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/s²*
5	*Density 'ρ' in kg/m³* *(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*	$Total\ clockwise\ moment = total\ anticlockwise\ moment$ $\Rightarrow F_1 \times d_1 = F_2 \times d_2$	
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)*	$P = \frac{work\ done}{time\ taken}$ $P = \frac{Energy\ \ ransfer}{time\ taken}$	*Power is the rate of doing work or rate of transferring the energy from one form to another*
16	*Efficiency:*	$Efficiency = \frac{useful\ \ \ \ \ \ output}{total\ \mathbf{energy}\ input} \times 100$	
17	*Pressure p in pascal (Pa)*	$p = \frac{F}{A}$	*F is the force in newton (N) and A is the area in m²*
18	*Pressure p due to liquid*	$p = \rho \times g \times h$	*ρ is the density in kg/m³, h is the height or depth of liquid in meters and g is the gravity*
19	*Atmospheric pressure*	*P=760mmHg = 76cm Hg =1.01x10⁵Pa*	
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* $p \propto V$	$pV = constant$ $p_1 \times V_1 = p_2 \times V_2$	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* $V = \frac{Ene\ gy}{char\ e} = \frac{E}{q}$	*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*	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{_2} + \frac{1}{R_3}$	
14	*Potential divider or potentiometer*	$\frac{\boldsymbol{V_1}}{_2} = \frac{\boldsymbol{R_1}}{_2}$	
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*	$\frac{p}{\boldsymbol{V_s}} = \frac{p}{\boldsymbol{n_s}}$	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	$P_p \quad P_s$ $I_p \times \boldsymbol{V_p} = \boldsymbol{I_s} \times V_s$ $\frac{p}{V_s} = \frac{}{I_p}$	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	${}^{A}_{Z}X$	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	

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