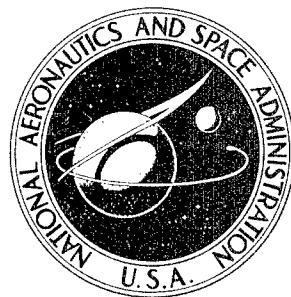


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COMPENDIUM OF HUMAN RESPONSES
TO THE AEROSPACE ENVIRONMENT

Volume IV

Conversion Tables

Alphabetic Index

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LOVELACE FOUNDATION FOR MEDICAL EDUCATION AND RESEARCH

Albuquerque, N. Mex.

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • NOVEMBER 1968

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Edited by Emanuel M. Roth, M.D.

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Fred B. Benjamin, D.M.D., Ph. D.
NASA Project Manager

Prepared under Contract No. NASr-115 by
LOVELACE FOUNDATION FOR MEDICAL EDUCATION AND RESEARCH
Albuquerque, N. Mex.

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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CONVERSION TABLES

The multiple systems of units and measures used in the basic biological, physical, and engineering sciences is often confusing to those with interdisciplinary interests. The following tables have been selected from the Arnold Engineering Development Center Document AEDC TDR 62-6 as most pertinent to such interests. Tables of electrical and thermodynamic units not covered in this extract may be found in the AEDC document.

The reader may convert from the measure of quantities in the units listed on the left to those across the top of the page by multiplying by the given factor. The small number to the upper right of each factor is the power of ten by which the factor is to be multiplied. For example, 8.68977^{-2} is equivalent to 0.0868977. Underscores indicate exact values.

Slight numerical differences will be noticed between the values herein and those in most currently existing texts because of the redefinition of the foot in 1960.

The only exception to this approach is the altitude table, which is taken from the ARDC Model Atmosphere 1959.

TABLE 1

Length (l, d)

	Å	cm	ft	in.	km	m	μ	mils	miles (US)	mm	miles (Nautical)	rods	yd
Angstrom Units	1.00000	1.00000^{-8}	3.28084^{-10}	3.93701^{-9}	1.00000^{-13}	1.00000^{-10}	1.00000^{-4}	3.93701^{-6}	6.21371^{-14}	1.00000^{-7}	5.39957^{-14}	1.98839^{-11}	1.09361^{-10}
Centimeters	1.00000^8	1.00000	3.28084^{-2}	3.93701^{-1}	1.00000^{-5}	1.00000^{-2}	1.00000^4	3.93701^2	6.21371^{-6}	1.00000^1	5.39957^{-6}	1.98839^{-3}	1.09361^{-2}
Feet	3.04800^9	3.04800^1	1.00000	1.20000^1	3.04800^{-4}	3.04800^{-1}	3.04800^5	1.20000^4	1.89394^{-4}	3.04800^2	1.64579^{-4}	6.06061^{-2}	3.33333^{-1}
Inches	2.54000^8	2.54000	8.33333^{-2}	1.00000	2.54000^{-5}	2.54000^{-2}	2.54000^4	1.00000^3	1.57828^{-5}	2.54000^1	1.37149^{-5}	5.05050^{-3}	2.77778^{-2}
Kilometers	1.00000^{13}	1.00000^5	3.28084^3	3.93701^4	1.00000	1.00000^3	1.00000^9	3.93701^7	6.21371^{-1}	1.00000^6	5.39957^{-1}	1.98839^2	1.09361^3
Meters	1.00000^{10}	1.00000^2	3.28084	3.93701^1	1.00000^{-3}	1.00000	1.00000^6	3.93701^4	6.21371^{-4}	1.00000^3	5.39957^{-4}	1.98839^{-1}	1.09361
Microns	1.00000^4	1.00000^{-4}	3.28084^{-6}	3.93701^{-5}	1.00000^{-9}	1.00000^{-6}	1.00000	3.93701^{-2}	6.21371^{-10}	1.00000^{-3}	5.39957^{-10}	1.98839^{-7}	1.09361^{-6}
Mils	2.54000^5	2.54000^{-3}	8.33333^{-5}	1.00000^{-3}	2.54000^{-8}	2.54000^{-5}	2.54000^1	1.00000	1.57828^{-8}	2.54000^{-2}	1.37149^{-8}	5.05050^{-6}	2.77778^{-5}
Miles (US)	1.60934^{13}	1.60934^5	5.28000^3	6.33600^4	1.60934	1.60934^3	1.60934^9	6.33600^7	1.00000	1.60934^6	8.68977^{-1}	3.20000^2	1.76000^3
Millimeters	1.00000^7	1.00000	3.28084^{-3}	3.93701^{-2}	1.00000^{-6}	1.00000^{-3}	1.00000^3	3.93701^1	6.21371^{-7}	1.00000	5.39957^{-7}	1.98839^{-4}	1.09361^{-3}
Miles (Nautical)	1.85200^{13}	1.85200^5	6.07612^3	7.29134^4	1.85200	1.85200^3	1.85200^9	7.29134^7	1.15078	1.85200^6	1.00000	3.68250^2	2.02537^3
Rods	5.02920^{10}	5.02920^2	1.65000^1	1.98000	5.02920^{-3}	5.02920	5.02920^6	1.98000^5	3.12500^{-3}	5.02920^3	2.71555^{-3}	1.00000	5.00000
Yards	9.14400^9	9.14400^1	3.00000	3.60000^1	9.14400^{-4}	9.14400^{-1}	9.14400^5	3.60000^4	5.68182^{-4}	9.14400^2	4.93737^{-4}	1.81818^{-1}	1.00000

