Physics definitions & formulae — All syllabuses

302 definitions and 108 formulae · chermistry.com/phy · built 2 Oct 2026

Definitions

The wording to learn comes first — the **syllabus'** own sentence where it gives one, otherwise *Physics Matters* (5th Ed). Where the textbook words it differently, its version is shown underneath, because that difference is where marks are lost.

must define — the syllabus asks you to be able to state this
tinted — the notes explain it, but neither the syllabus nor the textbook defines it, so no question can require it
2025 G3 ScPhy P2 Q4b — a paper that asked you to state this definition; click to open the question
2019 G3 ScPhy — a paper whose question named it, so you had to know it to answer

1. Physical Quantities, Units & Measurement

Physical quantity	physical quantities typically consist of a numerical magnitude and a unit > **Physics Matters words it:** A physical quantity is a quantity that can be measured. It consists of a numerical magnitude and a unit. Physics Matters 5e C1, book p.3 K323 1(a) 2022 G3 ScPhy
Length (SI unit) *l, h …*	The SI unit for length is the metre (m). Physics Matters 5e C1, book p.6 2021 G2 ScPhy · 2018 G3 Pure · 2017 G3 Pure · 2016 G3 ScPhy
Time (SI unit) *t*	The SI unit for time is the second (s). The year, month, day, hour and minute are other units for measuring time. Physics Matters 5e C1, book p.9 2025 G2 ScPhy · 2021 G2 ScPhy · 2020 G2 ScPhy · 2017 G3 ScPhy · 2015 G3 Pure
Standard form	A standard form is a way of writing numbers, in which a number between 1 to 10 is multiplied by an appropriate power of 10. Physics Matters 5e C1, book p.5 2023 G3 ScPhy · 2022 G3 ScPhy
Precision of an instrument	The smallest unit an instrument can measure is known as its precision. Physics Matters 5e C1, book p.8
Parallax error	When we use a metre rule, our eyes should be positioned such that our line of sight is perpendicular to (directly above) the rule (Figure 1.9(a)). Measurement errors introduced when this is not done are called parallax errors (Figure 1.9(b)). Physics Matters 5e C1, book p.9
Oscillation	Each complete to-and-fro motion is one oscillation. Physics Matters 5e C1, book p.9 2018 G3 Pure · 2015 G3 Pure
Period of a simple pendulum *T* MUST DEFINE	The period of a simple pendulum is the time taken for one complete oscillation. Physics Matters 5e C1, book p.10

Scalar quantities	Scalar quantities are physical quantities that have only magnitude. Physics Matters 5e C1, book p.12 2017 G3 Pure · 2016 G2 ScPhy
Vector quantities	Vector quantities are physical quantities that have both magnitude and direction. Physics Matters 5e C1, book p.12 2021 G3 ScPhy · 2019 G3 Pure · 2017 G3 Pure · 2016 G2 ScPhy · 2015 G3 Pure
Distance	The total length covered by a moving object regardless of the direction of motion Physics Matters 5e C1, book p.12 2025 G3 Pure · 2023 G3 ScPhy
Displacement	The distance measured in a straight line Physics Matters 5e C1, book p.12 2023 G3 ScPhy · 2022 G3 Pure
Speed *u, v* MUST DEFINE	Speed is the distance moved per unit time. Symbols u and v are also used for initial and final velocity in kinematics — say which you mean. Physics Matters 5e C1, book p.13 2025 G3 ScPhy · 2021 G3 ScPhy · 2020 G3 Pure · 2019 G2 ScPhy · 2017 G3 ScPhy
Velocity *u, v*	Velocity is the rate of change of displacement. Physics Matters 5e C1, book p.13 2025 G3 ScPhy · 2022 G3 Pure · 2021 G3 Pure · 2020 G3 Pure · 2017 G3 Pure
Vector diagram	We can use a vector diagram to add up two vectors. In a vector diagram, a vector quantity is represented by an arrow. • The length of the arrow is proportional to the magnitude of the vector. • The direction of the arrow indicates the direction of the vector. Physics Matters 5e C1, book p.13
Resultant vector	We need to find a single vector that produces the same effect as the vectors combined. The single vector, called the resultant vector, must be equivalent to the individual vectors combined in terms of magnitude and direction. Physics Matters 5e C1, book p.13
Range of an instrument NOT REQUIRED	The range of an instrument is the span of values it can measure — the quantity must fit. The notes define this; neither the syllabus nor Physics Matters does. K323 1(e) only says to take the range into consideration.

2. Kinematics

Speed *u, v* MUST DEFINE	Speed is the distance travelled per unit time. Its SI unit is metre per second (m/s). Physics Matters 5e C2, book p.18 2025 G3 ScPhy · 2024 G3 Pure · 2023 G3 ScPhy · 2022 G2 ScPhy · 2021 G3 Pure · 2020 G3 ScPhy

Average speed	Average speed assumes that each athlete ran at the same speed throughout the entire distance. Physics Matters 5e C2, book p.19 2025 G3 ScPhy · 2021 G3 Pure · 2019 G3 Pure · 2018 G2 ScPhy · 2017 G3 ScPhy · 2016 G2 ScPhy
Instantaneous speed	The speed of an object at a particular instant is known as its instantaneous speed. Physics Matters 5e C2, book p.19
Uniform speed	When the change in the distance travelled by an object for every unit of time is the same, the object undergoes constant or uniform speed (Table 2.2). Physics Matters 5e C2, book p.20
Distance	The total length covered by a moving object regardless of the direction of motion Physics Matters 5e C2, book p.20 2025 G3 ScPhy · 2024 G2 ScPhy · 2023 G3 ScPhy · 2022 G2 ScPhy · 2020 G2 ScPhy · 2019 G3 ScPhy
Displacement	The distance measured in a straight line from a fixed reference point Physics Matters 5e C2, book p.20 2023 G3 ScPhy · 2022 G3 Pure · 2021 G3 Pure · 2015 G3 Pure
Velocity *u, v*	Velocity is the rate of change in displacement. Its SI unit is metre per second (m/s). Physics Matters 5e C2, book p.21 2023 G3 ScPhy P2 Q5b · 2022 G3 Pure P2 Q1a · 2022 G3 Pure P2 Q1c · 2025 G3 ScPhy · 2023 G3 Pure · 2022 G3 Pure · 2021 G3 Pure · 2020 G3 Pure · 2019 G3 Pure
Acceleration *a* MUST DEFINE	Acceleration is the rate of change of velocity. Physics Matters 5e C2, book p.22 2019 G3 ScPhy P1 Q2 · 2025 G2 ScPhy · 2024 G3 ScPhy · 2022 G2 ScPhy · 2021 G3 Pure · 2020 G3 ScPhy · 2019 G3 Pure
Uniform acceleration *a*	Uniform acceleration is a constant rate of change of velocity. Physics Matters 5e C2, book p.23 2021 G3 Pure · 2019 G3 ScPhy
Deceleration *a*	The deceleration of an object that is slowing down is the positive value of its acceleration. Physics Matters phrases a deceleration as the positive value of the acceleration; in calculations a deceleration is a negative acceleration. Physics Matters 5e C2, book p.23
Acceleration of free fall *g*	the acceleration of free fall for a body near to the Earth is constant and is approximately 10 m / s^2 > **Physics Matters words it:** Acceleration due to gravity g is a constant. For objects close to Earth's surface, the value of g is generally taken to be 9.8 m/s^2. For simplicity in calculations, we take this value to be 10 m/s^2 throughout this book, unless otherwise stated. > Physics Matters 5e C2, book p.35 K323 2(i) 2020 G2 ScPhy · 2016 G2 ScPhy

Free fall	An object can only be in free fall if the only force acting on it is its own weight. Physics Matters 5e C4, book p.69 2020 G2 ScPhy · 2016 G2 ScPhy

3. Dynamics

Non-contact forces and contact forces	Forces are produced by the interaction between objects. Forces can be classified into two types: • non-contact forces, which do not require objects to be in contact to exist; and • contact forces, which exist between objects that are in contact. Physics Matters 5e C3, book p.44
Gravitational force *F, f* MUST DEFINE	The pull exerted by Earth's gravity on any object (i.e. weight) Physics Matters 5e C3, book p.44 2018 G2 ScPhy
Friction *F, f*	Friction is the contact force that opposes or tends to oppose motion between surfaces in contact. Physics Matters 5e C4, book p.65 2024 G3 ScPhy · 2022 G3 ScPhy · 2021 G3 Pure · 2016 G2 ScPhy
Air resistance *F, f*	The frictional force exerted by air that opposes the motion of moving objects Physics Matters 5e C3, book p.45 2025 G3 ScPhy · 2024 G3 ScPhy · 2023 G2 ScPhy · 2022 G2 ScPhy · 2021 G3 Pure · 2020 G3 Pure
Normal force *F, f*	The push exerted by a surface on an object pressing on it — this push is always perpendicular to the surface Physics Matters 5e C3, book p.45
Tension *F, f*	The pull exerted by a stretched spring, string or rope on an object attached to it Physics Matters 5e C3, book p.45 2016 G3 Pure
Mass *m, M*	mass is a measure of the amount of matter in a body K323 3(b) 2025 G3 ScPhy P2 Q4b · 2025 G3 Pure · 2024 G2 ScPhy · 2023 G3 Pure · 2022 G2 ScPhy · 2021 G3 ScPhy · 2020 G3 ScPhy
Weight *W* MUST DEFINE	Weight is the gravitational force acting on an object that has mass. Weight is a force, measured in newtons; K323 3(f) asks you to distinguish it from mass. Physics Matters 5e C3, book p.46 2025 G3 ScPhy P2 Q4b · 2025 G3 Pure · 2024 G2 ScPhy · 2023 G3 Pure · 2022 G2 ScPhy · 2021 G3 ScPhy · 2020 G3 ScPhy

Gravitational field	a gravitational field is a region in which a mass experiences a force due to gravitational attraction K323 3(c) 2021 G3 ScPhy P2 Q13d · 2025 G2 ScPhy · 2024 G3 Pure · 2023 G3 Pure · 2022 G3 Pure · 2021 G3 ScPhy · 2020 G3 ScPhy
Gravitational field strength *g*	gravitational field strength, g, as gravitational force per unit mass placed at that point K323 3(d) 2025 G2 ScPhy · 2024 G3 Pure · 2023 G3 Pure · 2021 G3 ScPhy · 2020 G3 ScPhy · 2018 G2 ScPhy
Balanced forces	If the resultant force acting on an object is zero, we say the forces acting on the object are balanced (Figure 4.3). Physics Matters 5e C4, book p.55
Newton's First Law of Motion	Newton's First Law of Motion states that every object will continue in its state of rest or uniform motion in a straight line unless a resultant force acts on it. K323 3(g) states that stating Newton's Laws is not required — you must apply them. Physics Matters 5e C4, book p.55
Inertia	mass is the property that resists change in motion of the body (inertia) > **Physics Matters words it:** The inertia of an object refers to the reluctance of the object to change its state of rest or motion, due to its mass. > Physics Matters 5e C4, book p.56 K323 3(k)
Unbalanced forces	If the resultant force acting on an object is not zero, we say the forces acting on the object are unbalanced. Physics Matters 5e C4, book p.57 2019 G3 Pure
Newton's Second Law of Motion	Newton's Second Law of Motion states that when a resultant force acts on an object of a constant mass, the object will accelerate in the direction of the resultant force. K323 3(g) states that stating Newton's Laws is not required — you must apply them. Physics Matters 5e C4, book p.57
One newton *N*	One newton is defined as the force that produces an acceleration of 1.0 m/s^2 on a mass of 1.0 kg. Physics Matters 5e C4, book p.57
Newton's Third Law of Motion	Newton's Third Law of Motion states that if body A exerts a force FAB on body B, then body B will exert an equal and opposite force FBA on body A. K323 3(g) states that stating Newton's Laws is not required — you must apply them. Physics Matters 5e C4, book p.59
Free-body diagram	In Section 4.1, we have been using arrows to represent forces acting on individual objects. These diagrams are called free-body diagrams. Physics Matters 5e C4, book p.61 2025 G2 ScPhy · 2021 G3 Pure · 2017 G3 ScPhy

Equilibrium of three forces (closed triangle)	If arrows representing the forces result in a closed triangle, we say that the forces are in equilibrium (i.e. the resultant force is zero) (Figure 4.17). If the arrows do not result in a closed triangle, there is a resultant force acting on the object. It is represented by the arrow from the tail of the first arrow to the head of the last arrow (Figure 4.18). Physics Matters 5e C4, book p.63
Free fall	An object can only be in free fall if the only force acting on it is its own weight. Physics Matters 5e C4, book p.69 2018 G2 ScPhy
Terminal velocity	When the air resistance acting against an object equals its weight, the object starts to travel at a constant speed known as terminal velocity. This means that the object has zero acceleration. Physics Matters 5e C4, book p.71 2025 G3 Pure · 2024 G3 Pure · 2020 G3 Pure · 2018 G3 Pure · 2017 G3 Pure · 2016 G3 Pure
Resultant force *F* NOT REQUIRED	The resultant force is the single force that has the same effect as all the forces acting on a body added together. The notes define this; neither the syllabus nor Physics Matters does, although both use the term throughout. 2023 G3 Pure · 2018 G3 Pure · 2017 G2 ScPhy · 2016 G3 ScPhy

4. Turning Effect of Forces

Lever	A lever is a rigid bar resting on a pivot or fulcrum. It is used to move a load when a force is applied. Physics Matters 5e C5, book p.78 2015 G3 Pure
Moment (turning effect) / torque	The turning effect of a force is called its moment. Physics Matters 5e C5, book p.78
Moment of a force *M* MUST DEFINE	The moment of a force M, or torque, about a pivot is the product of the force F and the perpendicular distance d from the pivot to the line of action of the force. Physics Matters 5e C5, book p.79 2023 G3 Pure P2 Q3b
Clockwise and anticlockwise moment *M*	A clockwise rotation about a pivot is a clockwise moment. An anticlockwise rotation about the pivot is an anticlockwise moment. Physics Matters 5e C5, book p.79
Principle of moments	The principle of moments states that when a body is in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of anticlockwise moments about the same pivot. Physics Matters 5e C5, book p.80 2025 G3 ScPhy · 2021 G3 Pure · 2017 G3 Pure · 2015 G3 Pure
Conditions for equilibrium	Thus, the conditions for a body in equilibrium are: • The resultant moment on the body is zero. • The resultant force on the body is also zero. Physics Matters 5e C5, book p.82

Centre of gravity	the weight of a body may be taken as acting at a single point known as its centre of gravity K323 4(e) 2025 G3 ScPhy P2 Q7 · 2021 G3 Pure P1 Q10 · 2019 G3 Pure P2 Q2 · 2025 G3 Pure · 2024 G3 Pure · 2023 G3 Pure · 2022 G3 ScPhy · 2021 G3 Pure · 2017 G3 Pure
Stability	The stability of an object is a measure of its ability to return its original position. Stability is Pure-only (K323 4(f)) and is a comparative judgement — answer in terms of centre-of-gravity height and base area. Physics Matters 5e C5, book p.86
Factors affecting stability	The stability of an object can be affected in two ways — the position of the centre of gravity and the area of the base of the object. The lower the centre of gravity of an object, the more stable it is. Pure-only; the G3 Science outcomes stop at centre of gravity. Physics Matters 5e C5, book p.86

5. Pressure

Pressure *p*, *P* MUST DEFINE	Pressure is the force acting per unit area. K323 5(a) says only 'define pressure in terms of force and area' — it supplies no wording of its own. Physics Matters 5e C6, book p.93 2022 G3 Pure P2 Q2a · 2022 G3 Pure P2 Q2b(i) · 2022 G3 Pure P2 Q2b(ii) · 2021 G3 Pure P2 Q4 · 2025 G2 ScPhy · 2024 G2 ScPhy · 2023 G2 ScPhy · 2022 G2 ScPhy · 2021 G3 ScPhy · 2020 G2 ScPhy
Density *ρ* MUST DEFINE	Density is defined as mass per unit volume. Physics Matters 5e C6, book p.100 2025 G2 ScPhy · 2024 G3 ScPhy · 2023 G3 ScPhy · 2022 G3 ScPhy · 2021 G2 ScPhy · 2020 G2 ScPhy
Pascal's principle (Pascal's law)	If a pressure is applied to an enclosed liquid, the pressure is transmitted to all other parts of the liquid undiminished. Physics Matters 5e C6, book p.98
Gauge pressure	In Figure 6.22, PB is known as the absolute pressure of the gas. The difference in pressure (i.e. PB – Patm) is known as the gauge pressure. Gauge pressure is not named in the K323 outcomes; Physics Matters only. Physics Matters 5e C6, book p.105

