Appendix A Conversions

- Unit Conversions
- Temperature Conversions
- Gases and Liquids

USAF/Northrop B-2 Spirit stealth bomber being refueled by a KC-10 tanker. The B-2 was designed to penetrate dense anti-aircraft defenses and deliver both conventional and nuclear weapons. The program has been controversial because of the high unit and O&S costs, and Northrop has only built 21 aircraft to date.

A scientist discovers that which exists.
An engineer creates that which never was.

Theodore von Kármán

A.1 Unit Conversions

A.1.1 Length

Multiply	By	To Obtain
Centimeter (cm)	3.281×10^{-2}	Feet
	3.938×10^{-1}	Inches
	1.000×10^{-5}	Kilometers
	1.000×10^{-2}	Meters
	1.094×10^{-2}	Yards
Foot (ft)	30.48	Centimeters
	12.00	Inches
	3.048×10^{-4}	Kilometers
	3.048×10^{-1}	Meters
	1.894×10^{-4}	Miles
	3.333×10^{-1}	Yards
Inch (in.)	2.540	Centimeters
	8.333×10^{-2}	Feet
	2.540×10^{-2}	Meters
	2.778×10^{-2}	Yards
	1.000×10^{-3}	Miles
Meter (m)	1.000×10^{2}	Centimeters
	3.281	Feet
	39.37	Inches
	1.000×10^{-3}	Kilometers
	6.214×10^{-4}	Miles
	1.094	Yards
Statute mile (mile or mi)	5.280×10^{3}	Feet
	1.609	Kilometers
	1.760×10^{3}	Yards
	0.868976	Nautical miles
Nautical mile (n mile)	6.076×10^{3}	Feet
	1.852×10^{3}	Meters
	1.15078	Miles
Yard (yd)	91.44	Centimeters
	3.000	Feet
	36.00	Inches
	9.144×10^{-1}	Meters
	5.682×10^{-4}	Miles

A.1.2 Area

Multiply	By	To Obtain
Acre	4.356×10^{4}	Square feet
	4.047×10^{3}	Square meters
	1.562×10^{-3}	Square miles
Square centimeter (cm^2)	1.076×10^{-3}	Square feet
	1.550×10^{-1}	Square inches
	1.000×10^{-4}	Square meters
	1.000×10^{2}	Square millimeters
Square foot (ft^2)	2.296×10^{-5}	Acres
	1.440×10^{2}	Square inches
	9.290×10^{-2}	Square meters
	3.587×10^{-8}	Square miles
	1.111×10^{-1}	Square yards
Square inch ($in.^2$)	6.4516	Square Centimeters
	6.944×10^{-3}	Square feet
	6.452×10^{-4}	Square meters
Square kilometer (km)	2.471×10^{2}	Acres
	1.076×10^{7}	Square feet
	3.861×10^{-1}	Square miles
Square meter (m^2)	2.471×10^{-4}	Acres
	1.000×10^{4}	Square centimeters
	10.76	Square feet
	1.550×10^{3}	Square inches
	3.861×10^{-7}	Square miles
Square mile	6.40×10^{2}	Acres
	2.778×10^{7}	Square feet
	2.590	Square kilometers
	2.590×10^{6}	Square meters
	3.0976×10^{6}	Square yards

A.1.3 Volume

Multiply	By	To Obtain
Cubic centimeter (cm^3)	3.531×10^{-5}	Cubic feet
	6.1024×10^{-2}	Cubic inches
	1.000×10^{-6}	Cubic meters
	1.308×10^{-6}	Cubic yards
	3.381×10^{-2}	Fluid ounce
Cubic foot (ft^3)	2.832×10^{4}	Cubic centimeters
	1.728×10^{3}	Cubic inches
	2.832×10^{-2}	Cubic meters
	28.317	Liters
	7.481	Gallons
Cubic inch ($in.^3$)	16.39	Cubic centimeters
	5.787×10^{-4}	Cubic feet
	1.639×10^{-5}	Cubic meters
Cubic meter (m^3)	1.000×10^{6}	Cubic centimeters
	35.31	Cubic feet
	6.102×10^{4}	Cubic inches
	1.308	Cubic yards
Gallon (U.S.) (gal)	1.3368×10^{-1}	Cubic feet
	3.78542	Liters
	3.785×10^{-3}	Cubic meters
	231	Cubic inches
	128	Fluid ounces
	8.000	Pints
	4.000	Quarts
Imperial gallon	2.774×10^{2}	Cubic inches
	1.201	Gallons (U.S.)
	4.546	Liters
Liter	3.532×10^{-2}	Cubic feet
	0.2642	Gallons
	1.000×10^{-3}	Cubic meters
	2.113	Pints
	1.05669	Quarts
	33.8142	Fluid ounces
Pint (U.S.) (pt)	1.671×10^{-2}	Cubic feet
	1.250×10^{-1}	Gallons
	4.732×10^{-1}	Liters
	0.5	Quarts
	28.875	Cubic inches
	16	Fluid ounces
Quart (U.S.) (qt)	3.342×10^{-2}	Cubic feet
	2.500×10^{-1}	Gallons
	9.463×10^{-1}	Liters
	2	Pints