1. LENGTH

TABLE 2

Area (A)

	Acre	in. (Circular)	Mil (Circular)	cm ²	ft ²	in. ²	m ²	mm ²	Rod ²	Yard ²
Acre	<u>1.00000</u>	<u>7.98657</u> ⁶	<u>7.98657</u> ¹²	<u>4.04686</u> ⁷	<u>4.35600</u> ⁴	<u>6.27264</u> ⁶	<u>4.04686</u> ³	<u>4.04686</u> ⁹	<u>1.60000</u> ²	<u>4.84000</u> ³
Circular inch	<u>1.25211</u> ⁻⁷	<u>1.00000</u>	<u>1.00000</u> ⁶	<u>5.06707</u>	<u>5.45415</u> ⁻³	<u>7.85398</u> ⁻¹	<u>5.06707</u> ⁻⁴	<u>5.06707</u> ²	<u>2.00336</u> ⁻⁵	<u>6.06017</u> ⁻⁴
Circular mil	<u>1.25211</u> ⁻¹³	<u>1.00000</u> ⁻⁶	<u>1.00000</u>	<u>5.06707</u> ⁻⁶	<u>5.45415</u> ⁻⁹	<u>7.85398</u> ⁻⁷	<u>5.06707</u> ⁻¹⁰	<u>5.06707</u> ⁻⁴	<u>2.00336</u> ⁻¹¹	<u>6.06017</u> ⁻¹⁰
Centimeter ²	<u>2.47105</u> ⁻⁸	<u>1.97353</u> ⁻¹	<u>1.97353</u> ⁵	<u>1.00000</u>	<u>1.07639</u> ⁻³	<u>1.55000</u> ⁻¹	<u>1.00000</u> ⁻⁴	<u>1.00000</u> ²	<u>3.95368</u> ⁻⁶	<u>1.19598</u> ⁻⁴
Feet ²	<u>2.29568</u> ⁻⁵	<u>1.83347</u> ²	<u>1.83347</u> ⁸	<u>9.29030</u> ²	<u>1.00000</u>	<u>1.44000</u> ²	<u>9.29030</u> ⁻²	<u>9.29030</u> ⁴	<u>3.67310</u> ⁻³	<u>1.11111</u> ⁻¹
Inch ²	<u>1.59423</u> ⁻⁷	<u>1.27324</u>	<u>1.27324</u> ⁶	<u>6.45160</u>	<u>6.94444</u> ⁻³	<u>1.00000</u>	<u>6.45160</u> ⁻⁴	<u>6.45160</u> ²	<u>2.55076</u> ⁻⁵	<u>7.71605</u> ⁻⁴
Meter ²	<u>2.47105</u> ⁻⁴	<u>1.97353</u> ³	<u>1.97353</u> ⁹	<u>1.00000</u> ⁴	<u>1.07639</u> ¹	<u>1.55000</u> ³	<u>1.00000</u>	<u>1.00000</u> ⁶	<u>3.95368</u> ⁻²	<u>1.19598</u>
Millimeter ²	<u>2.47105</u> ⁻¹⁰	<u>1.97353</u> ⁻³	<u>1.97353</u> ³	<u>1.00000</u> ⁻²	<u>1.07639</u> ⁻⁵	<u>1.55000</u> ⁻³	<u>1.00000</u> ⁻⁶	<u>1.00000</u>	<u>3.95368</u> ⁻⁸	<u>1.19598</u> ⁻⁶
Rod ²	<u>6.25000</u> ⁻³	<u>4.99161</u> ⁴	<u>4.99161</u> ¹⁰	<u>2.52928</u> ⁵	<u>2.72250</u> ²	<u>3.92040</u> ⁴	<u>2.52928</u> ¹	<u>2.52928</u> ⁷	<u>1.00000</u>	<u>3.02500</u> ¹
Yard ²	<u>2.06611</u> ⁻⁴	<u>1.65012</u> ³	<u>1.65012</u> ⁹	<u>8.36127</u> ³	<u>9.00000</u>	<u>1.29600</u> ³	<u>8.36127</u> ⁻¹	<u>8.36127</u> ⁵	<u>3.30578</u> ⁻²	<u>1.00000</u>

2. AREA

TABLE 3

Volume (V)