6. Energy

Energy (the stores-and-transfers model) *E*	there are energy stores, e.g. kinetic, potential (gravitational, chemical, elastic), nuclear and internal, and that energy can be transferred from one store to another: (i) Mechanically (by a force acting over a distance) (ii) Electrically (by an electric current) (iii) By heating (due to a temperature difference) (iv) By propagation of waves (both electromagnetic and mechanical) > **Physics Matters words it:** One useful model about energy is to think of energy like a non-physical and invisible substance that can be transferred from one energy store to another. > Physics Matters 5e C7, book p.113 K323 6(a) 2023 G3 Pure P2 Q9 · 2019 G3 Pure P2 Q3 · 2018 G3 Pure P2 Q3 · 2025 G3 ScPhy · 2024 G3 Pure · 2023 G3 ScPhy · 2022 G2 ScPhy · 2021 G3 ScPhy · 2020 G3 Pure
Principle of conservation of energy	The principle of conservation of energy states that energy cannot be created or destroyed. Energy can be transferred from one store to another. The total energy of an isolated system is constant. K323 6(c) says only 'state the principle of the conservation of energy' — no wording is given, so quote the textbook form. Physics Matters 5e C7, book p.120 2016 G2 ScPhy
Work done *W, E* MUST DEFINE	Work done by a constant force on an object is the product of the force and the distance moved by the object in the direction of the force. Physics Matters 5e C7, book p.124 2020 G3 Pure P2 Q4 · 2025 G2 ScPhy · 2024 G3 ScPhy · 2022 G3 ScPhy · 2021 G2 ScPhy · 2020 G2 ScPhy · 2019 G2 ScPhy
The joule *J*	One joule is the work done by a force of one newton, which moves an object through a distance of one metre in the direction of the force. Physics Matters 5e C7, book p.124
Power *P* MUST DEFINE	Power is defined as the work done or energy transferred per unit time. Physics Matters 5e C7, book p.126 2025 G3 ScPhy · 2024 G2 ScPhy · 2023 G3 Pure · 2021 G3 ScPhy · 2019 G2 ScPhy · 2018 G3 ScPhy
The watt *W*	One watt is defined as the work done or energy transferred of one joule per second, i.e. 1 W = 1 J/s. Physics Matters 5e C7, book p.126
Efficiency	In an ideal machine, the total energy output is equal to its total energy input. However, in reality, the useful energy output of a machine is always less than the energy input. Physics Matters gives no one-line definition; the syllabus gives only the formula (K323 6(f)). Pure-only. Physics Matters 5e C7, book p.127 2023 G3 ScPhy · 2018 G3 Pure · 2017 G3 ScPhy · 2015 G3 Pure
Renewable and non-renewable energy resources NOT REQUIRED	A non-renewable resource is one that will run out — it is used far faster than it is replaced. A renewable resource is replenished naturally and will not run out on a human timescale. The notes define these; neither the syllabus nor Physics Matters does. K323 6(g) lists examples only, and that outcome is Pure-only.

7. Kinetic Particle Model of Matter

Kinetic particle model of matter	The kinetic particle model of matter is made up of tiny particles that are in continuous motion. The Physics Matters sentence is malformed ('the model ... is made up of tiny particles'); use the notes' wording. Physics Matters 5e C8, book p.138
Brownian motion	This random motion of particles in a fluid is called Brownian motion. Physics Matters 5e C8, book p.140 2022 G3 Pure · 2021 G3 Pure · 2019 G3 Pure · 2018 G3 Pure
Temperature and average kinetic energy *θ, T*	Temperature rises with the average kinetic energy of the particles in a body and vice versa. Physics Matters 5e C8, book p.143 (repeated in the chapter summary, p.145)
Pressure at the particle level *p, P* MUST DEFINE	At the particle level, pressure is the average force exerted by the particles per unit area. Symbol clash: p is pressure, P is power — do not mix them in one answer. Pure-only. Physics Matters 5e C8, book p.144 (repeated in the chapter summary, p.145)
Internal energy	internal energy as an energy store that is made up of the total kinetic energy associated with the random motion of the particles and the total potential energy between the particles in the system G3 Science 7(d); K323 9(a) 2023 G3 ScPhy

8. Thermal Processes

Energy transfer by heating	energy is transferred (by heating) from a region of higher temperature to a region of lower temperature until thermal equilibrium is achieved between the two regions K323 8(a)
Thermal equilibrium	Thermal equilibrium describes a state in which two or more objects have the same temperature and that there is no net transfer of energy between them. Physics Matters 5e C9, book p.148
Internal energy (internal store)	The energy in the internal store of a substance is equal to the sum of all the potential energy due to the intermolecular forces and all the kinetic energy due to the motion of the particles. Physics Matters 5e C9, book p.148
Conduction	Conduction is a process of energy transfer where energy is transferred through the passing on of vibrational motion from one particle to another. K323 8(b) asks for the microscopic mechanism (vibration of atoms/molecules and movement of electrons), not a one-line definition. Physics Matters 5e C9, book p.150 2025 G2 ScPhy · 2024 G3 Pure · 2023 G3 Pure · 2020 G3 Pure · 2018 G2 ScPhy · 2017 G3 ScPhy
Good and poor thermal conductors	Materials that can transfer energy quickly by conduction are good thermal conductors. Materials that transfer energy slowly by conduction are poor thermal conductors. Poor thermal conductors are also known as thermal insulators. Physics Matters 5e C9, book p.151

Convection	Convection is a process of energy transfer by means of convection currents of a fluid (liquid or gas), due to a difference in density. Physics Matters 5e C9, book p.153 2024 G3 ScPhy · 2023 G3 Pure · 2022 G3 Pure · 2020 G3 Pure · 2019 G3 Pure · 2018 G2 ScPhy
Radiation	energy transfer by electromagnetic radiation does not require a material medium K323 8(d) 2025 G2 ScPhy · 2024 G3 ScPhy · 2020 G3 ScPhy · 2018 G3 ScPhy · 2017 G3 ScPhy
Emitters and absorbers of radiation	this rate of energy transfer to/from a body is affected by its: (i) surface colour and texture (ii) surface temperature (iii) surface area > **Physics Matters words it:** The shiny, smooth and light-coloured surface of an object absorbs incoming radiation at a slower rate. The same surface also emits radiation at a slow rate. Hence, a poor emitter of radiation is also a poor absorber of radiation. > Physics Matters 5e C9, book p.156 The syllabus lists three factors; Physics Matters mentions only surface colour and texture — learn all three. K323 8(d)

9. Thermal Properties of Matter

Internal energy	internal energy as an energy store that is made up of the total kinetic energy associated with the random motion of the particles and the total potential energy between the particles in the system K323 9(a) 2022 G3 Pure · 2019 G3 Pure · 2016 G3 Pure
Heat capacity *C*	Heat capacity C of an object is the change of its internal energy per unit change in its temperature. K323 9(b) says only 'define heat capacity' — no wording. Physics Matters uses the change-of-internal-energy form; the notes use the energy-to-raise-temperature form. Physics Matters 5e C10, book p.169 2025 G3 Pure · 2024 G3 Pure · 2023 G3 Pure · 2021 G3 Pure · 2020 G3 Pure · 2019 G3 Pure
Specific heat capacity *c* MUST DEFINE	Specific heat capacity c of a material is the change of its internal energy per unit mass for each unit change in its temperature. K323 9(b) supplies no wording; Physics Matters uses the change-of-internal-energy form, the notes the per-kilogram form. Physics Matters 5e C10, book p.169 2025 G3 Pure · 2024 G3 Pure · 2023 G3 Pure · 2021 G3 Pure · 2020 G3 Pure · 2019 G3 Pure
Melting	Melting is the change from the solid state to the liquid state when energy is transferred to the substance. Physics Matters 5e C10, book p.175 2023 G3 Pure · 2021 G3 Pure

Solidification	Solidification is the change from the liquid state to the solid state when energy is transferred out of the substance. Physics Matters 5e C10, book p.175
Boiling	Boiling is the change from the liquid state to the gaseous state when energy is transferred to the substance. Physics Matters 5e C10, book p.175 2025 G3 Pure · 2023 G3 Pure · 2022 G3 Pure · 2021 G3 Pure · 2019 G3 Pure · 2018 G3 Pure
Condensation	Condensation is the change from the gaseous state to the liquid state when energy is transferred out of the substance. Physics Matters 5e C10, book p.175 2016 G3 Pure P2 Q4a · 2016 G3 Pure P2 Q4b · 2021 G3 Pure
Melting point, freezing point, boiling point, condensation point	The temperature at which: a solid melts is called its melting point; a liquid solidifies or freezes is called its freezing point; a liquid boils is called its boiling point; and a gas condenses is called its condensation point. Physics Matters 5e C10, book p.175
Constant temperature during a change of state	melting/solidification and boiling/condensation as processes of energy transfer without a change in temperature K323 9(d)
Evaporation	Evaporation occurs when the faster particles at the surface of the liquid have enough energy to break away from the other liquid particles to escape into the air. Physics Matters 5e C10, book p.176 2025 G3 Pure · 2023 G3 Pure · 2018 G3 Pure · 2017 G3 Pure
Latent heat L	Latent heat L is the energy released or absorbed to change the state of a substance, at constant temperature. Physics Matters 5e C10, book p.179 2021 G3 Pure P2 Q10 · 2025 G3 Pure · 2024 G3 Pure · 2023 G3 Pure · 2022 G3 Pure · 2020 G3 Pure · 2019 G3 Pure
Latent heat of fusion L_f	Latent heat of fusion L_f is the amount of energy transferred to change a substance between the solid and liquid states, at constant temperature. Physics Matters 5e C10, book p.179 2024 G3 Pure · 2023 G3 Pure · 2021 G3 Pure · 2020 G3 Pure · 2016 G3 Pure
Specific latent heat of fusion l_f MUST DEFINE	Specific latent heat of fusion l_f is the amount of energy transferred per unit mass of a substance to change between the solid and liquid states, at constant temperature. Physics Matters 5e C10, book p.179 2024 G3 Pure · 2023 G3 Pure · 2021 G3 Pure · 2020 G3 Pure · 2016 G3 Pure
Latent heat of vaporisation L_v	Latent heat of vaporisation L_v is the amount of energy transferred to change a substance between the liquid and gaseous states, at constant temperature. Physics Matters 5e C10, book p.179 2025 G3 Pure · 2022 G3 Pure · 2021 G3 Pure · 2019 G3 Pure · 2018 G3 Pure

Specific latent heat of vaporisation l_v MUST DEFINE	Specific latent heat of vaporisation l_v is the amount of energy transferred per unit mass of a substance to change it between the liquid and gaseous states, at constant temperature. Physics Matters 5e C10, book p.180 2025 G3 Pure · 2022 G3 Pure · 2021 G3 Pure · 2019 G3 Pure · 2018 G3 Pure
Specific latent heat (umbrella term) l NOT REQUIRED	Specific latent heat l is the energy released or absorbed per unit mass to change the state of a substance, at constant temperature. The notes give this umbrella definition; K323 9(f) says only 'define latent heat and specific latent heat', and Physics Matters defines only the fusion and vaporisation forms. 2021 G3 Pure P2 Q10 · 2025 G3 Pure · 2024 G3 Pure · 2023 G3 Pure · 2022 G3 Pure · 2020 G3 Pure · 2019 G3 Pure
Melting point and freezing point are the same temperature NOT REQUIRED	For a pure substance the melting and freezing points are the same temperature, and so are the boiling and condensation points. The notes assert this; neither the syllabus nor Physics Matters states it.

10. General Properties of Waves

Wave	waves transfer energy without transferring matter > **Physics Matters words it:** A wave is a disturbance that propagates through space, transferring energy with it but not matter. > Physics Matters 5e C11, book p.190 K323 10(b) 2025 G3 ScPhy · 2024 G3 ScPhy · 2023 G3 Pure · 2022 G2 ScPhy · 2021 G3 ScPhy · 2020 G3 ScPhy
Medium	Medium: the substance or material which carries the wave Physics Matters 5e C11, book p.189
Transverse wave	A transverse wave has a direction of vibration that is perpendicular to the direction of wave travel. Physics Matters 5e C11, book p.192 2025 G2 ScPhy · 2023 G2 ScPhy · 2022 G2 ScPhy · 2021 G3 Pure · 2020 G3 Pure · 2016 G2 ScPhy
Longitudinal wave	A longitudinal wave has a direction of vibration that is parallel to the direction of wave travel. Physics Matters 5e C11, book p.192 2025 G2 ScPhy · 2024 G2 ScPhy · 2022 G3 Pure · 2021 G3 Pure · 2020 G3 Pure · 2016 G2 ScPhy
Displacement (of a point on a wave)	Displacement of any point on the wave is a vector pointing from its rest position to the point. Physics Matters 5e C11, book p.193 2022 G2 ScPhy · 2021 G3 Pure · 2019 G3 Pure · 2018 G3 Pure · 2017 G3 Pure · 2016 G3 ScPhy

Amplitude A	Amplitude of a wave is its maximum magnitude of displacement from its rest position. Physics Matters 5e C11, book p.193 2024 G3 Pure · 2023 G3 ScPhy · 2022 G2 ScPhy · 2020 G3 ScPhy · 2019 G2 ScPhy · 2018 G2 ScPhy
Crest	Crests are the highest points of a transverse wave. Physics Matters 5e C11, book p.193 2025 G3 Pure · 2023 G3 Pure · 2020 G3 ScPhy · 2019 G3 ScPhy · 2017 G3 Pure
Trough	Troughs are the lowest points of a transverse wave. Physics Matters 5e C11, book p.193 2017 G3 Pure
In phase	In phase describes two points on a wave that always have the same direction of motion (moving in step). Physics Matters 5e C11, book p.193 2019 G2 ScPhy
Waveform	The shape of the wave is called the waveform. Physics Matters 5e C11, book p.193
Wavelength λ MUST DEFINE	The wavelength λ is the shortest distance between two successive crests or troughs. Physics Matters defines it by successive crests or troughs; the notes use 'successive points in phase', which also covers longitudinal waves. Physics Matters 5e C11, book p.195 2025 G3 ScPhy · 2024 G2 ScPhy · 2023 G3 Pure · 2022 G2 ScPhy · 2021 G2 ScPhy · 2020 G2 ScPhy
Period T MUST DEFINE	The period T is the time taken by each point on the wave to complete one oscillation. Physics Matters 5e C11, book p.195 2022 G2 ScPhy P2 Q5a · 2022 G2 ScPhy P2 Q5b · 2017 G3 ScPhy P1 Q11 · 2024 G2 ScPhy · 2023 G2 ScPhy · 2022 G3 ScPhy
Frequency f MUST DEFINE	The frequency f is the number of oscillations each point completes per second. Physics Matters 5e C11, book p.195 2025 G2 ScPhy P2 Q7a · 2025 G2 ScPhy P2 Q7b · 2025 G2 ScPhy P2 Q7d · 2017 G3 Pure P2 Q5 · 2025 G3 ScPhy · 2024 G2 ScPhy · 2023 G3 Pure · 2022 G3 Pure · 2021 G2 ScPhy · 2020 G3 ScPhy
Wave speed v MUST DEFINE	Wave speed v is the distance travelled by a wave per second. Physics Matters 5e C11, book p.195
Wavefront	A wavefront is an imaginary line joining all adjacent points that are in phase. Physics Matters 5e C11, book p.196 2025 G2 ScPhy P1 Q13 · 2022 G3 Pure P1 Q22 · 2019 G3 ScPhy P1 Q10 · 2016 G2 ScPhy P2 Q3c · 2020 G2 ScPhy

