from several directions, or a source placed in or next to it. (Uses of nuclear radiation)

- ☐ **Explain how a chain reaction happens** Neutrons released by one fission are absorbed by other nuclei, which also split. (Nuclear fission)

- ☐ **Draw or interpret a chain reaction diagram** Show each fission releasing 2 or 3 neutrons that go on to cause more fissions. (Nuclear fission)

- ☐ **Complete a fusion equation** Balance the mass numbers and atomic numbers, as for any nuclear equation. (Nuclear fusion)

Forces

- ☐ **Draw and read vector arrows to scale** With a scale of 1 cm = 5 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)

- ☐ **Apply balanced moments to a balanced object** For a balanced object, total clockwise moment = total anticlockwise moment about the pivot. (Moments, levers and gears)

- ☐ **Find force or area from a pressure** $F = p \times A$ and $A = F \div p$. (Pressure in a fluid ($p = F/A$))

- ☐ **Calculate liquid pressure with $p = h\rho g$** For example, $3.0 \text{ m} \times 1000 \text{ kg/m}^3 \times 9.8 \text{ N/kg} = 29\,400 \text{ Pa}$. (Pressure with depth and upthrust)

- ☐ **Explain why pressure increases with depth** At a greater depth there is a greater height, and so a greater weight, of liquid above that point. (Pressure with depth and upthrust)

- ☐ **State that atmospheric pressure decreases with height** The higher you go, the lower the atmospheric pressure. (Atmospheric pressure)

- ☐ **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)

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- ☐ **Explain when velocity changes** Velocity changes if the speed changes, if the direction changes, or if both change. (Velocity)
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- ☐ **Calculate average speed from a graph** Read the total distance and total time, then divide. (Distance–time graphs)
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- ☐ **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 and velocity–time graphs)
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- ☐ **Explain terminal velocity for a falling object** It accelerates at first; drag increases with speed until the resultant force is zero. (Acceleration and velocity–time graphs)
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- ☐ **Explain changing motion using resultant force** Velocity (speed and/or direction) only changes if a resultant force acts. (Newton's First Law)
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- ☐ **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)
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- ☐ **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)
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- ☐ **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)
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- ☐ **Explain motion using the Third Law** A swimmer pushes water backwards; the water pushes the swimmer forwards. (Newton's Third Law)
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- ☐ **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)
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- ☐ **Evaluate reaction time measurements** Identify anomalies, calculate means and suggest how to make a test fairer. (Reaction time)
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- ☐ **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)
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- ☐ **Explain the safety implications of braking distances** Lower speeds and bigger gaps are needed in bad conditions and near hazards. (Factors affecting braking distance)
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- ☐ **Link speed to the braking force needed** A faster vehicle needs a greater braking force to stop in the same distance. (Braking forces and deceleration)
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- ☐ **Explain the dangers of large decelerations** The brakes may overheat, and the vehicle may skid so the driver loses control. (Braking forces and deceleration)
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- ☐ **Calculate momentum** For example, $0.16 \text{ kg} \times 25 \text{ m/s} = 4.0 \text{ kg m/s}$. (Momentum of moving objects)
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- ☐ **Find mass or velocity using $p = mv$** $m = p \div v$ and $v = p \div m$. (Momentum of moving objects)
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- ☐ **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)
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- ☐ **Calculate the total momentum of a system** Add the momentum of each object, taking direction into account. (Conservation of momentum)
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- ☐ **State that a force changes momentum** When a force acts on an object that is moving, or able to move, its momentum changes. (Changes in momentum)
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- ☐ **Calculate force from a change in momentum** Force = change in momentum ÷ time taken; the equation is on the equations sheet. (Changes in momentum)
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Waves