	Centimeter ³	Feet ³	Gallon	Inch ³	Liter	Meter ³	Yard ³
Centimeter ³	<u>1.00000</u>	3.53146 ⁻⁵	2.64171 ⁻⁴	6.10236 ⁻²	9.99972 ⁻⁴	<u>1.00000</u> ⁻⁶	1.30794 ⁻⁶
Feet ³	2.83168 ⁴	<u>1.00000</u>	7.48052	<u>1.72800</u> ³	2.83161 ¹	2.83168 ⁻²	3.70370 ⁻²
Gallon (U.S.)	3.78543 ³	1.33680 ⁻¹	<u>1.00000</u>	<u>2.31000</u> ²	3.78533	3.78543 ⁻³	4.95113 ⁻³
Inch ³	1.63871 ¹	5.78704 ⁻⁴	4.32900 ⁻³	<u>1.00000</u>	1.63866 ⁻²	1.63871 ⁻⁵	2.14335 ⁻⁵
Liter	1.00003 ³	3.53156 ⁻²	2.64178 ⁻¹	6.10253 ¹	<u>1.00000</u>	1.00003 ⁻³	1.30798 ⁻³
Meter ³	<u>1.00000</u> ⁶	3.53146 ¹	2.64171 ²	6.10236 ⁴	9.99972 ²	<u>1.00000</u>	1.30794
Yard ³ (U.S.)	7.64554 ⁵	<u>2.70000</u> ¹	2.01974 ²	<u>4.66560</u> ⁴	7.64538 ²	7.64554 ⁻¹	<u>1.00000</u>

3. VOLUME

TABLE 4

Mass (m)

	Grain	Gram _m	Kilogram _m	Ounce (avdp)	Pound _{mass}	Slug	Ton (short)
Grain	<u>1.00000</u>	6.47988 ⁻²	6.47988 ⁻⁵	2.28571 ⁻³	1.42857 ⁻⁴	4.44012 ⁻⁶	7.14285 ⁻⁸
Gram _{mass}	1.54323 ¹	<u>1.00000</u>	<u>1.00000⁻³</u>	3.52739 ⁻²	2.20462 ⁻³	6.85216 ⁻⁵	1.10231 ⁻⁶
Kilogram _{mass}	1.54323 ⁴	<u>1.00000³</u>	<u>1.00000</u>	3.52739 ¹	2.20462	6.85216 ⁻²	1.10231 ⁻³
Ounce (avdp)	4.37500 ²	2.83495 ¹	2.83495 ⁻²	<u>1.00000</u>	6.25000 ⁻²	1.94256 ⁻³	3.12500 ⁻⁵
Pound _{mass}	<u>7.00000³</u>	4.53592 ²	4.53592 ⁻¹	<u>1.60000¹</u>	<u>1.00000</u>	3.10809 ⁻²	<u>5.00000⁻⁴</u>
Slug	2.25218 ⁵	1.45939 ⁴	1.45939 ¹	5.14785 ²	3.21740 ¹	<u>1.00000</u>	1.60870 ⁻²
Ton (short)	<u>1.40000⁷</u>	9.07184 ⁵	9.07184 ²	<u>3.20000⁴</u>	<u>2.00000³</u>	6.21618 ¹	<u>1.00000</u>

4. MASS

TABLE 5

Time (t, r)

	Day	Hour	Microsecond	Millisecond	Minute	Second
Day	$\underline{1.00000}$	$\underline{2.40000}^1$	$\underline{8.64000}^{10}$	$\underline{8.64000}^7$	$\underline{1.44000}^3$	$\underline{8.64000}^4$
Hour	$\underline{4.16666}^{-2}$	$\underline{1.00000}$	$\underline{3.60000}^9$	$\underline{3.60000}^6$	$\underline{6.00000}^1$	$\underline{3.60000}^3$
Microsecond	$\underline{1.15741}^{-11}$	$\underline{2.77778}^{-10}$	$\underline{1.00000}$	$\underline{1.00000}^{-3}$	$\underline{1.66667}^{-8}$	$\underline{1.00000}^{-6}$
Millisecond	$\underline{1.15741}^{-8}$	$\underline{2.77778}^{-7}$	$\underline{1.00000}^3$	$\underline{1.00000}$	$\underline{1.66667}^{-5}$	$\underline{1.00000}^{-3}$
Minute	$\underline{6.94444}^{-4}$	$\underline{1.66667}^{-2}$	$\underline{6.00000}^7$	$\underline{6.00000}^4$	$\underline{1.00000}$	$\underline{6.00000}^1$
Second	$\underline{1.15741}^{-5}$	$\underline{2.77778}^{-4}$	$\underline{1.00000}^6$	$\underline{1.00000}^3$	$\underline{1.66666}^{-2}$	$\underline{1.00000}$

5. TIME

TABLE 6
Angle (α)

	Degree	Minute	Quadrant (right angle)	Radians	Revolutions	Seconds
Degree	<u>1.00000</u>	<u>6.00000¹</u>	1.11111 ⁻²	1.74533 ⁻²	2.77778 ⁻³	<u>3.60000³</u>
Minute	1.66667 ⁻²	<u>1.00000</u>	1.85185 ⁻⁴	2.90889 ⁻⁴	4.62963 ⁻⁵	<u>6.00000¹</u>
Quadrants (right angle)	<u>9.00000¹</u>	<u>5.40000³</u>	<u>1.00000</u>	1.57080	<u>2.50000⁻¹</u>	<u>3.24000⁵</u>
Radians	5.72958 ¹	3.43775 ³	6.36620 ⁻¹	<u>1.00000</u>	1.59155 ⁻¹	2.06265 ⁵
Revolutions	<u>3.60000²</u>	<u>2.16000⁴</u>	<u>4.00000</u>	6.28320	<u>1.00000</u>	<u>1.29600⁶</u>
Seconds	2.77777 ⁻⁴	1.66667 ⁻²	3.08642 ⁻⁶	4.84815 ⁻⁶	7.71605 ⁻⁷	<u>1.00000</u>