Sound	sound can be produced by vibrating sources and a medium is required for the transmission of sound > **Physics Matters words it:** Sound is a longitudinal wave travelling in the air, created by a vibrating source. > Physics Matters 5e C12, book p.206 K323 10(f) 2016 G3 Pure P2 Q9a · 2016 G3 Pure P2 Q9b(i) · 2016 G3 Pure P2 Q9b(ii) · 2025 G3 Pure · 2024 G2 ScPhy · 2023 G3 Pure · 2022 G3 ScPhy · 2021 G3 Pure · 2020 G3 ScPhy
Compression and rarefaction	The compressed regions are called compressions and the extended regions are called rarefactions. Physics Matters 5e C12, book p.206
Sound cannot travel through a vacuum	a medium is required for the transmission of sound > **Physics Matters words it:** Since a sound wave relies on the passing on of motion from a group of molecules to another group through collisions, it cannot propagate in a vacuum. > Physics Matters 5e C12, book p.207 K323 10(f)
Loudness	Loudness is generally related to the amplitude of a sound wave. The larger the amplitude, the louder the sound. Physics Matters 5e C12, book p.209 2020 G3 ScPhy
Pitch	The higher the frequency, the higher the pitch. Physics Matters 5e C12, book p.209 2024 G3 Pure · 2023 G3 ScPhy · 2022 G3 ScPhy · 2020 G3 Pure · 2018 G3 ScPhy
Audible range	The human ears can hear sounds of frequency from 20 Hz to 20 000 Hz (20 kHz). This is known as our audible range. Physics Matters 5e C12, book p.209
Infrasound	Frequencies below 20 Hz are called infrasound and frequencies above 20 000 Hz are called ultrasound. Physics Matters 5e C12, book p.209
Echo	The reflected sound is called an echo. Physics Matters 5e C12, book p.210 2023 G3 ScPhy · 2022 G3 Pure · 2020 G3 Pure · 2019 G3 ScPhy · 2015 G3 Pure
Ultrasound	Ultrasound is sound with frequencies above the upper limit of the human range of audibility. Ultrasound applications are Pure-only (K323 10(j)); the G3 Science outcomes stop at echoes. Physics Matters 5e C12, book p.212 2025 G3 Pure · 2022 G3 Pure · 2021 G3 Pure · 2020 G3 Pure · 2016 G3 Pure · 2015 G3 Pure
Echolocation	With the speed of sound, a computer-controlled sound emitter and sound sensor, the distance from the emitter to the reflecting surface can be easily calculated. This is called echolocation. Physics Matters 5e C12, book p.211

11. Electromagnetic Spectrum

Electromagnetic spectrum	the continuous electromagnetic wave spectrum covers a large range of wavelengths and frequencies The Physics Matters line is a sentence fragment, not a definition — treat the ordered spectrum diagram as the real content (K323 11(b)). Physics Matters 5e C13, book p.220 2025 G3 ScPhy · 2024 G3 ScPhy · 2023 G3 Pure · 2022 G3 ScPhy · 2021 G2 ScPhy · 2020 G3 Pure
Electromagnetic waves are transverse	all electromagnetic waves are transverse waves that travel with the same speed in vacuum > **Physics Matters words it:** All electromagnetic waves are transverse waves. > Physics Matters 5e C13, book p.221 K323 11(a)
Nature of electromagnetic waves	Electromagnetic waves are made up of oscillating electric and magnetic fields (Figure 13.2). They do not carry electric charges. Physics Matters 5e C13, book p.221
Speed of electromagnetic waves in a vacuum	all electromagnetic waves are transverse waves that travel with the same speed in vacuum > **Physics Matters words it:** All electromagnetic waves can travel without a medium, with the same speed of 3 x 10^8 m/s in a vacuum. > Physics Matters 5e C13, book p.221 K323 11(a)
Behaviour on entering a medium	When an electromagnetic wave travels from a vacuum to other media, the wave speed and wavelength decrease. The decrease in speed is different for different frequencies. However, the frequency stays the same as at the source when the wave goes into a different medium. Physics Matters 5e C13, book p.221
Ionising waves	Ionising waves are those with higher frequencies and hence higher energies. They can eject electrons from atoms and molecules to create ions. The ions can cause harm by disrupting cell functions and even killing them. Physics Matters 5e C13, book p.221
Emission from hot bodies	All material bodies emit a range of electromagnetic waves. In general, higher temperature bodies tend to emit more and higher frequency electromagnetic waves. Physics Matters 5e C13, book p.221
Radiotherapy	Radiotherapy: the use of ionising electromagnetic waves to kill cancer cells Physics Matters 5e C13, book p.229
Heating effect of electromagnetic waves	The exposure to strong ionising electromagnetic radiation such as ultraviolet light causes heating effects. Physics Matters ties the heating effect to ionising radiation; the hazard in K323 11(d) is over-exposure generally. Physics Matters 5e C13, book p.230
Ionisation of living cells	When a high frequency electromagnetic wave interacts with a particular atom or molecule and knocks an electron out from it, a charged ion is produced. Physics Matters 5e C13, book p.230

12. Light

Light ray and light beam	In the ray model of light, light is represented as straight lines with arrows to indicate the direction in which the light travels. Each of these lines is known as a light ray. A bundle of many light rays forms a light beam. Physics Matters 5e C14, book p.235
Incident ray, reflected ray and normal	The light ray going towards the surface is called the incident ray. The light ray going away from the surface is called the reflected ray. The perpendicular line (90 °) to the surface at the point of incidence is called the normal. Physics Matters 5e C14, book p.235
Angle of incidence and angle of reflection *i, r*	The angle between the incident ray and the normal is called the angle of incidence (θ_i). The angle between the reflected ray and the normal is called the angle of reflection (θ_r). Physics Matters 5e C14, book p.235
First law of reflection	The first law of reflection states that the incident ray, reflected ray and the normal at the point of incidence lie in the same plane. Physics Matters 5e C14, book p.236
Second law of reflection	for reflection, the angle of incidence is equal to the angle of reflection K323 12(b)
Regular and diffuse reflection	When a beam of light is reflected by a smooth surface, the reflected rays remain parallel to each other and maintain their spacing (Figure 14.6(a)). Thus, the reflection is described as regular (orderly) reflection. In contrast, a rough surface gives rise to irregular (disorderly) reflection (Figure 14.6(b)). Irregular reflection is also known as diffuse reflection because after reflection, the rays spread out in different directions. Physics Matters 5e C14, book p.236
Position of a plane mirror image	The image of a point object in a plane mirror is always as far behind the mirror as the object is in front of the mirror. Plane-mirror image construction is not in the K323 topic 12 outcomes; Physics Matters and the notes carry it. Physics Matters 5e C14, book p.237
Characteristics of plane mirror images	The image and object are equally far from the mirror. The image is virtual. The image and object have the same size. The image is laterally inverted. The image is upright. Not required by the K323 outcomes, but a standard source of 'describe the image' marks. Physics Matters 5e C14, book p.239
Refraction	Refraction is the bending of light as it passes from one optical medium to another. Physics Matters 5e C14, book p.243 2024 G3 ScPhy · 2023 G3 ScPhy · 2020 G3 ScPhy · 2019 G3 Pure · 2018 G3 Pure · 2016 G3 Pure
Refracted ray and angle of refraction *r*	The refracted ray is the light ray that enters a medium and undergoes a change of direction. The angle of refraction is the angle between the refracted ray and the normal at the point of incidence. Physics Matters 5e C14, book p.243
First law of refraction	The first law of refraction states that the incident ray, refracted ray and the normal at the point of incidence all lie in the same plane. Physics Matters 5e C14, book p.244

Second law of refraction	The second law of refraction states that for two given media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant, that is, sin i / sin r = constant. Physics Matters 5e C14, book p.244
Refractive index *n*	refractive index of a medium in terms of the ratio of speed of light in vacuum and in the medium K323 12(e) 2020 G3 Pure P2 Q11a · 2020 G3 Pure P2 Q11b · 2018 G3 Pure P2 Q11b · 2018 G3 Pure P2 Q11c · 2025 G3 ScPhy · 2024 G3 Pure · 2023 G3 ScPhy · 2022 G3 Pure · 2021 G3 Pure · 2020 G3 ScPhy
Principle of reversibility of light rays	The principle of reversibility of light rays states that regardless of how many times a light ray has been reflected or refracted, it will follow the same path when its direction is reversed. Physics Matters 5e C14, book p.245
Emergent ray	The ray that emerges from the glass block is known as the emergent ray. Physics Matters 5e C14, book p.246
Critical angle *c*	Critical angle θ_c is defined as the angle of incidence in an optically denser medium for which the angle of refraction in the less dense medium is 90 °. Physics Matters 5e C14, book p.250 2025 G3 Pure · 2023 G3 Pure · 2022 G3 Pure · 2020 G3 Pure · 2019 G3 Pure · 2018 G3 Pure
Total internal reflection	Total internal reflection is the complete reflection of a light ray in an optically denser medium at the boundary with an optically less dense medium. Physics Matters 5e C14, book p.250 2023 G3 Pure · 2021 G3 Pure · 2019 G3 Pure · 2015 G3 Pure
Conditions for total internal reflection	The incident ray must travel from an optically denser medium to an optically less dense medium. The angle of incidence must be greater than the critical angle. Physics Matters 5e C14, book p.250
Converging lens	A device made of glass or other transparent material that is able to concentrate light rays is called a converging lens. Physics Matters 5e C14, book p.255 2024 G3 ScPhy · 2023 G3 Pure · 2021 G3 Pure · 2020 G3 Pure · 2019 G3 Pure · 2018 G3 ScPhy
Principal axis	The line which passes through the centre of the lens and which is perpendicular to the plane of the lens Physics Matters 5e C14, book p.257 2024 G3 ScPhy · 2018 G3 Pure · 2017 G3 Pure
Optical centre *C*	The point on the principal axis that is the midpoint between the surfaces of the lens Physics Matters 5e C14, book p.257 2024 G3 ScPhy
Principal focal point *F*	The point on the principal axis where all the rays parallel to the principal axis meet after passing through the lens Physics Matters 5e C14, book p.257

Focal plane	The plane perpendicular to the principal axis on which all parallel rays meet after passing through the lens (It is a plane of all the possible focal points.) Physics Matters 5e C14, book p.257
Focal length *f*	The distance between the optical centre C and the principal focus point F Physics Matters 5e C14, book p.257 2024 G3 ScPhy P2 Q2a · 2023 G3 Pure P2 Q8a · 2023 G3 Pure P2 Q8b(i) · 2023 G3 Pure P2 Q8b(iii) · 2021 G3 Pure P2 Q6 · 2016 G3 Pure P2 Q5a · 2024 G3 Pure · 2023 G3 Pure · 2019 G3 Pure · 2018 G3 Pure · 2017 G3 Pure · 2016 G3 Pure
Real and virtual image	A real image can be formed on a screen placed at the image plane but a virtual image cannot be formed on a screen placed at its image plane. Physics Matters 5e C14, book p.259

13. Static Electricity

Electric charge *q, Q*	there are positive and negative charges and that charge is measured in coulombs > **Physics Matters words it:** "Charge" is a property of an object, just like mass. An electron has a negative charge while a proton has a positive charge. The SI unit of electric charge is the coulomb (C). Each electron or proton has the same amount of charge of 1.6 × 10^–19 C. > Physics Matters 5e C15, book p.268 K323 13(a) 2018 G3 Pure
Like and unlike charges	unlike charges attract and like charges repel K323 13(b)
Electric force	An electric charge can exert a force on another nearby charge. This force is known as electric force. The electric force can be attractive or repulsive. Physics Matters 5e C15, book p.269
Electric field	an electric field as a region in which an electric charge experiences a force K323 13(c) 2025 G3 Pure · 2024 G3 Pure · 2023 G3 Pure · 2021 G3 Pure · 2020 G3 Pure · 2018 G3 Pure
Rules for drawing electric field lines	the direction of the field lines gives the direction of the force acting on a positive test charge > **Physics Matters words it:** • The arrows always point towards a negative charge and away from a positive charge. • The lines are closer together when the electric field and electric force are stronger. • The field lines never cross one another. > Physics Matters 5e C15, book p.270 K323 13(d)
Electrostatic charging by induction	Objects can be charged by induction. Induction involves placing a charged rod close to the conductor(s) without contact. This induces the redistribution of charges in the conductors (Figures 15.15 and 15.16). Physics Matters 5e C15, book p.274

Earthing	An alternative to touching the sphere in step 2 is to connect one end of a metal wire to a metal water tap and use the other end to touch the sphere. This will allow the electrons to flow to the Earth through the pipes. This connection is called earthing. Physics Matters 5e C15, book p.274

14. Current of Electricity

Electric current *I* MUST DEFINE	current is the rate of flow of charge and that it is measured in amperes K323 14(a) 2019 G3 Pure
The ampere *A*	The SI unit for current is ampere (A) or coulomb (C) per second (s). One ampere is the electric current produced when one coulomb of charge passes a point in one second (Figure 16.2). Physics Matters 5e C16, book p.287
Conventional current	The direction of flow of positive charges is described as the conventional current, which assumes that positive charges flow out of the positive terminal of a battery to the negative terminal (Figure 16.3). Physics Matters 5e C16, book p.287 2021 G2 ScPhy · 2020 G2 ScPhy · 2016 G2 ScPhy
Electron flow	The flow of electrons from the negative terminal of the battery to the positive terminal is opposite to the conventional current. This movement of electrons in the electrical circuit is known as electron flow. Physics Matters 5e C16, book p.288 2022 G3 Pure · 2021 G2 ScPhy · 2020 G2 ScPhy · 2016 G2 ScPhy
Electromotive force (e.m.f.) *E* MUST DEFINE	the electromotive force (e.m.f.) of a source is the work done per unit charge by the source in driving charges around a complete circuit and that it is measured in volts > **Physics Matters words it:** The electromotive force (e.m.f.) of an electrical source is the work done by the source in driving a unit charge around a complete circuit. > Physics Matters 5e C16, book p.289 The syllabus puts 'per unit charge' on the work done; Physics Matters puts it on the charge driven round. G3 Science 12(f) asks only that e.m.f. is measured in volts. K323 14(d) 2023 G2 ScPhy P2 Q7a(i) · 2024 G3 Pure · 2021 G3 ScPhy · 2018 G2 ScPhy
Potential difference (p.d.) *V* MUST DEFINE	the potential difference (p.d.) across a component in a circuit is the work done per unit charge in driving charges through the component and that it is measured in volts K323 14(f) 2023 G3 Pure P1 Q35 · 2024 G2 ScPhy · 2023 G3 ScPhy · 2022 G3 ScPhy · 2021 G2 ScPhy · 2019 G3 ScPhy · 2017 G3 Pure

Resistance *R*	resistance = p.d. / current > **Physics Matters words it:** The resistance R of a component is the ratio of the potential difference V across it to the current I flowing through it. > Physics Matters 5e C16, book p.293 K323 14(g) 2025 G3 ScPhy · 2024 G3 ScPhy · 2023 G3 Pure · 2022 G2 ScPhy · 2021 G2 ScPhy · 2020 G3 ScPhy
Resistor	A resistor is a conductor or an insulator that has high resistance. It is used in a circuit to control the amount of current. Physics Matters 5e C16, book p.294 2025 G3 ScPhy · 2024 G2 ScPhy · 2022 G3 ScPhy · 2021 G2 ScPhy · 2020 G2 ScPhy · 2019 G3 ScPhy
Resistivity *ρ*	We define a constant ρ as the resistivity of a substance that depends on what the material is composed of. Resistivity itself is not named in K323; 14(i) asks only for the proportionality to length and cross-sectional area. Physics Matters 5e C16, book p.295
Effect of temperature on the resistance of a metal	The resistance of most metals increases linearly with temperature (Figure 16.18). Physics Matters 5e C16, book p.297
Ohmic conductor / Ohm's law	The voltage across a conductor is directly proportional to the current flowing through it. This is provided that all physical conditions and temperature remain constant. Physics Matters 5e C16, book p.297
Non-ohmic conductor	Conductors that do not have a direct proportional relationship between V and I are known as non-ohmic conductors. This is because the resistances of these conductors change as their temperature changes. Physics Matters 5e C16, book p.297

15. D.C. Circuits

Direct current (d.c.) circuit	In d.c. circuits, current flows in only one direction and the applied voltage is usually quite low. This is different from an alternating current (a.c.) circuit. In a.c. circuits, current changes direction fifty or sixty times every second. Physics Matters 5e C17, book p.304
Circuit diagram	A circuit diagram, or an electrical diagram, is a simplified diagrammatic representation of an electric circuit. It shows the connections between electrical components, which are often represented by symbols. Physics Matters 5e C17, book p.304 2025 G2 ScPhy · 2021 G3 Pure · 2019 G2 ScPhy · 2018 G3 Pure · 2015 G3 Pure
Series connection	A series connection is one in which the components are connected one after another in a single loop (Figure 17.2). Circuits that have components connected in series are called series circuits. Physics Matters 5e C17, book p.305
Current in a series circuit	the current at every point in a series circuit is the same K323 15(b)

