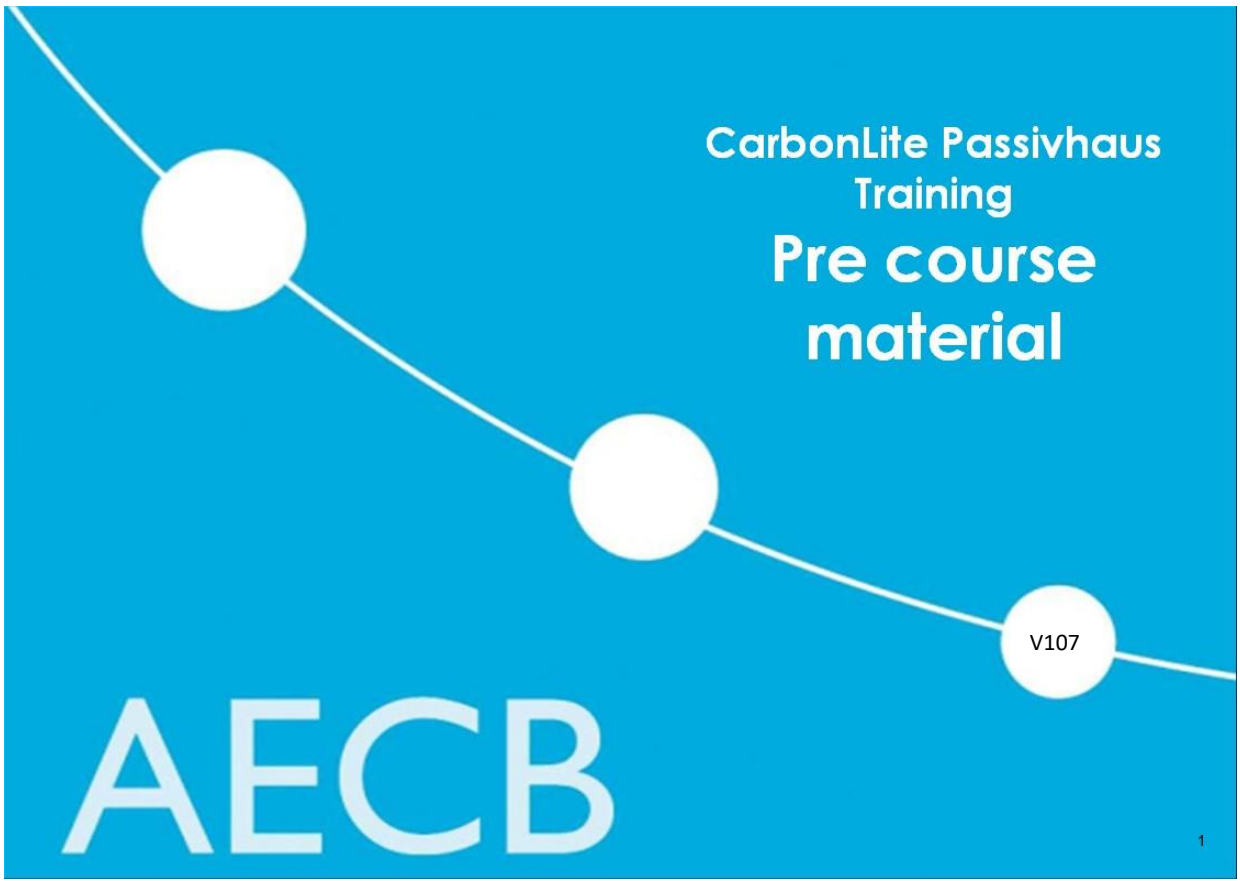

CarbonLite Pre-course Test

As there is a lot to take in during the Passivhaus Designer course we have developed some pre-course material to make sure that everyone has a base understanding beforehand. This means we can devote the time on the course to teaching the really useful stuff.

The first part of the document covers basic power and energy understanding. The second part is an exercise in re-arranging formulas. These latter will only be used in the Science section of the course, so don't worry if maths isn't your strong point.

We would suggest before looking at the examples using the following website to learn and test your ability:

http://www.mathtutor.ac.uk/algebra/transpositionofformulae

This exercise is just a primer so you are not overwhelmed, rather than as a conventional test with answers. Please let us know if get really stuck.

We will also send a construction pre-course reading pdf.
Both this document and the construction pdf can be downloaded from

http://www.passivhaustraining.co.uk/downloads/

Thanks

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Basic Rules for Rearranging Equations:

Add or subtract the same thing to both sides	if a = b then a + c = b + c
Multiply or divide both sides by the same thing	if a = b then a x c = b x c
Replace any term or expression by another equal expression	if a + b = c and b = d x e then a + (d x e) = c
Square or square root both sides	if a + b = c then $(a + b)^2 = c^2$
	if $a^2 = b/c$ then $a = \sqrt{(b/c)}$
Expand out and equation	if y(a + x) = 1 ya +yx = 1
Simplify	ab + ac = a(b+c)

Order of Operations (aka "BODMAS")

Sometimes it is obvious what order to solve an equation in:

$$\frac{15}{3+2} = ?$$

You do 3 + 2 = 5, then divide 15 by 5. 15 / 5 = 3.

Other times, it's not so obvious:
5 x 2 + 3 = ?

You could solve this in 1 of 2 ways:

- 5 x 2 = 10. Then do 10 + 3 = 13.
  OR
- 2 + 3 = 5. Then do 5 x 5 = 25.

