Exam Formula Sheets

NOVA SCOTIA APPRENTICESHIP AGENCY

Disclaimer: This document lists the Formula Sheets that are included with the Level and Certification exams administered by the Nova Scotia Apprenticeship Agency. This document is subject to change.

Baker

Red Seal

Baker Formulas: Baker - Exam Information

- Numbers of series = Total number of detonators ÷ Number of detonators per series
- Resistance of circuit = Resistance of one series ÷ Number of series
- Resistance of connecting wire = Length of connecting wire x 2 x Resistance of wire (ohms)
- Resistance of detonator circuit = Number of detonators x Resistance of detonators (ohms)
- Resistance of firing wire = Length of connecting wire x 2 x Resistance of wire (ohms)
- Resistance of one series = Number of detonators x Resistance of detonators
- Total resistance of blasting circuit = Resistance of detonator circuit + Resistance of connecting wire + Resistance of firing line

$$\text{Ds (Scaled distance)} = \frac{\text{D (Distance)}}{\sqrt{\text{W (Weight)}}}$$

V (Voltage) = I (Current) x R (Resistance)

$$\text{W (Weight)} = \left[\frac{\text{D (Distance)}}{\text{Ds (Scaled distance)}}\right]^2$$

Trench blasting

Metric	Imperial
B = Burden (m) = 0.6 m per 25 mm of borehole diameter	B = Burden (ft.) = 2 ft. per in. of borehole diameter
S = Spacing (m) = B	S = Spacing (ft.) = B
J = Subgrade drilling (m) = 0.5-0.66 x B	J = Subgrade drilling (ft.) = 0.5-0.66 x B
T = Collar length (m) = S or B	Collar length (ft.) = S or B

Quarry blasting

Metric	Imperial
L = Bench height (m)	L = Bench height (ft.)
B = Burden (m) = (25 to 35 x De) ÷ 1000	B = Burden (ft.) = (25 to 35 x De) ÷ 12
S = Spacing (m) = B x 1.0 to 1.8	S = Spacing (ft.) = B x 1.0 to 1.8
J = Subgrade drilling (m) = B x 0 to 0.5	J = Subgrade drilling (ft.) = B x 0 to 0.5

Metric	Imperial
T = Collar length (m) = B x 0.7	T = Collar length (ft.) = B x 0.7
C = Length of explosives column (m) = J + L – T	C = Length of explosives column (ft.) = J + L - T
Loading Density (kg/m) = 0.0007854 x De^2 x Explosive density	Loading Density (lb./ft.) = 0.3405 x De^2 x Explosive density
Number of units in explosives column = C x 1000 ÷ Length of explosive unit	Number of units in explosives column = C x 12 ÷ Length of explosive unit
Weight of explosives per borehole (kg/hole) = Length of explosives column x Loading density	Weight of explosives per borehole (lb./hole) = Length of explosives column x Loading density
Volume of material per borehole (m^3) = B x S x L	Volume of material per borehole (cu. yd.) = B x S x L ÷ 27
Powder factor (kg/m^3) = Weight of explosives per borehole ÷ Volume of material per borehole	Powder factor (lb./cu. yd.) = Weight of explosives per borehole ÷ Volume of material per borehole
Powder factor (kg/tonne) = Weight of explosives per borehole ÷ Volume of material per borehole x Weight of materials	Powder factor (lb./ton) = Weight of explosives per borehole ÷ Volume of material per borehole x Weight of materials

$\pi = 3.1416$

Arc Length = radius × degrees × 0.01745

$$\text{Arc Length} = \frac{\text{Arc Length Angle} \times C}{360^\circ}$$

Area of Circle = $A = \pi r^2$

Area of Rectangle = L × W

$C = \pi d$ or $C = 2\pi r$

Clip Spacing = 6D

Drum Capacity = (A + B) × B × C × F

$$\text{Factors for the Angle of Cut} = \frac{\text{Angle of Turn}}{\#\text{ of Welds} \times 2}$$

Red Seal... *cont'd*

$$\text{Lead Line Pull} = \frac{\text{Weight}}{\text{Ratio}}$$

Length of Bolt = Length of grip + Washer THK + Nut THK + 2 Threads

Mean Diameter = OD - 1 THK
ID + 1 THK

Number of Wire Rope Clips = 3D + 1

Pythagorean Theorem = $a^2 + b^2 = c^2$

$$\text{Sling Tension} = \frac{\text{Weight}}{\text{Number}} \times \frac{\text{Length}}{\text{Vertical Length}}$$

Tube Expansion = Clearance + Tube Reduction + Tube ID

V - Block Opening for a 90° Air Bend on Heavier Plate = 10 × THK of PL

Volume of Cube = L × W × H

Working Load Limit = $D^2 \times 8$

Wrench Size = 1 1/2 × Bolt Size + 1/8 in.

