Calculating the suface temperature of the sun using the Stefan-Boltzmann law

$$P = e\sigma AT^4$$
$$Q = mc\Delta T$$

First, we can solve the formula for T:

$$T = (\frac{P}{\sigma A})^{\frac{1}{4}} = (\frac{S4\pi D^2}{\sigma 4\pi R_s^2})^{\frac{1}{4}} = (\frac{SD^2}{\sigma R_s^2})^{\frac{1}{4}}$$

For the S, we can calculate using our experimental data(which we do not have) using the formula:

$$P = Q = mc\Delta T$$
$$W = \frac{P}{t}$$
$$S = \frac{W}{A}$$

Hence:

$$S = \frac{\frac{mc\Delta T}{t}}{A}$$

A is calculated:

Formula	
$A = 2\pi rh + 2\pi r^2$	Formula for surface area of cylinder
$A = 2\pi rh$	Surface area for cylinder assuming the top and bottom bases are neglible
$A = \pi rh$	Surface area for base-less cylinder assuming only 1/2 gets exposed to sunlight

Final formula:

$$T = (\frac{\frac{\frac{mc\Delta T}{t}}{\pi rh}D^2}{\sigma R_s^2})^{\frac{1}{4}}$$

Given	
$r = 7.5\ mm$	radius of test tube
$h = 100\ mm$	height of test tube
$m = 50\ g$	mass of water
$c = 4.186\ \frac{j}{g\backslash\text{celsius}}$	specific heat capacity of water
$t = 300\ s$	time of exposure
ΔT	measured temperature change over 300s
$D = 1.495978707 \times 10^{11} m$	Distance from Earth to Sun
$R_s = 6.955 \times 10^8 m$	Radius of the Sun
$\sigma = 5.67 \times 10^{-8} \frac{W}{m^2K^4}$	Stefan-Boltzmann constant
$\pi = 3.14$	Pi

In [14]:

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def Solar_Constant(deltaT,m = 50, r = 0.0075, h = 0.1, t = 300):
    return(((m * 4.186 * deltaT)/t)/(3.14* r * h))
def Temp(Solar_Constant):
    numerator = Solar_Constant * ((1.495978707*(10**11))**2)
    demominator = (5.67*(10**(-8))) * ((6.955*(10**8))**2)
    return (numerator/demominator)**(0.25)
TempChange = input("Input the predicted temperature change: ")
S = Solar_Constant(float(TempChange))
Sun = Temp(S)
print(str(int(S)) + " w/m^2 is the Solar Constant calculated from the given change in temperature.")
print(str(int(Sun)) + "K is the temperature of the Sun.")
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Input the predicted temperature change: 4.5
1333 w/m^2 is the Solar Constant calculated from the given change in temperature.
5742K is the temperature of the Sun.
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In [ ]: