Physics formula sheet

Mechanics

Equations of motion $v = \frac{\Delta s}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$

$\vec{s} = \vec{v} \cdot t$ $\vec{v} = \vec{a} \cdot t$ $\vec{s} = \frac{1}{2} \cdot \vec{a} \cdot t^2$

Forces $\vec{F} = m \cdot \vec{a}$ $F_f = \mu \cdot F_n$ $\vec{F}_G = m \cdot \vec{g}$ $F_{spring} = -k \cdot y$

Moment of force (Torque) $M = F \cdot r$

Air resistance $F_L = \frac{1}{2} \cdot c_W \cdot \rho_{Luft} \cdot A \cdot v^2$

Density $\rho = \frac{m}{V}$

Work $W = \vec{F} \cdot \vec{s}$

$W_{accelerating} = \frac{1}{2} \cdot m \cdot v^2$ $W_{lifting} = m \cdot g \cdot h$ $W_{extending\ a\ spring} = \frac{1}{2} \cdot k \cdot y^2$

Energy $E_k = \frac{1}{2} \cdot m \cdot v^2$ $E_{p(gravitational)} = m \cdot g \cdot h$ $E_{p(elastic)} = \frac{1}{2} \cdot k \cdot y^2$

Power $P = \frac{W}{t}$

Efficiency $\eta = \frac{E_{useful}}{E_{consumed}} = \frac{P_{useful}}{P_{consumed}}$

Uniform circular motion $f = \frac{1}{T}$ $\omega = \frac{\Delta \varphi}{\Delta t} = \frac{2\pi}{T} = 2\pi \cdot f$ $\left|\vec{v}\right| = \omega \cdot r = \frac{2\pi \cdot r}{T}$

$a_c = \omega^2 \cdot r = \frac{v^2}{r}$ $F_c = m \cdot \omega^2 \cdot r = \frac{m \cdot v^2}{r}$

Gravitation $F_G = G \cdot \frac{m_1 \cdot m_2}{r^2}$

Optics

Reflection $\Theta_{incidence} = \Theta_{reflection}$

Refraction $n_{medium} = \frac{c_{vacuum}}{c_{medium}}$ $n_1 \cdot \sin(\Theta_1) = n_2 \cdot \sin(\Theta_2)$ $c_2 \cdot \sin(\Theta_1) = c_1 \cdot \sin(\Theta_2)$

$\Theta_{critical} = \arcsin\left(\frac{c_{slower}}{c_{faster}}\right) = \arcsin\left(\frac{n_{lower}}{n_{higher}}\right)$

Magnification, Thin lens equation $m = \frac{h_i}{h_o} = \frac{d_i}{d_o}$ $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

Mathematics

Trigonometry	$\sin\alpha = \frac{\text{Opposite}}{\text{Hypotenuse}}$		$\cos\alpha = \frac{\text{Adjacent}}{\text{Hypotenuse}}$		$\tan\alpha = \frac{\text{Opposite}}{\text{Adjacent}}$
Circle	Circumference	$u = 2\pi \cdot r$	Area	$A = \pi \cdot r^2$	
Sphere	Surface area	$S = 4\pi \cdot r^2$	Volume	$V = \frac{4\pi}{3} \cdot r^3$	

Physical constants

Universal Gravitational Constant	$G = 6.67 \cdot 10^{-11} \frac{\text{N}\cdot\text{m}^2}{\text{kg}^2}$
mass of the Earth	$m_{\text{Earth}} = 5.972 \cdot 10^{24}$ kg
radius of the Earth	$r_{\text{Earth}} = 6.371 \cdot 10^{6}$ m
distance between the centers of Sun and Earth	$r_{\text{Sun-Earth}} = 1.496 \cdot 10^{11}$ m
orbital period of the Earth	$T_{\text{Earth}} = 365.26$ d
distance between the centers of Earth and Moon	$r_{\text{Earth-Moon}} = 3.844 \cdot 10^{8}$ m
mass of the Moon	$m_{\text{Moon}} = 7.346 \cdot 10^{22}$ kg
radius of the Moon	$r_{\text{Moon}} = 1.737 \cdot 10^{6}$ m
orbital period of the Moon	$T_{\text{Moon}} = 27.32$ d
mass of Venus	$m_{\text{Venus}} = 4.867 \cdot 10^{24}$ kg
radius of Venus	$r_{\text{Venus}} = 6.052 \cdot 10^{6}$ m
distance between the centers of Sun and Venus	$r_{\text{Sun-Venus}} = 1.082 \cdot 10^{11}$ m
orbital period of Venus	$T_{\text{Venus}} = 224.7$ d
mass of Mars	$m_{\text{Mars}} = 6.417 \cdot 10^{23}$ kg
radius of Mars	$r_{\text{Mars}} = 3.396 \cdot 10^{6}$ m
distance between the centers of Sun and Mars	$r_{\text{Sun-Mars}} = 2.279 \cdot 10^{11}$ m
orbital period of Mars	$T_{\text{Mars}} = 687.0$ d
mass of the Sun	$m_{\text{Sun}} = 1.99 \cdot 10^{30}$ kg
radius of the Sun	$r_{\text{Sun}} = 6.960 \cdot 10^{8}$ m