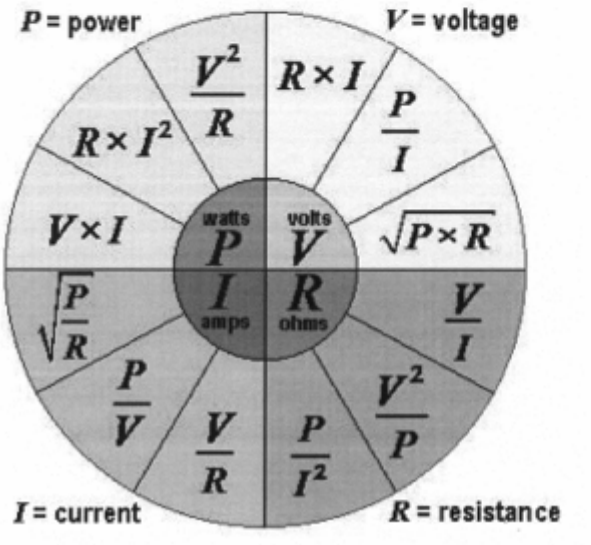
Carpenter

Red Seal

Carpenter Formulas: Carpenter – Exam Information

1. kVA = (V x A) / 1000
2. RPM = 120F / P
3. $V_S / V_P = N_S / N_P$
4. $N_S / N_P = I_P / I_S$
5. $P = I^2 R$
6. I = E/R
7. P = E x I
8. PF = *kw* / *k*VA
9. True 3Φ Power = E_L x I_L x PF x 1.732
10. P (Watts) = hp x 746
11. E_P x N_S = E_S x N_P
12. PF = W/VA
13. $V = V_L / 1.73$
14. $VA = \sqrt{P^2 + (VAR_L - VAR_C)^2}$
15. Wye $E_P = E_L / 1.732$
16. (Series Inductors) $L_T = L_1 + L_2 + L_3$
17. (Parallel Inductors) $1 / L_T = 1 / L_1 + 1/L_2 + 1 / L_3$
18. (Parallel Capacitors) $C_T = C_1 + C_2 + C_3$
19. (Series Capacitors) $1 / C_T = 1 / C_1 + 1/C_2 + 1 / C_3$
20. $X_L = 2\pi fl$
21. $X_C = 1 / 2\pi fC$
22. $C^2 = A^2 + B^2$
23. $Z = \sqrt{R^2 + (X_L - X_C)^2}$
24. Fault Current = Secondary current/ Impedance
25. 1 W = 3.41 BTU / H
26. N = 120F/P
27. Power (HP) = (Torque (lb.in.) x speed)/63,025
28. Motor Efficiency % = (Power out / Power in) x 100
29. $T_K = T_C + 273.15$
30. % Slip = (Stator speed – Rotor speed / Stator speed) x 100
31. % Voltage regulation (Transformers or Alternators) = ([Voltage no-load – Voltage full-load] / Voltage full-load) x 100
32. 3Φ Amps = VA / (Volts x 1.732)
33. Motor Torque (N·m) = (W x 9.549) / Speed
34. 1 ft.lb. = 1.356 N·m
35. Torque (ft.lb.) = (HP x 5252) / Speed
36. 3Φ Apparent Power (VA) = E_L x I_L x 1.732
37. $T_F = T_C$ x 9/5 + 32
38. 1 gallon = .0036047 $in.^3$

39. R factor = RSI x 5.68
40. R = KL/CM
41. $R_T = R_1 + R_2 + R_3$ (series)
42. Effective Value = Peak Value x 0.707
43. Angle Theta = $\cos^{-1}$ PF
44. $I_T = \sqrt{I_R^2 + (I_{XL} - I_{XC})^2}$ (parallel)
45. *Tau (T)* = RC
46. *Tau (T)* = L / R
47. *Tau (T)* = 63.2%
48. 1 – Φ half – wave rectifier: maximum value x 0.318
49. 1 – full – wave rectifier: maximum value x 0.637
50. 3 – half – wave rectifier: maximum value x 0.827
51. 3 – full – wave rectifier: maximum value x 0.955
52. $R_m = kV + 1$
53. $hp = \frac{(2\Pi) \times torque \times rpm}{33\,000}$
54. $E_{INST} = E_{MAX} \times \sin \angle\theta$



Construction Electrician

Red Seal

Construction Electrician Formulas: Construction Electrician - Exam Information

FORMULAS

1 ft^3 of water = 6.228 gal.

Btuh = M × C × ΔT

E = I × R

- E = voltage
- I = current
- R = resistance

P = V × A

- P = power
- V = volt
- A = ampere

VA = I × E

- VA = volt – ampere
- I = current
- E = volt

$$ft^3/hr. = \frac{\text{Size of dial}}{\text{spr}} \times 3\,600 \times \text{Pressure factor}$$

- $ft^3/hr.$ = cubic foot per hour
- spr = number of seconds per rotation

$$\text{Pressure factor} = \frac{\text{Atmospheric pressure} + \text{Gauge pressure}}{\text{Base pressure}}$$

FORMULAS

$$\text{Cfm} = \text{Btuh} / (1.08 \times \Delta T)$$

- cfm = cubic feet per minute
- T = temperature

$$\text{ft}^3/\text{hr} = \frac{\text{Size of dial}}{\text{spr}} \times 3\,600 \times \text{Pressure factor}$$

- ft^3/hr = cubic feet per hour
- spr = number of seconds per rotation

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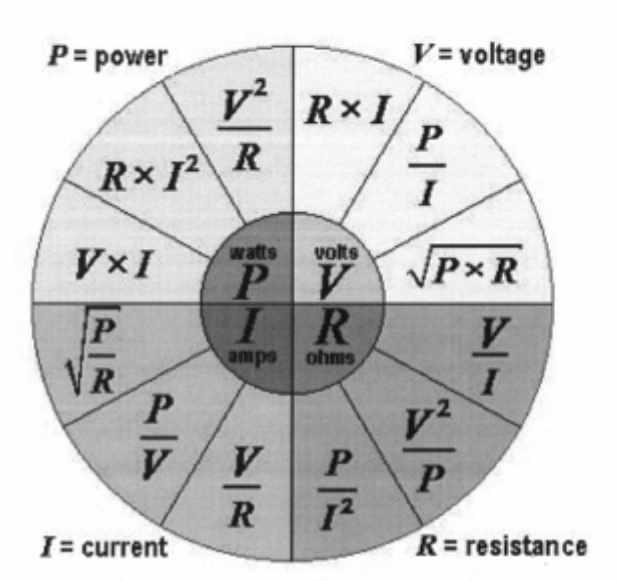