Potential difference in a series circuit	the sum of the potential differences in a series circuit is equal to the potential difference across the whole circuit > **Physics Matters words it:** In a series circuit, the total potential difference supplied to the circuit E is equal to the sum of the individual potential differences across the resistors. > Physics Matters 5e C17, book p.306 K323 15(c)
Effective resistance in a series circuit R_e	In a series circuit, the effective resistance Re is equal to the sum of the individual resistances. Physics Matters 5e C17, book p.306
Parallel connection	A parallel connection is one in which the components are placed next to each other in parallel and the ends are connected like the rungs of a ladder (Figure 17.8). Circuits that have components connected in parallel are called parallel circuits. Physics Matters 5e C17, book p.309
Current in a parallel circuit	the sum of the currents in the separate branches of a parallel circuit is equal to the current from the source > **Physics Matters words it:** In a parallel circuit, the total current flowing into or out of the parallel branches is equal to the sum of the individual currents in each parallel branch. > Physics Matters 5e C17, book p.309 K323 15(d)
Potential difference in a parallel circuit	the potential difference across the separate branches of a parallel circuit is the same K323 15(e)
Effective resistance in a parallel circuit R_e	In a parallel circuit, the reciprocal of the effective resistance of resistors 1/Re is equal to the sum of the reciprocal of the individual resistances. Physics Matters 5e C17, book p.310
Potential divider	A potential divider is a voltage divider, which makes use of the voltage drop across resistors in series to divide voltage. Physics Matters 5e C17, book p.315 2025 G3 Pure 2022 G3 Pure 2020 G3 Pure 2015 G3 Pure
Potentiometer	A potentiometer is a three-terminal variable resistor. The third terminal is connected to an adjustable knob and it can be adjusted to give any fraction of the potential difference across the ends of the resistor. Physics Matters 5e C17, book p.316 2022 G3 Pure
Transducer	Transducers convert changes in physical conditions, such as pressure, temperature or light, into electrical signals so that these physical conditions can be measured. Physics Matters 5e C17, book p.318
Negative temperature coefficient (NTC) thermistor	The thermistor is a type of semiconductor. The resistance of a thermistor varies with temperature, and thus thermistors are also known as thermally sensitive resistors. A negative temperature coefficient (NTC) thermistor is one where its resistance decreases with temperature. Physics Matters 5e C17, book p.318

Light-dependent resistor (LDR)	The light-dependent resistor (LDR) responds to light the same way a NTC thermistor responds to temperature. As the amount of light shining on an LDR increases, the resistance of the LDR decreases. Like thermistors, LDR are also made from semiconductors. Physics Matters 5e C17, book p.320 2025 G3 Pure · 2022 G3 Pure · 2017 G3 Pure · 2016 G3 Pure · 2015 G3 Pure

16. Practical Electricity

Electrical power *P* MUST DEFINE	In Chapter 7, we learnt that power is the rate of change of energy. The Physics Matters line is a cross-reference to Chapter 7, not a definition; symbol clash P (power) vs p (pressure). Physics Matters 5e C18, book p.327 2024 G2 ScPhy · 2017 G3 ScPhy
Power rating	The power rating of an appliance indicates the maximum allowable voltage and current for the appliance. Physics Matters 5e C18, book p.327 2024 G3 ScPhy · 2022 G2 ScPhy · 2021 G2 ScPhy · 2019 G3 ScPhy · 2017 G2 ScPhy · 2016 G3 Pure
Operating voltage	The operating voltage is the voltage level which an electrical system is designed to operate at. Physics Matters 5e C18, book p.327
Kilowatt-hour (kW h) *E*	One kW h of electricity is the energy used by a 1 kW device in an hour. Physics Matters 5e C18, book p.330 2023 G3 Pure P2 Q7a · 2023 G3 Pure P2 Q7b
Overheating of cables	Overheating occurs when: 1 the electrical cable passes current that exceeds its limits; 2 a large current flows through the wires due to too many plugs being connected to a socket (overloading); and 3 the contact between a plug and a socket is poor. Physics Matters 5e C18, book p.333
Fuse	A fuse is a safety device added to an electric circuit to prevent excessive current flow. It consists of a strip of fusible wire that will melt when the current flowing through it exceeds a certain value (Figure 18.11(a)). This device limits the amount of current, the value of which depends on its rating. Physics Matters 5e C18, book p.335 2020 G3 Pure P1 Q34 · 2025 G2 ScPhy · 2024 G3 ScPhy · 2023 G2 ScPhy · 2022 G2 ScPhy · 2021 G2 ScPhy · 2020 G2 ScPhy
Circuit breaker	Likewise, a circuit breaker is a safety device to prevent excessive current flow. But unlike fuses, a circuit breaker is not added to the plug of an electric appliance. Circuit breakers are part of the main electrical wiring to an apartment or room, as shown in Figure 18.12. Physics Matters 5e C18, book p.335 2022 G3 Pure · 2020 G3 Pure

Earthed metal casing	An earth metal casing is a metal housing that encloses the electrical parts of an appliance, keeping the user safe in the event of an electrical fault. The live current passing through the earth metal casing flows to the ground. Since the earth wire has almost no resistance, a large current flows and causes the circuit breaker to trip or the fuse to blow. Physics Matters 5e C18, book p.337
Double insulation	Some appliances use double insulation as a safety feature to keep users safe in the event of a fault. These appliances are enclosed in a plastic casing which is not earthed. Double insulation, as the name suggests, has two layers of insulation to enclose all exposed metalwork and “live” parts. The notes' 'two-pin plug / no earth wire' claim is the notes' own — neither the syllabus nor Physics Matters states it. Physics Matters 5e C18, book p.337 2022 G2 ScPhy
Live wire	The live wire is usually brown. It carries both the high voltage and the current. Physics Matters 5e C18, book p.338 (Figure 18.16) 2025 G3 ScPhy · 2024 G3 Pure · 2021 G2 ScPhy · 2020 G2 ScPhy · 2019 G3 Pure · 2017 G3 Pure
Neutral wire	The neutral wire is blue and is kept at zero voltage. It completes the path for current to flow through appliances in the electrical circuit. Physics Matters 5e C18, book p.338 (Figure 18.16) 2025 G3 ScPhy · 2024 G3 Pure · 2023 G2 ScPhy · 2022 G2 ScPhy · 2021 G2 ScPhy · 2020 G2 ScPhy
Earth wire	The earth wire is yellow and green. It is a safety wire that is needed to earth appliances with a metal case. Physics Matters 5e C18, book p.338 (Figure 18.16) 2025 G3 ScPhy · 2024 G3 Pure · 2023 G2 ScPhy · 2022 G2 ScPhy · 2021 G2 ScPhy · 2020 G2 ScPhy
Why switches, fuses and breakers go on the live wire	Switches and safety features such as fuses and circuit breakers have to be connected to the live wire in order to break or complete a circuit. Consider the case in Figure 18.17 where the switch is connected to the neutral wire instead. Then the appliance becomes “live” and can create an electric shock when a person touches it even when the switch is open. Physics Matters 5e C18, book p.338
Heating effect of electricity NOT REQUIRED	The heating effect of electricity is the transfer of energy to the internal store of a conductor when a current passes through it. In a heating element this is exactly what we want; in the connecting cables it is a waste — and a hazard. The notes define this; K323 16(a) asks only for its use in appliances, and Physics Matters gives no definition sentence.

17. Magnetism

Like poles repel, unlike poles attract	More precisely, the like poles of the magnet repel while the unlike poles attract. Physics Matters 5e C19, book p.344

Magnets have two poles / effects strongest at the poles	Magnets have two poles. The magnetic effects are strongest at the poles. Physics Matters 5e C19, book p.344
A freely suspended magnet rests north–south	A freely suspended magnet comes to rest in the north-south direction (Figure 19.2). Physics Matters 5e C19, book p.344
Poles always occur in pairs	The magnetic north and south poles of a magnet always occur in pairs. Physics Matters 5e C19, book p.345
Test for a magnet (repulsion)	However, repulsion can occur only between two magnets. We can only confirm that an object is a magnet if it repels another magnet (Figure 19.5). Physics Matters 5e C19, book p.345
Solenoid	Solenoid: coil of wire used as an electromagnet Physics Matters 5e C19, book p.347 2024 G3 Pure · 2023 G3 ScPhy · 2022 G3 ScPhy · 2020 G3 ScPhy
Proximity induced magnetism	Proximity induced magnetism can take place when a magnetic material is in contact or in close proximity to a strong magnet (Figures 19.7 and 19.8). Physics Matters 5e C19, book p.347
Induction / induced magnetism	induced magnetism caused by placing magnetic material close to a strong magnet or within a current-carrying solenoid K323 17(b)
Magnetic field	A magnetic field is a region in which the force of magnetism acts. Physics Matters 5e C19, book p.348 2025 G3 Pure · 2024 G3 Pure · 2021 G3 Pure · 2019 G3 ScPhy
Right-hand grip rule (solenoid)	The thumb points in the same direction as the north pole. The fingers curl in the same direction as the current flowing through the solenoid. Physics Matters 5e C19, book p.348
Demagnetisation	This process of demagnetisation can be achieved by: • placing the magnet in the east-west direction; and • hitting or heating the magnet. Physics Matters 5e C19, book p.349
Temporary magnets	Temporary magnets are magnets that retain their magnetism in the presence of an electric current or a permanent magnetic field. Physics Matters 5e C19, book p.351
Permanent magnets	Permanent magnets do not require the presence of an electric current or a permanent magnetic field to retain their magnetism. Physics Matters 5e C19, book p.351
Soft magnetic material	easily magnetised and demagnetised Physics Matters 5e C19, book p.351
Hard magnetic material	difficult to magnetise and demagnetise Physics Matters 5e C19, book p.351
Magnetic field lines	Magnets create these spatial magnetic fields, and the magnetic field lines are a visual tool used to represent magnetic fields. The Physics Matters line calls field lines 'a visual tool', which is not a usable definition; the notes' compass-direction form is. Physics Matters 5e C19, book p.353

Characteristics of magnetic field lines	• The magnetic field lines never cross one another. • The magnetic field lines are continuous and they form closed loops. • The distance between the magnetic field lines represents the strength of magnetic field. The closer the lines, the stronger the magnetic field. Physics Matters 5e C19, book p.353
Direction convention for field lines	By convention, the field lines have arrows that point out from the north pole of the magnet and point into the south pole. Physics Matters 5e C19, book p.353
Uniform magnetic field	A uniform magnetic field has field lines (Figure 19.23(a)). The field lines are equally spaced and parallel to one another. A uniform magnetic field exerts a constant magnetic force in the region. Physics Matters 5e C19, book p.355
Neutral point	Point X in Figure 19.25(a) is called a neutral point because the resultant magnetic field in that region is zero. The magnetic fields at point X from each magnet are equal and opposite — they cancel each other. Physics Matters 5e C19, book p.355

18. Electromagnetism

Right-hand grip rule (straight current-carrying conductor)	If we grip the conductor with the thumb pointing in the direction of the conventional current, the curl of the fingers shows the direction of the magnetic field (Figure 20.4). Physics Matters 5e C20, book p.363
Effect of changing the magnitude of the current	Changing the magnitude of the current changes the strength of magnetic field. The strength of magnetic field increases when the current is increased (Figure 20.5). Physics Matters 5e C20, book p.364
Effect of changing the direction of the current	Changing the direction of the current changes the direction of the magnetic field. The direction of the magnetic field is reversed when the direction of current is reversed (Figure 20.6). This direction is given by the right-hand grip rule. Physics Matters 5e C20, book p.364
Solenoid	A solenoid is a long piece of wire wound in a coil. Physics Matters 5e C20, book p.365 2024 G3 Pure · 2023 G3 ScPhy · 2020 G3 ScPhy · 2019 G3 Pure · 2015 G3 Pure
Electromagnet	A current-carrying solenoid is an electromagnet. Physics Matters calls any current-carrying solenoid an electromagnet; the notes require a soft-iron core. Physics Matters 5e C20, book p.365 2018 G3 ScPhy
Increasing the strength of a solenoid's magnetic field	The strength of magnetic field in a solenoid can be increased by: • increasing the current flowing through the solenoid; • increasing the number of turns per unit length of the solenoid; and • placing a soft iron core within the solenoid. Physics Matters 5e C20, book p.365
Condition for a force on a current-carrying conductor	A current-carrying conductor will experience a force if the magnetic field applied is perpendicular (or has a component that is perpendicular) to the direction of flow of current. Physics Matters 5e C20, book p.369

Motor effect (catapult effect)	This motion that is created is also known as the motor effect or catapult effect. When a current-carrying conductor is placed inside a uniform magnetic field, the magnetic fields interact in a manner similar to the pulling of the elastic band of a catapult (Figure 20.17). Physics Matters 5e C20, book p.370
Factors affecting the size and direction of the force (motor effect)	• Increasing the current produces a larger swing. • Increasing the strength of magnetic field produces a larger swing. • Reversing the direction of current induces a swing in the opposite direction. • Reversing the polarity of the magnet also reverses the direction of the swing. Physics Matters 5e C20, book p.370
Fleming's left-hand rule	The direction of the force can be determined using Fleming's left-hand rule. First, the left hand is held out with the forefinger, second finger and thumb perpendicular to each other (Figure 20.18). Next, the first finger is oriented in the direction of the magnetic field from north to south, and the second finger in the direction of conventional current. The resultant force that is induced by the current-carrying conductor will be given by the direction the thumb is pointing to. Physics Matters 5e C20, book p.370
Fleming's left-hand rule — when to use it	Fleming's left-hand rule is used to find either the direction of the force, magnetic field or current when the directions of two of these are known. The direction of the force, magnetic field or current are at right angles to one another. Physics Matters 5e C20, book p.371
Fleming's left-hand rule (mnemonic)	Forefinger — Field / seCond — Current / thuMb — Motion Physics Matters 5e C20, book p.370
Force on a beam of charged particles	A current-carrying wire experiences a force when its current is flowing perpendicularly to the direction of a magnetic field. Similarly, a beam of moving charged particles would also experience a force when a magnetic field is applied perpendicularly to the beam of particles. Physics Matters 5e C20, book p.371
Factors affecting the force on a charged particle	Similar to the current-carrying conductor, the force acting on a charged particle: • increases when the charge on the particle increases; • increases when the magnetic field increases; • is in the opposite direction if the particle is oppositely charged; and • is in the opposite direction if the direction of magnetic field or velocity of charged particle is reversed. Physics Matters 5e C20, book p.371
Current direction for a charged-particle beam	The direction of current is the same as the direction of force on the charge, since the charge is positive. Physics Matters 5e C20, book p.371
Increasing the turning effect on a current-carrying coil	the effect is increased by increasing (i) the number of turns on the coil (ii) the current > **Physics Matters words it:** The turning effect can be increased by: • increasing the number of turns in the coil; • increasing the current; and • adding a soft iron cylinder. > Physics Matters 5e C20, book p.372 The syllabus lists two factors; Physics Matters adds the soft-iron cylinder, which K323 18(f) treats separately. K323 18(e)
Split-ring commutator	Therefore, we say that the function of the split-ring commutator is to reverse the direction of the current in the coil every half a revolution. Physics Matters 5e C20, book p.372 2017 G3 Pure
Effect of a soft-iron cylinder in a motor	A soft iron core concentrates the magnetic field lines and thus increases the strength of magnetic field (Figure 20.22). A stronger magnetic field gives rise to a stronger force. Physics Matters 5e C20, book p.372

Split-ring action through the vertical position	As the coil rotates, it momentarily disconnects itself from the carbon brushes. At this point, the current from the cell is cut off from the coil and the momentum of the coil carries it past this position. Physics Matters 5e C20, book p.372

