1

Torque

Torque and Unit

Unstable Mass and Stable Weight

The [N] (newton) is the new standard unit of "force". **We formerly called the "mass" of an object the "weight" and used [kg] to indicate units of "mass" and [kgf] or [kgw] for "weight".** Because [kg] was used for both, the terms "mass" and "force" were used incorrectly for a long time.

We say "mass" for a particular measure that will not change anywhere on the earth, even under zero gravity conditions, but "weight" is an "amount" caused by an acceleration that is felt by the body on which the acceleration is acting.

So in a zero gravity condition "there is no feeling of weight" and "no weight". Even on the earth's surface, the gravity acceleration produced by differences in latitude or height is different and the "weight" will change.

For example, if we compare the weight of 1 [kg] at sea level and at the top of Mount Fuji, an approximately 1 [g] difference in mass unit will be found. Because the top of the mountain is much higher than sea level, the centrifugal force will be bigger due to the rotation of the earth and the gravity acceleration will be smaller.

MASS

WEIGHT (Sensation of weight on your hand)

Acceleration of gravity

Place	Latitude	Altitude [m]	Acceleration of Gravity [m/s²]	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
Matsumoto, Japan	36°14'	611	9.79654	−0.103
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

1-1 What is Torque

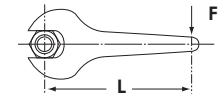
(1) Torque

Torque = Force × Length (T = F × L)

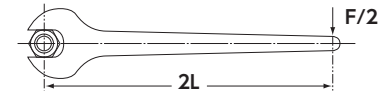
The force required to rotate an object, the "force moment" and "rotation moment", is known as torque.

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

T = F × L



= 2F × L/2 (If the force is doubled, halving the length will develop the same torque.)



= F/2 × 2L (If the force is halved, doubling the length will develop the same torque.)

(2) Weight and mass

- **Force unit** · · · · · · · · **[N] (newton) Sl 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

WEIGHT (Sensation of weight on your hand)

- **Mass unit** · · · · · · · · **[kg] (kilogram)**
- **Length unit** · · · · · · · · **[m] (meter)**

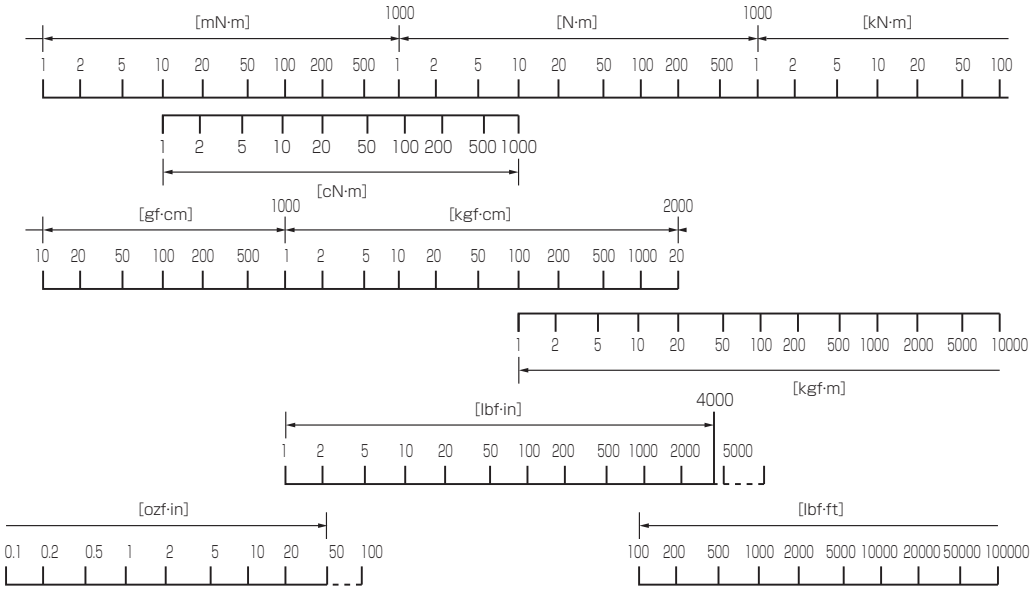
MASS

1-2 Torque Units [SI unit, Metric unit, American unit]

(1) Unit

- **Sl unit** · · · · · · · · · · · · · · **[N·m]**
  1000[mN·m]= 100[cN·m]= 1[N·m]= 0.001[kN·m]
- **Metric unit** · · · · · · · · · · · **[kgf·cm]**
  (Gravity unit) 1000[gf·cm]= 1[kgf·cm]= 0.01[kgf·m]
- **American unit** · · · · · · · · · **[lbf·in]**
  16[ozf·in]= 1[lbf·in]= 0.0833[lbf·ft]

Main application range of torque units



(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	0.10	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	0.0981	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	0.833
1lbf·ft =	1360	136	1.36	13800	13.8	0.138	192	12	1
Country/Region	Japan, China, Europe			Asia			U.S.A., Aircraft industry		

1 [N·m]= 10.1972 [kgf·cm] ≈ 10.20 [kgf·cm]
1 [kgf·cm]=0.0980665 [N·m] ≈ 0.0981 [N·m]

Conversion example:

T = 25.0 [kgf·cm]
= 25.0 x 0.0980665
= 2.4516625 [N·m]
≈ 2.45 [N·m]

(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: Number with significant 3 digits