Please read these few pages before registering for the "Municipal Hydronic Heat Pump". If you can successfully work through these 7 examples, your math is more than adequate to enable you able to focus on the fun parts of this course.

Item #2, says that an equation must remain equal on both sides, Item #1 reminds you of the general order of doing math calculations. #6 reminds you of how to use a fancy calculator if you have one. (this is not required). Please don't be intimidated; be patient with yourself and walk-through step by step.

1. Order of Operations (BEDMAS)

It is important to do math problems in the correct order. To help remember that, use the acronym "BEDMAS" which stands for:

1. Brackets (x + y)
2. Exponents x^n {and roots $\sqrt{x}$ }
3. Division and Multiplication
4. Addition and Subtraction

2. Balance Math rule of thumb. Like bookkeeping, any change made to one side of an equation, must be made equally to the other.

3. Unit Conversion Converting units between metric and imperial, or Celsius and Fahrenheit.

The MHHP course will require basic unit conversion, using formulas such as:

Multiply	By	To Obtain
BTU/HR	0.293	W
Ft.	0.3048	m
Ft./min., fpm	0.00508	m/s
$Ft.^2$	0.0929	m^2
$Ft.^3$	0.0283	m^3
Gallon (U.S. 231 in^3)	3.79	L
Gallon	0.00379	m^3
Horsepower (boiler)	9.81	KW
Inch	25.4	mm
Mile	1.61	km
Pound lb. (mass)	0.454	kg
Psi	6.89	kPa

Using the chart above, convert 50,000 BTU/HR into W:

BTU/HR X 0.293 = W

50,000 X 0.293 = W

=14,650 W or 14.65 KWH.

To convert from degrees Celcius (C) to degrees Fahrenheit (F) multiply the number of degrees C by 9/5 (or 1.8) and add 32.

To convert from degrees Fahrenheit (F) to degrees Celsius © first subtract 32 for the number of degrees F then multiply the remainder by 5/9 (or 0.556).

Convert 32C to F:
32C X 1.8 + 32 = F
57.6 + 32 = F
=89.6F

Convert 115F to C:
(115F – 32) X 0.556 = C
83 X 0.556 = C
=46.148C

4 Basic Formulas

The Municipal Hydronic Heat Pump course will require the understanding of algebraic equations, a statement of the equality of two expressions formulated by applying to a set of variables the algebraic operations, namely, addition, subtraction, multiplication, division, raising to a power, and extraction of a root. Examples follow:

Buffer Tank Sizing Formula:

$$V = \frac{t(Q_{HP} - Q_{min})}{500 \times \Delta T}$$

Where:

V = Minimum required volume of the buffer tank (gallons)
Q_{HP} = Maximum anticipated heat output of the heat pump (Btu/hr) *
Q_{min}=Minimum heating load for the pump to be on (Btu/hr)
t = Minimum “on-cycle” time for the heat pump (minutes)
ΔT = Change in the tank temperature in a complete cycle (°F)

Calculate for V with the following values:
QHP = 38,500 BTU/HR
QMIN = 11,550 BTU/HR
T = 10 min
DeltaT = 20F

$$V = \frac{10\ (38{,}500 - 11{,}550)}{500 \times 20}$$

$$V = \frac{10\ (26{,}950)}{10{,}000}$$

$$V = \frac{269{,}500}{10{,}000}$$

V = 26.95 USG

Calculating Flow Rate Requirements or Delta T's based on Heat Delivery:

$$\textbf{GPM} = \frac{\text{BTU/h}}{500 \times \Delta T\ (^\circ F)}$$

$$\boldsymbol{\Delta T\ (^\circ F)} = \frac{\text{BTU/h}}{500 \times \text{GPM}}$$

