Physics (0625)

IGCSE • Core • CAIE

Compact Cheat Sheet

The Practice Book
www.thepracticebook.org

1 Electricity and magnetism

KEY FORMULAS

Electric current

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

Current is the rate of flow of charge, measured in amperes (A). Use to find the current I from the charge Q in coulombs that passes a point in time t in seconds, or rearrange as $Q = It$ to find the charge.

Electrical power

$$P = IV$$

Power P is the rate at which a device transfers electrical energy, in watts (W). Use with the current I through a device and the p.d. V across it.

Resistance and Ohm's law

$$V = IR$$

Resistance R, in ohms, opposes the current. Use to relate the p.d. V across a component to the current I through it; rearrange as $R = V/I$ to calculate a resistance from measured values.

Total resistance in series

$$R = R_1 + R_2$$

For resistors connected in *series* the total resistance is the sum of the separate resistances. Use for any number of resistors joined one after another in a single loop.

KEY CONCEPTS

- **E.m.f. and potential difference**: Both are measured in *volts* (V). The *electromotive force* (e.m.f.) of a source is the electrical energy it gives to each unit of charge driven through it. The *potential difference* (p.d.) across a component is the energy delivered by each unit of charge as it passes through that component.
- **Electric charge and charging by friction**: There are two types of charge, *positive* and *negative*; like charges repel and unlike charges attract. An insulator is charged by *friction*, which transfers *electrons* from one material to the other. The material that gains electrons becomes negative and the one that loses electrons becomes positive. Only electrons move.
- **Electromagnetic induction**: When a conductor and a magnetic field move relative to each other, a voltage (e.m.f.) is *induced* across the conductor; if the circuit is complete an induced current flows. The induced e.m.f. is larger when the movement is faster, the magnet is stronger, or the coil has more turns. A steady, unchanging field induces nothing.
- **Magnetic poles and field lines**: Every magnet has a north pole and a south pole. *Like poles repel and unlike poles attract*. A magnetic field is the region in which a magnet exerts a force, shown by field lines that point *from north to south* outside the magnet. Where the lines are closer together the field is stronger.
- **The motor effect**: A current-carrying conductor placed in a magnetic field experiences a *force*, an effect called the *motor effect*, unless the current runs along the same line as the field. The force is greatest when the conductor is at right angles to the field. Increasing the current or using a stronger magnet increases the force.

2 Motion, forces and energy

KEY FORMULAS

Acceleration

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

Use to find the rate of change of velocity, in m/s². Here Δv is the change in velocity and t is the time taken. A negative value means the object is slowing down.

Density

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

Use to find density from mass m and volume V, in kg/m³ or g/cm³. A more dense material packs more mass into the same volume.

Kinetic energy

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

Use to find the energy stored in a moving object of mass m travelling at speed v, in joules.

Moment of a force

$$\text{moment} = F \times d$$

Use to find the turning effect of a force about a pivot, in newton metres (N m). Here d is the *perpendicular* distance from the pivot to the line of action of the force.

Newton's second law

$$F = ma$$

Use to find the resultant force on a mass m that accelerates at a, or the acceleration produced by a known resultant force. Force is in newtons.

Power

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

Use to find the rate of transferring energy or doing work, in watts (1 W = 1 J/s). Here ΔE is the energy transferred in time t.

Pressure

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

Use to find the pressure produced by a force F acting at right angles to an area A, in pascals (1 Pa = 1 N/m²).

Speed

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

Use to find how fast an object travels, in metres per second (m/s) when distance is in metres and time in seconds. *Velocity* is the speed in a stated direction.

Weight

$$W = mg$$

Use to find the weight, the gravitational force on a mass m, in newtons. Here g is the gravitational field strength, about 9.8 N/kg on Earth.

Work done

$$W = F \times d$$

Use to find the energy transferred when a force F moves an object a distance d in the direction of the force, in joules.

KEY CONCEPTS

- **Centre of gravity**: The *centre of gravity* is the single point at which the whole weight of an object can be taken to act. For a symmetrical object of uniform density it lies at the centre of symmetry.
- **Conservation of energy**: Energy is held in different stores, including *kinetic*, *gravitational potential*, *chemical* and *elastic*. The principle of conservation of energy states that energy is never created or destroyed, only transferred from one store to another, so the total energy stays the same.
- **Measuring length, volume and time**: Length is measured with a *ruler*, the volume of a liquid with a *measuring cylinder* (reading the bottom of the *meniscus* at eye level), and time with a *clock* or *stopwatch*. Each quantity is recorded with its correct SI unit: the metre, the cubic metre (or litre), and the second.
- **Resultant force**: The *resultant force* is the single force that has the same effect as all the forces acting on an object combined. A non-zero resultant changes the object's velocity (speeding up, slowing down or changing direction); a zero resultant means the object stays at rest or keeps a constant velocity.