Industrial Electrician

Red Seal

Industrial Electrician Formulas: Industrial Electrician – Exam Information

Industrial Mechanic (Millwright)

Harmonized Levels 1, 2

WLL=D^2 X 8

L/H X W/2

FORMULA: $C = \pi D$

FORMULA: $\left(\frac{D+d}{2}\right)\pi + 2C$

Harmonized Level 3

WLL=D^2 X 8

L/H X W/2

FORMULA: $C = \pi D$

FORMULA: $\left(\frac{D+d}{2}\right)\pi + 2C$

TEMPERATURE CHANGE X 7.2 X 10^{-6} X DISTANCE

10^{-6} x ΔT x L

hp = (gpm x psi) / 1714 (constant)

Harmonized Level 4

RPM = $\frac{sfm\ x\ 12}{\pi d}$

F= 1.77 x R x W x $(RPM/1000)^2$

sfm = $\frac{\pi d\ x\ RPM}{12}$

1 ft^3 of steel = 490 lb.

1 m^3 of steel = 7 849 kg

Area of circle = $\pi \times \text{radius}^2$

Force = pressure × area

Gear pass frequency = rpm × # teeth

Pythagorean theorem : $a^2 + b^2 = c^2$

$$\text{rpm} = \frac{\text{cutting speed} \times 4}{\text{diameter}}$$

$$\text{Shims to be added at point X} = G \times \frac{A}{B}$$

$$\text{Sling stress} = \left(\frac{\text{length}}{\text{height}} \times \text{weight} \right) \div \text{\# of legs (to a maximum of 3 legs)}$$

Spacing of wire rope clips = 6 × wire rope diameter

Surface speed = rpm × π × diameter

Thermal expansion = $\Delta T \times$ length × coefficient of expansion

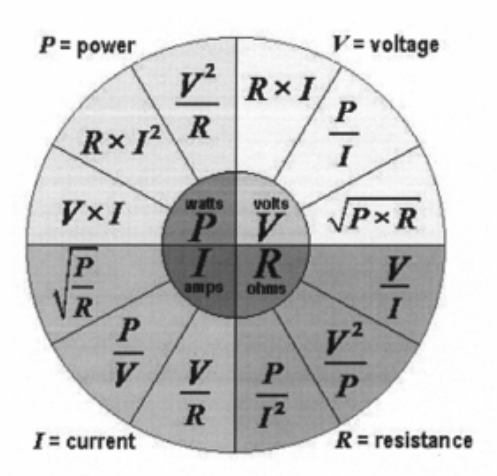
Volume of cube = a^3

Volume of cylinder = height × π × radius^2

Wire rope clips = 3 × diameter + 1 (up to and including 7/8 in. diameter)

Wire rope clips = 3 × diameter + 2 (1 in. diameter and larger)

Working load limit of a 6 × 19 wire rope = $\text{diameter}^2 \times 8$



$$R = \frac{kL}{CM}$$

Capacitors in series: $C_T = \frac{1}{\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}+\cdots}$ Capacitors in parallel: $C_T = C_1 + C_2 + C_3 + \ldots$

Resistors in series: $R_T = R_1 + R_2 + R_3 + \ldots$ Resistors in parallel: $R_T = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\cdots}$

Inductors in series: $L_T = L_1 + L_2 + L_3 + \ldots$ Inductors in parallel: $L_T = \frac{1}{\frac{1}{L_1}+\frac{1}{L_2}+\frac{1}{L_3}+\cdots}$

$$X_C = \frac{1}{2\pi fc} \qquad X_L = 2\pi fL$$

$$Tau\ (\tau) = RC$$

$$Tau\ (\tau) = L/R$$

$$Tau\ (\tau) = 63.2\%$$

$$1-\emptyset\ half-wave\ rectifier: maximum\ value \times 0.318$$

$$1-\emptyset\ full-wave\ rectifier: maximum\ value \times 0.637$$

$$3-\emptyset\ half-wave\ rectifier: maximum\ value \times 0.827$$

$$3 - \emptyset\ full - wave\ rectifier: maximum\ value \times 0.955$$

$$VA = \sqrt{P^2 + (VAR_L - VAR_C)^2}$$

RLC Series Circuits:

$$E_T = \sqrt{ER^2 + (E_L - E_C)^2}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

RLC Parallel Circuits:

$$Z = \frac{1}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{X_L} - \frac{1}{X_C}\right)^2}}$$

$$I_T = {I_R}^2 + (I_L - I_C)^2$$

$$PF = \frac{W}{VA} \times 100$$

$$R = p \times \frac{L}{A}$$

$$Rt_2 = Rt_1[1 + \alpha_{T1}(t_2 - t_1)]$$

$$X_L = \frac{V}{I}$$

Insulator (Heat & Frost)

Levels 1, 2, 3

(NS formula Sheet)

Square / Rectangle

P = 2(L + W)

