Formulas

Measurement unit abbreviations

°C	degree Celsius
°F	degree Fahrenheit
ΔT	temperature difference
BTU	British thermal unit
Btuh	British thermal units per hour
ft.	foot
gpg	grains per American gallon
gpm	gallons per minute
in.	inch
kg	kilogram
kN	kilonewton
kPa	kilopascal
L	litre
lb.	pound
lbf	pound-force
m	metre
mm	millimetre
ppm	parts per million
psi	pounds per square inch
s	second
U.S. gal.	American gallon

Constants

π	3.1416
1 ft² of equivalence of direct radiation (EDR)	240 Btuh
1 U.S. gal.	8.33 lb.
12 000 BTU of cooling	1 ton
Pressure head conversion unit	0.433 psi/ ft.
Travel offset of a 45° elbow	1.414

Coefficients

Material	Coefficient of linear expansion per 1 °F	Coefficient of linear expansion per 1 °C
ABS	0.0000550	0.0000990
Brass	0.0000105	0.0000189
Cast iron	0.0000059	0.0000108
Copper	0.0000095	0.0000171
PVC	0.0000330	0.0000594
Steel	0.0000067	0.0000120

Conversion factors

To convert	To	Multiply by
°C	°F	1.8 and add 32
gpg	ppm	17.12
kg	lb.	2.205
kg / m³	lb. / ft³	0.06243
kN	lb.	224.81
kN / m	lbf / ft.	68.52
kN / m³	lbf / ft³	6.360
kPa	lbf / ft²	20.88
kPa	lbf / in²	0.1450
L	gal. imp.	0.2200
L / s	gpm	13.20
m	ft.	3.281
m²	ft²	10.76
mm	in.	0.03937
m / s²	ft. / s²	3,281

General formulas

Description	Full	Abbreviated
Boyle's law	$\frac{\text{volume}_1}{\text{volume}_2} = \frac{\text{pressure}_2}{\text{pressure}_1}$	$\frac{V_1}{V_2} = \frac{P_1}{P_2}$
Charles' law	$\frac{\text{volume}_1}{\text{temperature}_1} = \frac{\text{volume}_2}{\text{temperature}_2}$	$\frac{V_1}{T_1} = \frac{P_1}{T_2}$

General formulas (continued)

Expansion	length × temperature difference × coefficient of expansion	$L \times \Delta T \times \alpha$
Force	pressure × area	$P \times A$
gpm	$\frac{\text{BTU}}{\text{pounds per gallon} \times \text{temperature difference}}$	$\frac{\text{BTU}}{\text{lb./gal.} \times \Delta T}$
gpm	$\frac{\text{total Btuh}}{\text{temp. diff.} \times \text{mass} \times \text{specific heat capacity}}$	$\frac{\text{total Btuh}}{\Delta T \times M \times \text{spec. heat cap.}}$
Grade	$\frac{\text{drope or rise}}{\text{run}}$	
Grains	(number of persons × gallons per day) × (hardness in grains + iron concentration × days of regeneration	(# pers. × gal./day) × (hardness in grains + Fe conc.) × days of regeneration
Litres	area × rainfall intensity	A × rainfall intensity
Watt's law	power = voltage × current	$P = V \times I$
Pressure	height × density	H × dens.

Hydronic thermal formulas

Temperature difference	$\frac{\text{Btuh}}{500 \times \text{gallons per minute}}$	$\frac{\text{Btuh}}{500 \times \text{gpm}}$
gpm	$\frac{\text{Btuh}}{500 \times \text{temperature difference of water}}$	$\frac{\text{Btuh}}{500 \times \Delta T\,(\text{water})}$
Btuh	gallons per minute × 500 × temperature difference	gpm × 500 × ΔT

Area formulas

Circle	$\pi \times \text{radius}^2$	πr^2
Cylinder (open top)	$(\pi \times \text{radius}^2) + (\pi \times \text{diameter} \times \text{height})$	$\pi r^2 + \pi DH$
Cylinder (totally enclosed)	$(2 \times \pi \times \text{radius}^2) + (\pi \times \text{diameter} \times \text{height})$	$2\pi r^2 + \pi DH$
Rectangle	$\text{length} \times \text{width}$	$L \times W$
Rectangle box (open top)	$(\text{length} \times \text{width}) + 2(\text{width} \times \text{height}) + 2(\text{length} \times \text{height})$	$(L \times W) + 2(W \times H) + 2(L \times H)$
Rectangle box (totally enclosed)	$2(\text{length} \times \text{width}) + 2(\text{width} \times \text{height}) + 2(\text{length} \times \text{height})$	$2(L \times W) + 2(W \times H) + 2(L \times H)$
Sphere	$4 \times \pi \times \text{radius}^2$	$4\pi r^2$
Triangle	$\frac{\text{base} \times \text{height}}{2}$	$\frac{B \times H}{2}$

Circumference and perimeter formulas

Circle	$\pi \times \text{diameter}$	πD
Rectangle	$2 \times (\text{length} + \text{width})$	$2(L + W)$
Triangle	side a + side b + side c	a + b + c

Volume formulas

Cylinder	$\pi \times \text{radius}^2 \times \text{height}$	$4\pi r^2 H$
Rectangle box	length × width × height	L × W × H
Sphere	$\frac{4 \times \pi \times \text{radius}^3}{3}$	$\frac{4\pi r^3}{3}$