# Physics formula sheet

### **Mechanics**

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

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$$\vec{s} = \vec{v} \cdot t$$

$$\vec{v} = \vec{a} \cdot t$$

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

$$\vec{F} = m \cdot \vec{a}$$

 $M = F \cdot r$ 

$$F_f = \mu \cdot F_r$$

$$\vec{F}_C = m \cdot \vec{c}$$

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

$$F_{L} = \frac{1}{2} \cdot c_{W} \cdot \rho_{Luft} \cdot A \cdot v^{2}$$

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

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

$$^{2}$$
 Wiffing =  $m \cdot a \cdot$ 

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

$$E_k = \frac{1}{2} \cdot m \cdot v^2$$

$$E_{p(gravitational)} = m \cdot g \cdot h$$

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

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

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

$$f=\frac{1}{T}$$

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

$$\left| \vec{\mathbf{v}} \right| = \omega \cdot \mathbf{r} = \frac{2\pi \cdot \mathbf{r}}{T}$$

$$a_c = \omega^2 \cdot r = \frac{V}{I}$$

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

$$F_{\rm G} = {\rm G} \cdot \frac{m_1 \cdot m_2}{r^2}$$

## **Optics**

$$m = \frac{h_i}{h_0} = \frac{d_i}{d_0}$$

### **Mathematics**

$$\sin \alpha = \frac{\text{Opposite}}{\text{Hypotenuse}}$$

$$\sin \alpha = \frac{\text{Opposite}}{\text{Hypotenuse}}$$
  $\cos \alpha = \frac{\text{Adjacent}}{\text{Hypotenuse}}$   $\tan \alpha = \frac{\text{Opposite}}{\text{Adjacent}}$ 

$$\tan \alpha = \frac{\text{Opposite}}{\text{Adjacent}}$$

Circumference 
$$u = 2\pi \cdot r$$
 Area  $A = \pi \cdot r^2$ 

$$u = 2\pi \cdot r$$

$$A = \pi$$

$$S = 4\pi \cdot r^2$$

Surface area 
$$S = 4\pi \cdot r^2$$
 Volume  $V = \frac{4\pi}{3} \cdot r^3$ 

### **Physical constants**

Universal Gravitational Constant
mass of the Earth

radius of the Earth

distance between the centers of Sun and Earth

orbital period of the Earth

distance between the centers of Earth and Moon

mass of the Moon radius of the Moon orbital period of the Moon

mass of Venus radius of Venus

distance between the centers of Sun and Venus

orbital period of Venus

mass of Mars radius of Mars

distance between the centers of Sun and Mars

orbital period of Mars mass of the Sun radius of the Sun

G = 6.67 ·	· 10 <sup>-11</sup>	N·m <sup>2</sup>
G = 0.01		kg <sup>2</sup>

 $m_{\text{Earth}} = 5.972 \cdot 10^{24} \text{ kg}$  $r_{\text{Earth}} = 6.371 \cdot 10^6 \text{ m}$ 

 $r_{\text{Sun-Earth}} = 1.496 \cdot 10^{11} \text{ m}$ 

 $T_{\text{Earth}} = 365.26 \text{ d}$ 

 $r_{\text{Earth-Moon}} = 3.844 \cdot 10^8 \text{ m}$   $m_{\text{Moon}} = 7.346 \cdot 10^{22} \text{ kg}$  $r_{\text{Moon}} = 1.737 \cdot 10^6 \text{ m}$ 

 $T_{\text{Moon}} = 27.32 \text{ d}$ 

 $m_{\text{Venus}} = 4.867 \cdot 10^{24} \text{ kg}$   $r_{\text{Venus}} = 6.052 \cdot 10^6 \text{ m}$  $r_{\text{Sun-Venus}} = 1.082 \cdot 10^{11} \text{ m}$ 

 $T_{Venus} = 224.7 d$ 

 $m_{\text{Mars}} = 6.417 \cdot 10^{23} \text{ kg}$  $r_{\text{Mars}} = 3.396 \cdot 10^6 \text{ m}$ 

 $r_{\text{Sun-Mars}} = 3.390 \cdot 10^{-11} \text{ m}$ 

 $T_{\text{Mars}} = 687.0 \text{ d}$   $m_{\text{Sun}} = 1.99 \cdot 10^{30} \text{ kg}$  $r_{\text{Sun}} = 6.960 \cdot 10^8 \text{ m}$ 

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

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 $\frac{kg}{m^3}$ (at 20 °C):

air	1.29	cork	$0.3 \cdot 10^{3}$	iron	$7.86 \cdot 10^3$
helium	0.179	oak wood	$0.7 \cdot 10^{3}$	steel	$7.9 \cdot 10^{3}$
alcohol	$0.789 \cdot 10^{3}$	ice	$0.917 \cdot 10^{3}$	copper	$8.92 \cdot 10^3$
water	$0.998 \cdot 10^{3}$	concrete	$2.2 \cdot 10^{3}$	silver	$10.5 \cdot 10^3$
sea water	$1.03 \cdot 10^{3}$	window glass	$2.5 \cdot 10^{3}$	lead	11.34 · 10 <sup>3</sup>
glycerol	$1.26 \cdot 10^3$	aluminium	$2.70 \cdot 10^{3}$	gold	$19.29 \cdot 10^3$

#### 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 →