

Important Equations in Physics for IGCSE course

General Physics:

1	For constant motion:	$v = \frac{s}{t}$	'v' is the velocity in m/s, 's' is the distance or displacement in meters and 't' is the time in sec
2	For acceleration 'a'	$a = \frac{v - u}{t}$	u is the initial velocity, v is the final velocity and t is the time
3	Graph: in velocity-time graph the area under the graph is the total distance covered	Area of a rectangular shaped graph = base \times height Area of triangular shaped graph = $\frac{1}{2} \times$ base \times height	
4	Weight is the force of gravity and mass is the amount of matter	$w = m \times g$	w is the weight in newton (N), m is the mass in kg and g is acceleration due to gravity = 10 m/s^2
5	Density ' ρ ' in kg/m^3 (ρ is the rho)	$\rho = \frac{m}{V}$	m is the mass and V is the volume
6	Force F in newtons (N)	$F = m \times a$	m is the mass and a is acceleration
7	Terminal Velocity: falling with air resistance	Weight of an object (downward) = air resistance (upwards) implies no net force, therefore no acceleration, <u>constant velocity</u>	
8	Hooke's Law	$F = k \times x$	F is the force, x is the extension in meters and k is the spring constant
9	Moment of a force in N.m (also turning effect)	moment of force = $F \times d$	d is the perpendicular distance from the pivot and F is the force
10	Law of moment or equilibrium	Total clockwise moment = total anticlockwise moment $\Rightarrow F_1 \times d_1 = F_2 \times d_2$	
11	Conditions of Equilibrium	Net force on x-axis=zero, net force on y-axis= zero, net moment=zero	
11	Work done W joules (J)	$W = F \times d$	F is the force and d is the distance covered by an object same direction
12	Kinetic Energy E_k in joules (J)	$E_k = \frac{1}{2} \times m \times v^2$	m is the mass(kg) and v is the velocity (m/s)
13	Potential Energy ΔE_p in joules (J)	$\Delta E_p = m \times g \times \Delta h$	m is mass (kg) and g is gravity and Δh is the height from the ground
14	Law of conservation of energy:	Loss of E_p = gain of E_k $m \times g \times h = \frac{1}{2} \times m \times v^2$	
15	Power in watts (W)	$P = \frac{\text{work done}}{\text{time taken}}$ $P = \frac{\text{Energy transfer}}{\text{time taken}}$	Power is the rate of doing work or rate of transferring the energy from one form to another
16	Efficiency:	$\text{Efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$	
17	Pressure p in pascal (Pa)	$p = \frac{F}{A}$	F is the force in newton (N) and A is the area in m^2
18	Pressure p due to liquid	$p = \rho \times g \times h$	ρ is the density in kg/m^3 , h is the height or depth of liquid in meters and g is the gravity
19	Atmospheric pressure	$P = 760 \text{ mmHg} = 76 \text{ cm Hg} = 1.01 \times 10^5 \text{ Pa}$	
20	Energy source	renewable can be reused Hydroelectric eg dam, waterfall Geothermal eg from earth's rock Solar eg with solar cell Wind energy eg wind power station Tidal/wave energy eg tide in ocean	non-renewable cannot be reused Chemical energy eg petrol, gas Nuclear fission eg from uranium

Thermal Physics:

1	Boyle's law: Pressure and volume are inversely proportional $p \propto V$	$pV = \text{constant}$ $p_1 \times V_1 = p_2 \times V_2$	p_1 and p_2 are the two pressures in Pa and V_1 and V_2 are the two volumes in m^3
2	Thermal Expansion (Linear)	$\Delta L = \alpha \times L_o \times \Delta\theta$ L_o is the original length in meters, $\Delta\theta$ is the change in temperature in $^{\circ}C$, ΔL is the change in length in meters ($L_1 - L_o$) and α is the linear expansivity of the material	
3	Thermal Expansion (Cubical)	$\Delta V = \gamma V_o \Delta\theta$ $\gamma = 3\alpha$	V_o is the original volume in m^3 , $\Delta\theta$ is the change in temperature in $^{\circ}C$, ΔV is the change in volume in m^3 ($V_1 - V_o$) and γ is the cubical expansivity of the material.
4	Charle's Law: Volume is directly proportional to absolute temperature $V \propto T$	$\frac{V}{T} = \text{constant}$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$	V is the volume in m^3 and T is the temperature in kelvin (K).
5	Pressure Law: Pressure of gas is directly proportional to the absolute temperature $p \propto T$	$\frac{p}{T} = \text{constant}$ $\frac{p_1}{T_1} = \frac{p_2}{T_2}$	p is the pressure in Pa and T is the temperature in Kelvin (K).
6	Gas Law (combining above laws) $\frac{pV}{T} = \text{constant}$	$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$	In thermal physics the symbol θ is used for celsius scale and T is used for kelvin scale.
7	Specific Heat Capacity: Amount of heat energy required to raise the temperature of 1 kg mass by $1^{\circ}C$.	$c = \frac{Q}{m \times \Delta\theta}$	c is the specific heat capacity in $J/(kg^{\circ}C)$, Q is the heat energy supplied in joules (J), m is the mass in kg and $\Delta\theta$ is the change in temperature
8	Thermal Capacity: amount of heat require to raise the temperature of a substance of any mass by $1^{\circ}C$	Thermal capacity = $m \times c$ Thermal capacity = $\frac{Q}{\Delta\theta}$	The unit of thermal capacity is $J^{\circ}C$.
9	Specific latent heat of fusion (from solid to liquid)	$L_f = \frac{Q}{m}$	L_f is the specific latent heat of fusion in J/kg or J/g , Q is the total heat in joules (J), m is the mass of liquid change from solid in kg or g.
10	Specific latent heat of vaporization (from liquid to vapour)	$L_v = \frac{Q}{m}$	L_v is the specific latent heat of vaporization in J/kg or J/g , Q is the total heat in joules (J), m is the mass of vapour change from liquid in kg or g.
11	Thermal or heat transfer	In solid = conduction In liquid and gas = convection and also convection current (hot matter goes up and cold matter comes down) In vacuum = radiation	
12	Emitters and Radiators	Dull black surface = good emitter, good radiator, bad reflector Bright shiny surface = poor emitter, poor radiator, good reflector	
13	Another name for heat radiation	Infrared radiation or radiant heat	
14	Melting point	Change solid into liquid, energy weaken the molecular bond, no change in temperature, molecules move around each other	
15	Boiling point	Change liquid into gas, energy break molecular bond and molecules escape the liquid, average kinetic energy increase, no change in temperature, molecule are free to move	
16	Condensation	Change gas to liquid, energy release, bonds become stronger	
17	Solidification	Change liquid to solid, energy release bonds become very strong	
18	Evaporation	Change liquid to gas at any temperature, temperature of liquid decreases, happens only at the surface	

Waves, light and sound:

1	Wave motion	Transfer of energy from one place to another						
2	Frequency f	Number of cycle or waves in one second, unit hertz (Hz)						
3	Wavelength λ	Length of one complete waves, unit, meters (m)						
4	Amplitude a	Maximum displacement of medium from its mean position, meters						
5	wavefront	A line on which the disturbance of all the particles are at same point from the central position eg a crest of a wave is a wavefront						
6	Wave equation 1	$v = f \times \lambda$		v is the speed of wave in m/s, f is the frequency in (hertz) Hz, λ is the wavelength in meters				
7	Wave equation 2	$f = \frac{1}{T}$		T is the time period of wave in seconds				
8	Movement of particles of the medium	Longitudinal waves=> back and forth parallel to the direction of the waves Transverse waves=> perpendicular to the direction of the waves						
9	Law of reflection	Angle of incidence $i =$ angle of reflection angle $i^{\circ} =$ angle r°						
10	Refraction	From lighter to denser medium \rightarrow light bend towards the normal From denser to lighter medium \rightarrow light bend away from the normal						
11	Refractive index n (Refractive index has not units)	$n_{\text{glass}} = \frac{\sin \angle i_{\text{air or vacuum}}}{\sin \angle r_{\text{glass}}}$			$n_{\text{glass}} = \frac{\text{speed of light in air or vacuum}}{\text{speed of light in glass}}$			
12	Diffraction	Bending of waves around the edges of a hard surface						
13	Dispersion	Separation of different waves according to colours or frequency for example by using prism						
14	Image from a plane mirror	Virtual, upright, same size and laterally inverted and same distance from the mirror inside						
15	Image from a convex lens	When close: virtual, enlarge, upright When far: real, small, upside down						
16	Image from a concave lens	Virtual, upright, small						
17	Critical angle	When light goes from denser to lighter medium, the incident angle at which the reflected angle is 90° , is called critical angle.						
18	Total internal reflection (TIR)	When light goes from denser to lighter medium, the refracted ray bend inside the same medium called (TIR) eg optical fibre						
19	Electromagnetic Spectrum: travel in vacuum, oscillating electric and magnetic fields $\leftarrow \lambda$ (decrease) and f (increase) λ (increases) and f (decrease)\rightarrow							
	Gamma rays	X-Rays	Ultra violet rays	Visible (light) rays	Infrared rays	Micro waves	Radio waves	
20	Gamma rays: for killing cancer cells X-rays: in medicine UV rays: for sun tan and sterilization of medical instruments			Visible light: light rays, monochromatic means one colour Infrared: remote controls, treatment of muscular pain Micro waves: international communication, mobile phones Radio waves: radio and television communication				
21	Colours of visible light VIBGYO R wavelengths	Violet $4 \times 10^7 \text{m}$	Indigo	Blue	Green	Yellow	Orange	Red $7 \times 10^7 \text{m}$
22	Speed of light waves or electromagnetic waves	In air: $3 \times 10^8 \text{m/s}$		In water: $2.25 \times 10^8 \text{m/s}$		In glass: $2 \times 10^8 \text{m/s}$		
23	Light wave	Transverse electromagnetic waves						
24	Sound wave are longitudinal waves	particles of the medium come close to each other \rightarrow compression particles of the medium move away \rightarrow rarefaction						
25	Echo	$v = \frac{2 \times d}{t}$		v is the speed of sound waves, d is the distance in meters between source and the reflection surface and t is the time for echo				
26	Properties of sound waves	<u>Pitch</u> is similar to the frequency of the wave <u>Loudness</u> is similar to the amplitude of the wave						
27	Speed of sound waves	Air : 330-340 m/s		Water: 1400 m/s	Concrete : 5000 m/s	Steel: 6000–7000 m/s		

Electricity and magnetism:

1	Ferrous Materials	Attracted by magnet and can be magnetized	iron, steel, nickel and cobalt (iron temporary and steel permanent)		
2	Non-ferrous materials	Not attracted by magnet and cannot be magnetized	copper, silver, aluminum, wood, glass		
3	Electric field	The space or region around a charge where a unit charge experience force Direction is outward from positive charge and inward into negative charge			
4	Electric field intensity	Amount force exerted by the charge on a unit charge (q) placed at a point in the field	E is the electric field intensity in N/C $E = \frac{F}{q}$		
5	Current (I): Rate of flow of charges in conductor	$I = \frac{Q}{t}$	I is the current in amperes (A), Q is the charge in coulombs (C) t is the time in seconds (s)		
6	Current	In circuits the current always choose the easiest path			
7	Ohms law	Voltage across the resistor is directly proportional to current, $V \propto I$ provided if the physical conditions remains same $\frac{V}{I} = R$	V is the voltage in volts (V), I is the current in amperes (A) and R is resistance in ohms (Ω)		
8	Voltage (potential difference)	Energy per unit charge $V = \frac{\text{Energy}}{\text{charge}} = \frac{E}{q}$	q is the charge in coulombs (C), V is the voltage in volts (V) Energy is in joules (J)		
9	E.M.F. Electromotive force	E.M.F. = lost volts inside the power source + terminal potential difference $EMF = Ir + IR$			
10	Resistance and resistivity	$R = \rho \frac{L}{A}$ ρ is the resistivity of resistor in $\Omega.m$	R is the resistance a resistor, L is the length of a resistor in meters A is the area of cross-section of a resistor in m^2		
11	Circuit	In series circuit \rightarrow the current stays the same and voltage divides In parallel circuit \rightarrow the voltage stays the same and current divides			
12	Resistance in series	$R = R_1 + R_2 + R_3$	R, R ₁ , R ₂ and R ₃ are resistances of resistors in ohms		
13	Resistance in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$			
14	Potential divider or potentiometer	$\frac{V_1}{V_2} = \frac{R_1}{R_2}$			
15	Potential divider	$V_2 = \left(\frac{R_2}{R_1 + R_2}\right) \times V$	$V_1 = \left(\frac{R_1}{R_1 + R_2}\right) \times V$		
16	Power	$P = I \times V$	$P = I^2 \times R$	$P = \frac{V^2}{R}$	P is the power in watts (W)
17	Power	$P = \frac{\text{Energy}}{\text{time}}$		The unit of energy is joules (J)	
18	Diode	Semiconductor device... current pass only in one direction, rectifier			
19	Transistor	Semiconductor device works as a switch , collector, base, emitter			
20	Light dependent resistor	LED resistor depend upon light, brightness increases the resistance decrease			
21	Thermistor	Resistor depend upon temperature, temperature increase resistance decrease			
22	Capacitor	Parallel conductor with insulator in between to store charges			
23	Relay	Electromagnetic switching device			
24	Fleming's RH or LH rule	thumb Direction of motion	First finger Direction of magnetic field	seCond finger Direction of current	
25	Transformer	$\frac{V_p}{V_s} = \frac{n_p}{n_s}$	V_p and V_s are the voltages; n_p and n_s are the no of turns in primary and secondary coils		

26	Transformer	$P_p = P_s$ $I_p \times V_p = I_s \times V_s$ $\frac{V_p}{V_s} = \frac{I_s}{I_p}$	Power in primary coil = Power in secondary coil I_p and I_s the currents in primary and secondary coil												
27	E.M induction	Emf or current is induced in a conductor when it cuts the magnetic field lines													
28	a.c. generator	Produce current, use Fleming's right hand rule													
29	d.c. motor	Consume current, use Fleming's left hand rule													
30	Logic Gates	AND Gate	OR Gate	NOT Gate	NAND Gate	NOR Gate									
		1	2	out	1	2	out	in	out	1	2	out	1	2	out
		0	0	0	0	0	0	0	1	0	0	1	0	0	1
		0	1	0	0	1	1	1	0	0	1	1	0	1	0
		1	0	0	1	0	1			1	0	1	1	0	0
		1	1	1	1	1	1			1	1	0	1	1	0
31	Cathode rays	Stream of electrons emitted from heated metal (cathode). This process is called thermionic emission.													
32	CRO	Horizontal or y-plates for vertical movement of electron beam Timebase or x-plates for horizontal movement													

Atomic Physics:

1	Alpha particles α -particles	Double positive charge Helium nucleus Stopped by paper Highest ionization potential	
2	Beta-particles β -particles	Single negative charge Fast moving electrons Stopped by aluminum Less ionization potential	
3	Gamma-particles γ -rays	No charge Electromagnetic radiation Only stopped by thick a sheet of lead Least ionization potential	
4	Half-life	Time in which the activity or mass of substance becomes half	
5	Atomic symbol	$\begin{matrix} A \\ Z \\ X \end{matrix}$	A is the total no of protons and neutrons Z is the total no of protons
6	Isotopes	Same number of protons but different number of neutrons	