19. Electromagnetic Induction

Electromagnetic induction	a changing magnetic field can induce an e.m.f. in a circuit K323 19(a)(i)
Faraday's Law of electromagnetic induction	Faraday's Law of electromagnetic induction states that the magnitude of the induced e.m.f. in a circuit is directly proportional to the rate of change of magnetic flux in the circuit. The syllabus never states Faraday's law in flux terms; K323 19(a)(iii) asks only for the factors affecting the induced e.m.f. Physics Matters 5e C21, book p.382
Magnetic flux	Magnetic flux is the magnetic field in a given area. Physics Matters 5e C21, book p.382
Lenz's Law	the direction of the induced e.m.f. opposes the change producing it > **Physics Matters words it:** Lenz's Law states that the direction of the induced e.m.f., and hence the induced current in a closed circuit, is always such that its magnetic effect opposes the motion or change producing it. > Physics Matters 5e C21, book p.382 K323 19(a)(ii)
Lenz's law and conservation of energy	Lenz's law is a consequence of the law of conservation of energy. Physics Matters 5e C21, book p.383
Factors affecting the magnitude of the induced e.m.f.	The magnitude of the induced e.m.f increases if: • the speed of the relative motion between the coil and the magnet is increased; • the number of turns of the coil is increased; or • the strength of the magnet is increased. Physics Matters 5e C21, book p.383
Generator effect	Likewise, a moving conductor in the presence of a magnetic field will also produce an e.m.f. or a current in the conductor. This is referred to as the generator effect. Physics Matters 5e C21, book p.384
Fleming's right-hand rule	The direction of conventional current is determined using Fleming's right-hand rule. First, the right hand is held out with the forefinger, second finger and thumb perpendicular to each other. Next, the thumb is pointed in the direction of motion of the conductor, and first finger in the direction of the magnetic field, from north to south. The direction of conventional current is given by the direction the second finger is pointing to. Physics Matters 5e C21, book p.384
Fleming's right-hand rule (mnemonic)	Forefinger — Field / seCond — Current induced / thuMb — Motion. Physics Matters 5e C21, book p.384
Alternating current (from a generator)	An alternating current is produced by an alternating induced e.m.f. Physics Matters 5e C21, book p.385 2020 G3 Pure P2 Q10a · 2025 G3 Pure · 2024 G3 Pure · 2019 G3 Pure

Slip rings	Slip rings are important as they make sure that the ends of the rotating rectangular coil do not get twisted together as the rectangular coil rotates. Slip rings also provide the electric contact with the brushes so that electric current can flow continuously in the a.c. generator. Physics Matters 5e C21, book p.385
Transformer	A transformer is a device that can change a high alternating voltage to a low alternating voltage, or vice versa. Physics Matters 5e C21, book p.389 2025 G3 Pure · 2024 G3 Pure · 2023 G3 Pure · 2022 G3 Pure · 2021 G3 Pure · 2020 G3 Pure
Structure of a transformer	A transformer is made of two coils of wire called the primary coil and secondary coil. The primary coil is connected to an a.c. input and the secondary coil is connected to a load (output). These coils are wound around a laminated soft iron core. Physics Matters 5e C21, book p.389 2020 G3 Pure · 2016 G3 Pure
Eddy currents / why the core is laminated	Lamination reduces the transfer of energy to the internal (thermal) store by eddy currents, which are local induced electric currents that flow in loops. Physics Matters 5e C21, book p.389
Why the core is soft iron	Soft iron is used because it is easily magnetised and demagnetised. Physics Matters 5e C21, book p.389
Step-up transformer $N_s > N_p$	If Ns > Np, the secondary (output) voltage will be greater than the primary (input) voltage. This is a step-up transformer. Physics Matters 5e C21, book p.390
Step-down transformer $N_p > N_s$	Conversely, if Np > Ns, the secondary (output) voltage will be smaller than the primary (input) voltage. This is a step-down transformer. Physics Matters 5e C21, book p.390 2023 G3 Pure
Ideal transformer	The above relationship holds if and only if there are no energy losses in the system. That is, all the energy that is applied to the primary coils are transferred to the secondary coil. We call such a transformer an ideal transformer. Physics Matters 5e C21, book p.390 2025 G3 Pure · 2022 G3 Pure · 2021 G3 Pure · 2018 G3 Pure · 2015 G3 Pure
Efficiency *eta*	We define the term efficiency η as a ratio of the output power over the input power. Physics Matters 5e C21, book p.390 2016 G3 Pure P2 Q11b · 2016 G3 Pure P2 Q11c · 2023 G3 Pure · 2021 G3 Pure · 2017 G3 Pure
Advantage of high-voltage transmission	The second solution is to reduce the current transmitted. This will reduce ohmic heating of transmission cables. However, to maintain the power that is transmitted, the voltage needs to be increased substantially. Physics Matters 5e C21, book p.391
Why current is always generated in alternating form	If d.c. generators are used, the direct current electricity that is produced cannot be stepped up or down. Then, the power loss during transmission would be very high. Therefore, current produced is always in alternating form. Physics Matters 5e C21, book p.392

20. Radioactivity

Atom	the composition of an atom in terms of a positive nucleus (with protons and neutrons) and negatively charged electrons > **Physics Matters words it:** An atom consists of a positively charged nucleus (plural: nuclei) and negatively charged electrons moving around the nucleus (Figure 22.1). > Physics Matters 5e C22, book p.398 K323 20(a) 2025 G2 ScPhy · 2024 G3 Pure
Nucleus	a positive nucleus (with protons and neutrons) K323 20(a) 2025 G3 Pure · 2024 G3 ScPhy
Relative charges of subatomic particles	electron −1 / proton +1 / neutron 0 Physics Matters 5e C22, book p.398
Proton (atomic) number *Z*	The proton number is the number of protons in an atom. Physics Matters 5e C22, book p.399
Nucleon	Protons and neutrons are also called nucleons. Physics Matters 5e C22, book p.399 2025 G2 ScPhy P1 Q19 · 2025 G3 Pure
Nucleon (mass) number *A*	The nucleon number is the total number of neutrons and protons in the nucleus of an atom. Physics Matters 5e C22, book p.399 2025 G3 Pure
Nuclide	In nuclear physics and nuclear chemistry, the various species of atoms whose nuclei contain a particular number of protons and neutrons are called nuclides. Physics Matters 5e C22, book p.399 2024 G3 ScPhy P2 Q8b(i) · 2025 G2 ScPhy · 2024 G3 ScPhy
Nuclide notation *nuclide(A, Z, X)*	nucleon (mass) number in superscript / proton (atomic) number in subscript / chemical symbol of the nuclide (can be obtained from the periodic table) Physics Matters 5e C22, book p.400 2025 G2 ScPhy
Isotopes	Isotopes are atoms of the same element that have the same number of protons but different numbers of neutrons. Physics Matters 5e C22, book p.400 2025 G3 Pure · 2024 G3 Pure
Nuclear decay	nuclear decay is a random and spontaneous process whereby an unstable nucleus loses energy by emitting radiation > **Physics Matters words it:** Nuclear decay is a random process by which an unstable atomic nucleus loses its energy by emission of electromagnetic radiation or particle(s). > Physics Matters 5e C22, book p.401 The syllabus requires 'random and spontaneous'; the Physics Matters sentence omits 'spontaneous'. K323 20(d)

Spontaneous and random nature of decay	nuclear decay is a random and spontaneous process K323 20(d)
Ionisation	Ionisation refers to the ability to eject electrons from atoms to form ions. Physics Matters 5e C22, book p.402
Alpha particle *α*	An α-particle consists of two protons and two neutrons tightly bound together. It is identical to a helium nucleus. Physics Matters 5e C22, book p.402
Beta particle *β*	An β-particle is a fast-moving electron ejected from a radioactive nucleus. Physics Matters 5e C22, book p.402
Gamma ray *γ*	A γ-ray is electromagnetic radiation emitted by a radioactive nucleus with excess energy. Physics Matters 5e C22, book p.402
Alpha decay	When a nucleus undergoes α-decay: • it emits an α-particle (identical to helium nucleus 4/2 He); and • the nucleon number decreases by four and the proton number decreases by two. Physics Matters 5e C22, book p.403
Nuclide equation	We can use an equation involving nuclide notation to represent the changes in the composition of the nucleus. This is known as the nuclide equation. Physics Matters 5e C22, book p.403 2025 G3 Pure
Beta decay	When a nucleus undergoes β-decay: • it emits a β-particle (an electron); and • the nucleon number remains the same and the proton number increases by one. Physics Matters 5e C22, book p.404
Gamma radiation (emission)	Very often, when nuclei undergo α-decay or β-decay, γ radiation is also emitted. Physics Matters 5e C22, book p.404
Ionising radiation	Ionising radiation is radiation with high energies that can knock off electrons from atoms to form ions. Physics Matters 5e C22, book p.404
Background radiation	Background radiation refers to nuclear radiation in an environment where no radioactive source has been deliberately introduced. Physics Matters 5e C22, book p.404 2024 G3 Pure P2 Q9b 2025 G3 ScPhy 2024 G3 Pure
Becquerel (activity) *A*	One becquerel (1 Bq) is equal to 1 disintegration per second. Symbol clash: A is activity here and nucleon number elsewhere in the same chapter. Physics Matters 5e C22, book p.405
Count rate	The measurement of radiation is sometimes expressed as being a rate of counts per unit time, also known as the count rate. Physics Matters 5e C22, book p.405 2024 G3 Pure
Corrected count rate	When carrying out any measurements with radioactive sources, we should first measure the background radiation. Subtract this background count rate from the measurements to obtain the corrected count rate for the radioactive source. Physics Matters 5e C22, book p.406

Half-life $t_{½}$	The half-life of a radioactive nuclide is the time taken for half the nuclei of that nuclide in any sample to decay. Physics Matters 5e C22, book p.406 2025 G3 ScPhy P2 Q11b(iv) · 2024 G3 Pure P2 Q9c(ii) · 2024 G3 Pure P2 Q9c(iii) · 2025 G3 Pure · 2024 G2 ScPhy
Decay curve	Figure 22.9 is called the decay curve. It is the graph of number of atoms or count rate against time. Physics Matters 5e C22, book p.407
Nuclear fission	Nuclear fission is a process in which the nucleus of an atom splits (usually into two parts) and releases a huge amount of energy. Physics Matters 5e C22, book p.410
Parent nucleus and daughter nuclei	The original atom is called the parent nucleus. The parent nucleus decays to form other atoms called the daughter nuclei. The daughter nuclei may be stable or may decay further. Physics Matters 5e C22, book p.410
Chain reaction	The neutrons produced in the nuclear fission will go on to split more nuclei. This creates a self-sustaining chain reaction that is controlled in a nuclear reactor (Figure 22.17). Physics Matters 5e C22, book p.412
Nuclear fusion	Nuclear fusion is a process in which two light atomic nuclei combine to form one heavier atomic nucleus and releases a huge amount of energy. Physics Matters 5e C22, book p.411
Conditions for nuclear fusion	Nuclear fusion cannot happen at low temperature and pressure as the two nuclei cannot come into close range of each other due to the repulsive forces. Hence, nuclear fusion requires very high temperatures and pressures and is currently not used in nuclear power plants. Physics Matters 5e C22, book p.413
Radioactivity NOT REQUIRED	Radioactivity is the spontaneous emission of ionising radiation by unstable radioactive nuclei (for example, uranium), as particles or electromagnetic radiation. The notes define this; neither the syllabus nor Physics Matters defines 'radioactivity' itself — both define nuclear decay instead.

Formulae

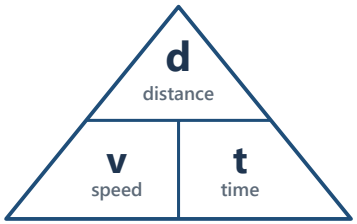
Symbols and units come from the syllabus' own *Summary of key quantities, symbols and units*. Where a formula is one product or quotient, a **memory triangle** sits beside it: cover the quantity you want to find — two cells side by side are multiplied, one above the other are divided.

1. Physical Quantities, Units & Measurement

Speed

Boxed; C1 writes it in words ("distance / time taken"). C2 p.18 writes "distance travelled / time taken".

$$\text{speed} = \frac{\text{distance}}{\text{time taken}}$$



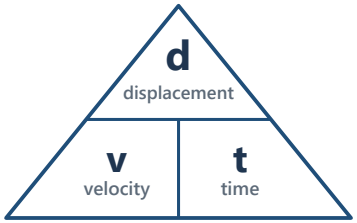
speed **m / s** also km / h, cm / s
distance **m** also km, cm, mm
time taken **s** also h, min, ms

Physics Matters 5e C1, book p.13

Velocity

Boxed, in words.

$$\text{velocity} = \frac{\text{displacement}}{\text{time taken}}$$



velocity **m / s** also km / h, cm / s
displacement **m** also km, cm, mm
time taken **s** also h, min, ms

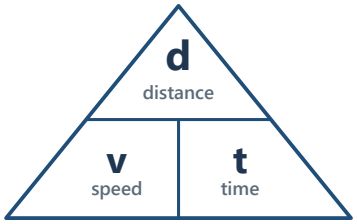
Physics Matters 5e C1, book p.13

2. Kinematics

Speed

Page-image verified.

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$



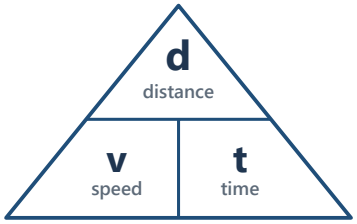
speed **m / s** also km / h, cm / s
distance travelled **m** also km, cm, mm
time taken **s** also h, min, ms

Physics Matters 5e C2, book p.18

Speed (symbol form)

The only place the textbook writes the speed/velocity relation with single-letter symbols (also the "triangle method" Helpful Note on p.21). d is the book's own symbol; the syllabus table gives no symbol for distance.

$$v = \frac{d}{t}$$



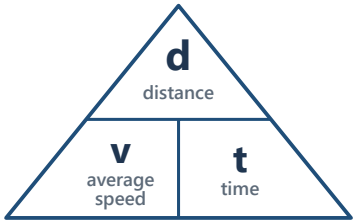
v velocity (or speed) **m / s**
d displacement (or distance) **m**
t time **s**

Physics Matters 5e C2, book p.30

Average speed

Syllabus LO 2(b) in both Pure and Science.

$$\text{average speed} = \frac{\text{total distance travelled}}{\text{total time taken}}$$

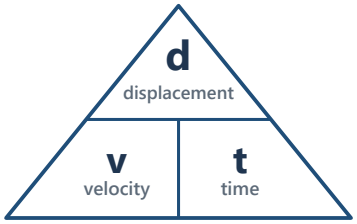


average speed **m / s** also km / h, cm / s
total distance travelled **m** also km, cm, mm
total time taken **s** also h, min, ms

Physics Matters 5e C2, book p.19

Velocity

$$\text{velocity} = \frac{\text{displacement}}{\text{time taken}}$$

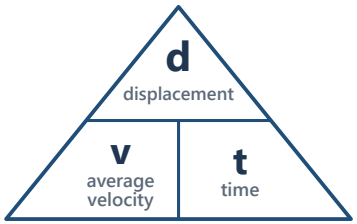


velocity **m / s**
displacement **m**
time taken **s**

Physics Matters 5e C2, book p.21

Average velocity

$$\text{average velocity} = \frac{\text{total displacement}}{\text{total time taken}}$$



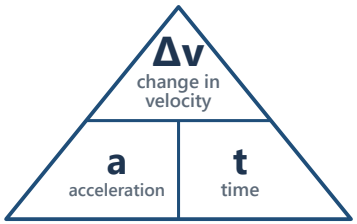
average velocity **m / s**
total displacement **m**
total time taken **s**

Physics Matters 5e C2, book p.21

Acceleration

Page-image verified: the boxed form reads "change of velocity", although the chapter map on p.39 and the syllabus LO both say "change in velocity".

$$\text{acceleration} = \frac{\text{change of velocity}}{\text{time taken}}$$



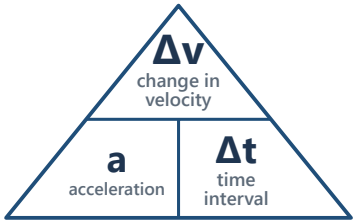
acceleration **m / s²**
change of velocity **m / s**
time taken **s**

Physics Matters 5e C2, book p.22

Uniform acceleration (delta form)

Page-image verified.

$$a = \frac{\Delta v}{\Delta t}$$



- a uniform acceleration m / s²
- Δv change in velocity m / s
- Δt time interval between t_u and t_v s

