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Torque and Unit

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Unstable Mass and Stable Weight

The newton, N is the international standard unit of "force". Previously, "mass" was an object of weight. "Mass" was expressed "kg", and weight as "kgf" or "kgw". "Mass" means a unchangeable amount and it is same at anywhere on the earth or at zero gravity area. However, "weight" is result by the acceleration of gravity, and "no feeling of weight" and "no weight" at zero gravity condition. There are different gravities on our earth. The state of latitude or land height above sea level make weight differences. For example, there is difference in 1g between 1kg weight at sea level and the top of high mountain, 3776m due to various centrifugal forces.



MASS



WEIGHT (Sensation of weight on your hand)

Acceleration of gravity

Place	Latitude	Altitude [m]	Acceleration of Gravity [m/s ²]	Difference from International Standard [%]
International Standard	—	—	9.80665	0
Omori (Tohnichi Tokyo)	35°34'	7	9.79782	-0.090
Kofu (Tohnichi Plant)	35°36'	255	9.79785	-0.090
Sapporo, Japan	43°04'	15	9.80596	-0.007
Naha, Japan	26°12'	21	9.79095	-0.160
Nagoya, Japan	35°09'	46	9.79732	-0.095
Osaka, Japan	34°47'	15	9.79703	-0.098
Hiroshima, Japan	34°22'	1	9.79658	-0.103
Mexico City	19°20'	2269	9.77927	-0.279
Singapore	1°18'	8	9.78066	-0.265
Helsinki	60° 10'	21	9.81901	+0.126

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1-1

What is Torque

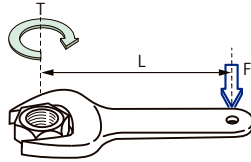
(1) Torque

Torque = Force × Length

The force required to rotate an object, the “force moment” and “rotation moment”, is known as torque.

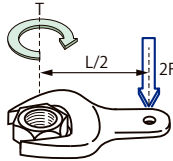
Torque (T) is shown as the product of the force (F) and the length (L).

$$T = F \times L$$



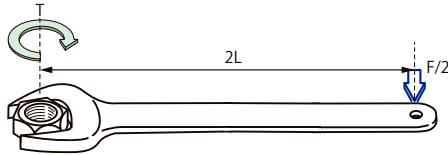
$$= 2F \times L/2$$

Doubled force with a half length is same torque.



$$= F/2 \times 2L$$

Halved force with double length is same torque.



(2) Weight and mass

■ Force unit

[N] (newton) SI unit

One newton [N] (≈ 0.1 [kgf]) is the force caused by accelerating a mass of 1kg at 1m/s^2 .

[kgf] (kilogram·f) old JIS unit

■ Mass unit

[kg] (kilogram)

■ Length unit

[m] (meter)

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Torque Units [SI Metric American]

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(1) Unit

■ SI unit [N·m]

$$1000 [\text{mN}\cdot\text{m}] = 100 [\text{cN}\cdot\text{m}] = 1 [\text{N}\cdot\text{m}] = 0.001 [\text{kN}\cdot\text{m}]$$

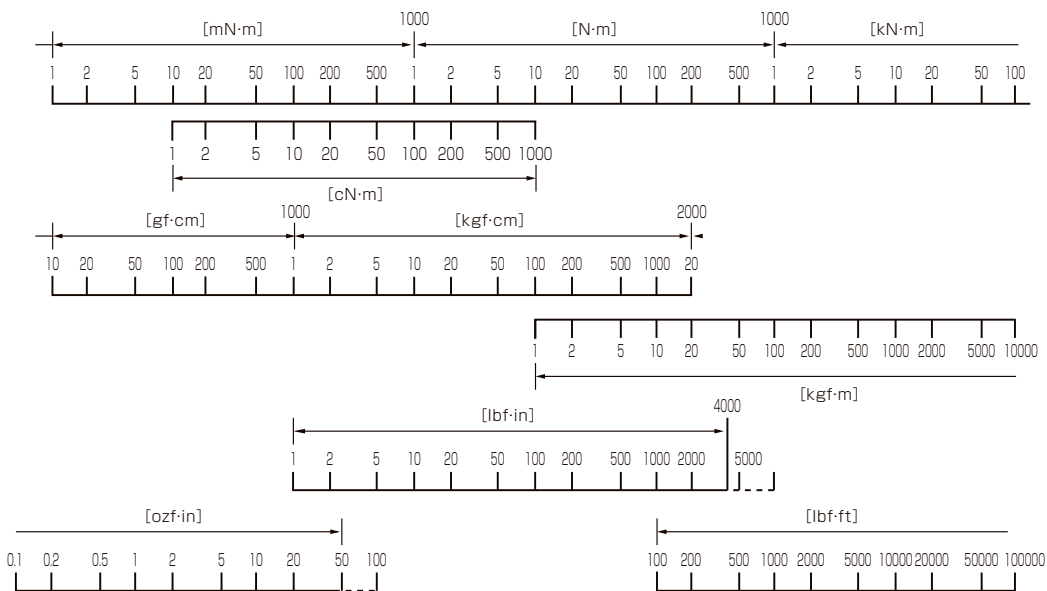
■ Metric unit [kgf·cm]

$$1000 [\text{gf}\cdot\text{cm}] = 1 [\text{kgf}\cdot\text{cm}] = 0.01 [\text{kgf}\cdot\text{m}]$$