6. ANGLE

TABLE 7

Velocity (v)

	cm/sec	ft/min	ft/sec	Kilometer/hr	Knot	Meter/min	Meter/sec	Mile/hr
Centimeter/second	<u>1.00000</u>	1.96850	3.28084 ⁻²	<u>3.60000⁻²</u>	1.94384 ⁻²	<u>6.00000⁻¹</u>	<u>1.00000⁻²</u>	2.23694 ⁻²
Feet/minute	<u>5.08000⁻¹</u>	<u>1.00000</u>	1.66667 ⁻²	<u>1.82880⁻²</u>	9.87473 ⁻³	<u>3.04800⁻¹</u>	<u>5.08000⁻³</u>	1.13636 ⁻²
Feet/second	<u>3.04800¹</u>	<u>6.00000¹</u>	<u>1.00000</u>	<u>1.09728</u>	5.92484 ⁻¹	<u>1.82880¹</u>	<u>3.04800⁻¹</u>	6.81818 ⁻¹
Kilometer/hour	2.77778 ¹	5.46807 ¹	9.11344 ⁻¹	<u>1.00000</u>	5.39957 ⁻¹	<u>1.66667¹</u>	2.77778 ⁻¹	6.21371 ⁻¹
Knot*	5.14444 ¹	1.01268 ²	1.68781	<u>1.85200</u>	<u>1.00000</u>	3.08667 ¹	5.14444 ⁻¹	1.15078
Meter/minute	1.66667	3.28084	5.46807 ⁻²	<u>6.00000⁻²</u>	3.23974 ⁻²	<u>1.00000</u>	1.66667 ⁻²	3.72823 ⁻²
Meter/second	<u>1.00000²</u>	1.96850 ²	3.28084	<u>3.60000</u>	1.94384	<u>6.00000¹</u>	<u>1.00000</u>	2.23694
Mile/hour	4.47040 ¹	8.80000 ¹	1.46667	1.60934	8.68976 ⁻¹	2.68224 ¹	<u>4.47040⁻¹</u>	<u>1.00000</u>

*One knot = one nautical mile per hour

7. VELOCITY

TABLE 8

Force (f)

	Dyne	Gram force	Kilogram force	Newton	Poundal	Pound force
Dyne	<u>1.00000</u>	1.01972^{-3}	1.01972^{-6}	<u>1.00000⁻⁵</u>	7.23301^{-5}	2.24809^{-6}
Gram force	<u>9.80665^2</u>	<u>1.00000</u>	<u>1.00000^{-3}</u>	<u>9.80665^{-3}</u>	7.09316^{-2}	2.20462^{-3}
Kilogram force	<u>9.80665^5</u>	<u>1.00000^3</u>	<u>1.00000</u>	9.80665	7.09316^1	2.20462
Newton	<u>1.00000^5</u>	1.01972^2	1.01972^{-1}	<u>1.00000</u>	7.23301	2.24809^{-1}
Poundal	1.38255^4	1.40981^1	1.40981^{-2}	1.38255^{-1}	<u>1.00000</u>	3.10809^{-2}
Pound force	<u>4.44822^5</u>	4.53594^2	4.53594^{-1}	4.44822	3.21740^1	<u>1.00000</u>

8. FORCE

TABLE 9

Pressure (p)

