Physics Formula Sheet

Displacement $\Delta x = x_f - x_i$	**Average Velocity** $v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$	**Average Acceleration** $a_{avg} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$
Displacement with Constant Uniform Acceleration $\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$	**Velocity with Constant Uniform Acceleration** $v_f = v_i + a\Delta t$	**Displacement with Constant Uniform Acceleration** $\Delta x = v_i \Delta t + \frac{1}{2}a(\Delta t)^2$
Final Velocity After any Displacement $v_f^2 = v_i^2 + 2a\Delta x$	**Pythagorean Theorem for Right Triangles** $a^2 + b^2 = c^2$	**Definition of the Tangent Function for Right Triangles** $\tan \mathbf{q} = \frac{opposite}{adjacent}$
Definition of the Sine Function for Right Triangles $\sin \mathbf{q} = \frac{opposite}{hypotenuse}$	**Definition of the Cosine Function for Right Triangles** $\cos \mathbf{q} = \frac{adjacent}{hypotenuse}$	**Law of Cosines** $c^2 = a^2 + b^2 - 2ab(\cos C)$
Law of Sines $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$	**Projectiles Launched at an Angle** $v_x = v_i(\cos \mathbf{q})$=constant $\Delta x = v_i(\cos \mathbf{q})\Delta t$ $v_{y,f} = v_i(\sin \mathbf{q}) - g\Delta t$ $v_{y,f}^2 = v_i^2(\sin \mathbf{q})^2 - 2g\Delta y$ $\Delta y = v_i(\sin \mathbf{q})\Delta t - \frac{1}{2}g(\Delta t)^2$	**Vertical Motion of a Projectile that Falls from Rest** $v_{y,f} = -g\Delta t$ $v_{y,f}^2 = -2g\Delta y$ $\Delta y = -\frac{1}{2}g(\Delta t)^2$
Horizontal Motion of a Projectile $v_x = v_{x,i}$ = constant $\Delta x = v_x \Delta t$	**Pythagorean Theorem** $a^2 + b^2 = c^2$	**Force** $\sum F = ma$ or $F = ma$
Net Work Done by a Constant Net Force $W_{net} = F_{net} d(\cos \mathbf{q})$	**Kinetic Energy** $KE = \frac{1}{2}mv^2$	**Work-Kinetic Energy Theorem** $W_{net} = \Delta KE$
Gravitational Potential Energy $PE_g = mgh$	**Conservation of Mechanical Energy** $ME_i = ME_f$	**Elastic Potential Energy** $PE_{elastic} = \frac{1}{2}kx^2$
Power $P = \frac{W}{\Delta t}$ $P = Fv$	**Momentum** $p = mv$	**Impulse** $impulse = F\Delta t$
Conservation of Momentum $m_1 v_{1,i} + m_2 v_{2,i} = m_1 v_{1,f} + m_2 v_{2,f}$	**Impulse-Momentum Theorem** $F\Delta t = \Delta p = mv_f - mv_i$	**Perfectly Inelastic Collision** $m_1 v_{1,i} + m_2 v_{2,i} = (m_1 + m_2)v_f$
Momentum and Kinetic Energy Remain Constant in an Elastic Collision $m_1 v_{1,i} + m_2 v_{2,i} = m_1 v_{1,f} + m_2 v_{2,f}$ $\frac{1}{2}m_1 v_{1,i}^2 + \frac{1}{2}m_2 v_{2,i}^2 = \frac{1}{2}m_1 v_{1,f}^2 + \frac{1}{2}m_2 v_{2,f}^2$	**Angular Displacement** $\Delta \mathbf{q} = \frac{\Delta s}{r}$	**Angular Speed** $\mathbf{w}_{avg} = \frac{\Delta \mathbf{q}}{\Delta t}$
Angular Acceleration $\mathbf{a}_{avg} = \frac{\mathbf{w}_2 - \mathbf{w}_1}{t_2 - t_1} = \frac{\Delta \mathbf{w}}{\Delta t}$	**Tangential Speed** $v_t = r\mathbf{w}$	**Tangential Acceleration** $a_t = r\mathbf{a}$
Centripetal Acceleration $a_c = \frac{v_t^2}{r}$ $a_c = r\mathbf{w}^2$	**Force That Maintains Circular Motion** $F_c = \frac{mv_t^2}{r}$ $F_c = mr\mathbf{w}^2$	**Newton's Universal Law of Gravitation** $F_g = G\frac{m_1 m_2}{r^2}$
Torque $\mathbf{t} = Fd(\sin \mathbf{q})$	**Newton's Second Law for Rotating Objects** $\mathbf{t}_{net} = I\mathbf{a}$	**Angular Momentum** $L = I\mathbf{w}$
Calculating Rotational Kinetic Energy $KE_{rot} = \frac{1}{2}I\mathbf{w}^2$	**Mass Density** $\mathbf{r} = \frac{m}{V}$	**Bouyant Force** $F_B = F_g(displaced\_fluid) = m_f g$
Bouyant Force on Floating Objects $F_B = F_g(object) = m_0 g$	**Pressure** $P = \frac{F}{A}$	**Fluid Pressure as a Function of Depth** $P = P_0 + \mathbf{r}gh$