■ American unit [lbf·in]

$$16 [\text{ozf}\cdot\text{in}] = 1 [\text{lbf}\cdot\text{in}] = 0.0833 [\text{lbf}\cdot\text{ft}]$$

■ Example of Torque Ranges



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Torque and Unit

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Torque Units [SI, Metric, American unit]

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(2) Unit of Torque and Conversion Values

	SI unit system			Metric (Gravity) unit system			American unit system		
	mN·m	cN·m	N·m	gf·cm	kgf·cm	kgf·m	ozf·in	lbf·in	lbf·ft
1mN·m =	1	0.1	0.001	10.2	0.0102	0.000102	0.142	0.00885	0.000738
1cN·m =	10	1	0.01	102	0.102	0.00102	1.42	0.0885	0.00738
1N·m =	1000	100	1	10200	10.2	0.102	142	8.85	0.738
1gf·cm =	0.0981	0.00981	0.0000981	1	0.001	0.00001	0.0139	0.000868	0.0000723
1kgf·cm =	98.1	9.81	0.0981	1000	1	0.01	13.9	0.868	0.0723
1kgf·m =	9810	981	9.81	100000	100	1	1390	86.8	7.23
1ozf·in =	7.06	0.706	0.00706	72.0	0.072	0.00072	1	0.0625	0.00521
1lbf·in =	113	11.3	0.113	1150	1.15	0.0115	16	1	0.0833
1lbf·ft =	1360	136	1.36	13800	13.8	0.138	192	12	1
Country/Region	Japan, China, Europe			Asia			US, Aircraft industry		

1 [N·m] = 10.1972 [kgf·cm] ≈ 10.20 [kgf·cm]

1 [kgf·cm] = 0.0980665 [N·m] ≈ 0.0981 [N·m]

Note: 3 Significant Digits.

Conversion example:

$$\begin{aligned}
 T &= 25.0 \text{ [kgf·cm]} \\
 &= 25.0 \times 0.0980665 \\
 &= 2.4516625 \text{ [N·m]} \\
 &\approx 2.45 \text{ [N·m]}
 \end{aligned}$$

(3) [kgf·cm] ([kgf·m]) to [N·m] Conversion Value

Conversion value 1[kgf·cm]=0.0980665[N·m]
1[kgf·m]=9.80665[N·m]

kgf·cm

	0	1	2	3	4	5	6	7	8	9
10	0.981	1.08	1.18	1.27	1.37	1.47	1.57	1.67	1.77	1.86
20	1.96	2.06	2.16	2.26	2.35	2.45	2.55	2.65	2.75	2.84
30	2.94	3.04	3.14	3.24	3.33	3.43	3.53	3.63	3.73	3.82
40	3.92	4.02	4.12	4.22	4.31	4.41	4.51	4.61	4.71	4.81
50	4.90	5.00	5.10	5.20	5.30	5.39	5.49	5.59	5.69	5.79
60	5.88	5.98	6.08	6.18	6.28	6.37	6.47	6.57	6.67	6.77
70	6.86	6.96	7.06	7.16	7.26	7.35	7.45	7.55	7.65	7.75
80	7.85	7.94	8.04	8.14	8.24	8.34	8.43	8.53	8.63	8.73
90	8.83	8.92	9.02	9.12	9.22	9.32	9.41	9.51	9.61	9.71
100	9.81	9.90	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7

kgf·cm

	0	10	20	30	40	50	60	70	80	90
100	9.81	10.8	11.8	12.7	13.7	14.7	15.7	16.7	17.7	18.6
200	19.6	20.6	21.6	22.6	23.5	24.5	25.5	26.5	27.5	28.4
300	29.4	30.4	31.4	32.4	33.3	34.3	35.3	36.3	37.3	38.2
400	39.2	40.2	41.2	42.2	43.1	44.1	45.1	46.1	47.1	48.1
500	49.0	50.0	51.0	52.0	53.0	53.9	54.9	55.9	56.9	57.9
600	58.8	59.8	60.8	61.8	62.8	63.7	64.7	65.7	66.7	67.7
700	68.6	69.6	70.6	71.6	72.6	73.5	74.5	75.5	76.5	77.5
800	78.5	79.4	80.4	81.4	82.4	83.4	84.3	85.3	86.3	87.3
900	88.3	89.2	90.2	91.2	92.2	93.2	94.1	95.1	96.1	97.1
1000	98.1	99.0	100	101	102	103	104	105	106	107

kgf·m

	0	1	2	3	4	5	6	7	8	9
10	98.1	108	118	127	137	147	157	167	177	186
20	196	206	216	226	235	245	255	265	275	284
30	294	304	314	324	333	343	353	363	373	382
40	392	402	412	422	431	441	451	461	471	481
50	490	500	510	520	530	539	549	559	569	579
60	588	598	608	618	628	637	647	657	667	677
70	686	696	706	716	726	735	745	755	765	775
80	785	794	804	814	824	834	843	853	863	873
90	883	892	902	912	922	932	941	951	961	971
100	981	990	1000	1010	1020	1030	1040	1050	1060	1070

Note: 3 Significant Digits.
Technical Data