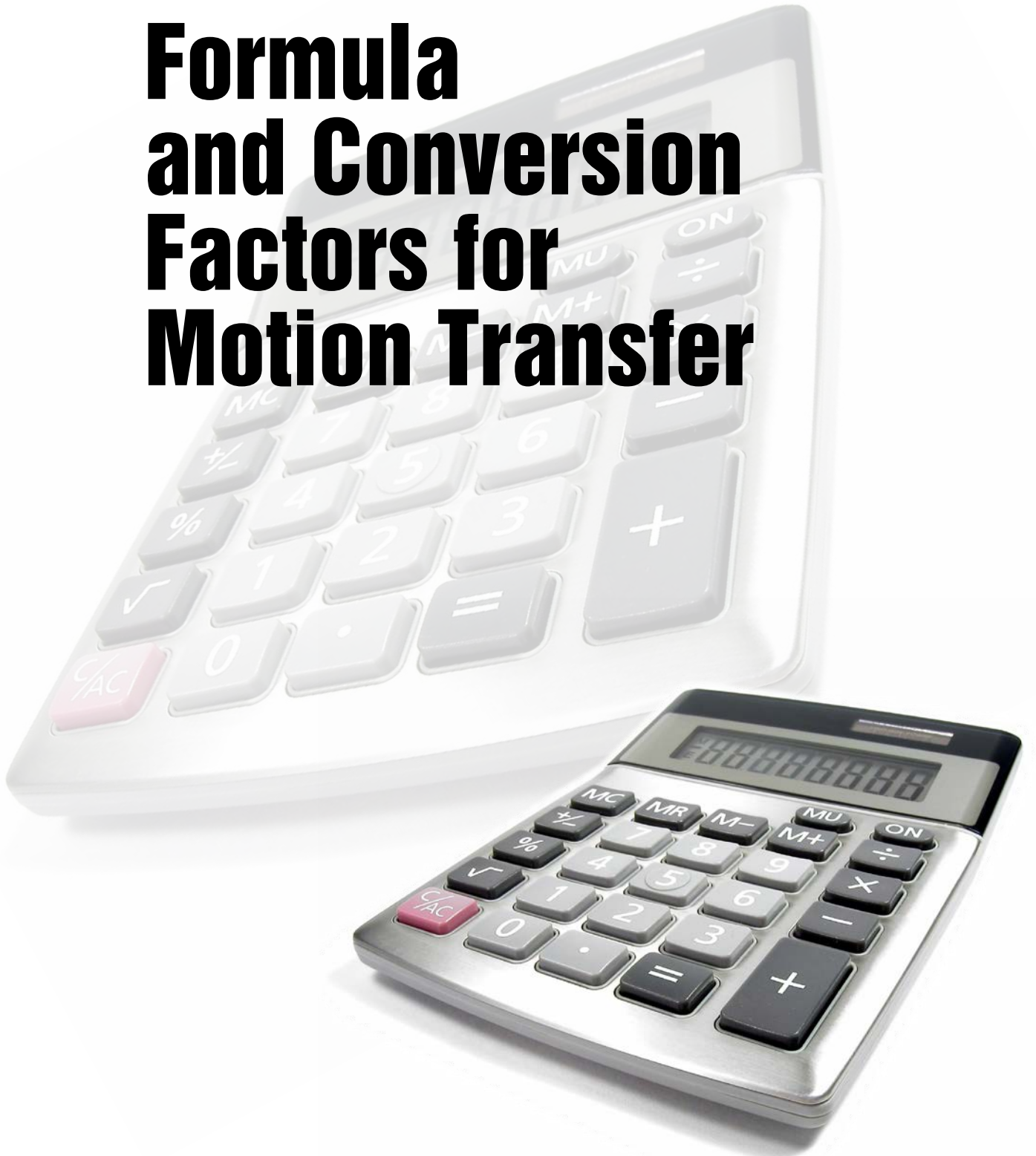




# Formula and Conversion Factors for Motion Transfer



# Formula and Conversion Factors

## SI BASE UNITS

Quantity	Unit Symbol	Name
length	m	meter
mass	kg	kilogram
time	s	second
electric current	A	ampere
Thermodynamic temperature	K	kelvin
luminous intensity	cd	candela

## LETTER SYMBOLS & SI UNITS IN POWER TRANSMISSION ENGINEERING

Symbol	Quantity	SI Unit Symbol	Name
Mechanics			
E	modulus of elasticity (Young's modulus)	Pa	pascal
F	force	N	Newton
G (W)	weight	N	Newton
J	moment of inertia	kgm <sup>2</sup>	kilogram meter squared
M (T)	torque	Nm	Newton meter
m	mass	kg	kilogram
P	power	W	watt
p	pressure	Pa	pascal
ρ	density (mass density)	kg/m <sup>3</sup>	-
σ	stress	Pa	pascal
W (E)	work (energy)	J	joule
η	efficiency	1	-
μ	coefficient of friction	1	-

## FORMULAE

International System(SI)

Imperial System (FPS)