	Standard Atmosphere	Bar**	Dynes/cm ² (Barye)	Feet Water at 60°F*	cm _{H₂O} /cm ²	Inches Hg at 32°F*	Inches Water at 60°F*	Kg _f /cm ²	lb _f /ft ²	lb _f /in. ²	Micron Hg at 32°F	mm Hg _{O₂} * at 32°F
Standard Atmosphere	1.00000	1.01325	1.01325 ⁶	3.39320 ¹	1.03323 ³	2.99213 ¹	4.07184 ²	1.03323	2.11622 ³	1.46959 ¹	7.60000 ⁵	7.60000 ²
Bar**	9.86923 ⁻¹	1.00000	1.00000 ⁶	3.34882 ¹	1.01972 ³	2.95300 ¹	4.01859 ²	1.01972	2.08854 ³	1.45038 ¹	7.50062 ⁵	7.50062 ²
Dynes/centimeter ² (Barye)	9.86923 ⁻⁷	1.00000 ⁻⁶	1.00000	3.34882 ⁻⁵	1.01972 ⁻³	2.95300 ⁻⁵	4.01859 ⁻⁴	1.01972 ⁻⁶	2.08854 ⁻³	1.45038 ⁻⁵	7.50062 ⁻¹	7.50062 ⁻⁴
Feet Water (at 60°F)*	2.94707 ⁻²	2.98612 ⁻²	2.98612 ⁴	1.00000	3.04500 ¹	8.81801 ⁻¹	1.20000 ¹	3.04500 ⁻²	6.23664 ¹	4.33100 ⁻¹	2.23977 ⁴	2.23977 ¹
Gram _{force} /centimeter ²	9.67841 ⁻⁴	9.80665 ⁻⁴	9.80665 ²	3.28408 ⁻²	1.00000	2.89590 ⁻²	3.94089 ⁻¹	1.00000 ⁻³	2.04816	1.42233 ⁻²	7.35559 ²	7.35559 ⁻¹
Inches Mercury at 32°F*	3.34211 ⁻²	3.38639 ⁻²	3.38639 ⁴	1.13404	3.45315 ¹	1.00000	1.36085 ¹	3.45315 ⁻²	7.07262 ¹	4.91154 ⁻¹	2.54000 ⁴	2.54000 ¹
Inches Water at 60°F*	2.45589 ⁻³	2.48843 ⁻³	2.48843 ³	8.33333 ⁻²	2.53750	7.34834 ⁻²	1.00000	2.53750 ⁻³	5.19720	3.60917 ⁻²	1.86648 ³	1.86648
Kilogram _{force} /centimeter ²	9.67841 ⁻¹	9.80665 ⁻¹	9.80665 ⁵	3.28408 ¹	1.00000 ³	2.89590 ¹	3.94089 ²	1.00000	2.04816 ³	1.42233 ¹	7.35559 ⁵	7.35559 ²
Pound _{force} /foot ²	4.72541 ⁻⁴	4.78803 ⁻⁴	4.78803 ²	1.60343 ⁻²	4.88243 ⁻¹	1.41390 ⁻²	1.92411 ⁻¹	4.88243 ⁻⁴	1.00000	6.94444 ⁻³	3.59131 ²	3.59131 ⁻¹
Pound _{force} /inch ²	6.80460 ⁻²	6.89476 ⁻²	6.89476 ⁴	2.30894	7.03070 ¹	2.03602	2.77072 ¹	7.03070 ⁻²	1.44000 ²	1.00000	5.17149 ⁴	5.17149 ¹
Microns Mercury at 32°F*	1.31579 ⁻⁶	1.33322 ⁻⁶	1.33322	4.46474 ⁻⁵	1.35951 ⁻³	3.93701 ⁻⁵	5.35768 ⁻⁴	1.35951 ⁻⁶	2.78450 ⁻³	1.93368 ⁻⁵	1.00000	1.00000 ⁻³
Millimeters Mercury at 32°F*	1.31579 ⁻³	1.33322 ⁻³	1.33322 ³	4.46474 ⁻²	1.35951	3.93701 ⁻²	5.35768 ⁻¹	1.35951 ⁻³	2.78450	1.93368 ⁻²	1.00000 ³	1.00000

*For g = 980.665 centimeters per second²

**Some writers erroneously use the term bar for barye.

9. PRESSURE

TABLE 10
Energy, Work (e)

	Btu	I.T. Calorie	electron volt	erg (dyne-cm)	ft-lb _f	gm _f -cm	hp hr (Mech)	ab. Joule	kilocalorie	kg _f -m	kw hr	watt hr	ft poundal
Btu	1.00000	2.51996 ²	6.58577 ²¹	1.05504 ¹⁰	7.78159 ²	1.07584 ⁷	3.93009 ⁻⁴	1.05504 ³	2.51996 ⁻¹	1.07584 ²	2.93067 ⁻⁴	2.93067 ⁻¹	2.50365 ⁴
I.T. Calorie	3.96832 ⁻³	1.00000	2.61344 ¹⁹	4.18674 ⁷	3.08798	4.26928 ⁴	1.55958 ⁻⁶	4.18674	1.00000 ⁻³	4.26928 ⁻¹	1.16298 ⁻⁶	1.16298 ⁻³	9.93528 ¹
electron volt	1.51842 ⁻²²	3.82637 ⁻²⁰	1.00000	1.60200 ⁻¹²	1.18157 ⁻¹⁹	1.63358 ⁻¹⁵	5.96755 ⁻²⁶	1.60200 ⁻¹⁹	3.82637 ⁻²³	1.63358 ⁻²⁰	4.45000 ⁻²⁶	4.45000 ⁻²³	3.80160 ⁻¹⁸
erg (dyne-cm)	9.47831 ⁻¹¹	2.38849 ⁻⁸	6.24220 ¹¹	1.00000	7.37562 ⁻⁸	1.01972 ⁻³	3.72506 ⁻¹⁴	1.00000 ⁻⁷	2.38849 ⁻¹¹	1.01972 ⁻⁸	2.77778 ⁻¹⁴	2.77778 ⁻¹¹	2.37304 ⁻⁶
ft-lb _f	1.28509 ⁻³	3.23836 ⁻¹	8.46328 ¹⁸	1.35582 ⁷	1.00000	1.38255 ⁴	5.05050 ⁻⁷	1.35582	3.23836 ⁻⁴	1.38255 ⁻¹	3.76616 ⁻⁷	3.76616 ⁻⁴	3.21740 ¹
gm _f -cm	9.29505 ⁻⁸	2.34231 ⁻⁵	6.12150 ¹⁴	9.80665 ²	7.23301 ⁻⁵	1.00000	3.65304 ⁻¹¹	9.80665 ⁻⁵	2.34231 ⁻⁸	1.00000 ⁻⁵	2.72407 ⁻¹¹	2.72407 ⁻⁸	2.32715 ⁻³
hp hr (Mech)	2.54447 ³	6.41196 ⁵	1.67573 ²⁵	2.68452 ¹³	1.98000 ⁶	2.73745 ¹⁰	1.00000	2.68452 ⁶	6.41196 ²	2.73745 ⁵	7.45700 ⁻¹	7.45700 ²	6.37046 ⁷
ab. Joule (Watt sec)	9.47831 ⁻⁴	2.38849 ⁻¹	6.24220 ¹⁸	1.00000 ⁷	7.37562 ⁻¹	1.01972 ⁴	3.72506 ⁻⁷	1.00000	2.38849 ⁻⁴	1.01972 ⁻¹	2.77778 ⁻⁷	2.77778 ⁻⁴	2.37304 ¹
kilocalorie	3.96832	1.00000 ³	2.61344 ²²	4.18674 ¹⁰	3.08798 ³	4.26928 ⁷	1.55958 ⁻³	4.18674 ³	1.00000	4.26928 ²	1.16298 ⁻³	1.16298	9.93528 ⁴
kg _f -m	9.29505 ⁻³	2.34231	6.12150 ¹⁹	9.80665 ⁷	7.23301	1.00000 ⁵	3.65304 ⁻⁶	9.80665 ⁶	2.34231 ⁻³	1.00000	2.72407 ⁻⁶	2.72407 ⁻³	2.32715 ²
kw hr	3.41219 ³	8.59858 ⁵	2.24719 ²⁵	3.60000 ¹³	2.65222 ⁶	3.67098 ¹⁰	1.34102	3.60000 ⁶	8.59858 ²	3.67098 ⁵	1.00000 ³	1.00000 ³	8.54293 ⁷
watt hr	3.41219	8.59858 ²	2.24719 ²²	3.60000 ¹⁰	2.65222 ³	3.67098 ⁷	1.34102 ⁻³	3.60000 ³	8.59858 ⁻¹	3.67098 ²	1.00000 ⁻³	1.00000	8.54293 ⁴
ft poundal	3.99417 ⁻⁵	1.00651 ⁻²	2.65047 ¹⁷	4.21401 ⁵	3.10810 ⁻²	4.29710 ²	1.56974 ⁻⁸	4.21401 ⁻²	1.00651 ⁻⁵	4.29710 ⁻³	1.17056 ⁻⁸	1.17056 ⁻⁵	1.00000