Physics Matters 5e C2, book p.23

Uniform acceleration (initial and final velocity form)

Page-image verified; the OCR markdown loses the t_v / t_u subscripts entirely. Worked examples then use the shorter a = (v - u) / Δ t.

$$a = \frac{v - u}{t_v - t_u}$$

- a uniform acceleration m / s²
- v final velocity m / s
- u initial velocity m / s
- t_v time at which an object is at final velocity v s
- t_u time at which an object is at initial velocity u s

Physics Matters 5e C2, book p.23

Velocity from a displacement–time graph

Pure works in displacement/velocity; the G3 Science syllabus LO 2(e)-(g) works in distance/speed for motion in one direction, i.e. gradient of a distance–time graph gives speed.

velocity = gradient of displacement-time graph

velocity m / s

Physics Matters 5e C2, book p.25

Acceleration from a velocity–time graph

Science syllabus wording: gradient of a speed–time graph.

acceleration = gradient of velocity-time graph

acceleration m / s²

Physics Matters 5e C2, book p.26

Displacement from the area under a velocity–time graph

Helpful Note p.30: "Only the area under a velocity–time graph gives the displacement. The area under a displacement–time graph does not give displacement." Science syllabus LO 2(h) says area under a speed–time graph gives distance travelled.

displacement = area under the velocity-time graph

displacement m

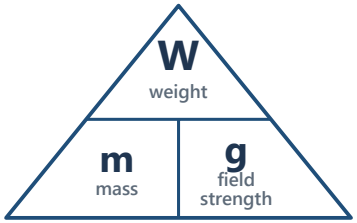
Physics Matters 5e C2, book p.30

3. Dynamics

Gravitational field strength

Page-image verified.

$$g = \frac{W}{m}$$



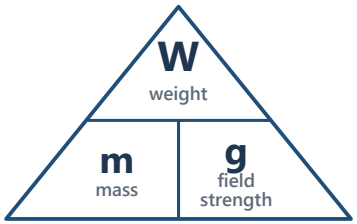
g gravitational field strength N / kg
W weight N
m mass of the object kg

Physics Matters 5e C3, book p.47

Weight

Page-image verified: "From the equation g = W/m, we have W = mg." Syllabus wording: weight = mass x gravitational field strength.

$$W = mg$$



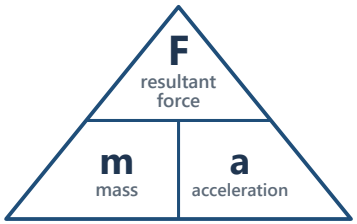
W weight N
m, M mass kg also g, mg
g gravitational field strength N / kg

Physics Matters 5e C3, book p.48

Newton's Second Law (resultant force)

Page-image verified. Also stated in C3 p.48. Syllabus wording: resultant force = mass x acceleration.

$$F = ma$$



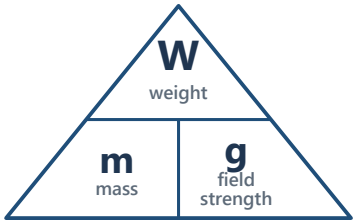
F resultant force N
m, M mass of object kg
a acceleration of object m / s²

Physics Matters 5e C4, book p.57

Gravitational field strength equals acceleration of free fall

Page-image verified: "gravitational field strength near the Earth's surface (g = W/m = 10 N/kg) is equivalent to the acceleration of free fall (g = W/m = 10 m/s²)". Same equation, two readings of the unit — worth keeping as its own note rather than a second formula.

$$g = \frac{W}{m}$$



g gravitational field strength / acceleration of free fall m / s² also N / kg
W weight N
m, M mass kg

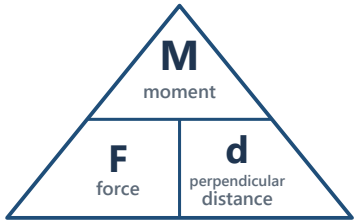
Physics Matters 5e C3, book p.48

4. Turning Effect of Forces

Moment of a force

Page-image verified: the book prints "M = Fd" with d defined as the perpendicular distance. The syllabus quantities table gives no symbol for moment of force, only the unit N m; syllabus wording is "moment of a force (or torque) = force x perpendicular distance from the pivot".

$$M = Fd$$



M moment of a force (or torque) N m
F, f force applied N
perpendicular distance from the pivot to the line of action of the force m

Physics Matters 5e C5, book p.79

Principle of moments

The boxed equation on p.80 reads "Sum of clockwise moments about any pivot = Sum of anticlockwise moments about the same pivot" (note "any", where the definition sentence says "a"). The chapter map on p.89 uses the singular "moment".

sum of clockwise moments about a pivot
= sum of anticlockwise moments about the same pivot

moment of a force N m

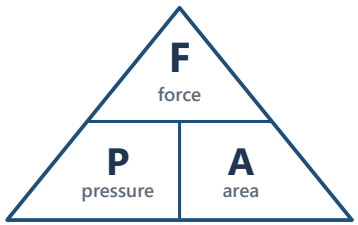
Physics Matters 5e C5, book p.80

5. Pressure

Pressure

Textbook prints the capital P; the syllabus table allows p or P.

$$P = \frac{F}{A}$$



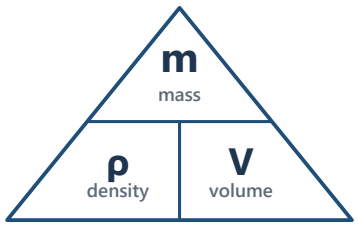
P pressure Pa (N/m²)
F force N
A contact area m²

Physics Matters 5e C6, book p.93

Density

Physics Matters prints a lower-case v for volume; the syllabus table uses V.

$$\rho = \frac{m}{V}$$



ρ density kg/m³ (g/cm³)
m mass kg
V volume m³

Physics Matters 5e C6, book p.100

Pressure transmitted through a hydraulic press

Derived on p.97 as P_1 = F_1/A_1 = F_2/A_2 because the liquid transmits the pressure undiminished. Pure only.

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

- F_1 force applied on piston 1 N
- A_1 area of piston 1 m^2
- F_2 force exerted on piston 2 N
- A_2 area of piston 2 m^2

Physics Matters 5e C6, book p.97

Multiplier effect of a hydraulic press

Pure only. Distances move the other way: A_1 * d_1 = A_2 * d_2 (p.99).

$$F_2 = F_1 \frac{A_2}{A_1}$$

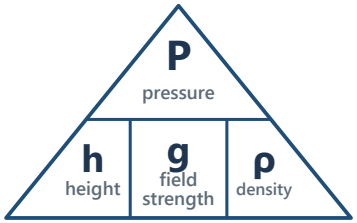
- F_2 force applied on piston 2 N
- F_1 force applied on piston 1 N
- A_2 area of piston 2 m^2
- A_1 area of piston 1 m^2

Physics Matters 5e C6, book p.98 (repeated in the chapter summary, p.107)

Pressure due to a liquid column

Pure only — the G3 Science syllabus has no 'pressure due to a liquid column' outcome. Valid only when the pressure at the liquid surface is taken as zero.

$$P = h\rho g$$



- P pressure Pa (N/m^2)
- h height (depth below the air–liquid surface) m
- ρ density of the liquid kg/m^3
- g gravitational field strength N/kg (m/s^2)

Physics Matters 5e C6, book p.103

Pressure difference between two levels in a liquid

Pure only. This is the general form; P = h*ρ*g is the special case P_A = 0.

$$P_B - P_A = h\rho g$$

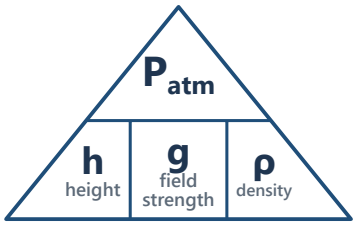
- P_B pressure at the lower level Pa
- P_A pressure at the upper level Pa
- h difference in depth between the two levels m
- ρ density of the liquid kg/m^3
- g gravitational field strength N/kg (m/s^2)

Physics Matters 5e C6, book p.102 (summary p.107 calls h*rho*g the pressure difference or gauge pressure)

Mercury barometer (atmospheric pressure)

Pure only. Textbook writes it as P_B = h*ρ*g with P_A = 0 above the mercury; 1 atm = 760 mm Hg.

$$P_{\text{atm}} = h\rho g$$



- P_{atm} atmospheric pressure Pa
- h vertical height of the mercury column m
- ρ density of mercury kg/m^3
- g gravitational field strength N/kg (m/s^2)

Physics Matters 5e C6, book p.104

Manometer (gas pressure)

Pure only. p.107 gives both cases: P_atm - P_gas = h*ρ*g if P_gas < P_atm, and P_gas - P_atm = h*ρ*g if P_gas > P_atm.

$$P_{\text{gas}} = h\rho g + P_{\text{atm}}$$

- P_{gas} pressure of the gas Pa
- P_{atm} atmospheric pressure Pa
- h height of the liquid column m
- ρ density of the liquid kg/m³
- g gravitational field strength N/kg (m/s²)

Physics Matters 5e C6, book p.105 (both cases stated on p.107)

6. Energy

Kinetic energy

$$E_k = \frac{1}{2}mv^2$$

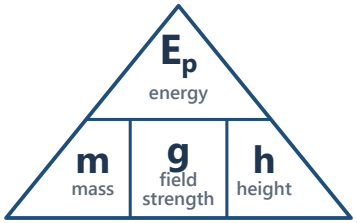
- E_k energy in the kinetic store J
- m mass of the body kg
- v speed of the body m/s

Physics Matters 5e C7, book p.119

Gravitational potential energy

Valid near the Earth's surface.

$$E_p = mgh$$



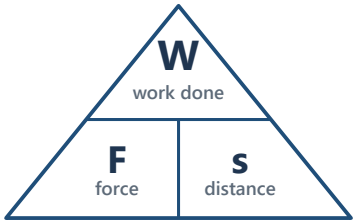
- E_p energy in the gravitational potential store J
- m mass of the body kg
- g gravitational field strength N/kg (m/s²)
- h height m

Physics Matters 5e C7, book p.119

Work done by a constant force

Textbook uses s, not d, for the distance.

$$W = Fs$$



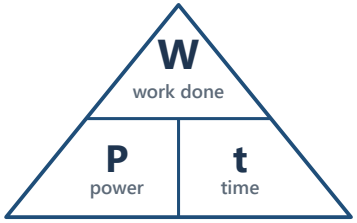
- W work done by a constant force F J
- F constant force N
- s distance moved in the direction of the force m

Physics Matters 5e C7, book p.124

Power

p.126 also notes that the product P*t gives the work done W or the energy E transferred.

$$P = \frac{W}{t} = \frac{E}{t}$$



- P power W
- W work done J
- E energy transferred J
- t time taken s

Physics Matters 5e C7, book p.126

Efficiency

Pure only — no efficiency outcome in the G3 Science syllabus and no mention of efficiency anywhere in Discover Physics 5e.

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100\%$$

useful energy output useful energy output J
total energy input total energy input J

Physics Matters 5e C7, book p.127 (repeated in the chapter summary, p.134)

Energy accounting for a machine

Stated as an application of the principle of conservation of energy. Pure only, since it is used for efficiency.

$$\text{total energy input} = \text{useful energy output} + \text{non-useful energy}$$

total energy input total energy input J
useful energy output useful energy output J
non-useful energy energy dissipated, usually to the internal store of the surroundings J

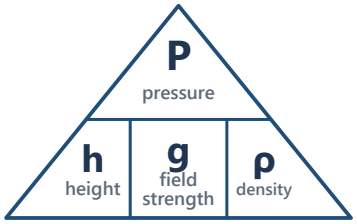
Physics Matters 5e C7, book p.127

7. Kinetic Particle Model of Matter

Pressure difference in a liquid (recalled from Chapter 6)

The only equation printed in Chapter 8, and only as a cross-reference. C8 writes the factors in the order ρ*h*g; C6 p.103 writes h*ρ*g. Pure only.

$$P = \rho h g$$



P pressure difference Pa
ρ density kg/m³
h height difference m
g gravitational field strength N/kg (m/s²)

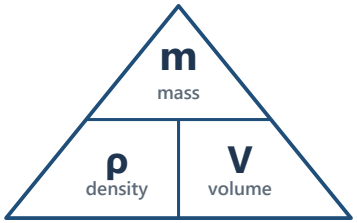
Physics Matters 5e C8, book p.143 (Link box; original statement C6 p.103)

8. Thermal Processes

Density (recalled when explaining convection)

Physics Matters C9 states NO equation of its own; density is only used qualitatively on p.153 ('it expands and increases in volume. As volume increases, density decreases'). This entry is the C6 formula carried over for the notes page.

$$\rho = \frac{m}{V}$$



ρ density kg/m³ (g/cm³)
m mass kg
V volume m³

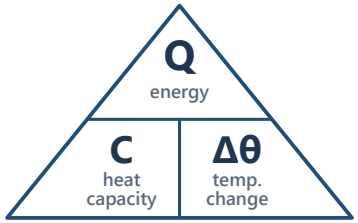
Physics Matters 5e C6, book p.100

9. Thermal Properties of Matter

Heat capacity

Read from the page image; the OCR renders the box as 'C =^Q^' with the denominator lost.

$$C = \frac{Q}{\Delta\theta}$$



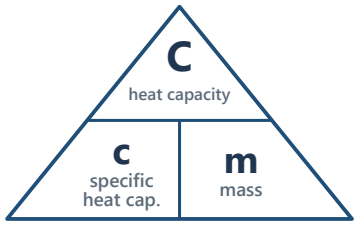
- ***C*** heat capacity J/°C, J/K
- ***Q*** change in internal energy by energy transfer J
- ***Δ θ*** change in temperature K or °C

Physics Matters 5e C10, book p.169

Specific heat capacity

PM prints both forms in one box. Read from the page image; the OCR shows only 'c ='.

$$c = \frac{C}{m} = \frac{Q}{m\Delta\theta}$$

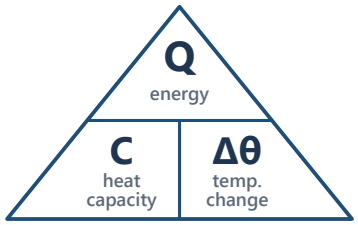


- ***c*** specific heat capacity J/(g °C), J/(g K)
- ***C*** heat capacity J/K or J/°C
- ***Q*** change in internal energy by energy transfer J
- ***m*** mass of substance kg
- ***Δ θ*** change in temperature K or °C

Physics Matters 5e C10, book p.169

Energy transferred by heating (heat capacity form)

$$Q = C\Delta\theta$$



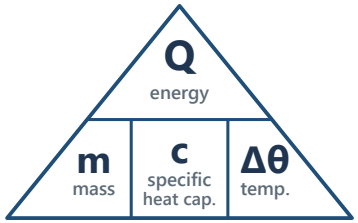
- ***Q*** energy transferred by heating J
- ***C*** heat capacity J/°C, J/K
- ***Δ θ*** change in temperature K or °C

Physics Matters 5e C10, book p.171

Energy transferred by heating (specific heat capacity form)

The syllabus wording is energy transfer (by heating) = mass x specific heat capacity x change in temperature.

$$Q = mc\Delta\theta$$



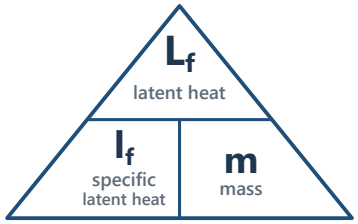
- ***Q*** energy transferred by heating J
- ***m*** mass of substance kg
- ***c*** specific heat capacity J/(g °C), J/(g K)
- ***Δ θ*** change in temperature K or °C

Physics Matters 5e C10, book p.171

Latent heat of fusion

Subscripts read from the page image; the OCR gives a bare 'L = l m'.

$$L_f = l_f m$$



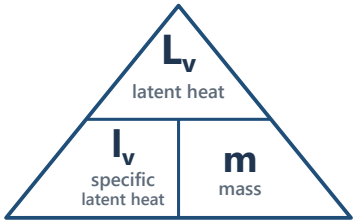
- ***L_f*** latent heat of fusion J
- ***l_f*** specific latent heat of fusion J/kg
- ***m*** mass of substance kg

Physics Matters 5e C10, book p.179

Latent heat of vaporisation

Subscripts read from the page image.