## POWER

Lifting motion
$P = \frac{m \cdot g \cdot v}{\eta \cdot 1000}$
Linear motion
$P = \frac{F_r \cdot v}{1000}$
$F_r = \mu \cdot m \cdot g$
Rotary motion
$P = \frac{M \cdot n}{9550}$
P - Power in kW
F <sub>r</sub> - Frictional resistance in N
m - Mass in kg
g - Acceleration of free fall (9.81) in m/s <sup>2</sup>
v - Velocity in m/s
η - Efficiency in decimals
μ - Coefficient of friction
M - Torque in Nm
n - Rotational speed in 1/min or r/min

Lifting motion
$P = \frac{W \cdot v}{\eta \cdot 33000}$
Linear motion
$P = \frac{F_r \cdot v}{33000}$
$F_r = \mu \cdot W$
Rotary motion
$P = \frac{M \cdot n}{5250}$
P - Power in hp
F <sub>r</sub> - Frictional resistance in lbf
W - Weight in lb
v - Velocity in ft/min
η - Efficiency in decimals
μ - Coefficient of friction
M - Torque in lbf . ft
n - Rotational speed in rpm

International System(SI)

Imperial System (FPS)

## TORQUE

M - F . r
$P = \frac{9550 \cdot P}{n}$
M - Torque in Nm
F - Force in N
r - Radius of lever in m
P - Power in kW
n - Rotational speed in 1/min or r/min

M - F . r
$P = \frac{5250 \cdot P}{n}$
M - Torque in lbf . ft
F - Force in lbf
r - Radius of lever in ft
P - Power in hp
n - Rotational speed in rpm

## WORK

W - F . s = m . g . s
$W = \frac{j \cdot n^2}{182.5}$
W - Work (energy) in Nm = Ws = J
F - Force in N
s - Length of path in m
m - Mass in kg
g - Acceleration of free fall (9.81) in m/s <sup>2</sup>
J - Moment of inertia in kgm <sup>2</sup>
n - Rotational speed in 1/min or r/min

W - F . s
$W = \frac{WK^2 \cdot n^2}{5880}$
W - Work (energy) in lb . ft
F - Force in lbf
s - Length of path in ft
m - Mass in kg
g - Acceleration of free fall (9.81) in m/s <sup>2</sup>
WK- Flywheel effect lb . ft <sup>2</sup>
n - Rotational speed in rpm

## ACCELERATION OR BRAKING TIME

$t_a = \frac{j \cdot n}{9.55 M_a}$
t <sub>a</sub> - Acceleration or braking time in s
J - Moment of inertia in kgm <sup>2</sup>
n - Rotational speed in 1/min or r/min
M <sub>a</sub> - Acceleration or braking torque in Nm

$t_a = \frac{WK^2 \cdot n}{308 M_a}$
t <sub>a</sub> - Acceleration or braking time in s
WK- Flywheel effect in kgm <sup>2</sup>
n - Rotational speed in rpm
M <sub>a</sub> - Acceleration or braking torque in lb . ft

## MOMENT OF INERTIA

Solid Cylinder
$J = \frac{1}{2} \cdot m \cdot r_{ext}^2$
$= \frac{1}{32} \cdot 1000 \cdot \pi \cdot \rho \cdot l \cdot d_{ext}^4$
$= 98 \rho \cdot l \cdot d_{ext}^4$
Hollow Cylinder
$J = \frac{1}{2} \cdot m \cdot (r_{ext}^2 + r_{int}^2)$
$= \frac{1}{32} \cdot 1000 \cdot \pi \cdot \rho \cdot l \cdot (d_{ext}^4 - d_{int}^4)$
$= 98 \cdot \rho \cdot l \cdot (d_{ext}^4 - d_{int}^4)$

Solid Cylinder
$WK^2 = \frac{1}{2} \cdot W \cdot r_{ext}^2$
$= \frac{\pi}{32} \cdot \rho \cdot l \cdot d_{ext}^4$
$= 0.1 \rho \cdot l \cdot d_{ext}^4$
Hollow Cylinder
$WK^2 = \frac{1}{2} \cdot W \cdot (r_{ext}^2 + r_{int}^2)$
$= \frac{\pi}{32} \cdot \rho \cdot l \cdot (d_{ext}^4 - d_{int}^4)$
$= 0.1 \cdot \rho \cdot l \cdot (d_{ext}^4 - d_{int}^4)$

## torsional stiffness and resonant frequency

$$C_T \leq \frac{(F_R \times 2 \pi)^2}{\left( \frac{1}{J_M} + \frac{1}{J_L} \right)} \quad FR \leq \frac{1}{2 \pi} \times \sqrt{\left( \frac{1}{J_M} + \frac{1}{J_L} \right)} \times C_T$$

Where  
**C<sub>T</sub>** = torsional stiffness (Nm/rad);  
**J<sub>M</sub>** = motor inertia (kgm<sup>2</sup>)  
**F<sub>R</sub>** = resonant frequency (Hz)  
**J<sub>L</sub>** = load inertia (kgm<sup>2</sup>)