So the order in which we multiply or add (the "order of operations") really does matter. We can get completely wrong answers if we do things in the wrong order.

In the example above, the first way was the correct way. How do we know?

Brackets
Order (e.g. y to the power of 2, or y^2. Also, y to the power of -3, or $\sqrt[3]{y}$)
Divide
Multiply
Add
Subtract

BODMAS tells us the order that we have to do things in. Things that are higher up get done first. So in our example, we multiply first and then do the addition because multiplication comes before addition in BODMAS.

Power and Energy:

A basic understanding of power and energy is fundamental to the course. These questions are designed to get you started.

Power describes the rate of energy which is consumed. It is measured in Watts (W). One thousand watts is a kilowatt (kW). Quantity, or Energy is measured in Wh (Watts x Hours) or kWh (1000 x Watts x Hours).

1. A 60W light bulb is left on for 5 days continuously.

A 1.5kW kettle boils water 50 times (each time for 3 minute).

Which uses more energy?

2. A single storey house has a length of 15 metres, width 8 metres and 4 metres height. What is the volume of the house? What are the units for this volume?

The house has 8 in number 60 Watt light bulbs installed. What is the electrical lighting load (power) per unit floor area? What are the units for this figure?

3. A house has a floor area of 115$m^{2.}$ It is heated by a single 2kW electric heater in the living room and a 300W towel rail in the bathroom. Throughout one year the electric heater is turned on at full power for 300 hours and at half power for 850 hours. The towel rail is turned on for 600 hours.

What is the maximum power (in Watts) of the heating system? (W)

What is the maximum power, per meter squared of heating power? (W/m^2)

What is the total energy used for heating in the building over the year? (kWh)

What is the total energy used for heating in the building, per meter squared over the year? (kWh/m^2)

4. A house uses a 65 $kWh/(m^2yr)$ for space heating annually (i.e. 65kWh per square meter of floor area in a year) and a total of 11667.5 kWh/yr .

What floor area was used to calculate the above figures?

5. A 2.5kW electric heater is used to heat a small flat. The electricity meter was connected to the heater. That showed the quantity of energy used over a week is 83,600 Wh. How long was the heater switched on?

Re-arranging Equations:

6. The rate of heat flow (power) due to the flow of fluid is as shown in the first equation. Is the second equation also correct (Y/N)?

$$P_v = V_v \cdot n_{eff} \cdot c \cdot \Delta T$$

$$P_v = n_{eff} \cdot \Delta T \cdot V_v \cdot c$$

7. The heat flow due to a linear thermal bridge and a point thermal bridge is as shown in the first equation. Is the second equation correct (Y/N)?

$$P = (\psi \cdot L + \chi) \cdot \Delta T$$

$$P = \psi \cdot L + \chi \cdot \Delta T$$

8. For a single element, the rate of heat flow (power) through a solid element is a as follows:

$$P = U \cdot A \cdot f_t \cdot \Delta T$$

Rearrange to make A the subject, which of the following is correct:

a) $$A = \frac{P}{U \cdot f_t \cdot \Delta T}$$

b) $$A = \frac{U \cdot A \cdot f_t \cdot \Delta T}{P}$$

c) $$A = P \cdot U \cdot A \cdot f_t \cdot \Delta T$$

9. Using the same equation, and where

$$U = 1/R$$

What is P in terms of R_t?

a) $$P = \frac{A \cdot f_t \cdot \Delta T}{R}$$

b) $$P = \frac{1}{R \cdot A \cdot f_t \cdot \Delta T}$$

c) $$P = \frac{R}{A \cdot f_t \cdot \Delta T}$$

10. According to PHI method the ventilation thermal efficiency uses the following equation:

$$\eta_{HR} = \frac{T_{IN} - T_{EXH} + P_{el}/(\dot{V} \cdot c)}{T_{IN} - T_{OUT}}$$

Rearrange to make T_{exh} the subject, and multiply out all the brackets. Which of the following is correct?

a) $$T_{EXH} = 2\eta_{HR} \cdot T_{IN} + \eta_{HR} \cdot T_{OUT} + \frac{P_{el}}{\dot{V} \cdot c}$$

b) $$T_{EXH} = T_{IN} - \eta_{HR} \cdot T_{IN} + \eta_{HR} \cdot T_{OUT} + \frac{P_{el}}{\dot{V} \cdot c}$$

c) $$T_{EXH} = T_{IN} - \frac{\eta_{HR}}{T_{IN}} + \frac{\eta_{HR}}{T_{OUT}} + \frac{P_{el}}{\dot{V} \cdot c}$$

11. if U_1 = 0.10, A_1=2 and U_2=0.05, A_2=1.5 and ΔT = 20 what is P? (note no units)

$$P = (\sum U \cdot A) \cdot \Delta T$$

Order of Operations

Obtain the value of x in each of the following problems. The values of the following are the same throughout:

y = 10
z = 2
a = 3

12. $x = 14 \times 2 + 4$

13: $x = y \times z + a$

14: $x = y \times (z + a)$

15: $x = \frac{y}{z+a}$

16: $x = y \div (z + a)$

17: $x = y \div z + a$

18: $x = (y \div 2)^3 \div (a^2 - z^2) \times z \div y$

19: $x = \sqrt{\frac{y-a+\frac{y}{z+a}}{-0.5} + 34}$

(If you can do this last one, you are doing very well; none of the equations in the course are this hard!)