HVAC FORMULAS

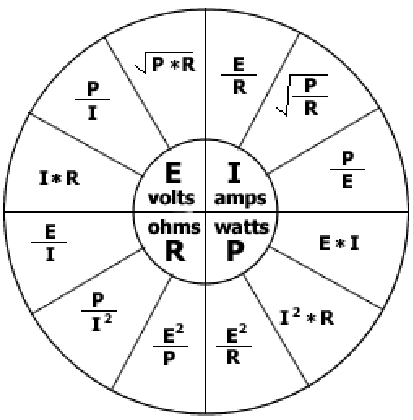
Temperature Conversions: C=Celsius K=Kelvin F=Fahrenheit R=Rankine				
C = K - 273.15	K = C + 273.15	F = (1.8 x C) + 32	C = (F – 32) / 1.8	R = F + 459.67

Pressure Conversions

Atmospheric pressure at sea level = 14.7 Psia = 0 Psig = 29.92 in Hg = 407.2 in WC = 101.4 kPa

Gas Laws: P1=Pressure 1 P2=Pressure 2 V1=Volume 1 V2=Volume 2 T1=Temp 1 T2=Temp 2			
Boyle's Law (w/ sample variations)	**Charles' Law** (w/ sample variations)	**General Law of Perfect Gas** (w/sample variations)	**Dalton's Law** (w/ sample variations)
P1 x V1 = P2 x V2	**V1 / T1 = V2 / T2**	**(P1 x V1) / T1 = (P2 x V2) / T2**	**P total = P1 + P2**
V2 = (P1 x V1) / P2	V2 = (V1 x T2) / T1	P2 = (P1 x V1 x T2) / (T1 x V2)	P2 = P total – P1
P2 = (P1 x V1) / V2	T2 = (V2 x T1) / V1	T1 = (P1 x V1 x T2) / (P2 x V2)	P1 = P total – P2

Ohms Law and the Power Formula



Characteristics of Simple Circuits	
Series Circuits	**Parallel Circuits**
E total = E1 + E2 + E3…	E total = E1 = E2 = E3…
I total = I1 = I2 = I3…	I total = I1 + I2 + I3…
R total = R1 + R2 + R3…	R total = 1 / [(1 / R1) + (1/ R2) + (1/ R3) …]
P total = P1 + P2 + P3…	P total = P1 + P2 + P3…

Electric Motor Applications: EFF=Efficiency HP=Horsepower PF=Power Factor I=Amps E=Volts			
To Find:	**Direct Current**	**Single Phase**	**Three Phase**
HP	(E x I x EFF) / 746	(E x I x EFF x PF) / 746	(1.732 x E x I x EFF x PF) / 746
I	(746 x HP) / (E x EFF)	(746 x HP) / (E x EFF x PF)	(746 x HP) / (1.732 x E x EFF x PF)
EFF	(746 x HP) / (E x I)	(746 x HP) / (E x I x PF)	(746 x HP) / (1.732 x E x I X PF)
PF	N/A	Input Watts / (E x I)	Input Watts / (1.732 x E x I)

Useful Electric Motor Performance Formulas		
RPM = Frequency x 60 x Poles	HP = (Torque in lb/ft x RPM) / 5250	kW = (Torque in Nm x RPM) / 9550
Torque in lb/ft = (HP x 5250) / RPM	Torque in Nm = (kW x 9550) / RPM	

Energy Conversions

1 ton of refrigeration= 12,000 BTU/hr
1 ton of refrigeration= 200 BTU/min
1 ton of refrigeration= 288,000 BTU/24 hrs
1 Therm= 100,000 BTU/hr
Work (ft/lb)= Force (lb) x Distance (ft)

1 HP= 746 Watts
1 Watt= 3.413 BTU/hr
1 kW= 3,413 BTU/hr
1.341 HP= 3,413 BTU/hr
Watts per ton= (HP/ton) x 746

Compiled by J.R. Kok for Lewis-Clark State College and ICTE (May 2019)

HVAC FORMULAS

Fan and Pump Laws: P= Pressure H= Head	
Fan Laws	**Pump Laws**
CFM2 / CFM1 = RPM2 / RPM1	GPM2 / GPM1 = RPM2 / RPM1
P2 / P1 = $(CFM2\ /\ CFM1)^2$	H2 / H1 = $(GPM2\ /\ GPM1)^2$

Formulas for Sizing Duct	
Airflow	FPM = CFM / duct area in sq ft
Duct pressure	Total pressure = static pressure + velocity pressure
Square equivalent of round duct	3.14 x $radius^2$ = sq in of duct → sq in / 144 = sq ft

The Sensible Heat Formula: Q = C x M x ΔT Q= quantity of sensible heat in BTU/hr M= mass C= specific heat of material ΔT= temp difference	
Applied to Standard Air	**Applied to Water (not glycol)**
Q = 1.08 x CFM x ΔT	Q = 500 x GPM x ΔT
CFM = Q / 1.08 x ΔT	GPM = Q / 500 x ΔT
CFM = kW x 3413 / 1.08 x ΔT *(when kW used instead of BTU/hr)*	GPM = tons x 24 / ΔT *(when using tons instead of 12,000 BTU/hr)*

Hydronic Formulas	
Expansion tank pressure setting	$P^{\ tank}$ = (H / 2.31) + 5
Flow mixes	(Flow3 x Temp3) = (Flow1 x Temp1) + (Flow2 x Temp2)
Pump motor size	HP = GPM x PSI x specific gravity of fluid / 1713 x efficiency of pump

Approximate Energy Content of Fuels

1 cu ft natural gas= 1,000 BTU/hr
1 ton of coal= 25,000,000 BTU/hr
1 gallon of #2 fuel oil= 139,600 BTU/hr

1 cord of wood= 30,000,000 BTU/hr
1 gallon of LP= 95,000 BTU/hr

Refrigeration Calculations: COP= Coefficient of Performance EER= Energy Efficiency Ratio SEER= Seasonal Energy Efficiency Ratio	
Compression ratio = discharge pressure / suction pressure	Net refrigeration effect = enthalpy of vapor leaving evaporator – enthalpy of liquid entering evaporator
COP = net refrigeration effect (BTU/hr) / heat of compression (BTU/hr)	Heat of compression = enthalpy of vapor leaving compressor – enthalpy of vapor entering compressor
EER = output cooling in BTU per hr / input energy in watts per hr	SEER = (output cooling in BTU per hr x seasonal run time) / (input energy in watts per hr x seasonal run time)