Definitions: $1 \text{ Btu} = 1 \text{ I.T. Cal} \times \frac{1 \text{ lb}_m}{0.45359237 \text{ kg}}$
 $1 \text{ I.T. Cal} = 1/860 \text{ int. watt hr}$
 $1 \text{ int. watt} = 1.000165 \text{ ab. watt}$

$1 \text{ Btu}_{\text{mean}} = 1055.8 \text{ absolute joules}$
 $1 \text{ Btu}_{\text{39}} = 1060 \text{ absolute joules}$
 $1 \text{ Btu}_{\text{60}} = 1054.6 \text{ absolute joules}$
 $1 \text{ I.T. Btu} = 1055.04 \text{ absolute joules}$
 $1 \text{ I.T. Cal}_{15} = 4.1854 \text{ absolute joules}$
 $1 \text{ I.T. Calorie} = 4.18674 \text{ absolute joules}$

$1 \text{ Cal}_{\text{mean}} = 4.190 \text{ absolute joules}$
 $1 \text{ Cal}_{20} = 4.181 \text{ absolute joules}$
 $1 \text{ Thermochemical Calorie} = 4.1840 \text{ absolute joules}$
 $1 \text{ International Joule} = 1.000165 \text{ absolute joules}$
 $1 \text{ I.T. Calorie} = 1/860 \text{ international watt hour}$
 $\text{Kilocalorie or large calorie} = 1000 \text{ calories}$

10. ENERGY

TABLE 11

Power (P)