A = L x W

V = L x W x H

Triangle

P = Add all three sides

$$A = \frac{\text{base x true height}}{2}$$

$$V = \frac{\text{base x true height x length}}{2}$$

Circle

C = Pi x D

A = Pi x R x R

Cylinder

SA = Pi x D x H

V = Pi x R x R x H

Sphere

SA = Pi x D x D

$$V = \frac{\text{Pi x R x R x R x 4}}{3}$$

Cone

SA = Pi x R x slant

V = Pi x R x slant x true height

Miter Measurement

$$\text{Heel} = \frac{\text{(CLR + ½ OD) x 1.57}}{\text{\# of mitres}}$$

$$\text{Throat} = \frac{\text{(CLR – ½ OD) x 1.57}}{\text{\# of Mitres}}$$

FORMULAS

$C = D \times \pi$

$P = 2(L + W)$

$a^2 + b^2 = c^2$

$V = L \times W \times h$

$V = \pi r^2 \times h$

$$\frac{\left(CLR \pm \frac{1}{2} OD\right) \times 1.57}{\#\ of\ mitres}$$

$SA = s\pi r$

$SA = 4\pi r^2$

$SA = \pi r^2$

$SA = \pi dh$

$\pi = 3.14$

h = *height*

SA = *surface* area

CLR = *centreline* radius

OD = *outside* diameter

$$Lateral\ Surface = \frac{Perimeter\ of\ Base \times Slant\ height}{2}$$

Ironworker

Red Seal (Generalist, Reinf., Struct./Orn.)

Ironworker (Generalist) Formulas: Ironworker (Generalist) - Exam Information

Ironworker (Reinforcing): Ironworker (Reinforcing) - Exam Information

Ironworker (Sructural/Ornamental): Ironworker (Structural/Ornamental) - Exam Information

$$a^2 + b^2 = c^2$$

$$A = L \times W$$

$$V = A \times D$$

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}}$$

$\pi = 3.14$

$\text{Area of a circle} = \pi \times \text{Radius}^2$

$\text{Area of a rectangle} = \text{Length} \times \text{Width}$

$\text{Area of a triangle} = \frac{(\text{Base} \times \text{Height})}{2}$

$\text{Circumference of a circle} = \pi \times \text{Diameter}$

$\text{Pythagorean Theorem} = a^2 + b^2 = c^2$

Machinist

Level 1

1. D = 0.5413 × P
2. Major diameter = (N × 0.013) + 0.060
3. Thread depth = 0.6134 × P
4. Blade length = 2(CD) + π D
5. $2\sqrt{r^2 - d^2}$
6. rpm= $\frac{12 \times CS}{\pi \times D}$
7. $\frac{CS \times RPM}{D}$

Formulas

1. D = 0.6495 × P
2. (0.125 × P)
3. D = 0.61343 × P
4. D = 0.5413 X P
5. CW = (0.125 X P)
6. BWS = 0.57735 × pitch
7. PD = Major Diameter - (0.6495 × P)
8. M = PD – (0.8663 × P) + 3W
9. $RPM = \frac{Cutting\ Speed \times 4}{D}$
10. F = N × CPT × rpm
11. RPM = CS × 320/D
12. F= N × (CPT × rpm)
13. $Tailstock\ Offset \frac{TPF \times Length\ of\ work}{24}$
14. $d = D - \frac{TPF \times TL}{12}$
15. $TL = \frac{(D-d) \times 12}{TPF}$

$$w = 0.57735 \times P$$

$$\text{Feed (ipm)} = N \times FPT \times rpm$$

$$rpm = \frac{12 \times CS}{\pi \times D}$$

$$rpm = (1000 \times CS) \div (\pi \times D)$$

$$\text{Time} = L \div (F \times N)$$

$$\text{Time} = L \div (N \times FPT \times rpm)$$

$$\text{Major Diameter} = (N \times 0.013) + 0.060$$

$$M = E - (0.86603P) + 3W$$

$$M = E^2 / 4SM$$

$$\text{Tap Drill Size} = MD - P$$

$$\text{Thread Depth} = 0.5413 \times P$$

$$\text{Thread Depth} = 0.6134 \times P$$

$$\text{Table Feed Rate} = rpm \times N \times F$$

$$L = (0.55 \times T) \div (1.57 \times R)$$

$$(R + 0.4T) \times 1.5708$$

$$PD = MajØ - 2(3/8H)$$

$$\text{Cutting Force} = \text{length} \times \text{thickness} \times \text{shear strength}$$

$$\text{sine Ø} = \frac{\text{opposite}}{\text{hypothenuse}}$$

$$\text{cosine} = \frac{\text{adjacent}}{\text{hypothenuse}}$$

$$\text{tangent} = \frac{\text{opposite}}{\text{adjacent}}$$

$$Cubes = L \times W \times H \times U.W.$$

$$Hollow\ balls = 3.14 \times D \times D \times T \times U.W.$$

$$Pipe = 3.14 \times D \times L \times T \times U.W.$$

$$Angle\ iron = W \times H \times T \times L \times U.W.$$

$$Plate\ steel = W \times L \times T \times U.W.$$

$$Wedge = W \times \frac{L}{2} \times H \times U.W.$$

$$Solid\ balls = 3.14 \times \frac{D \times D \times D}{6} \times U.W.$$

$$Cyliners = 3.14 \times \frac{D}{2} \times \frac{D}{2} \times L \times U.W.$$

$$Pyramid = W \times L \times \frac{H}{3} \times U.W.$$

$$Stress = \frac{W}{N} \times \frac{L}{H}$$

$$Cones = 3.14 \times \frac{D \times D}{4} \times \frac{H}{3} \times U.W.$$

$$Round\ Plate = 3.14 \times \frac{D}{2} \times \frac{D}{2} \times T \times U.W.$$

$$Vertical\ capacity = SWL\ (single\ vertical) \times \frac{H}{L} \times N$$

Unit Weights

Unit weight per cubic meter (cubic foot) of steel = 7 850 kg (490 lb.)

