Important Equations in Physics for IGCSE course by Baaz Pathan

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)*	$P = \frac{work\ done}{time\ taken}$ $P = \frac{Energy\ \ ransfer}{time\ taken}$	*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 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/^{o}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:

<table>
<tr><td>1</td><td>Wave motion</td><td colspan="7">Transfer of energy from one place to another</td></tr>
<tr><td>2</td><td>Frequency f</td><td colspan="7">Number of cycle or waves in one second, unit hertz (Hz)</td></tr>
<tr><td>3</td><td>Wavelength λ</td><td colspan="7">Length of one complete waves, unit, meters (m)</td></tr>
<tr><td>4</td><td>Amplitude a</td><td colspan="7">Maximum displacement of medium from its mean position, meters</td></tr>
<tr><td>5</td><td>wavefront</td><td colspan="7">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</td></tr>
<tr><td>6</td><td>Wave equation 1</td><td colspan="2">$v = f \times \lambda$</td><td colspan="5">v is the speed of wave in m/s, f is the frequency in (hertz) Hz, λ is the wavelength in meters</td></tr>
<tr><td>7</td><td>Wave equation 2</td><td colspan="2">$f = \frac{1}{T}$</td><td colspan="5">T is the time period of wave in seconds</td></tr>
<tr><td>8</td><td>Movement of particles of the medium</td><td colspan="7">Longitudinal waves=> back and forth parallel to the direction of the waves
Transverse waves=> perpendicular to the direction of the waves</td></tr>
<tr><td>9</td><td>Law of reflection</td><td colspan="7">Angle of incidence i = angel of reflection
$angle\ i^o = angle\ r^o$</td></tr>
<tr><td>10</td><td>Refraction</td><td colspan="7">From lighter to denser medium → light bend towards the normal
From denser to lighter medium → light bend away from the normal</td></tr>
<tr><td>11</td><td>Refractive index n (Refractive index has not units)</td><td colspan="3">$n_{glass} = \frac{\sin \angle i_{air\ or\ vacuum}}{\sin \angle r_{glass}}$</td><td colspan="4">$n_{glass} = \frac{speed\ of\ light\ in\ air\ or\ vacuum}{speed\ of\ light\ in\ glass}$</td></tr>
<tr><td>12</td><td>Diffraction</td><td colspan="7">Bending of waves around the edges of a hard surface</td></tr>
<tr><td>13</td><td>Dispersion</td><td colspan="7">Separation of different waves according to colours or frequency for example by using prism</td></tr>
<tr><td>14</td><td>Image from a plane mirror</td><td colspan="7">Virtual, upright, same size and laterally inverted and same distance from the mirror inside</td></tr>
<tr><td>15</td><td>Image from a convex lens</td><td colspan="7">When close: virtual, enlarge, upright
When far: real, small, upside down</td></tr>
<tr><td>16</td><td>Image from a concave lens</td><td colspan="7">Virtual, upright, small</td></tr>
<tr><td>17</td><td>Critical angle</td><td colspan="7">When light goes from denser to lighter medium, the incident angle at which the reflected angle is 90^o, is called critical angle.</td></tr>
<tr><td>18</td><td>Total internal reflection (TIR)</td><td colspan="7">When light goes from denser to lighter medium, the refracted ray bend inside the same medium called (TIR) eg optical fibre</td></tr>
<tr><td rowspan="2">19</td><td colspan="8">Electromagnetic Spectrum: travel in vacuum, oscillating electric and magnetic fields
←λ (decrease) and f (increase) λ (increases) and f (decrease)→</td></tr>
<tr><td>Gammas rays</td><td>X-Rays</td><td>Ulra violet rays</td><td>Visible (light) rays</td><td>Infrared rays</td><td>Micro waves</td><td colspan="2">Radio waves</td></tr>
<tr><td>20</td><td colspan="3">Gamma rays: for killing cancer cells
X-rays: in medicine
UV rays: for sun tan and sterilization of medical instruments</td><td colspan="5">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</td></tr>
<tr><td>21</td><td>Colours of visible light VIBGYO R wavelengths</td><td><u>V</u>iolet
$4\times10^{-7}m$</td><td><u>I</u>ndigo</td><td><u>B</u>lue</td><td><u>G</u>reen</td><td><u>Y</u>ellow</td><td><u>O</u>range</td><td><u>R</u>ed
$7\times10^{-7}m$</td></tr>
<tr><td>22</td><td>Speed of light waves or electromagnetic waves</td><td colspan="2">In air: $3\times10^8 m/s$</td><td colspan="2">In water:
$2.25\times10^8 m/s$</td><td colspan="3">In glass:
$2\times10^8 m/s$</td></tr>
<tr><td>23</td><td>Light wave</td><td colspan="7">Transverse electromagnetic waves</td></tr>
<tr><td>24</td><td>Sound wave are longitudinal waves</td><td colspan="7">particles of the medium come close to each other → compression
particles of the medium move away → rarefaction</td></tr>
<tr><td>25</td><td>Echo</td><td colspan="2">$v = \frac{2 \times d}{t}$</td><td colspan="5">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</td></tr>
<tr><td>26</td><td>Properties of sound waves</td><td colspan="7"><u>Pitch</u> is similar to the frequency of the wave
<u>Loudness</u> is similar to the amplitude of the wave</td></tr>
<tr><td>27</td><td>Speed of sound waves</td><td colspan="2">Air :
330-340 m/s</td><td colspan="2">Water:
1400 m/s</td><td>Concrete :
5000 m/s</td><td colspan="2">Steel:
6000–7000 m/s</td></tr>
</table>

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* $V = \frac{Ene\ \boldsymbol{g}y}{cha\boldsymbol{r}\ \ e} = \frac{E}{q}$	*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*

<table>
<tr><td>26</td><td>Transformer</td><td>$P_p \quad P_s$
$I_p \times \boldsymbol{V_p} = \boldsymbol{I_s} \times V_s$
$\frac{p}{V_s} = \frac{}{I_p}$</td><td>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="2">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="2">Produce current, use Fleming’s right hand rule</td></tr>
<tr><td>29</td><td>d.c. motor</td><td colspan="2">Consume current, use Fleming’s left hand rule</td></tr>
<tr><td>30</td><td>Logic Gates</td><td colspan="2">
<table>
<tr><td colspan="3">AND Gate</td><td colspan="3">OR Gate</td><td colspan="2">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>in</td><td>out</td><td>1</td><td>2</td><td>out</td><td>1</td><td>2</td><td>out</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td></td><td></td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td></td><td></td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>31</td><td>Cathode rays</td><td colspan="2">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="2">Horizontal or y-plates for vertical movement of electron beam
Timebase or x-plates for horizontal movement</td></tr>
</table>

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	