	Btu/hr	Btu/min	Btu/sec	I.T.Cal/hr	I.T.Cal/min	I.T.Cal/sec	erg/sec	ft-lb _f /min	ft-lb _f /sec	hp (Elec)	hp (Mech)	hp (Metric)	kg _m /sec	kV	V
Btu/hr	1.00000	1.66667 ⁻²	2.77778 ⁻⁴	2.51996 ²	4.19993	6.99988 ⁻²	2.93067 ⁶	1.29693 ¹	2.16155 ⁻¹	3.9851 ⁻⁴	3.93009 ⁻⁴	3.98460 ⁻⁴	2.98845 ⁻²	2.93067 ⁻⁴	2.93067 ⁻¹
Btu/min	6.00000 ¹	1.00000	1.66667 ⁻²	1.51197 ⁴	2.51996 ²	4.19993	1.75840 ⁸	7.78158 ²	1.29693 ¹	2.35711 ⁻²	2.35805 ⁻²	2.39076 ⁻²	1.79307	1.75840 ⁻²	1.75840 ¹
Btu/sec	3.60000 ³	6.0000 ¹	1.00000	9.07183 ⁵	1.51197 ⁴	2.51996 ²	1.05504 ¹⁰	4.6694 ⁴	7.78158 ²	1.41426	1.41483	1.43446	1.07584 ²	1.05504	1.05504 ³
I.T.Cal/hr	3.96832 ⁻³	6.61387 ⁻⁵	1.10231 ⁻⁶	1.00000	1.66667 ⁻²	2.77778 ⁻⁴	1.16298 ⁴	5.14663 ⁻²	8.57772 ⁻⁴	1.55896 ⁻⁶	1.55958 ⁻⁶	1.58122 ⁻⁶	1.18591 ⁻⁴	1.16298 ⁻⁶	1.16298 ⁻³
I.T.Cal/min	2.38099 ⁻¹	3.96832 ⁻³	6.61387 ⁻⁵	6.00000 ¹	1.00000	1.66667 ⁻²	6.97790 ⁵	3.08798	5.14663 ⁻²	9.35376 ⁻⁵	9.35751 ⁻⁵	9.48730 ⁻⁵	7.11547 ⁻³	6.97790 ⁻⁵	6.97790 ⁻²
I.T.Cal/sec	1.42859 ¹	2.38100 ⁻¹	3.96832 ⁻³	3.60000 ³	6.00000 ¹	1.00000	4.18674 ⁷	1.85279 ²	3.08798	5.61225 ⁻³	5.61451 ⁻³	5.69238 ⁻³	4.26928 ⁻¹	4.18674 ⁻³	4.18674
erg/sec	3.41219 ⁻⁷	5.68699 ⁻⁹	9.47831 ⁻¹¹	8.59858 ⁻⁵	1.43310 ⁻⁶	2.38849 ⁻⁸	1.00000	4.42537 ⁻⁶	7.37562 ⁻⁸	1.34102 ⁻¹⁰	1.34102 ⁻¹⁰	1.35962 ⁻¹⁰	1.01972 ⁻⁸	1.00000 ⁻¹⁰	1.00000 ⁻⁷
ft-lb _f /min	7.71052 ⁻²	1.28509 ⁻³	2.14181 ⁻⁵	1.94302 ¹	3.23836 ⁻¹	5.39727 ⁻³	2.25970 ⁵	1.00000	1.66667 ⁻²	3.02909 ⁻⁵	3.03030 ⁻⁵	3.07233 ⁻⁵	2.30425 ⁻³	2.25970 ⁻⁵	2.25970 ⁻²
ft-lb _f /sec	4.62611	7.71052 ⁻²	1.28509 ⁻³	1.16581 ³	1.94302 ¹	3.23836 ⁻¹	1.35582 ⁷	6.00000 ¹	1.00000	1.81745 ⁻³	1.81818 ⁻³	1.84340 ⁻³	1.38255 ⁻¹	1.35582 ⁻³	1.35582
hp (Elec)	2.54549 ³	4.24249 ¹	7.07081 ⁻¹	6.41453 ⁵	1.06909 ⁴	1.78182 ²	7.46000 ⁹	3.30132 ⁴	5.50221 ²	1.00000	1.00040	1.01427	7.60707 ¹	7.46000 ⁻¹	7.46000 ²
hp (Mech)	2.54447 ³	4.24079 ¹	7.06798 ⁻¹	6.41196 ⁵	1.06866 ⁴	1.78110 ²	7.45701 ⁹	3.30000 ⁴	5.50000 ²	9.95999 ⁻¹	1.00000	1.01387	7.60402 ¹	7.45701 ⁻¹	7.45701 ²
hp (Metric)	2.50966 ³	4.18277 ¹	6.97129 ⁻¹	6.32424 ⁵	1.05404 ⁴	1.75673 ²	7.35500 ⁹	3.25486 ⁴	5.42476 ²	9.85924 ⁻¹	9.86320 ⁻¹	1.00000	7.50000 ¹	7.35500 ⁻¹	7.35500 ²
kg _m /sec	3.34622 ¹	5.57703 ⁻¹	9.29505 ⁻³	8.43233 ³	1.40539 ²	2.34231	9.80665 ⁷	4.33981 ²	7.23301	1.31456 ⁻²	1.31509 ⁻²	1.33333 ⁻²	1.00000	9.80665 ⁻³	9.80665
kilowatt	3.41219 ³	5.68699 ¹	9.47831 ⁻¹	8.59858 ⁵	1.43310 ⁴	2.38849 ²	1.00000 ¹⁰	4.42537 ⁴	7.37562 ²	1.34048	1.34102	1.35962	1.01972 ²	1.00000	1.00000 ³
watt	3.41219	5.68699 ⁻²	9.47831 ⁻⁴	8.59858 ²	1.43310 ¹	2.38849 ⁻¹	1.00000 ⁷	4.42537 ¹	7.37562 ⁻¹	1.34048 ⁻³	1.34102 ⁻³	1.35962 ⁻³	1.01972 ⁻¹	1.00000 ⁻³	1.00000

11. POWER

TABLE 14

Temperature* (T, θ)

To convert from the units below to those on the right, perform the indicated operations in order.	$^{\circ}\text{C}$				$^{\circ}\text{F}$		$^{\circ}\text{K}$	$^{\circ}\text{R}$
	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{K}$	$^{\circ}\text{R}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$		
	$\times 1$	$\times 9/5 + 32$	$+ 273.15$	$\times 9/5 + 491.67$				
	$- 32 \times 5/9$	$\times 1$	$\times 5/9 + 255.372$	$+ 459.67$				
	$- 273.15$	$\times 9/5 - 459.67$	$\times 1$	$\times 9/5$				
	$\times 5/9 - 273.15$	$- 459.67$	$\times 5/9$	$\times 1$				

*Based on the thermodynamic temperature scale as defined by the Tenth General Conference on Weights and Measure meeting at Paris in October 1954.