- ☐ **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)
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- ☐ **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)
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- ☐ **Describe measuring the speed of sound in air** Time a sound over a long measured distance, then use speed = distance ÷ time. (Properties of waves)
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- ☐ **Describe reflection, absorption and transmission for materials** E.g. a mirror reflects most light, black card absorbs most light and clear glass transmits most light. (Reflection of waves)
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- ☐ **Give examples of sound–vibration conversions** E.g. the eardrum, a microphone's diaphragm, a loudspeaker cone, or a wall carrying sound into the next room. (Sound waves)
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- ☐ **Use $v = f \lambda$ for sound** E.g. the wavelength of a 20 kHz sound in air (speed 340 m/s) is $340 \div 20\,000 = 0.017$ m. (Sound waves)
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- ☐ **Calculate distance from an echo time** Distance = speed × time, then halve it because the pulse travels there and back. (Waves for detection and exploration)
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- ☐ **Use $v = f \lambda$ with standard form** E.g. find the wavelength of a 100 MHz radio wave using a speed of 3.0×10^8 m/s. (Types of electromagnetic waves)
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- ☐ **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. (EM waves: refraction and absorption)
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- ☐ **Use radiation dose data to compare risks** Compare doses in sieverts or millisieverts: the bigger the dose, the greater the risk of harm. (EM waves: production and hazards)
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- ☐ **Draw a ray diagram for a convex lens** Use a ray parallel to the axis that refracts through F, and a ray through the centre that goes straight on. (Lenses)
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- ☐ **Distinguish transparent, translucent and opaque** Transparent and translucent objects transmit light (translucent ones scatter it); opaque objects do not. (Visible light)
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- ☐ **Explain everyday designs using emission and absorption** E.g. solar water-heating panels are matt black so they absorb as much of the Sun's radiation as possible. (Emission and absorption of infrared radiation)
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- ☐ **Define a perfect black body** An object that absorbs all of the radiation incident on it, and does not reflect or transmit any. (Emission and absorption of infrared radiation)
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- ☐ **Interpret intensity–wavelength graphs** The hotter body's curve is higher and its peak is at a shorter wavelength. (Perfect black bodies and radiation)
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Magnetism and electromagnetism

- ☐ **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)
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- ☐ **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)

- ☐ **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)

- ☐ **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)

- ☐ **Explain why the cone vibrates** The current alternates, so the force on the coil keeps reversing, pushing the coil and cone back and forth. (Loudspeakers)

- ☐ **Explain how the vibrating cone produces sound** The cone pushes and pulls on the air, making pressure variations (compressions and rarefactions) that travel as a sound wave. (Loudspeakers)

- ☐ **Recall what affects the size of induced pd** Faster movement (faster change of field), a stronger magnetic field and more turns on the coil all increase it. (Induced potential)

- ☐ **Recall what affects the direction of induced pd** Reversing the direction of movement, or reversing the magnetic field, reverses it. (Induced potential)

- ☐ **Describe the job of slip rings** Each end of the coil stays connected to the same brush, so the output pd alternates as the coil turns. (Uses of the generator effect)

- ☐ **Explain how sound makes the coil move** The pressure variations of the sound wave make the diaphragm, and the coil attached to it, vibrate. (Microphones)

- ☐ **Use the turns-ratio equation** Substitute into $V_p / V_s = n_p / n_s$ and rearrange to find a pd or a number of turns. (Transformers)

- ☐ **Explain why the core is made of iron** Iron is easily magnetised, so it carries the changing magnetic field through the secondary coil. (Transformers)

Space physics

- ☐ **Explain why a main sequence star is stable** The inward pull of gravity is balanced by the outward expansion caused by the energy released by fusion. (Our solar system)

- ☐ **Explain how stars make new elements** Hydrogen fuses into helium, then heavier elements up to iron form, and elements heavier than iron form in supernovae. (The life cycle of a star)

- ☐ **Calculate orbital speed from radius and time** Use speed = distance ÷ time, where the distance for one orbit is $2 \times \pi \times \text{radius}$. (Orbital motion and satellites)

- ☐ **Describe the Big Bang theory** The universe began from a very small region that was extremely hot and dense. (Red-shift)
- ☐ **Use galaxy data to describe a relationship** The speed a galaxy moves away is roughly directly proportional to its distance, so you can use this to make predictions. (Red-shift)

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