HVAC FORMULAS

TON OF REFRIGERATION - The amount of heat required to melt a ton (2000 lbs.) of ice at 32°F

288,000 BTU/24 hr.
12,000 BTU/hr.

APPROXIMATELY 2 inches in Hg. (mercury) = **1 psi**

WORK = Force (energy exerted) X Distance
Example: A 150 lb. man climbs a flight of stairs 100 ft. high

Work = 150 lb. X 100 ft.
Work = 15,000 ft.-lb.

ONE HORSEPOWER = 33,000 ft.-lb. of work in 1 minute

ONE HORSEPOWER = 746 Watts

CONVERTING KW to BTU:

1 KW = 3413 BTU’s

Example: A 20 KW heater (20 KW X 3413 BTU/KW = 68,260 BTU’s

CONVERTING BTU to KW:

3413 BTU’s = 1 KW

Example: A 100,000 BTU/hr. oil or gas furnace
(100,000 ÷ 3413 = 29.3 KW)

COULOMB = 6.24×10^{18} (1 Coulomb = 1 Amp)

E = voltage (emf)
I = Amperage (current)
R = Resistance (load)

WATTS (POWER) = volts x amps or P = E x I

$$P(\text{in KW}) = \frac{E \times I}{1,000}$$

U FACTOR = reciprocal of R factor
Example:

$$\frac{1}{19} R = .05U$$

= BTU’s transferred / 1 Sq.Ft. / 1°F / 1 Hour

VA (how the secondary of a transformer is rated) = volts X amps

Example: 24V x .41A = 10 VA

ONE FARAD CAPACITY = 1 amp. stored under 1 volt of pressure

MFD (microfarad) = $\frac{1}{1,000,000}$ Farad

$\frac{\textbf{LRA}}{\textbf{5}}$ (Locked rotor amps) = FLA (Full Load Amps)

LRA = FLA x 5

TXV (shown in equilibrium)

	46.7		Bulb Pressure
Spring Pressure	9.7	37	Evaporator Pressure

Bulb Pressure = opening force
Spring and Evaporator Pressures = closing forces

RPM of motor = $\frac{\text{60Hz x 120}}{\text{No. of Poles}}$

1800 RPM Motor – slippage makes it about 1750
3600 RPM Motor – slippage makes it about 3450

DRY AIR = 78.0% Nitrogen
21.0% Oxygen
1.0% Other Gases

WET AIR = Same as dry air <u>plus water vapor</u>

SPECIFIC DENSITY = $\frac{1}{\text{Specific Volume}}$

SPECIFIC DENSITY OF AIR = $\frac{1}{13.33}$ = .075 lbs./cu.ft.

STANDARD AIR = .24 Specific Heat (BTU's needed to raise 1 lb. 1 degree)

SENSIBLE HEAT FORMULA (Furnaces):

BTU/hr. – Specific Heat X Specific Density X 60 min./hr. **=** X CFM X ΔT

$$.24 \times .075 \times 60 \times CFM \times \Delta T = \underline{1.08 \times CFM \times \Delta T}$$

ENTHALPY = Sensible heat and Latent heat

TOTAL HEAT FORMULA
(for cooling, humidifying or dehumidifying)

$$BTU/hr. = \text{Specific Density} \times 60\ min./hr. \times CFM \times \Delta H$$

$$= 0.75 \times 60 \times CFM \times \Delta H$$

$$= \underline{4.5 \times CFM \times \Delta H}$$

RELATIVE HUMIDITY = $\dfrac{\text{Moisture present}}{\text{Moisture air can hold}}$

SPECIFIC HUMIDITY = grains of moisture per dry air

7000 GRAINS in 1 lb. of water

DEW POINT = when wet bulb equals dry bulb

TOTAL PRESSURE (Ductwork) = Static Pressure plus Velocity Pressure

CFM = Area (sq. ft.) X Velocity (ft. min.)