Unit weight per square meter (square foot) of 1 cm (1 in.) of steel = 78.5 kg (40.8 lb.)

Unit weight of concrete per cubic meter (cubic foot) = 2 400 kg (150 lb.)

Formulas

1. Amps x Resistance = Volts
2. Volts divided by Resistance = Amps
3. Voltage divided by Amps = Resistance
4. inside – outside = ΔT (Temperature Difference)

Relative Density of Fuel Oil = 0.893

$$\text{psi} = \frac{\text{Height} \times \text{Specific Gravity}}{2.31}$$

Formulas

1 ft.² EDR = 240 Btuh

1 U.S. gal. = 8.33 lb.

12 000 BTU of cooling = 1 ton

Boyle's law: $\frac{V_1}{V_2} = \frac{P_2}{P_1}$

Charles' Law: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Expansion = length $\times$ ΔT $\times$ coefficient of expansion

Force = pressure $\times$ area

$$\text{gpm} = \frac{\text{BTU}}{\text{lb./gal.} \times \Delta\text{T}}$$

$$\text{gpm} = \frac{\text{total Btuh}}{\Delta\text{T} \times \text{mass} \times \text{minutes} \times \text{specific heat capacity}}$$

$$\text{Grade} = \frac{\text{drop or rise}}{\text{run}}$$

Grains = (# of persons $\times$ gallons per day)
$\times$ (hardness in grains + iron concentration)
$\times$ days of regeneration

Litres = area $\times$ rainfall intensity

Pressure = height $\times$ density

Pressure head conversion unit = 0.433 psi/ ft.

Travel offset of a 45° elbow = 1.414

Hydronic Thermal Formulas

$$\Delta T = \frac{Btuh}{500 \times gpm}$$

$$gpm = \frac{Btuh}{500 \times \Delta T\ (water)}$$

$$Btuh = gpm \times 500 \times \Delta T$$

Circumference / Perimeter

Circumference of circle $= \pi d$

Perimeter of rectangle $= 2(L + W)$

Perimeter of triangle $= a + b + c$

Area

Area of circle $= \pi r^2$

Area of cylinder (open top) $= \pi r^2 + \pi dH$

Area of cylinder (totally enclosed) $= 2\pi r^2 + \pi dH$

Area of rectangle box (open top) $= (L \times W) + 2(W \times H) + 2(L \times H)$

Area of rectangle box (totally enclosed) $= 2(L \times W) + 2(W \times H) + 2(L \times H)$

Area of rectangle $= L \times W$

Area of sphere $= \pi d^2$ or $4\pi r^2$

Area of triangle $= \frac{bH}{2}$

Volume

Volume of cylinder $= \pi r^2 H$

Volume of rectangle box $= L \times W \times H$

Volume of sphere $= \frac{4\pi r^3}{3}$

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 (grains per U.S. gal.)	ppm	17.12
kg	lb.	2.205
kg / m³	lb. / ft.³	0.06243
kN	lb.	224.81
kN / m	lbf / ft.	68.52
kN / m³	lbf / ft.³	6.360
kPa	lbf / in.² (psi)	0.1450
kPa	lbf / ft.²	20.88
L	gal. (imp.)	0.2200
L / s	gal. / min (gpm)	13.20
m	ft.	3.281
m²	ft.²	10.76
mm	in.	0.03937
m / s²	ft. / s²	3.281

Formulas

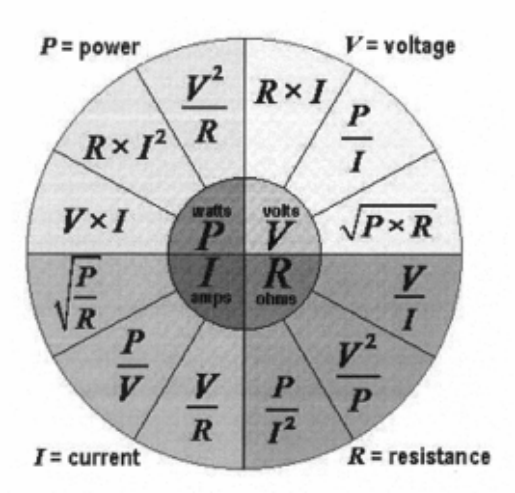
1. Ruling span = average span + 2/3 (max.–average)
2. Vrms = Voltmax × 0.707
3. Irms = Imax × 0.707
4. V = IR
5. $L_T = \frac{1}{\frac{1}{L_1}+\frac{1}{L_2}+\frac{1}{L_3}}$
6. R = E/I
7. $R_T = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}}$
8. $R_T = R_1 + R_2$
9. $R_T = R_1 + R_2 + R_3$
10. C = A/H
11. $\frac{R_1 \times R_2}{R_1 + R_2}$
12. E = I × R
13. $R_T = R_1 + R_2 + R_3 + R_4$
14. T = O/A
15. E = P/R
16. $H^2 = a^2 + b^2$
17. I = P/E
18. $F = \frac{rpm \times pp}{60}$
19. $E_T = E_1 + E_2$
20. $C_T = \frac{1}{\frac{1}{C_1}+\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}+\frac{1}{C_4}}$
21. E^2/R
22. I = E/R
23. $P = I^2 R$
24. V inst = Vmax × Sin theta
25. $C_T = \frac{1}{\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}}$