$$L_v = l_v m$$



- L_v latent heat of vaporisation J
- l_v specific latent heat of vaporisation J/kg
- m mass of substance kg

Physics Matters 5e C10, book p.180

Energy balance in a mixing (calorimetry) experiment

PM states this only in words - 'Energy transferred out of the sphere = Energy transferred into the water' (Let us Investigate 10A) - never as a boxed symbolic formula.

$$m_1 c_1 \Delta\theta_1 = m_2 c_2 \Delta\theta_2$$

- m mass of each body kg
- c specific heat capacity of each body J/(g °C), J/(g K)
- $\Delta\theta$ temperature change of each body K or °C

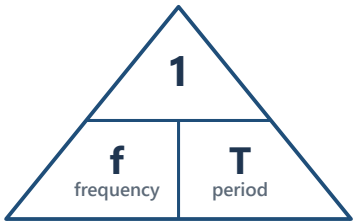
Physics Matters 5e C10, book p.172

10. General Properties of Waves

Frequency and period

Read from the page image; the OCR renders it as 'f =^1^ ... T'.

$$f = \frac{1}{T}$$



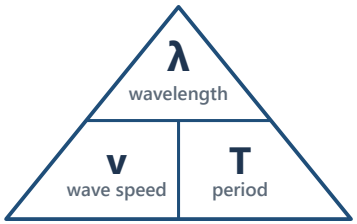
- f frequency Hz
- T period s

Physics Matters 5e C11, book p.195

Wave speed from wavelength and period

Greek λ read from the page image, not the OCR.

$$v = \frac{\lambda}{T}$$



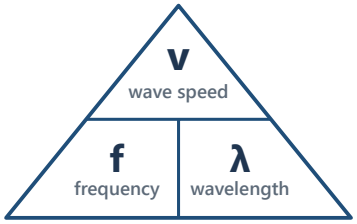
- v wave speed m/s
- λ wavelength m also cm
- T period s

Physics Matters 5e C11, book p.195

Wave equation

PM: 'To conclude, the relationship between v, f and λ is v = f λ.' Greek read from the page image.

$$v = f\lambda$$



v wave speed m/s
f frequency Hz
λ wavelength **m** also cm

Physics Matters 5e C11, book p.195

Speed of sound by the echo method

From Let us Investigate 12A: v = total distance travelled / time. The to-and-fro distance for each interval is 2d, so the general echo relation is 2d = v t. Read from the page image.

$$v = \frac{15 \times 2d}{t}$$

v speed of sound in air m/s
d distance from the wall **m**
t time for 15 intervals s

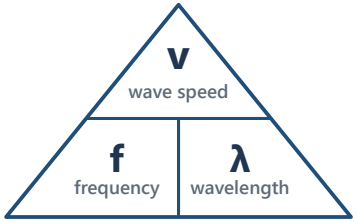
Physics Matters 5e C12, book p.211

11. Electromagnetic Spectrum

Wave speed equation for electromagnetic waves

Fact 4: 'The wave speed equation, v = f λ, applies to all electromagnetic waves.' Greek read from the page image.

$$v = f\lambda$$



v wave speed m/s
f frequency Hz
λ wavelength **m** also cm

Physics Matters 5e C13, book p.221

Speed of electromagnetic waves in a vacuum (constant)

PM never uses the symbol c for this in C13 (it uses it for the speed of light in C14, p.244). The printed value is 3 x 10^8 m/s, not 3.0 x 10^8 m/s.

$$c = 3 \times 10^8$$

c speed of all electromagnetic waves in a vacuum m/s

Physics Matters 5e C13, book p.221

12. Light

Second law of reflection

Greek subscripts read from the page image. Syllabus symbols are i and r.

$$\theta_i = \theta_r$$

$\boldsymbol{\theta_i}$ angle of incidence **degree** (°)
$\boldsymbol{\theta_r}$ angle of reflection **degree** (°)

Physics Matters 5e C14, book p.236

Second law of refraction (Snell's law)

Read from the page image.

$$\frac{\sin i}{\sin r} = \text{constant}$$

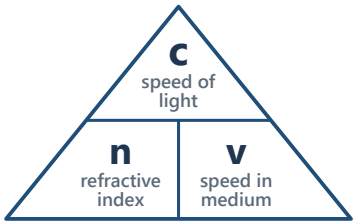
- ***i*** angle of incidence **degree (°)**
- ***r*** angle of refraction **degree (°)**

Physics Matters 5e C14, book p.244

Refractive index from speeds

Read from the page image.

$$n = \frac{c}{v}$$



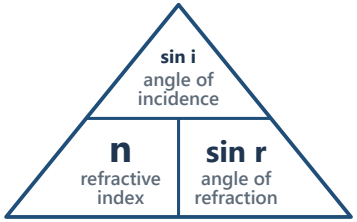
- ***n*** refractive index of the medium **no unit**
- ***c*** speed of light in a vacuum **m/s**
- ***v*** speed of light in the medium **m/s**

Physics Matters 5e C14, book p.244

Refractive index from angles

PM: 'For a light ray passing from a vacuum into a given medium'. It notes on p.245 that i may be measured in air, since the speeds of light in air and vacuum are almost the same.

$$n = \frac{\sin i}{\sin r}$$



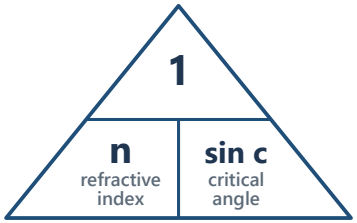
- ***n*** refractive index of the medium **no unit**
- ***i*** angle of incidence in a vacuum **degree (°)**
- ***r*** angle of refraction in the medium **degree (°)**

Physics Matters 5e C14, book p.244

Refractive index and critical angle

Pure only - critical angle is not in the G3 Science table. PM writes the critical angle as θ_c; rearranged, sin c = 1 / n. Read from the page image.

$$n = \frac{\sin i}{\sin r} = \frac{1}{\sin c}$$



- ***n*** refractive index of the medium **no unit**
- ***c*** critical angle **degree (°)**

Physics Matters 5e C14, book p.251

General refractive index relation for two media

Stated as a general formula inside Worked Example 14C ('When the first medium is not air or a vacuum...'), used there to get critical angles at a glass-water boundary. Read from the page image.

$$\frac{n_1}{n_2} = \frac{\sin \theta_2}{\sin \theta_1}$$

- n_1 refractive index of medium 1 **no unit**
- n_2 refractive index of medium 2 **no unit**
- θ_1 angle in medium 1 **degree (°)**
- θ_2 angle in medium 2 **degree (°)**

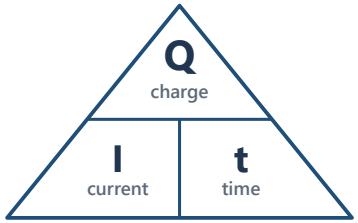
Physics Matters 5e C14, book p.253

14. Current of Electricity

Current, charge and time

Boxed equation; PM's "where" list gives I = current (A), Q = charge (C), t = time taken (s).

$$I = \frac{Q}{t}$$



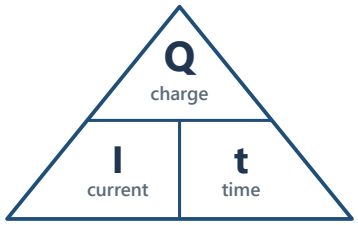
I current **A** also mA
Q charge **C** also A s
t time taken **s** also h, min, ms

Physics Matters 5e C16, book p.287

Charge = current × time

PM only writes this rearrangement inside Worked Example 16A ("Total electric charge is given by Q = I × t"); it is included because both syllabuses state the LO as "charge = current × time" (K323 14(c), K326-328 12(e)).

$$Q = It$$



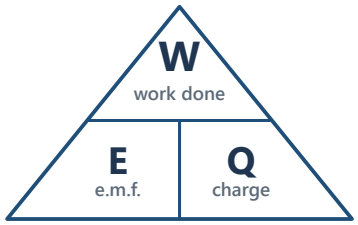
Q charge **C** also A s
I current **A** also mA
t time **s** also h, min, ms

Physics Matters 5e C16, book p.288

Electromotive force

Boxed equation. PM: "The SI unit of e.m.f. is volt (V). Its SI unit may also be written as J/C, but it is uncommon to do so." The chapter map on p.300 uses the symbol ε for the same equation.

$$E = \frac{W}{Q}$$



E e.m.f. of the electrical source V
W work done J
Q amount of charge **C** also A s

Physics Matters 5e C16, book p.289

Total e.m.f. of cells in series

Pure only — K323 14(e) "calculate the total e.m.f. where several sources are arranged in series" is absent from K326-328 topic 12. PM states it only in words ("The resultant or total e.m.f. is the sum of the individual e.m.f. of each cell", Figure 16.8) and numerically (1.5 V + 1.5 V = 3.0 V); it never writes the algebra. For cells in parallel PM states "The resultant or total e.m.f. is equal to that of a single cell."

$$E_{\text{total}} = E_1 + E_2 + \ldots + E_n$$

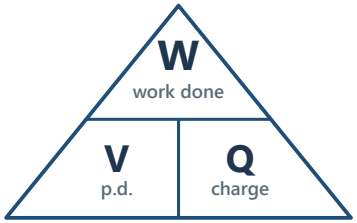
E_{total} resultant (total) e.m.f. V
E_1, E_2 e.m.f. of each cell V

Physics Matters 5e C16, book p.290

Potential difference

Boxed equation.

$$V = \frac{W}{Q}$$



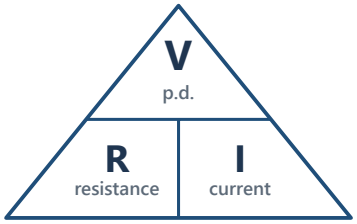
V potential difference or voltage across a component **V** also mV
W work done **J**
Q amount of charge **C** also A s

Physics Matters 5e C16, book p.290

Resistance

Boxed equation; the ohm symbol was read from the page image, not the OCR.

$$R = \frac{V}{I}$$



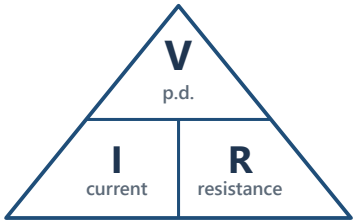
R resistance of the component **Ω**
V p.d. across the component **V, mV**
I current flowing through the component **A** also mA

Physics Matters 5e C16, book p.293

Voltage, current and resistance

PM: "Recall that resistance R = V/I. We can rearrange this equation to form a relationship between voltage and current, that is, V = IR."

$$V = IR$$



V potential difference **V** also mV
I current **A** also mA
R resistance **Ω**

Physics Matters 5e C16, book p.297

Resistance, length and cross-sectional area

Boxed equation. PM first states the two proportionalities separately: R is directly proportional to l, and R is inversely proportional to A. Both syllabuses require these (K323 14(i), K326-328 12(j)).

$$R = k\frac{l}{A}$$

R resistance **Ω**
k a constant (for a given material) —
l length of the conductor **m** also km, cm, mm
A cross-sectional area **m²** also m^2, cm^2

Physics Matters 5e C16, book p.295

Resistance and resistivity

Textbook extension: ρ is not in either syllabus quantities table (ρ there is density). Stated in PM p.295 and Figure 16.17, and identically in Discover Physics C13 p.239.

$$R = \rho\frac{l}{A}$$

R resistance **Ω**
ρ resistivity of the material **Ω m**
l length **m** also km, cm, mm
A cross-sectional area **m²** also m^2, cm^2

Physics Matters 5e C16, book p.295

Resistivity rearranged

PM p.296: "resistivity is the resistance of a material for a unit area per unit length … resistivity is an intrinsic property of a material. The SI unit of resistivity is ohm metre (Ωm)."

$$\rho = R\frac{A}{l}$$

- ρ resistivity Ω m
- R resistance Ω
- A cross-sectional area m^2 also m^2, cm^2
- l length m also km, cm, mm

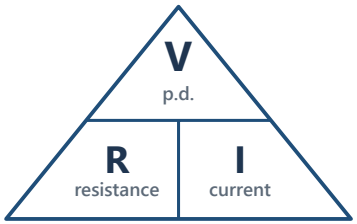
Physics Matters 5e C16, book p.295

15. D.C. Circuits

Resistance (recalled in C17)

Both syllabuses require it inside whole-circuit calculations (K323 15(g), K326-328 13(g)).

$$R = \frac{V}{I}$$



- R resistance Ω
- V potential difference V also mV
- I current A also mA

Physics Matters 5e C16, book p.293 (recalled at C17 p.306, Link box "Recall from Chapter 16: V = IR")

Potential differences in series

PM switches notation mid-page: the boxed statement and E = V_1 + V_2 use E, but the algebra immediately below uses V_ε (V_ε = IR_1 + IR_2). Discover Physics C14 uses V_ε throughout and never E.

$$E = V_1 + V_2 + \ldots + V_n$$

- E total p.d. supplied to the circuit (e.m.f. of the source) V
- V_1, V_2 p.d. across each resistor V, mV

Physics Matters 5e C17, book p.306

Effective resistance in series

Boxed as R_e = V_ε / I = R_1 + R_2 + … + R_n. All ohm symbols read from the page image.

$$R_e = R_1 + R_2 + \ldots + R_n$$

- R_e effective (combined) resistance Ω
- R_1, R_2 individual resistances Ω

Physics Matters 5e C17, book p.306

Currents in parallel

$$I = I_1 + I_2 + \ldots + I_n$$

- I current from the source A also mA
- I_1, I_2 current in each branch A also mA

Physics Matters 5e C17, book pp.309-310

Potential difference in parallel

$$V_{\text{epsilon}} = V_1 = V_2 = \ldots = V_n$$

- $V_{epsilon}$ p.d. across the source V, mV
- V_1, V_2 p.d. across each branch V, mV

Physics Matters 5e C17, book p.310

Effective resistance in parallel

Boxed equation; verified from the page image.