Temperature of triple point of water = 273.16°K = 491.688°R = 32.018°F = 0.01°C

Temperature of ice point of water = 273.15°K = 491.67°R = 0°C = 32°F

14. TEMPERATURE

TABLE 15

Altitude (A)

Altitude (feet)	Temperature °F.	Pressure	
		mm. Hg.	p.s.i.
0	59.000	759.99	14.696
500	57.217	746.76	14.440
1000	55.434	733.53	14.184
1500	53.652	720.27	13.928
2000	51.869	707.03	13.672
2500	50.086	693.80	13.416
3000	48.304	681.51	13.178
3500	46.521	669.24	12.941
4000	44.739	656.95	12.703
4500	42.956	644.68	12.466
5000	41.174	632.38	12.228
5500	39.392	621.00	12.008
6000	37.610	609.63	11.788
6500	35.827	598.22	11.568
7000	34.045	586.84	11.348
7500	32.263	575.46	11.128
8000	30.481	564.92	10.924
8500	28.700	554.38	10.720
9000	26.918	543.84	10.516
9500	25.137	533.30	10.312
10000	23.355	522.75	10.108
10500	21.574	513.00	9.9200
11000	19.793	503.28	9.7318
11500	18.012	493.52	9.5432
12000	16.231	483.79	9.3551
12500	14.450	474.04	9.1665
13000	12.669	465.05	8.9926
13500	10.888	456.06	8.8188
14000	9.108	447.07	8.6449
14500	7.327	438.07	8.4710
15000	5.546	429.08	8.2972

TABLE 15
(continued)

Altitude (feet)	Temperature °F.	Pressure	
		mm. Hg.	p.s.i.
15500	3.766	420.80	8.1370
16000	1.985	412.52	7.9769
16500	0.205	404.22	7.8163
17000	- 1.576	395.94	7.6562
17500	- 3.356	387.65	7.4961
18000	- 5.136	380.03	7.3487
18500	- 6.916	372.41	7.2014
19000	- 8.695	364.77	7.0535
19500	-10.475	357.15	6.9062
20000	-12.255	349.53	6.7589
21000	-15.814	335.51	6.4877
22000	-19.373	321.51	6.2171
23000	-22.931	308.08	5.9573
24000	-26.489	295.25	5.7092
25000	-30.047	282.40	5.4607
26000	-33.604	270.64	5.2333
27000	-37.161	258.88	5.0059
28000	-40.718	247.62	4.7883
29000	-44.275	236.88	4.5805
30000	-47.831	226.13	4.3727
31000	-51.387	216.33	4.1832
32000	-54.942	206.53	3.9937
33000	-58.497	197.17	3.8127
34000	-62.052	188.25	3.6402
35000	-65.607	179.33	3.4677
36000	-67.244	171.25	3.3115
37000	-68.881	163.18	3.1554
38000	---	155.55	3.0078
39000	---	148.37	2.8690
40000	-69.700	141.18	2.7301

TABLE 15
(continued)

Altitude (feet)	Temperature °F.	Pressure	
		mm. Hg.	p.s.i.
41000	---	134.81	2.6069
42000	---	128.44	2.4837
43000	---	122.43	2.3675
44000	---	116.78	2.2582
45000	-69.700	111.13	2.1490
46000	---	106.12	2.0520
47000	---	101.11	1.9552
48000	---	96.380	1.8637
49000	---	91.933	1.7777
50000	-69.700	87.488	1.6918
51000	---	83.543	1.6155
52000	---	79.599	1.5392
53000	---	75.877	1.4672
54000	---	72.380	1.3996
55000	-69.700	68.882	1.3320
56000	---	65.778	1.2720
57000	---	62.674	1.2119
58000	---	59.746	1.1553
59000	---	56.993	1.1021
60000	-69.700	54.239	1.0488
61000	---	51.069	9.8753×10^{-1}
62000	---	47.902	9.2628
63000	---	44.732	8.6498
64000	---	41.562	8.0368
65000	---	38.395	7.4244
70000	-69.700	33.640	6.5049
80000	-69.700	20.874	4.0365
90000	-57.204	13.033	2.5202
100000	-40.893	8.2906	1.6031
150000	40.425	1.0988	2.1248×10^{-2}
200000	- 10.69	1.6934	3.2744×10^{-3}
300000	-160.5	7.605×10^{-4}	1.471×10^{-5}
400000	464.2	1.351×10^{-5}	2.612×10^{-7}
500000	1473	3.721×10^{-6}	7.195×10^{-8}
1000000	2104	1.777×10^{-7}	3.437×10^{-9}
2000000	2604	3.612×10^{-9}	6.984×10^{-11}

AEROSPACE ENVIRONMENTS

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3. Ionizing Radiation
4. Magnetic Fields
5. Electric Current
6. Thermal Environment
7. Acceleration
8. Vibration
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