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Continuity Equation $A_1 v_1 = A_2 v_2$	**Bernoulli's Equation** $P + \frac{1}{2} r v^2 + rgh = const.$	**Ideal Gas Law** $PV = Nk_B T$
Celsius-Fahrenheit Temperature Conversion $T_F = \frac{9}{5} T_C + 32.0$	**Celsius-Kelvin Temperature Conversion** $T = T_C + 273.15$	**Conservation of Energy** $\Delta PE + \Delta KE + \Delta U = 0$
Specific Heat Capacity $c_p = \frac{Q}{m\Delta T}$	**Latent Heat** $Q = mL$	**Defining Work in Terms of Changing Volume** $W = Fd$ $W = P\Delta V$
Equation for the Efficiency of a Heat Engine $eff = \frac{W_{net}}{Q_h} = \frac{Q_h - Q_c}{Q_h} = 1 - \frac{Q_c}{Q_h}$	**The First Law of Thermodynamics** $\Delta U = Q - W$	**Hooke's Law** $F_{elastic} = -kx$
Period of a Simple Pendulum in Simple Harmonic Motion $T = 2p\sqrt{\frac{L}{g}}$	**Period of a Mass-Spring System in Simple Harmonic Motion** $T = 2p\sqrt{\frac{m}{k}}$	**Speed of a Wave** $v = fl$
Intensity of a Spherical Wave Intensity = $\frac{P}{4pr^2}$	**Harmonic Series of Standing Waves on a Vibrating String** $f_n = n\frac{v}{2L}$ $n = 1,2,3,...$	**Harmonic Series of a Pipe Open at Both Ends** $f_n = n\frac{v}{2L}$ $n = 1,2,3..$
Harmonic Series of a Pipe Closed at One End $f_n = n\frac{v}{4L}$ $n = 1,2,3...$	**Wave Speed Equation** $c = fl$	**Mirror /Thin Lens Equation** $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$
Equation for Magnification $M = \frac{h'}{h} = -\frac{q}{p}$	**Index of Refraction** $n = \frac{c}{v}$	**Snell's Law** $n_i(\sin q_i) = n_r(\sin q_r)$
Critical Angle $\sin q_c = \frac{n_r}{n_i}$ $n_i \rangle n_r$	**Equation for Constructive Interference** $d(\sin q) = m\, l$	**Equation for Destructive Interference** $d(\sin q) = \left(m + \frac{1}{2}\right) l$ $m = 0. \pm 1, \pm 2...$
Coulomb's Law $F_{electric} = k_C\left(\frac{q_1 q_2}{r^2}\right)$	**Electric Field Strength From a Point Charge** $E = k_C \frac{q}{r^2}$	**Electrical Potential Energy in a Uniform Electric Field** $PE_{electric} = -qEd$
Electric Potential Energy for a Pair of Charges $PE_{electric} = k_C \frac{q_1 q_2}{r}$	**Potential Difference** $\Delta V = \frac{\Delta PE_{electric}}{q}$	**Potential Difference in a Uniform Electric Field** $\Delta V = -E\Delta d$
Potential Difference Between a Point at Infinity and a Point Near a Point Charge $\Delta V = k_C \frac{q}{r}$	**Capacitance** $C = \frac{Q}{\Delta V}$	**Capacitance for a Parallel-Plate Capacitor in a Vacuum** $C = e_0 \frac{A}{d}$
Electrical Potential Energy Stored in a Charged Capacitor $PE_{electric} = \frac{1}{2} Q\Delta V$	**Electric Current** $I = \frac{\Delta Q}{\Delta t}$	**Resistance** $R = \frac{\Delta V}{I}$
Electric Power $P = I\Delta V$	**Resistors in Series** $R_{eq} = R_1 + R_2 + R_3...$	**Resistors in Parallel** $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}...$
Magnitude of a Magnetic Field $B = \frac{F_{magnetic}}{qv}$	**Force in a Current-Carrying Conductor Perpendicular to a Magnetic Field** $F_{magnetic} = BI\ell$	**Faraday's Law of Magnetic Induction** $emf = -N\frac{\Delta[AB(\cos q)]}{\Delta t}$
Maximum EMF for a Generator Maximum emf = NABω	**Transformer Equation** $\Delta V_2 = \frac{N_2}{N_1}\Delta V_1$	**Energy of a Light Quantum** $E = hf$