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$$

- R_e effective (combined) resistance Ω
- R_1, R_2 individual resistances Ω

Physics Matters 5e C17, book p.310

Two resistors in parallel (product over sum)

Valid for exactly two resistors. PM also gives the special case R_e = R/2 when R_1 = R_2 = R, with current I/2 in each branch.

$$R_e = \frac{R_1 R_2}{R_1 + R_2}$$

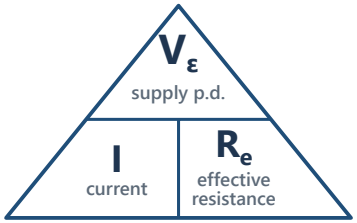
R_e effective resistance Ω
R_1, R_2 the two resistances Ω

Physics Matters 5e C17, book p.310

Current in a whole circuit

Table 17.2 also gives the p.d. across any one resistor R_i as V_i = I R_i.

$$I = \frac{V_{\text{epsilon}}}{R_e}$$

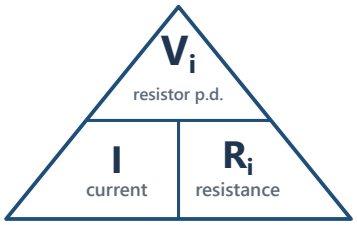


I current drawn from the source **A** also mA
$V_{epsilon}$ p.d. across the source **V, mV**
R_e effective resistance of the circuit Ω

Physics Matters 5e C17, book p.312 (Table 17.2)

P.d. across one resistor

$$V_i = IR_i$$



V_i p.d. across resistor i **V, mV**
I current through it **A** also mA
R_i its resistance Ω

Physics Matters 5e C17, book p.312 (Table 17.2)

Potential divider (output across R_1)

Pure only (K323 15(h)). PM gives the companion V_2 = R_2/(R_1 + R_2) × V_s on the same page. Verified from the page image.

$$V_1 = \frac{R_1}{R_1 + R_2} V_s$$

V_1 p.d. across R_1 **V, mV**
R_1, R_2 the two series resistances Ω
V_s supply voltage **V** also mV

Physics Matters 5e C17, book p.315

Potential divider (output across R_2)

Pure only. This is the form PM's own chapter map uses for V_out; on p.315 the same relation is written as V_2 = R_2/(R_1 + R_2) × V_s.

$$V_{\text{out}} = \frac{R_2}{R_1 + R_2} V_{\text{epsilon}}$$

V_{out} output voltage, taken across R_2 **V** also mV
R_1, R_2 the two series resistances Ω
$V_{epsilon}$ supply voltage **V** also mV

Physics Matters 5e C17, book p.322 (chapter map)

Potential divider by length (potentiometer/rheostat)

Pure only. PM gives the companion V_2 = l_2/(l_1 + l_2) × V_s. OCR TRAP: the italic l looks like I in the extracted text — these are LENGTHS, not currents; confirmed from the page image. PM: "This ratio of the resistances can also be expressed in terms of the length of the resistor or rheostat or the angle of turns of a potentiometer slider." Worked Example 17E applies the same fraction to angles: V_out = (90°/270°) V_s.

$$V_1 = \frac{l_1}{l_1 + l_2} V_s$$

V₁ p.d. across the first section V, mV
l₁, l₂ equivalent lengths of R_1 and R_2 m also km, cm, mm
V_s supply voltage V also mV

Physics Matters 5e C17, book p.317

Potentiometer output by track position

Pure only. The chapter map writes it twice: V_out = (R_AC/R_AB) V_ε = (AC/AB) V_ε. Verified from the page image.

$$V_{\text{out}} = \frac{R_{\text{AC}}}{R_{\text{AB}}} V_{\text{epsilon}}$$

V_out output voltage between the slider C and end A V also mV
R_AC resistance of track section AC Ω
R_AB resistance of the whole track AB Ω
V_epsilon supply voltage V also mV

Physics Matters 5e C17, book p.322 (chapter map)

Thermistor in a potential divider

Pure only (K323 15(i), 15(j)). Both ohm symbols in PM's "where" list were read from the page image. Same form applies to an LDR: Worked Example 17G uses V_out = R_LDR/(R_1 + R_LDR) × V_s with the LDR as the lower resistor.

$$V_{\text{out}} = \frac{R}{R + R_{\text{TH}}} V_{\text{epsilon}}$$

V_out output voltage V also mV
R resistance of the fixed resistor Ω
R_TH resistance of the thermistor Ω
V_epsilon voltage supplied by electrical source V also mV

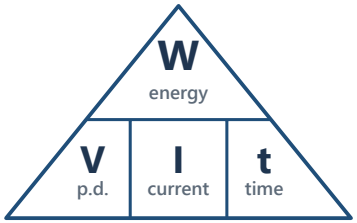
Physics Matters 5e C17, book p.319 (Figure 17.25)

16. Practical Electricity

Electrical work done (energy transferred)

Boxed equation. The syllabuses write it as E = V I t (K323 16(b), K326-328 14(b)); PM's chapter map on p.340 also uses E = VIt. PM's Helpful Note mnemonic: "Energy has vitality. W = VIt".

$$W = VIt$$

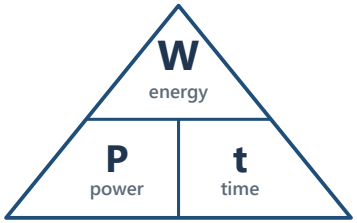


W work done (energy transferred) J
V p.d. of electrical component or heating element V, mV
I current flowing through the component A also mA
t time s also h, min, ms

Physics Matters 5e C18, book p.327

Power as rate of energy transfer

$$P = \frac{W}{t}$$



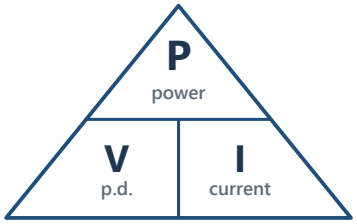
P power **W**
W work done (energy transferred) **J**
t time **s** also h, min, ms

Physics Matters 5e C18, book p.327

Electrical power

Boxed equation, obtained by "replacing W with = VIt and simplifying".

$$P = VI$$



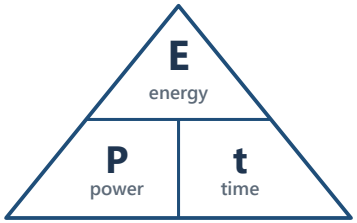
P power **W**
V p.d. across the component **V, mV**
I current through it **A** also mA

Physics Matters 5e C18, book p.327

Energy from power and time

The chapter map states "E = Pt" as a general relationship, linked to E = VIt by "related to power by P = VI". This is the form used for kW h: energy in kW h = power in kW × time in h (Worked Example 18C table).

$$E = Pt$$



E energy transferred **J** also kW h
P power **W**
t time **s** also h, min, ms

Physics Matters 5e C18, book p.340 (chapter map); applied at p.329 and p.330

Energy in terms of current and resistance

Bold equation (not a callout box). Neither syllabus lists this as an LO — both stop at P = VI and E = VIt — but both textbooks state it (PM p.328, Discover Physics C15 p.270). PM uses it on p.333 (written there as E = I^2 R t) to explain overheating.

$$W = I^2Rt$$

W work done (energy transferred) **J**
I current flowing in the resistor or heating element **A** also mA
R resistance of the resistor or heating element **Ω**
t time **s** also h, min, ms

Physics Matters 5e C18, book p.328

Energy in terms of p.d. and resistance

Derived "since I = V/R". Not a syllabus LO in either band; stated in both textbooks.

$$W = \frac{V^2t}{R}$$

W work done (energy transferred) **J**
V p.d. across the resistor or heating element **V, mV**
t time **s** also h, min, ms
R resistance of the resistor or heating element **Ω**

Physics Matters 5e C18, book p.328

Power in terms of current and resistance

PM's Helpful Note warning: "we cannot use these equations to say that power is directly proportional to resistance or power is inversely proportional to resistance since resistance, voltage and current are interlinked."

$$P = I^2R$$

P power **W**
I current flowing in the resistor or heating element **A** also mA
R resistance of the resistor or heating element **Ω**

Physics Matters 5e C18, book p.328

Power in terms of p.d. and resistance

Ohm symbols in PM's "where" list read from the page image.

$$P = \frac{V^2}{R}$$

P power **W**
V p.d. across the resistor or heating element **V**, mV
R resistance of the resistor or heating element **Ω**

Physics Matters 5e C18, book p.328

The kilowatt-hour in joules

Stated exactly in this three-step form in the callout beside Figure 18.4; PM also says "Each kilowatt-hour is equivalent to 3.6 MJ. That is 3 600 000 J of energy."

$$1\text{kW}h = 1\text{kW} \times 1h = 1000W \times 3600s = 3.6 \times 10^{6J}$$

energy **J** also kW h

Physics Matters 5e C18, book p.330

19. Electromagnetic Induction

Transformer (turns-ratio) equation

Boxed. Verified on the page image: the book prints Vp/Vs = Np/Ns (primary over secondary on both sides), matching syllabus K323 19(e). Whole chapter is Pure only — the G3 Science syllabus (K326–328) has no electromagnetic induction topic.

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

$\boldsymbol{V_p}$ primary (input) voltage **V**
$\boldsymbol{V_s}$ secondary (output) voltage **V**
$\boldsymbol{N_p}$ number of turns in primary coil —
$\boldsymbol{N_s}$ number of turns in secondary coil —

Physics Matters 5e C21, book p.390

Secondary voltage

Rearrangement printed in the text.

$$V_s = \frac{N_s}{N_p}V_p$$

$\boldsymbol{V_s}$ secondary (output) voltage **V**
$\boldsymbol{V_p}$ primary (input) voltage **V**
$\boldsymbol{N_s}$ number of turns in secondary coil —
$\boldsymbol{N_p}$ number of turns in primary coil —

Physics Matters 5e C21, book p.390

Ideal transformer power equation

Boxed. Holds if and only if there are no energy losses (ideal transformer).

$$V_p I_p = V_s I_s$$

- V_p primary (input) voltage V
- I_p primary (input) current A
- V_s secondary (output) voltage V
- I_s secondary (output) current A

Physics Matters 5e C21, book p.390

Current ratio from the power equation

$$\frac{I_p}{I_s} = \frac{V_s}{V_p}$$

- I_p primary (input) current A
- I_s secondary (output) current A
- V_s secondary (output) voltage V
- V_p primary (input) voltage V

Physics Matters 5e C21, book p.390

Current ratio in terms of turns

Note the inversion — the current ratio is the reciprocal of the voltage ratio.

$$\frac{I_p}{I_s} = \frac{N_s}{N_p}$$

- I_p primary (input) current A
- I_s secondary (output) current A
- N_s number of turns in secondary coil —
- N_p number of turns in primary coil —

Physics Matters 5e C21, book p.390

Secondary current

$$I_s = \frac{N_p}{N_s} I_p$$

- I_s secondary (output) current A
- I_p primary (input) current A
- N_p number of turns in primary coil —
- N_s number of turns in secondary coil —

Physics Matters 5e C21, book p.390

Transformer efficiency

Boxed. For an ideal transformer η = 1 or 100%.

$$\text{eta} = \frac{\text{output power}}{\text{input power}} \times 100\%$$

- ***eta*** efficiency %
- ***output power*** useful output power W
- ***input power*** input power W

Physics Matters 5e C21, book p.390

Power loss in transmission cables (ohmic heating)

Printed inline as 'ohmic heating (P = I2R) in the cables'; the page image confirms the exponent is 2.

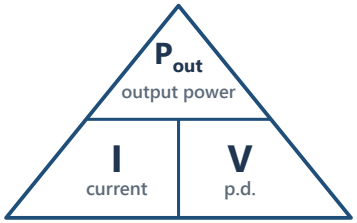
$$P = I^2 R$$

- P power lost in the cables W
- I current in the cables A
- R resistance of the cables Ω

Physics Matters 5e C21, book p.391

Transmission current

$$I = \frac{P_{\text{out}}}{V}$$



I current in the transmission cable A
P out power transmitted W
V transmission voltage V

Physics Matters 5e C21, book p.391

Power loss in terms of transmission voltage

Shows why raising V lowers the loss; verified against the page image.

$$P_{\text{loss}} = I^2R = \frac{P_{\text{out}}}{V}^2 R$$

P loss power lost in the cables W
I current in the transmission cable A
R resistance of the cables Ω
P out power transmitted W
V transmission voltage V

Physics Matters 5e C21, book p.391

20. Radioactivity

Number of neutrons in a nucleus

Boxed as 'Number of neutrons in a nucleus = nucleon number A – proton number Z'; the book gives no symbol for the neutron count. Verified against the page image.

$$\text{number of neutrons} = A - Z$$

A nucleon number —
Z proton number —

Physics Matters 5e C22, book p.399

Background count rate from a 10-minute count

Step 3 of the background-measurement procedure; verified against the page image.

$$\text{number of counts per minute} = \frac{\text{number of counts in 10 minutes}}{10}$$

number of counts per minute background count rate counts/min

Physics Matters 5e C22, book p.405

Corrected count rate

Stated in prose on p.406; Worked Example 22B writes it as (Cr – Cb).

$$\text{corrected count rate} = \text{measured count rate} - \text{background count rate}$$

corrected count rate count rate due to the source alone counts/min or counts/s
measured count rate count rate recorded with the source present counts/min or counts/s
background count rate count rate with no source present counts/min or counts/s

Physics Matters 5e C22, book p.406

Alpha decay (general form)

The book states this rule in words (‘the nucleon number decreases by four and the proton number decreases by two’); the general symbolic form is not printed in the book. Pure only: K323 20(f) ‘use equations involving nuclide notation to represent changes in the composition of the nucleus when radioactive emissions occur’ has no counterpart in the G3 Science syllabus (K326–328 topic 16 stops at (e)).

$$ {}^{A}_{Z}X = {}^{A-4}_{Z-2}Y + {}^{4}_{2}\mathrm{He} $$

- ***A*** nucleon number of the parent —
- ***Z*** proton number of the parent —
- ***X*** parent nuclide —
- ***Y*** daughter nuclide —

Physics Matters 5e C22, book p.403

Alpha decay of radium-226

Verified against the page image. Nucleon numbers 226 → 222 + 4; proton numbers 88 → 86 + 2. Pure only: K323 20(f) ‘use equations involving nuclide notation to represent changes in the composition of the nucleus when radioactive emissions occur’ has no counterpart in the G3 Science syllabus (K326–328 topic 16 stops at (e)).

$$ {}^{226}_{88}\mathrm{Ra} = {}^{222}_{86}\mathrm{Rn} + {}^{4}_{2}\mathrm{He} $$

- ***Ra*** radium-226 (parent) —
- ***Rn*** radon-222 (daughter) —
- ***He*** alpha particle (helium nucleus) —

Physics Matters 5e C22, book p.403

Beta decay (general form)

Rule stated in words (‘the nucleon number remains the same and the proton number increases by one’); the general symbolic form is not printed in the book. Pure only: K323 20(f) ‘use equations involving nuclide notation to represent changes in the composition of the nucleus when radioactive emissions occur’ has no counterpart in the G3 Science syllabus (K326–328 topic 16 stops at (e)).

$$ {}^{A}_{Z}X = {}^{A}_{Z+1}Y + {}^{0}_{-1}e $$

- ***A*** nucleon number of the parent —
- ***Z*** proton number of the parent —
- ***e*** beta particle (electron) —

Physics Matters 5e C22, book p.404

Beta decay of carbon-14

Verified against the page image — the electron carries superscript 0 and subscript –1. Pure only: K323 20(f) ‘use equations involving nuclide notation to represent changes in the composition of the nucleus when radioactive emissions occur’ has no counterpart in the G3 Science syllabus (K326–328 topic 16 stops at (e)).

$$ {}^{14}_{6}C = {}^{14}_{7}N + {}^{0}_{-1}e $$

- ***C*** carbon-14 (parent) —
- ***N*** nitrogen-14 (daughter) —
- ***e*** beta particle (electron) —

Physics Matters 5e C22, book p.404

Alpha decay of uranium-238 with gamma emission

Verified against the page image: two γ rays of different energies, each written with superscript 0 and subscript 0. Pure only: K323 20(f) ‘use equations involving nuclide notation to represent changes in the composition of the nucleus when radioactive emissions occur’ has no counterpart in the G3 Science syllabus (K326–328 topic 16 stops at (e)).

$$ {}^{238}_{92}U = {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He} + 2\,{}^{0}_{0}\gamma $$

- ***U*** uranium-238 (parent) —
- ***Th*** thorium-234 (daughter) —
- ***He*** alpha particle —
- ***γ*** gamma ray —

Physics Matters 5e C22, book p.404

Nuclear fission of uranium-235 (Figure 22.14)

Verified against the page image. Pure only: K323 20(j) covers nuclear fission and fusion; the G3 Science syllabus has no such outcome and Discover Physics 5e C17 contains no fission or fusion section at all.

$$ {}^{1}_{0}n + {}^{235}_{92}U = {}^{144}_{56}\mathrm{Ba} + {}^{90}_{36}\mathrm{Kr} + 2{}^{1}_{0}n $$

- ***n*** neutron —
- ***U*** uranium-235 (parent nucleus) —
- ***Ba*** barium-144 (daughter nucleus) —
- ***Kr*** krypton-90 (daughter nucleus) —

Physics Matters 5e C22, book p.410

Nuclear fission of uranium-235 (alternative products)

Verified against the page image: Ba-139, Kr-94, three neutrons. 'In a nuclear fission, there are several possible fission products.' Pure only: K323 20(j) covers nuclear fission and fusion; the G3 Science syllabus has no such outcome and Discover Physics 5e C17 contains no fission or fusion section at all.

$$ {}^{235}_{92}U + {}^{1}_{0}n = {}^{139}_{56}\mathrm{Ba} + {}^{94}_{36}\mathrm{Kr} + 3{}^{1}_{0}n $$

- ***n*** neutron —
- ***U*** uranium-235 —
- ***Ba*** barium-139 —
- ***Kr*** krypton-94 —

Physics Matters 5e C22, book p.411

Nuclear fusion of hydrogen-2 and hydrogen-3

Verified against the page image (Figure 22.15); γ rays are also released. Pure only: K323 20(j) covers nuclear fission and fusion; the G3 Science syllabus has no such outcome and Discover Physics 5e C17 contains no fission or fusion section at all.

$$ {}^{2}_{1}H + {}^{3}_{1}H = {}^{4}_{2}\mathrm{He} + {}^{1}_{0}n $$

- ***H*** hydrogen-2 and hydrogen-3 nuclei —
- ***He*** helium-4 nucleus —
- ***n*** neutron —

Physics Matters 5e C22, book p.411