26. P = EI
27. $C_T = C_1 + C_2 + C_3$
28. E = P/I
29. $I_T = I_1 + I_2 + I_3$
30. Guy tension = line tension divided by anchor distance x guy length
31. $Guy\ Length = \sqrt{L^2} + H^2$
32. $Guy\ Tension\ = \frac{Line\ Tension \times \sqrt{L^2+H^2}}{L}$

Level 2

Formulas

1. $X_L = 2\pi fL$
2. $h^2 = a^2 + b^2$
3. Power Factor = true power/apparent power
4. P = E × I
5. C total = C1 + C2 + C3
6. L total = L1 + L2 + L3
7. $X_c = {}^{1}/_{2\,\pi fc}$
8. $Z = \sqrt{R^2 + (XL - XC)^2}$
9. E = I x R
10. Current triangle



11. $a^2+b^2=c^2$
12. PF = cos of theta
13. $\frac{E^2}{R}$
14. $P = I^2R$
15. $\frac{E_p}{E_s} = \frac{I_s}{I_p}$
16. $\frac{N_p}{N_s} = \frac{E_p}{E_s}$
17. $\frac{N_p}{N_s} = \frac{I_s}{I_p}$
18. KVA/primary voltage × 1 ½
19. $ET = \sqrt{ER^2 + EL^2}$
20. $Z = \sqrt{R^2 + XC^2}$
21. $X_{CT} = X_{C1} = X_{C2} = X_{C3}$
22. $Z = \frac{1}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{X_L} - \frac{1}{X_C}\right)^2}}$

$$\text{Compressive force} = \left(\text{tension} \times \frac{\text{height}}{\text{length}}\right)$$

$$\text{Conductor tension} = \frac{\text{conductor weight} \times \text{span}^2}{8 \times \text{sag}}$$

$$\text{Conductor weight} = \frac{\text{span A} + \text{span B}}{2} \times \text{weight per unit} \times \text{SF}$$

$$\text{kVA} = \frac{(\text{V1} \times \text{I1}) + (\text{V2} \times \text{I2})}{1\ 000}$$

$$\text{Pull} = \frac{\text{weight} + (10\%\ \text{weight} \times \#\ \text{of sheaves})}{\text{MA}}$$

$$\text{Ratio} = \text{primary voltage} \div \text{secondary voltage}$$

$$\text{Ruling span} = \text{average span} + \frac{2}{3}(\text{maximum span - average span})$$

$$\text{WYE phase-to-phase voltage} = \text{phase-to-ground voltage} \times 1.73$$

$$COP = \frac{Cap.W}{P_w} = \frac{Cap.Btuh}{P_{Btuh}}$$

$$Q_S = 1.08 \times cfm \times \Delta°F$$

$$Q_T = 4.5 \times cfm \times \Delta H$$

$$Q_L = 0.68 \times cfm \times \Delta h$$

$$Btu's = WT \times SH \times TD$$

$$3 - phase\ V_{Im} = \frac{Max.Dev.}{E_{ave}} \times 100\%$$

$$V = \pi r^2\ x\ h$$

$$P_1 \times RPM_1 = P_2 \times RPM_2$$

$$CFM_N = (RPM_N / RPM_O) \times CFM_O$$

$$SP_N = (RPM_N / RPM_O)^2 \times SP_O \quad \text{or} \quad (CFM_N / CFM_O)^2 \times SP_O$$

$$BHP_N = (RPM_N / RPM_O)^3 \times BHP_O \quad \text{or} \quad (CFM_N / CFM_O)^3 \times BHP_O$$

$$CR = \frac{Absolute\ Discharge\ Pressure}{Absolute\ Suction\ Pressure}$$

Level 3

1. $COP = \frac{Cap.W}{P_w} = \frac{Cap.Btuh}{P_{Btuh}}$
2. $Q_S = 1.08 \times cfm \times \Delta°F$
3. $Q_T = 4.5 \times cfm \times \Delta H$
4. $Btu's = WT \times SH \times TD$
5. $3\,\emptyset\, V_{Im} = \frac{Max.Dev.}{E_{ave}} \times 100\%$
6. $Q = U \times A \times TD$
7. $U = K/X = 1/R$
8. $Q = \frac{A \times TD}{R}$
9. $Q = \frac{k \times A \times TD \times 24\ hr}{Th}$
10. $Q = gpm \times 600 \times TD$
11. $Travel^2 = Set^2 \times Run^2$
12. $C = fDL$
13. $\%\ OA = \frac{RAT - MAT}{RAT - OAT} \times 100\%$
14. $MAT = (\%\ RA \times RAT) + (\%\ RA \times RAT)$
15. $Reset\ Ratio = \frac{Control\ Temperature\ Change}{Outside\ Air\ Temperature\ Change}$
16. $Pressure\ Relief\ Capacity = Factor\ x\ Diameter\ (ft)\ x\ Length\ (ft)$
17. 