Calculate the GPM required to deliver 45,800 BTU/HR with a 30F Delta T:

$$\text{GPM} = \frac{\text{BTU/HR}}{500 \times \text{Delta T}}$$

$$\text{GPM} = \frac{45{,}800}{500 \times 30}$$

$$\text{GPM} = \frac{45{,}800}{15{,}000}$$

GPM = 3.05

Calculate the temperature rise (Delta T) of a circuit with a flow rate of 5 GPM and a heat source adding 20,000 BTU/HR:

$$\text{Delta T} = \frac{\text{BTU/HR}}{500 \times \text{GPM}}$$

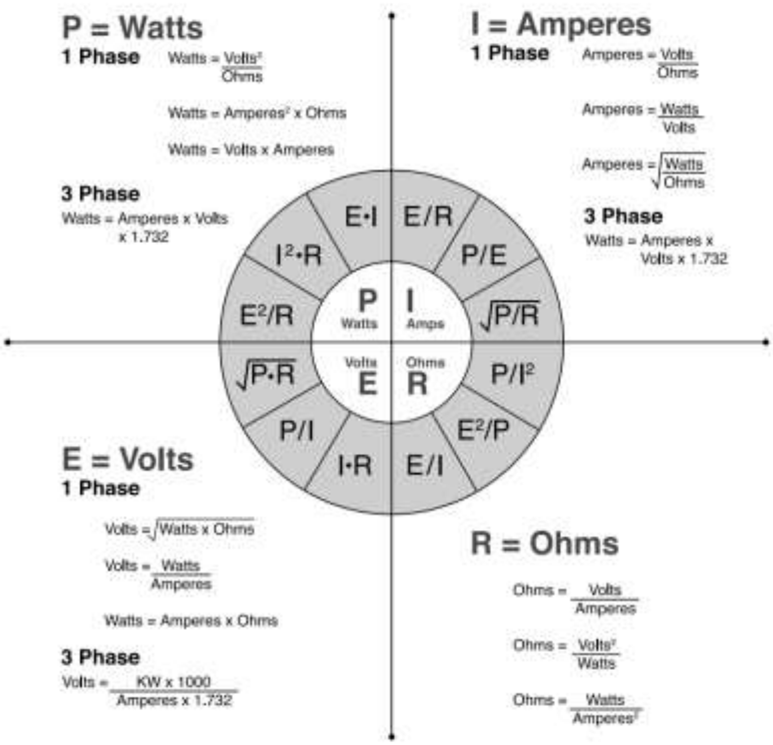
$$\text{Delta T} = \frac{20{,}000}{500 \times 5}$$

$$\text{Delta T} = \frac{20{,}000}{2{,}500}$$

Delta T = 8F

5. Ohm's Law

Ohm's Law defines the relationships between (P) power, € voltage, (I) current, and (R) resistance. One ohm is the resistance value through which one volt will maintain a current of one ampere.



Using the above formulas, calculate the amperage of a 3,000 Watt Electric Resistance heating element operating at 240 Volts:

$$A = \frac{\text{Watts}}{\text{Volts}}$$

$$A = \frac{3{,}000}{240}$$

$$A = 12.5$$

6. Calculators, only read this if you use a scientific type, not required in this course

Note: If you enter information into a calculator, make sure the brackets are in the correct place and place the exponent outside the brackets.

* if your calculator does not have a square root (somewhat common) guess the root, square it then check if the guess was correct. 3 or 4 tries will give you a very close answer.

Example for calculator)

The symbol $\sqrt{\ }$ implies $\sqrt[2]{\ }$ known as a square root, but it is possible to have a number 3 in that top position.

* if your calculator does not have a cube root (not common) guess the root, cube it then check if the guess was correct. 3 or 4 tries will give you a very close answer.

Most calculators have an X^2 button and y^x (which may appear as ^).

ex) $2^3 = 2 \times 2 \times 2 = 8$

Calculator:	2	y^x	3	enter

Some calculators will have $\sqrt[3]{\ }$ as a button, but it may appear as $\sqrt[x]{\ }$ and you must input the number you want for X before pressing the button.

3	$\sqrt[x]{\ }$	64	enter

The Math Tutorial was developed by TECA's POMA Committee for use as a recommended pre-requisite for all POMA registrants as of 1st Edition Jan. 2019 dated POMA Manual. Updated for the MHHP course by Jeremy Young on August 25th 2021.