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 × height Area of triangular shaped graph = ½ × base × 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 rhoo)	$\rho = \frac{m}{V}$	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, constant velocity	
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	$Total\ clockwise\ moment = total\ anticlockwise\ moment$ $=> F_1 \times d_1 = F_2 \times d_2$	
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)	$P = \frac{work\ done}{time\ taken}$ $P = \frac{Energy\ transfer}{time\ taken}$	Power is the rate of doing work or rate of transferring the energy from one form to another
16	Efficiency:	$Efficiency = \frac{useful\ energy\ output}{total\ energy\ input} \times 100$	
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=760mmHg = 76cm Hg =$1.01x10^5$ Pa	
20	Energy source	renewable can be reused	non-renewable cannot be reused
		Hydroelectric eg dam, waterfall	Chemical energy eg petrol, gas
		Geothermal eg from earth's rock	Nuclear fission eg from uranium
		Solar eg with solar cell	
		Wind energy eg wind power station	
		Tidal/wave energy eg tide in ocean	

Thermal Physics:

1	Boyle's law: Pressure and volume are inversely proportional $p \propto V$	$pV = constant$ $p_1 \times V_1 = p_2 \times V_2$	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 ^oC, 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)	$\Delta V = \gamma\ Vo\ \ \Delta\theta$ $\gamma = 3\alpha$	V_o is the original volume in m^3, $\Delta\theta$ is the change in temperature in ^oC, 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 $V \propto T$	$\frac{V}{T} = constant$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$	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 $p \propto T$	$\frac{p}{T} = constant$ $\frac{p_1}{T_1} = \frac{p_2}{T_2}$	p is the pressure in Pa and T is the temperature in Kelvin (K).
6	Gas Law (combining above laws) $\frac{pV}{T} = constant$	$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$	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^oC.	$c = \frac{Q}{m \times \Delta\theta}$	c is the specific heat capacity in J/(kg ^oC), 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^oC	Thermal capacity=m×c $Thermal\ capacity = \frac{Q}{\Delta\theta}$	The unit of thermal capacity is $J/^oC$.
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 = angel of reflection $angle\ i^o = angle\ r^o$						
10	Refraction	From lighter to denser medium → light bend towards the normal From denser to lighter medium → light bend away from the normal						
11	Refractive index n (Refractive index has not units)	$n_{glass} = \frac{\sin \angle i_{air\ or\ vacuum}}{\sin \angle r_{glass}}$	$n_{glass} = \frac{speed\ of\ light\ in\ air\ or\ vacuum}{speed\ of\ light\ in\ glass}$					
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^o, 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 ←λ (decrease) and f (increase) λ (increases) and f (decrease)→							
	Gammas rays	X-Rays	Ulra 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 $4\times10^{-7}m$	Indigo	Blue	Green	Yellow	Orange	Red $7\times10^{-7}m$
22	Speed of light waves or electromagnetic waves	In air: $3\times10^{8}m/s$	In water: $2.25\times10^{8}m/s$	In glass: $2\times10^{8}m/s$				
23	Light wave	Transverse electromagnetic waves						
24	Sound wave are longitudinal waves	particles of the medium come close to each other → compression particles of the medium move away → 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	Pitch is similar to the frequency of the wave Loudness 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∝ 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* $V = \frac{Energy}{charge} = \frac{E}{q}$	*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 Ω.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→ the current stays the same and voltage divides In parallel circuit → 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*	$V_2 = (\frac{R_2}{R_1 + R_2}) \times V$	$V_1 = (\frac{R_1}{R_1 + R_2}) \times V$
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*	$P = \frac{Energy}{time}$	*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*

<table>
<tr><td>26</td><td>Transformer</td><td colspan="5">$P_p = P_s$
$I_p \times V_p = I_s \times V_s$
$\frac{V_p}{V_s} = \frac{I_s}{I_p}$</td><td colspan="10">Power in primary coil =Power in secondary coil
I_p and I_s the currents in primary and secondary coil</td></tr>
<tr><td>27</td><td>E.M induction</td><td colspan="15">Emf or current is induced in a conductor when it cuts the magnetic field lines</td></tr>
<tr><td>28</td><td>a.c. generator</td><td colspan="15">Produce current, use Fleming's right hand rule</td></tr>
<tr><td>29</td><td>d.c. motor</td><td colspan="15">Consume current, use Fleming's left hand rule</td></tr>
<tr><td rowspan="6">30</td><td rowspan="6">Logic Gates</td><td colspan="3">AND Gate</td><td colspan="3">OR Gate</td><td colspan="3">NOT Gate</td><td colspan="3">NAND Gate</td><td colspan="3">NOR Gate</td></tr>
<tr><td>1</td><td>2</td><td>out</td><td>1</td><td>2</td><td>out</td><td colspan="2">in</td><td>out</td><td>1</td><td>2</td><td>out</td><td>1</td><td>2</td><td>out</td></tr>
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<tr><td>31</td><td>Cathode rays</td><td colspan="15">Stream of electrons emitted from heated metal (cathode). This process is called thermionic emission.</td></tr>
<tr><td>32</td><td>CRO</td><td colspan="15">Horizontal or y-plates for vertical movement of electron beam
Timebase or x-plates for horizontal movement</td></tr>
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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*	$^{A}_{Z}X$	*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*	