Equations for Building Physics Module

1. R-value calculation

$$R = d / \lambda$$

R = Thermal resistance (m^2K/W)
d = Thickness of material (m)
λ = Thermal conductivity of material (W/mK)

2. U-value calculation

$$U = 1/(R_{si} + R_1 + R_2 + ... + R_{se})$$

U = U-value of building element (W/m^2K)
R_{si} = Internal surface resistance (m^2K/W)
R_{se} = External surface resistance (m^2K/W)
R_1 = thermal resistance of building component 1 (m^2K/W)
R_2 = thermal resistance of building component 2 etc... (m^2K/W)

3. Heat loss through a building element

$$\text{Heat loss } (Q) = U \times A \times (T_e - T_i)$$

U = U-value of building element (W/m^2K)
A = Area of building element (m^2)
T_e = external temperature (K)
T_i = internal temperature (K)

4. Heat loss through a thermal bridge

$$\text{Heat loss} = \Psi \times L \times (T_e - T_i)$$

Ψ = psi-value (thermal bridge) (W/mK)
L = length of thermal bridge (m)
T_e = external temperature (K)
T_i = internal temperature (K)

5.

U-value of a window from its components

$$U_{window} = (A_g \times U_g + A_f \times U_f + L_g \times \psi_g) / (A_g + A_f)$$

A_g = Area of window glazing (m^2)
U_g = U-value of window glazing (W/m^2K)
A_f = Area of window frame (m^2)
U_f = U-value of window frame (W/m^2K)
L_g = length of thermal bridge between glazing and frame (m)
Ψ_g = psi-value (thermal bridge) between glazing and frame (W/mK)

6.

Ventilation heat loss

$$\text{Ventilation heat loss} = C_v \times N \times V \times (T_e - T_i)$$

C_v = Specific heat capacity of air – usually given as 1210 J/m^3K
N = Number of air changes per second (ach/s)
V = Volume of the building that is heated (m^3)
T_i = Internal temperature and Te = external temperature

7.

Heat gain via solar transmittance

$$Q_s = A \times g \times Irr$$

A = area of glazing (m^2)
g = solar transmittance of glazing
Irr = solar irradiation (W/m^2)

8.

Sd value for vapour permeability

$$S_d = \mu \times d$$

S_d = equivalent air layer thickness (m)
μ = mu-value or water vapour resistance factor
d = thickness of material (membrane)