HOW TO CALCULATE AREA

Rectangular Duct

$A = \underline{L \times W}$

Round Duct

$A = \dfrac{\pi D^2}{4}$ OR πr^2

RETURN AIR GRILLES – Net free area = about 75%

3 PHASE VOLTAGE UNBALANCE =

$$\frac{100 \times \text{maximum deg. from average volts}}{\text{Average Volts}}$$

NET OIL PRESSURE = Gross Oil Pressure – Suction Pressure

COMPRESSION RATIO = $\frac{\text{Discharge Pressure Absolute}}{\text{Suction Pressure Absolute}}$

HEAT PUMP AUXILIARY HEAT – sized at 100% of load

ARI HEAT PUMP RATING POINTS (SEER Ratings) 47° 17°

NON-BLEND REFRIGERANTS:

Constant Pressure = Constant Temperature during Saturated Condition

BLENDS – Rising Temperature during Saturated Condition

28 INCHES OF WC = 1 psi

NATURAL GAS COMBUSTION:

Excess Air = 50%

15 $ft.^3$ of air to burn 1 $ft.^3$ of methane produces:

16 $ft.^3$ of flue gases:

1 $ft.^3$ of oxygen

12 $ft.^3$ of nitrogen

1 $ft.^3$ of carbon dioxide

2 $ft.^3$ of water vapor

Another 15 $ft.^3$ of air is added at the draft hood

GAS PIPING (Sizing – CF/hr.) = $\frac{\text{Input BTU's}}{\text{Heating Value}}$

Example: $\frac{\text{80,000 Input BTU's}}{\text{1000 (Heating Value per CF of Natural Gas)}}$

= 80 CF/hr.

Example: $\frac{\text{80,000 Input BTU's}}{\text{2550 (Heating Value per CF of Propane)}}$

= 31 CF/hr.

FLAMMABILITY LIMITS	Propane	Butane	Natural Gas
	2.4-9.5	1.9-8.5	4-14

COMBUSTION AIR NEEDED	Propane	Natural Gas
(PC=Perfect Combustion)	23.5 $ft.^3$ (PC)	10 $ft.^3$ (PC)
(RC=Real Combustion)	36 $ft.^3$ (RC)	15 $ft.^3$ (RC)
ULTIMATE CO_2	13.7%	11.8%

CALCULATING OIL NOZZLE SIZE (GPH):

$$\frac{\text{BTU Input}}{140{,}000 \text{ BTU's}} = \text{Nozzle Size (GPH)}$$

OR

$$\frac{\text{BTU Output}}{140{,}000 \times \text{Efficiency of Furnace}}$$

FURNACE EFFICIENCY:

$$\% \text{ Efficiency} = \frac{\text{energy output}}{\text{energy input}}$$

OIL BURNER STACK TEMPERATURE (Net) = Highest Stack Temperature minus Room Temperature

Example: 520° Stack Temp. – 70° Room Temp. = Net Stack Temperature of 450°

KELVIN TO CELSIUS: C = K – 273

CELSIUS TO KELVIN: K = C + 273

ABSOLUTE TEMPERATURE MEASURED IN KELVINS

SINE = side opposite **COSINE** = side adjacent sin hypotenuse cos hypotenuse

TANGENT = $\dfrac{\text{side opposite}}{\text{side adjacent}}$
tan

PERIMETER OF SQUARE:	$P = 4s$	P = Perimeter s = side
PERIMETER OF RECTANGLE:	$P = 2l + 2w$	P – Perimeter l = length w = width
PERIMETER OF TRIANGLE:	$P = a + b + c$	P = Perimeter a = 1st side b = 2nd side c = 3rd side
PERIMETER OF CIRCLE:	$C = \pi D$ $C = 2\pi r$	C = Circumference π = 3.1416 D = Diameter r = radius
AREA OF SQUARE:	$a = s^2$	A = Area s = side
AREA OF RECTANGLE:	$A = lw$	A = Area l = length w = width
AREA OF TRIANGLE:	$A = 1/2bh$	A = Area b = base h = height
AREA OF CIRCLE:	$A = \pi r^2$ $A = \dfrac{\pi}{4} D^2$	A = Area π = 3.1416 r = radius D = Diameter

VOLUME OF RECTANGULAR SOLID:

$V = l\,wh$

V = Volume
l = length
w = width
h = height

VOLUME OF CYLINDRICAL SOLID:

$V = \pi r^2 h$

$V = \frac{\pi}{4} D^2 h$

V = Volume
π = 3.1416
r = radius
D = Diameter
h = height

CAPACITANCE IN SERIES:

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \ldots\ldots}$$

CAPACITANCE IN PARALLEL:

$$C = C_1 + C_2 + \ldots\ldots$$

GAS LAWS:

Boyle's Law: $P_1 V_1 = P_2 V_2$

P = Pressure (absolute)
V = Volume

Charles' Law: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

P = Pressure (absolute)
T = Temperature (absolute)

General Gas Law: $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

P = Pressure (absolute)
V = Volume
T = Temperature (absolute)

PYTHAGOREAN THEOREM:

$C^2 = a^2 + b^2$

c = hypotenuse
a & b = sides