A.1.4 Velocity

Multiply	By	To Obtain
Centimeter per second (cm/s)	3.281×10^{-2}	Feet per second
	3.937×10^{-1}	Inches per second
	1.000×10^{-2}	Meters per second
Foot per second (fps or ft/s)	30.48	Centimeters per second
	1.097	Kilometers per hour
	5.921×10^{-1}	Knots
	3.048×10^{-1}	Meters per second
	6.818×10^{-1}	Miles per hour
Inch per second (ips)	8.333×10^{-2}	Feet per second
	2.540	Centimeters per second
Kilometer per hour (km/h)	9.113×10^{-1}	Feet per second
	5.396×10^{-1}	Knots
	6.214×10^{-1}	Miles per hour
Knot (kt)	1.689	Feet per second
	1.151	Miles per hour
	1.000	Nautical miles per hour
	1.852	Kilometers per hour
Meter per second (m/s)	3.281	Feet per second
	3.600	Kilometers per hour
	1.943	Knots
	2.237	Miles per hour
Mile per hour (mph)	1.467	Feet per second
	1.609	Kilometers per hour
	0.8684	Knots
	0.4470	Meters per second

A.1.5 Acceleration

Feet per second^2 (ft/s^2)	30.48	Centimeters per second^2
	0.6818	Miles per hour-second

A.1.6 Angular Rate and Frequency

Multiply	By	To Obtain
Radians per second (rad/s)	0.1592	Revolutions per second
	9.549	Revolutions per minute
	57.296	Degrees per second
Revolutions per minute (rpm)	0.01667	Revolutions per second
	0.10472	Radians per second
	6	Degrees per second
Cycle per second (cps)	1.000	Hertz
	2π	Radians per second

A.1.7 Mass

Multiply	By	To Obtain
Kilogram (kg)	1.000×10^{3}	Grams
	6.854×10^{-2}	Slugs
Slug	1.459×10^{4}	Grams
	14.59	Kilograms

A.1.8 Weight

Multiply	By	To Obtain
Gram (g)	3.528×10^{-2}	Ounces
	2.205×10^{-3}	Pounds
Pound (lb)	4.536×10^{2}	Grams
	16	Ounces
Short ton	2000	Pounds
	907.185	Kilograms
Metric tonne	2205	Pounds
	1000	Kilograms

A.1.9 Force

Multiply	By	To Obtain
Dyne	1.020×10^{-3}	Grams
	1.000×10^{-5}	Newtons
	2.248×10^{-6}	Pounds
Gram (g)	3.528×10^{-2}	Ounces
	2.205×10^{-3}	Pounds
	9.807×10^{2}	Dynes
	9.807×10^{-3}	Newtons
Kilogram (kg)	2.205	Pounds
	9.807	Newtons
	70.93	Poundals
Pound (lb)	4.536×10^{-1}	Kilograms
	4.448	Newtons
	32.17	Poundals
Poundal	1.410×10^{-2}	Kilograms
	1.383×10^{-1}	Newtons
	3.108×10^{-2}	Pounds