Acceleration of free fall in $\frac{\text{m}}{\text{s}^2}$:

Earth (north pole)	9.83	Earth (Europe)	9.81	Earth (equator)	9.78
Moon	1.62	Venus	8.83	Mars	3.73
Jupiter	23.1	Mercury	3.70	Sun	274
Saturn	9.0	Uranus	8.7	Neptune	11.0

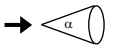
Density in $\frac{\text{kg}}{\text{m}^3}$ (at 20 °C and 1‘013 mbar):

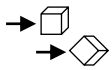
air	1.293	acetone	$0.791 \cdot 10^3$	aluminium	$2.70 \cdot 10^3$
argon	1.784	alcohol	$0.789 \cdot 10^3$	brass	$8.47 \cdot 10^3$
carbon dioxide	0.179	benzene	$0.879 \cdot 10^3$	concrete	$2.2 \cdot 10^3$
helium	0.179	glycerol	$1.26 \cdot 10^3$	copper	$8.92 \cdot 10^3$
hydrogen	0.090	mercury	$13.55 \cdot 10^3$	cork	$0.3 \cdot 10^3$
methan	0.717	methanol	$0.792 \cdot 10^3$	gold	$19.29 \cdot 10^3$
neon	0.900	olive oil	$0.92 \cdot 10^3$	ice	$0.917 \cdot 10^3$
nitrogen	1.250	gasoline	$0.75 \cdot 10^3$	iron	$7.86 \cdot 10^3$
oxygen	1.429	petroleum	$0.85 \cdot 10^3$	lead	$11.34 \cdot 10^3$
propane	2.010	sea water	$1.03 \cdot 10^3$	oak wood	$0.7 \cdot 10^3$
xenon	5.897	water	$0.998 \cdot 10^3$	silver	$10.5 \cdot 10^3$
				steel	$7.9 \cdot 10^3$
				window glass	$2.5 \cdot 10^3$

Coefficient of static friction		coefficient of kinetic friction		coefficient of rolling resistance	
steel on steel	0.78	steel on steel	0.42	steel on steel	0.0015
tyre on asphalt	0.85	tyre on asphalt	0.65	tyre on asphalt	0.008
steel on ice	0.027	steel on ice	0.014		
wood on stone	0.7	wood on stone	0.3		
wood on wood	0.4	wood on wood	0.3		
glass on glass	0.94	glass on glass	0.40		

Drag coefficients (air resistance)

Person (erect)	0.78	sphere	0.47
Passenger car (closed)	0.36	hollow cone, $\alpha = 30°$	0.34
Motorcycle	0.7	hollow cone, $\alpha = 60°$	0.51
Truck	0.6 - 1.5	circular disc	1.11
Bicycle incl. person	1	Square plate	1.10
Parachute	1.4	cube	1.05
Aerofoil	0.05	cube	0.80





Speed of light in $\frac{\mathbf{m}}{\mathbf{s}}$

vacuum	$2.998 \cdot 10^8$	water	$2.25 \cdot 10^8$	ice	$1.90 \cdot 10^8$
air	$2.997 \cdot 10^8$	diamond	$1.24 \cdot 10^8$	PMMA (Plexiglass)	$2.01 \cdot 10^8$

Indices of refraction

ethanol	1.36	water	1.33	salt	1.54
methanol	1.33	diamond	2.42	window glass	1.52