Maximum Kinetic Energy of a Photoelectron $KE_{max} = hf - hf_t$	**Wavelength of Matter Waves** $l = \frac{h}{p} = \frac{h}{mv}$	**Frequency of Matter Waves** $f = \frac{E}{h}$	**Relationship Between Rest Energy and Mass** $E_0 = mc^2$	**Binding Energy of a Nucleus** $E_{bind} = \Delta mc^2$	**Half-Life** $T_{1/2} = \frac{0.693}{l}$

Physics Formula Sheet

Quantities		Units	Conversions	Quantities		Units	Conversions
Dx	Displacement	m = meters		**v**	Velocity	m/s	
a	Acceleration	m/s^2		**F**	Force	N = newtons	= kg • m/s^2
W	Work	J = joule	= N•m=kg•m^2/s^2	**KE**	Kinetic Energy	J	
PE_g	Gravitational Potential Energy	J		**$PE_{elastic}$**	Elastic Potential Energy	J	
P	Power	W = Watt	= J/s	**p**	Momentum	kg•m/s	
FDt	Impulse	N•s		**s**	Arc length	m	
Dq	Angular displacement	rad = radians		**w**	Angular speed	rad/s	
a	Angular acceleration	rad/s^2		**v_t**	Tangential speed	m/s	
a_t	Tangential acceleration	m/s^2		**a_c**	Centripetal acceleration	m/s^2	
F_c	Force that maintains circular motion	N		**F_g**	Gravitational force	N	
G	Constant of universal gravitation	$\frac{N \bullet m^2}{kg^2}$		**t**	Torque	N•m	= kg•m^2/s^2
d(sinq)	Lever arm	m		**I**	Moment of inertia	kg•m^2	
L	Angular momentum	kg•m^2/s		**KE_{rot}**	Rotational kinetic energy	J	
P	Pressure	Pa = pascal	= N/m^2= 10^{-5} atm	**r**	Density	kg/m^3	= 10^{-3}g/cm^3
k_B	Boltzmann's constant	J/K		**T**	Kelvin Temperature	K = kelvins	
T_C	Celsius temperature	°C = degrees Celsius		**T_F**	Fahrenheit temperature	°F = degrees Fahrenheit	
DU	Change in Internal Energy	J = Joules		**c_p**	Specific heat capacity at constant pressure	$\frac{J}{kg \bullet °C}$	
L	Latent Heat	$\frac{J}{kg}$		**Q**	Heat	J	
eff	efficiency			**$F_{elastic}$**	Spring force	N	
k	Spring constant	N/m		**T**	Period	s	
f	Frequency	Hz	Hertz = s^{-1}	**l**	Wavelength	m	
	Sound intensity	W/m^2			Decibel level	dB	
f_n	Frequency of the nth harmonic	Hz		**L**	Length of a vibrating string or an air column	m	
p	Object distance	m		**q**	Image distance	m	
R	Radius of curvature	m		**f**	Focal length	m	
M	Magnification			**q_i**	Angle of incidence	°	
q_r	Angle of refraction	°		**n**	Index of refraction		
p	Distance from object to lens	m		**q**	Distance from image to lens	m	
h¢	Image height	m		**h**	Object height	m	
q_c	Critical angle	°		**q**	Angle from the center of an interference pattern	°	
d	Slit separation	m		**m**	Order number		
$F_{electric}$	Electric force	N		**q**	Charge	C e	= 6.3 x 10^{18} e = 1.6 x 10^{-19} C
k_C	Coulomb constant	$N \bullet \frac{m^2}{C^2}$		**E**	Electric field strength	N/C	
$PE_{electric}$	Electrical potential energy	J		**V**	Electric potential	V = volt	= J/C
DV	Potential difference	V		**C**	Capacitance	F = farad	= C/V
I	Current	A = ampere	=C/s	**R**	Resistance	Ω = ohm	= V/A

Physics Formula Sheet

Quantities		Units	Conversions	Quantities		Units	Conversions
B	Magnetic field	T = tesla	$= \frac{N}{C \bullet m/s} = \frac{N}{A \bullet m}$	$F_{magnetic}$	Magnetic force	N	
ℓ	Length of conductor in field	m		**N**	Number of turns		
DV_{max}	Maximum potential difference	V		DV_{rms}	rms potential difference	V	
I_{max}	Maximum current	A		I_{rms}	rms current	A	
M	Mutual inductance	H = Henry	$= \frac{Vs}{A}$	**L**	Self-inductance	H	
E	Photon energy	J eV = electron volts		f_t	Threshold frequency	Hz	
hf_t	Work function	eV		KE_{max}	Maximum Kinetic Energy	eV	
m	mass	u = unified mass unit or atomic mass unit	= 1.660 559 x 10^{-27}kg = 931.50 MeV/c^2	**lN**	Activity or decay rate	Bq = becquerel Ci = Curie	= 1 decay/s = 3.7 x 10^{10} Bq
$T_{1/2}$	Half-life	s					

***Remember the same symbol could be used for different quantities.**