3 Nuclear physics

KEY FORMULAS

Alpha decay equation

$$^{A}_{Z}\mathrm{X} \rightarrow {}^{A-4}_{Z-2}\mathrm{Y} + {}^{4}_{2}\alpha$$

In *alpha decay* the nucleus emits an alpha particle, so the nucleon number A falls by 4 and the proton number Z falls by 2. Use when a question states a source decays by alpha emission; the daughter is a different element.

Nuclide notation and neutron number

$$^{A}_{Z}\mathrm{X}, \quad \text{neutrons} = A - Z$$

Read any nuclide as $^{A}_{Z}\mathrm{X}$: the bottom number is the *proton number* Z (it fixes the element) and the top number is the *nucleon number* A (protons plus neutrons). Use to count particles: protons $= Z$, neutrons $= A - Z$, and electrons $= Z$ in a neutral atom.

KEY CONCEPTS

- **Dangers of ionising radiation**: Ionising radiation knocks electrons off atoms in living cells. This can *kill cells* or *damage DNA*, which may cause mutations or cancer. The larger the dose received, the greater the risk, so exposure must always be kept as low as possible.
- **Detecting radiation and count rate**: Unstable nuclei emit radiation that is detected with a *Geiger-Müller tube* connected to a counter, which records a *count rate* (counts per second or per minute). A higher count rate means more radiation is reaching the detector.
- **Nature and charge of the three radiations**: *Alpha* (α) is a helium nucleus, 2 protons and 2 neutrons, with charge $+2$. *Beta* (β) is a fast-moving electron with charge -1. *Gamma* (γ) is a high-energy electromagnetic wave with no charge and no mass.
- **Nuclear model of the atom**: An atom is a tiny, dense *nucleus* of *protons* and *neutrons* surrounded by *electrons* in orbits far outside it. Almost all the mass and all the positive charge sit in the nucleus, while almost all the volume is empty space. A neutral atom has equal numbers of protons and electrons.
- **Penetration and ionising power**: *Alpha* is the most ionising but the least penetrating, stopped by a sheet of paper or skin. *Beta* is moderately ionising and is stopped by a few mm of aluminium. *Gamma* is the least ionising but the most penetrating, reduced only by thick lead or concrete. The rule is that the more ionising a radiation is, the less penetrating it is.
- **What half-life means**: The *half-life* of a radioactive isotope is the time taken for half of the unstable nuclei in a sample to decay, which is also the time for the count rate to fall to half its value. Because decay is random, the same fraction always decays in equal times, so the amount keeps halving but never quite reaches zero.

4 Space physics

KEY CONCEPTS

- **Gravity keeps the planets in orbit**: The Sun's *gravity* holds every planet in its orbit. This gravitational pull grows weaker with distance, so a planet further from the Sun is pulled less strongly, moves more slowly and takes longer to complete one orbit.
- **Redshift**: When the light from a distant galaxy is split into a spectrum, the lines are shifted toward the *red* (longer wavelength) end. This *redshift* shows that the galaxy is moving away from us, and a larger redshift means a faster speed of recession.
- **Structure of the Solar System**: The Solar System is one star (the Sun) together with *eight planets* and their moons, plus dwarf planets, asteroids and comets. It formed long ago from a slowly collapsing cloud of gas and dust.
- **The expanding Universe and the Big Bang**: More distant galaxies show greater redshifts, so they are moving away faster. This means the whole Universe is *expanding*. Tracing that expansion backwards points to the *Big Bang*: the Universe began from a single hot, dense point and has been expanding ever since.
- **The Sun is a star**: The Sun is a *medium-sized star* made mostly of hydrogen and helium. It releases energy by *nuclear fusion* in its core, where hydrogen nuclei join to form helium, and it is just one of the billions of stars in our galaxy.
- **The three motions in the Earth and Moon system**: Three motions run at once. The Earth *spins* on its axis once every 24 hours, the Earth *orbits* the Sun once every year (about 365 days), and the *Moon* orbits the Earth about once every month.
- **Why we have day and night**: The Earth spins once on its axis every 24 hours. The half of the Earth facing the Sun has *day* and the half turned away has *night*. Because the Earth rotates from west to east, the Sun appears to rise in the east and set in the west.