A.1.10 Pressure

Multiply	By	To Obtain
Atmosphere (atm)	29.92	Inches of mercury (0°C)
	760	Millimeters of mercury (0°C)
	1.0133	Bars
	14.70	Pounds per square inch
	1.01325×10^{6}	Dynes per centimeter
	1.01325×10^{5}	Newtons per meter
Bar	9.870×10^{-7}	Atmospheres
	1.000	Dyne per square centimeter
	1.0×10^{5}	Newtons per square meter
	7.501×10^{2}	Millimeters of mercury (0°C)
	1.451×10^{-5}	Pounds per square inch
Dyne per square centimeter ($dyne/cm^2$)	2.952×10^{-5}	Inches of mercury (0°C)
	1.020×10^{-2}	Kilograms per square meter
	7.501×10^{-4}	Millimeters of mercury (0°C)
	1.450×10^{-5}	Pounds per square inch
Inch of mercury (in. Hg)	3.342×10^{-2}	Atmospheres (0°C)
	3.388×10^{-2}	Bars
	3.388×10^{3}	Dynes per square centimeter
	13.60	Inches of water
	25.40	Millimeters of mercury
	3.388×10^{3}	Newtons per square meter
	70.73	Pounds per square foot
	4.912×10^{-1}	Pounds per square inch
Inch of water (in. H_2O) (4°C)	2.458×10^{-3}	Atmospheres
	7.355×10^{-2}	Inches of mercury
	1.868	Millimeters of mercury
	2.491×10^{2}	Newtons per square meter
	3.613×10^{-2}	Pounds per square inch
	5.203	Pounds per square foot
Kilogram per square meter (kg/m^2)	9.678×10^{-5}	Atmospheres
	98.07	Bars
	2.896×10^{-3}	Inches of mercury
	9.807	Newtons per square meter
	6.588	Poundals per square foot
	2.048×10^{-1}	Pounds per square foot
	1.422×10^{-3}	Pounds per square inch

(continued)

Multiply	By	To Obtain
Millimeter of mercury (0°C) (torr or mm Hg)	1.333×10^{3}	Dynes per square centimeter
	3.937×10^{-2}	Inches of mercury
	5.354×10^{-1}	Inches of water
	1.333×10^{2}	Newtons per square meter
	1.934×10^{-2}	Pounds per square inch
Newton per square meter [pascal (Pa)] (N/m^2)	9.869×10^{-6}	Atmospheres
	10	Dynes per square centimeter
	2.953×10^{-4}	Inches of mercury
	1.020×10^{-1}	Kilograms per square meter
	2.089×10^{-2}	Pounds per square foot
	1.450×10^{-4}	Pounds per square inch
Pound per square foot (psf)	4.725×10^{-4}	Atmospheres
	4.788×10^{-4}	Bars
	4.788×10^{2}	Dynes per square centimeter
	1.414×10^{-2}	Inches of mercury
	4.882	Kilograms per square meter
	47.88	Newtons per square meter
	6.944×10^{-3}	Pounds per square inch
Pound per square inch (psi)	6.804×10^{-2}	Atmospheres
	6.895×10^{4}	Dynes per square centimeter
	2.036	Inches of mercury
	7.031×10^{-2}	Kilograms per square meter
	6.895×10^{3}	Newtons per square meter
	1.44×10^{2}	Pounds per square foot

A.1.11 Density

Multiply	By	To Obtain
Pound per cubic foot (lb/ft^3)	5.787×10^{-4}	Pounds per cubic inch
	16.018	Kilograms per cubic meter
	1.6018×10^{-2}	Grams per cubic centimeter

A.1.12 Work and Energy

Multiply	By	To Obtain
British thermal unit (Btu)	2.530×10^{2}	Calories
	7.783×10^{2}	Foot pounds
	3.927×10^{-4}	Horsepower hours
	1.055×10^{3}	Joules
	1.055×10^{3}	Newton meters
	2.930×10^{-4}	Kilowatt hours
	1.055×10^{3}	Watt seconds
Foot pound (ft·lb)	1.285×10^{-3}	British thermal units
	5.050×10^{-7}	Horsepower hours
	1.356	Joules
	3.766×10^{-7}	Kilowatt hours
	1.356	Newton meters
Horsepower hour (hp·h)	2.545×10^{3}	British thermal units
	1.980×10^{6}	Foot pounds
	2.684×10^{6}	Joules
	7.457×10^{-1}	Kilowatt hours
Joule	9.486×10^{-4}	British thermal units
	2.389×10^{-1}	Calories
	1.000×10^{7}	Dyne centimeters (ergs)
	7.376×10^{-1}	Foot pounds
	1.000	Newton meter
	1.000	Watt second
Kilowatt hour (kWh)	3.415×10^{3}	British thermal units
	2.655×10^{6}	Foot pounds
	1.341	Horsepower hours
	3.600×10^{6}	Joules
	3.670×10^{5}	Kilogram meters
	3.600×10^{6}	Watt seconds
Dyne centimeter	7.3756×10^{-8}	Foot pounds
	1.000×10^{-7}	Newton meters

A.1.13 Power

Multiply	By	To Obtain
British thermal unit per minute (BTU/min)	3.969×10^{6}	Calories per second
	12.97	Foot-pounds per second
	2.357×10^{-2}	Horsepower
	17.58	Joules per second
	2.987×10^{-2}	Kilogram meters per second
	17.58	Watts
Foot-pound per second (ft·lb/s)	7.713×10^{-2}	British thermal units per minute
	3.239×10^{-1}	Calories per second
	1.818×10^{-3}	Horsepower
	1.356	Joules per second
	1.383×10^{-1}	Kilogram meters per second
	1.356	Watts
Horsepower (hp)	42.42	British thermal units per minute
	550	Foot-pounds per second
	33,000	Foot-pounds per minute
	7.457×10^{2}	Joules per second
	76.04	Kilogram-meters per second
	7.457×10^{2}	Watts
Kilogram-meter per second	33.47	British Thermal Units per minute
	7.233	Foot-pounds per second
Watt (joule per second) (W)	5.689×10^{-2}	British thermal units per minute
	2.388×10^{-1}	Calories per second
	7.376×10^{-1}	Foot-pounds per second
	1.341×10^{-3}	Horsepower
	1.020×10^{-1}	Kilogram-meters per second

A.2 Temperature Conversions

- $T(°C) = (5/9)\ [T(°F) - 32]$
- $T(°C) = (5/9)\ [T(°R) - 491.67]$
- $T(°C) = T(°K) - 273.15$
- $T(°F) = (9/5)\ T(°C) + 32$
- $T(°F) = (9/5)\ [T(°K) - 273.15] + 32$
- $T(°F) = T(°R) - 459.67$

A.3 Gases and Liquids

A.3.1 Standard Values for Air at Sea Level

- $p_0 = 2116.22$ psi $= 1.01325 \times 10^5$ N/m^2 $= 29.92$ in. Hg $= 760$ mm Hg
- $T_0 = 518.67°\text{R} = 59.0°\text{F} = 288.15°\text{K} = 15.0°\text{C}$
- $g_0 = 32.174$ ft/s^2 $= 9.80665$ m/s^2
- $\rho_0 = 0.002377$ slug/ft^3 $= 0.12492$ kg·s^2/m^4
- $\nu_0 = 1.5723 \times 10^{-4}$ ft^2/s $= 1.4607 \times 10^{-5}$ m^2/s
- $\mu_0 = 1.2024 \times 10^{-5}$ lb/ft·s $= 1.7894 \times 10^{-5}$ kg/m·s
- $\mu_0 = 3.737 \times 10^{-7}$ slug/(ft·s)

A.3.2 Specific Weights of Other Gases at One Atmosphere and 0°C

- Carbon dioxide = 0.12341 lb/ft^3
- Helium = 0.01114 lb/ft^3
- Hydrogen = 0.005611 lb/ft^3
- Nitrogen = 0.07807 lb/ft^3
- Oxygen = 0.089212 lb/ft^3

A.3.3 Specific Weights (Specific Gravity) of Some Liquids at 0°C

- Alcohol (methyl) = 50.5 lb/ft^3 (0.810)
- Gasoline = 44.9 lb/ft^3 (0.72)
- JP1 = 49.7 lb/ft^3 (0.80)
- JP3 = 48.2 lb/ft^3 (0.775)
- JP4 = 49.0 lb/ft^3 (0.785)
- JP5 = 51.1 lb/ft^3 (0.817)
- JP7 = 48.6–50.3 lb/ft^3 (0.779–0.806)
- JP8 = 55.81 lb/ft^3 (0.894)
- JP10 = 58.62 lb/ft^3 (0.939)
- Kerosene = 51.2 lb/ft^3 (0.82)
- Sea water = 63.99 lb/ft^3 (1.025)
- Water = 62.43 lb/ft^3 (1.000)