Sheet Metal Worker

Levels 1, 2, 3, 4

1) $\frac{degrees}{360°}\ x\ \pi\ x\ Diameter + allowances = Elbow\ Runner\ Length$

2) $\frac{Large\ Diameter\ x\ Vertical\ Height}{Large\ Diameter - Small\ Diameter} = Apex\ Height$

3) $a^2 + b^2 = c^2$

4) $CFM = Area\ x\ FPM$

5) $Angle\ of\ Bend\ x\ (0.01743R + 0.0078t) = Bend\ Allowance$
R= radius t= Metal thickness

6) $\frac{Offset^2\ + Length^2}{4\ x\ Offset} = Swing\ Point\ Radius$

7) $A = \pi r^2$

8) $\frac{(4x\sqrt{(offset^2+length^2)} - length)}{3} = Runner\ Length$

9) $1.08\ x\ CFM\ x\ \Delta T\ =\ BTU/hr$

10) $\pi r^2 h = Volume\ of\ a\ cylinder$

11) $RPM\ x\ Percent\ Increase = New\ RPM$

12) $\frac{180\ x\ Diameter\ of\ Cone\ Base}{Slant\ height} = Pattern\ Angle$

13) $\sqrt{Apex^2\ + Radius^2} = Slant\ Length$

14) $\frac{Angle\ of\ Elbow}{2\ x\ \#\ of\ Gores - 2} = Mitre\ Angle$

15) $\sin\left(\frac{Pattern\ Angle}{2}\right)\ x\ Slant\ Height\ x\ 2 = Chord\ \ Length$

16) $\mathrm{Tan}(Mitre\ Angle)\ x\ Centerline\ Radius\ x\ (2\ x\ \#of\ gores - 2) = Cut\ Size\ for\ \emptyset\ Elbow$

17) $\frac{Offset}{\sin(Elbow\ Angle)} - 2\ x\ \left[\tan\left(\frac{Elbow\ Angle}{2}\right)\ x\ Centerline\ Radius\right] = Offset\ Pipe\ Length$

18) $\Delta H\ x\ CFM\ x\ 4.5 = \mathrm{BTU/hr}$

19) $4005\sqrt{Velocity\ Pressure} = Air\ velocity$ $\quad Velocity\ Pressure = (Velocity \div 4005)^2$

20) $(\%\ of\ Outside\ Air\ x\ Outside\ Air\ Temp.) + (\%\ of\ Return\ Air\ x\ Return\ Air\ Temp.) = Mixed\ Air\ Temperature$

21) $\frac{Left\ Angle}{360°} \times \pi \times 2(Left\ Heel\ Radius) + \frac{Right\ Angle}{360°} \times \pi \times 2(Right\ Heel\ Radius) = Heel\ Stretchout\ for\ Y - Branch$

22) $\frac{1}{2} h\ (B_1 + B_2) = Area\ of\ Trapezoid$

23) $\frac{CFM_{new}}{CFM_{old}} = \frac{RPM_{new}}{RPM_{old}}$ **or** $\frac{Diameter_{new}}{Diameter_{old}} = \frac{RPM_{old}}{RPM_{new}}$

24) $(Diameter\ of\ first\ pulley\ x\ 1.57) + (Diameter\ of\ second\ pulley\ x\ 1.57) + (Centerline\ distance\ between\ pulleys\ x\ 2) = Fan\ Belt\ Length$

25) $\frac{Offset\ x\ Height}{Length\ of\ Duct} = Duct\ Miter$

26) $\sqrt{\frac{4\ x\ a\ x\ b}{\pi}} = Round\ Duct\ Equivalent$

27) $°F = °C\ x\ 1.8 + 32$ **or** $°C = °F - 32 \div 1.8$

28) $\frac{Volume\ of\ Room\ x\ \#\ of\ Air\ Changes}{60} = Required\ cfm$

29) $Heat\ Loss = \frac{\Delta T\ x\ Area}{R-Value}$

30) $Outside\ Pulley\ Velocity = \frac{\pi\ x\ Diameter}{12}\ x\ RPM$

31) $E = I\ x\ R$ (E= Voltage I= Amps R= Ohms)

32) $P = E\ x\ I$ (P= Watts E= Voltage I= Amps)

33) $Friction\ Loss = \frac{length\ of\ duct\ (ft)}{100}\ x\ inches\ of\ wc\ per\ 100ft$

34) $New\ External\ Static\ Pressure = Existing\ ESP\ x\ (new\ rpm \div existing\ rpm)^2$