5 Thermal physics

KEY FORMULAS

Kelvin temperature conversion

$$T_K = \theta_C + 273$$

Converts a Celsius temperature θ_C to the absolute (Kelvin) scale. Use when a temperature must be expressed on the absolute scale, for example to describe how close a substance is to absolute zero.

Specific heat capacity equation

$$\Delta E = mc\Delta\theta$$

Energy needed to change the temperature of mass m by $\Delta\theta$ with no change of state. Here c is the specific heat capacity in J/(kg °C); keep m in kg and use the temperature *change*.

KEY CONCEPTS

- **Conduction**: Conduction is the transfer of thermal energy through a material without the material itself moving. Particles at the hot end gain energy and vibrate more, then pass energy to neighbouring particles through collisions. *Metals* are the best conductors, while *non-metals and gases* are poor conductors, called insulators.
- **Convection**: Convection is the transfer of thermal energy through a *fluid* (a liquid or a gas) by the bulk movement of the fluid. Warmer fluid expands, becomes less dense and rises, while cooler, denser fluid sinks to take its place. Convection cannot occur in a solid or in a vacuum.
- **Gas pressure and the particle model**: A gas exerts pressure because its particles are in constant random motion and collide with the walls of the container. Each collision exerts a tiny force, and the combined effect of countless collisions per second is the gas pressure. Reducing the volume or raising the temperature makes the particles strike the walls more often, so the pressure rises.
- **Latent heat and change of state**: During melting at the melting point or boiling at the boiling point the temperature stays constant even though energy is still supplied. This *latent heat* energy is used to break the forces between particles and change the state, not to raise the temperature.
- **Particle model of matter**: All matter is made of tiny particles in constant motion. In a *solid* the particles vibrate about fixed positions in a regular arrangement held by strong forces; in a *liquid* they are still close together but can slide past one another; in a *gas* they are far apart and move quickly in all directions, filling any container.
- **Thermal expansion of solids, liquids and gases**: When a substance is heated its particles move more and take up more room, so the substance expands. For the same temperature rise the expansion is greatest for *gases*, smaller for *liquids* and least for *solids*, because weaker forces between particles let them move apart more easily.
- **Thermal radiation**: Thermal radiation is the transfer of thermal energy as *infrared* waves. It needs no medium, so it can travel through a vacuum, which is how energy from the Sun reaches the Earth. Every object emits thermal radiation, and a hotter object emits more.

6 Waves

KEY CONCEPTS

- **Converging and diverging lenses**: A *converging (convex)* lens bends parallel light inward to meet at the *principal focus*. A *diverging (concave)* lens spreads parallel light outward so it appears to come from a focus behind the lens. The distance from the lens to the principal focus is the *focal length*.
- **Dispersion through a prism**: White light is a mixture of all colours. A glass prism refracts each colour by a slightly different amount, *violet most* and *red least*, so the white light fans out into the visible spectrum. The colour order is red, orange, yellow, green, blue, indigo, violet (ROYGBIV).
- **Law of reflection**: When light reflects from a plane mirror the *angle of incidence* equals the *angle of reflection*, both measured from the *normal*, which is the line drawn at right angles (90°) to the mirror surface at the point where the ray strikes.
- **Refraction of light**: Refraction is the change in direction of light as it crosses between two media because its *speed* changes. Going from air into a denser medium such as glass or water the light slows and bends *toward* the normal; leaving the denser medium it speeds up and bends *away* from the normal.
- **Sound as a longitudinal wave**: Sound is produced by a *vibrating source* and travels as a *longitudinal* wave through a medium, which may be a solid, liquid or gas. Sound *cannot travel through a vacuum*, so space is silent. The audible range for a typical human is about 20 Hz to $20\,000$ Hz.
- **The electromagnetic spectrum order**: In order of *increasing frequency* and *decreasing wavelength* the regions are: radio, microwave, infrared, visible, ultraviolet, X-rays, gamma rays. All are transverse waves and all travel at the same very high speed in a vacuum.
- **The wave equation**: A wave transfers *energy* from place to place without transferring matter. Speed, frequency and wavelength are linked by $v = f\lambda$, where v is the wave speed, f is the frequency in hertz and λ is the wavelength. Rearrange as $\lambda = v/f$ or $f = v/\lambda$.
- **Transverse and longitudinal waves**: In a *transverse* wave the vibration is at right angles to the direction of travel, for example light and water ripples. In a *longitudinal* wave the vibration is along the direction of travel, forming compressions and rarefactions, for example sound.

Generated 2026/06/15