# Formula and Conversion Factors

## FORCE

		N	kp	p	tonf (UK)	lbf	ozf
1N	=	1	0.1020	102.0	$100.4 \times 10^{-6}$	0.2248	3.597
1kp	=	9.807	1	1000	$0.984 \times 10^{-3}$	2.205	35.27
1p	=	$9.81 \times 10^{-3}$	$1 \times 10^{-3}$	1	$0.984 \times 10^{-6}$	$2.2 \times 10^{-3}$	$35.3 \times 10^{-3}$
1tonf (UK)	=	9964	1016	$1.02 \times 10^6$	1	2240	$35.8 \times 10^3$
1lbf	=	4.448	0.4536	453.6	$0.5 \times 10^{-9}$	1	16
1ozf	=	-	$28.4 \times 10^{-3}$	28.35	$27.9 \times 10^{-6}$	$62.5 \times 10^{-3}$	1

## VELOCITY

		km/h	m/min	m/s	mile/h	ft/min	ft/s	in/s
1km/h	=	1	16.667	0.2778	0.6214	54.68	0.9113	10.936
m/min	=	0.06	1	$16.7 \times 10^{-3}$	$37.3 \times 10^{-3}$	3.281	$54.7 \times 10^{-3}$	0.656
1m/s	=	3.6	60	1	2.237	196.85	3.281	39.37
1mile/h	=	1.609	26.82	0.4470	1	88	1.467	17.6
1ft/min	=	$18.3 \times 10^{-3}$	0.3048	$5.08 \times 10^{-3}$	$11.4 \times 10^{-3}$	1	$16.7 \times 10^{-3}$	0.2
1ft/s	=	1.097	18.288	0.3048	0.6818	60	1	12
1in/s	=	$91 \times 10^{-3}$	1.524	$25.4 \times 10^{-3}$	$56.8 \times 10^{-3}$	5	$83.3 \times 10^{-3}$	1

## TORQUE

		Nm	Ncm	kgfm	lbf.ft	lbf.in	ozf.in
1Nm	=	1	100	0.10197	0.73756	8.8507	141.61
Ncm	=	0.01	1	$1.02 \times 10^{-3}$	$7.376 \times 10^{-3}$	$88.5 \times 10^{-3}$	1.4161
1kgfm	=	9.8067	980.67	1	7.233	86.796	1389
1lbf.ft	=	1.356	135.6	0.1383	1	12	192
1lbf.in	=	0.1129	11.29	$11.5 \times 10^{-3}$	$83.3 \times 10^{-3}$	1	16
1ozf.in	=	$7.062 \times 10^{-3}$	0.7062	$0.72 \times 10^{-3}$	$5.21 \times 10^{-3}$	$62.5 \times 10^{-3}$	1

## POWER

		kW	PS	hp	kgfm/s	ft.lbf/s
1kW	=	1	1.360	1.341	102.0	737.6
1PS	=	0.7355	1	0.9863	75	542.5
1hp	=	0.7457	1.014	1	76.04	550
1kgfm/s	=	$9.81 \times 10^{-3}$	$13.33 \times 10^{-3}$	$13.15 \times 10^{-3}$	1	7.233
1ft.lbf/s	=	$1.36 \times 10^{-3}$	$1.84 \times 10^{-3}$	$1.82 \times 10^{-3}$	0.1383	1

## MOMENT OF INERTIA AND OTHER FLYWHEEL EFFECTS

		kgm <sup>2</sup> ( <i>mr</i> <sup>2</sup> )	kgfm <sup>2</sup> ( <i>GD</i> <sup>2</sup> )	lb.ft <sup>2</sup> ( <i>WK</i> <sup>2</sup> )	kpms <sup>2</sup>	ft lbf s <sup>2</sup>
1kgm <sup>2</sup> ( <i>mr</i> <sup>2</sup> )	=	1	4	23.73	0.102	0.7376
1kgfm <sup>2</sup> ( <i>GD</i> <sup>2</sup> )	=	0.25	1	5.933	$25 \times 10^{-3}$	0.1844
1lb.ft <sup>2</sup> ( <i>WK</i> <sup>2</sup> )	=	$42.1 \times 10^{-3}$	0.1686	1	$4.30 \times 10^{-3}$	$31.1 \times 10^{-3}$
1kpms <sup>2</sup>	=	9.807	39.23	232.7	1	7.233
1ft lbf s <sup>2</sup>	=	1.356	5.423	32.17	0.1383	1

## LENGTH

	mm	m	in	ft	yds	km	miles
1mm	1	0.001	0.3937	0.0033	0.00109	-	-
1m	1000	1	39.370	3.2808	1.0936	0.001	0.0006215
1in	25.4	0.0254	1	0.0833	0.0277	0.0000254	0.0000158
1ft	304.8	0.3048	12	1	0.3333	0.000304	0.0001894
1yd	914.4	0.9144	36	3	1	0.000914	0.000568
1km	-	1000	39,370.07	3,280.83	1,093.613	1	0.6215
1mile	-	1,609	63,346.45	5,278.87	1,759.623	1.609	1