35) $New\ horsepower = Existing\ hp\ x\ (new\ rpm \div existing\ rpm)^3$

36) $Velocity\ (FPM) = 4005\ X\ \sqrt{IN.\ W.C.}$

Conversions

1) $1\ ft^3 = 1728\ in^3$
2) $1\ ft^2 = 144\ in^2$
3) $1\ ft = 12\ in$
4) $1\ ft^3 = 6.22\ imp.gal.$
5) $1\ ft^3 = 7.48\ US\ gal.$
6) $1\ imp.gal. = 277.4\ in^3$
7) $1\ US\ gal. = 231\ in^3$
8) $1\ in = 25.4\ mm$
9) $1\ ft = 30.48\ cm$
10) $1\ meter = 39.37\ in$
11) $1\ m = 1000\ mm$ ***or*** $100\ cm$
12) $1\ cm = 10\ mm$
13) $1\ Km = 1000\ m$
14) $1\ Kg = 2.2\ lbs$
15) $1\ m^3 = 1000\ 000\ cm^3$
16) $1\ m^2 = 10\ 000\ cm^2$
17) $1\ imp.gal.of\ Water = 10.05\ lbs.$
18) $1\ US\ gal.of\ Water = 8.35\ lbs.$
19) $1\ ft^3\ of\ Water = 62.5\ lbs$
20) $1\ lb.of\ Air = 13.33\ ft^3$
21) $Specific\ Heat\ of\ Air = 0.24\ Btu$
22) $1\ ft^2\ of\ 10\ gauge\ Mild\ Steel = 5\ lbs.$
23) $Calorific\ Value\ of\ Natural\ Gas = 1000\ Btu/hr$
24) $Calorific\ Value\ of\ Propane\ Gas = 2500\ Btu/hr$
25) *1 psi = 6.895 kPa*
26) *1 psi = 27.7" wc*
27) *1 Btu (Does the following):*

- *Raises 1 lb. of water by 1°F*
- *Raises 1 ft³ of air by 55°F*
- *Raises 55 ft³ of air by 1°F*

Formulas

Use the π button for calculations.
Only round off the final answers.

Pythagorean theorem: $a^2 + b^2 = c^2$

$$\text{Apex height} = \frac{\text{large diameter} \times \text{vertical height}}{\text{large diameter} - \text{small diameter}}$$

Area of a circle $= \pi r^2$

Bend allowance = degrees (0.01743R + 0.0078t)

$$\text{Belt length} = \frac{\pi \times \text{diameter} \times \text{degrees}}{360°}$$

BTU / h = 1.08 × cfm × temperature difference

$C = \pi \times$ diameter

cfm = area sq. ft. × fpm

$$\frac{cfm_2}{cfm_1} = \frac{rpm_2}{rpm_1}$$

$$\frac{D_2}{D_1} = \frac{rpm_1}{rpm_2}$$

Elbow cut size = tan (mitre angle) × centre line radius × (2 × # of gores − 2)

$$\text{Grille measurement area cfm} = \frac{(\text{length} \times \text{width})}{144} \times \frac{\%\ \text{free area}}{100} \times \text{velocity}$$

$$\text{Grille size area} = \frac{\text{cfm}}{\text{fpm}} \times \frac{100}{\%\ \text{free area}}$$

$$\text{Mitre angle} = \frac{\text{angle of elbow}}{2 \times \text{number of gores} - 2}$$

New rpm = rpm × percent increase

$$\text{Pattern angle} = \frac{\text{base} \times 180°}{\text{slant side}}$$

$$\text{Rain cap notch} = \frac{R}{C\angle} \times 2\pi - \pi D$$

$$S\angle = \frac{O}{H}$$

$$C\angle = \frac{A}{H}$$

$$T\angle = \frac{O}{A}$$

$$\frac{\text{Static pressure}_2}{\text{Static pressure}_1} = \left[\frac{\text{cu. ft./rpm}_2}{\text{cu. ft./rpm}_1}\right]^2$$

$$\text{Swing point radius} = \frac{\text{offset}^2 + \text{length}^2}{4 \times \text{offset}}$$

$$\text{Unknown duct side} = \frac{100\%\ \text{free area} \times \text{duct area}}{\text{known duct side}}$$

$$\text{Volume} = r^2h$$

$$\text{Wraper/ belt length} = \frac{4\sqrt{[\text{offset}^2 + \text{length}^2]} - \text{length}}{3}$$

$$\text{Table Feed Rate} = \text{rpm} \times \text{N} \times \text{F}$$

$$\text{Tap Drill Size} = \text{MD} - \text{P}$$

$$\textit{Cutting}\,\text{Force} = \textit{length} \times \textit{thickness} \times \textit{shear}\,\text{strength}\ (C = LTS)$$

$$\text{rpm} = (1000 \times \text{CS}) \div (\pi \times \text{D})$$

$$\text{A}\ (\textit{bend allowance}) = (R + C)\frac{2\pi\text{N}}{360}$$

$$\text{Time} = \text{L} \div (\text{N} \times \text{FPT} \times \text{rpm})$$

$$Cubes = L \times W \times H \times U.W.$$

$$Hollow\ balls = 3.14 \times D \times D \times T \times U.W.$$

$$Pipe = 3.14 \times D \times L \times T \times U.W.$$

$$Pipe = 3.14 \times M.D. \times L \times T \times U.W.$$

$$Plate\ steel = W \times L \times T \times U.W.$$

$$Wedge = W \times \frac{L}{2} \times H \times U.W.$$

$$Cylinders = 3.14 \times \frac{D}{2} \times \frac{D}{2} \times L \times U.W.$$

$$Cylinders = 3.14 \times (\frac{D^2}{4}) \times L \times U.W.$$

$$Solid\ cylinder = 3.14 \times R^2 \times L$$

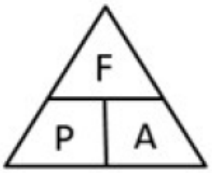
$$Stress = \frac{W}{N} \times \frac{L}{H}$$

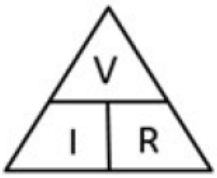
$$Round\ plate = 3.14 \times \frac{D}{2} \times \frac{D}{2} \times T \times U.W.$$

$$Load = \frac{Y}{Z} \times W$$

$$Tandem\ lift\ W \times D = W \times D$$

Formulas





Area of a circle = πr^2

Watt = *voltage x current*