height vs Pressure

$$data := \begin{bmatrix} 0 & 101 \\ 500 & 99.5 \\ 1000 & 97.7 \\ 1500 & 96 \\ 2000 & 94.2 \\ 2500 & 92.5 \\ 3000 & 90.8 \\ 3500 & 89.1 \\ 4000 & 87.5 \\ 4500 & 85.9 \\ 5000 & 84.3 \\ 6000 & 81.2 \\ 7000 & 78.2 \\ 8000 & 75.3 \\ 9000 & 72.4 \end{bmatrix}$$

$x := data^{\langle 0 \rangle}$ $y := data^{\langle 1 \rangle}$ $kJ := 1000\ J$

clear.sym (x)

$$Guess := \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

```
Func(t) := | if Fit = 0
           |    coeffs ← line(x, y)
           |    coeffs_0 + coeffs_1 t
           | else if Fit = 1
           |    coeffs ← lgsfit(x, y, Guess)
           |    coeffs_0 / (1 + coeffs_1 e^(−coeffs_2 t))
           | else if Fit = 2
           |    coeffs ← expfit(x, y)
           |    coeffs_0 · e^(coeffs_1 t) + coeffs_2
           | else if Fit = 3
           |    coeffs ← lnfit(x, y)
           |    coeffs_0 ln(t) + coeffs_1
           | else if Fit = 4
           |    coeffs ← pwrfit(x, y, Guess)
           |    coeffs_0 t^(coeffs_1) + coeffs_2
           | else
           |    coeffs ← sinfit(x, y, Guess)
           |    coeffs_0 sin(t + coeffs_1) + coeffs_2
```

```
coeffs := | if Fit = 0
          |    coeffs ← line(x, y)
          | else if Fit = 1
          |    coeffs ← lgsfit(x, y, Guess)
          | else if Fit = 2
          |    coeffs ← expfit(x, y)
          | else if Fit = 3
          |    coeffs ← lnfit(x, y)
          | else if Fit = 4
          |    coeffs ← pwrfit(x, y, Guess)
          | else
          |    coeffs ← sinfit(x, y, Guess)
          | return coeffs
```

$$= \begin{bmatrix} -0.006 \\ 0.928 \\ 101.317 \end{bmatrix}$$

$$function := \begin{array}{l} \text{if } Fit = 0 \\ \quad b \leftarrow coeffs_0 \cdot x + coeffs_1 \\ \text{else if } Fit = 1 \\ \quad b \leftarrow \dfrac{coeffs_0}{1 + coeffs_1 \, e^{-coeffs_2 \, x}} \\ \text{else if } Fit = 2 \\ \quad b \leftarrow coeffs_0 \cdot e^{coeffs_1 \, x} + coeffs_2 \\ \text{else if } Fit = 3 \\ \quad b \leftarrow coeffs_0 \, \ln(x) + coeffs_1 \\ \text{else if } Fit = 4 \\ \quad b \leftarrow coeffs_0 \, x^{coeffs_1} + coeffs_2 \\ \text{else} \\ \quad b \leftarrow coeffs_0 \, \sin\left(x + coeffs_1\right) + coeffs_2 \\ \text{return } b \end{array}$$

$$Pressure(x) := function \xrightarrow{float,\,3} -0.00625 \cdot x^{0.928} + 101.0$$

$$\mu := \text{mean}(y)$$

$$R\_squared := 1 - \frac{\sum \left(y - Pressure(x)\right)^2}{\sum \left(y - \mu\right)^2}$$

$$\begin{bmatrix} 0 & \text{“linear”} \\ 1 & \text{“logistic”} \\ 2 & \text{“exponential”} \\ 3 & \text{“logarithmic”} \\ 4 & \text{“power”} \\ 5 & \text{“sine”} \end{bmatrix}$$

$$Fit \equiv 4$$

$$Pressure(x) := -0.00625\ kPa \cdot \left(\frac{x}{ft}\right)^{0.928} + 101.0\ kPa$$

$$Pressure(x) = -0.00625 \cdot x^{0.928} + 101.0$$

x is height

$$R\_squared = 0.99794$$

Pressure equation was created by fitting a curve to data

$$R := 286.9\ \frac{J}{kg \cdot K}$$

$$T_{hot\_air} := 175.302\ °C$$

$$V_{balloon} := 200000\ ft^3$$

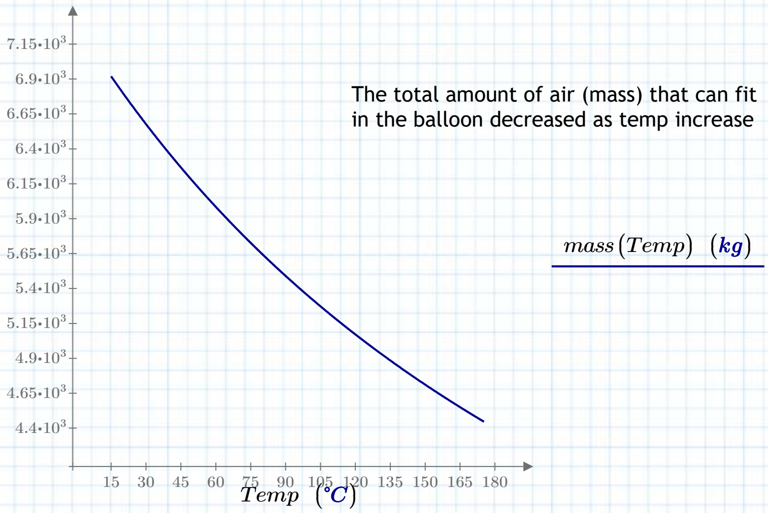
$$Q = Mass \cdot \Delta T \cdot Cp$$

$$Cp_{air} := 1.005\ \frac{kJ}{kg \cdot K} = \left(2.755 \cdot 10^5\right)\ \frac{J}{kg \cdot 1\ °C}$$

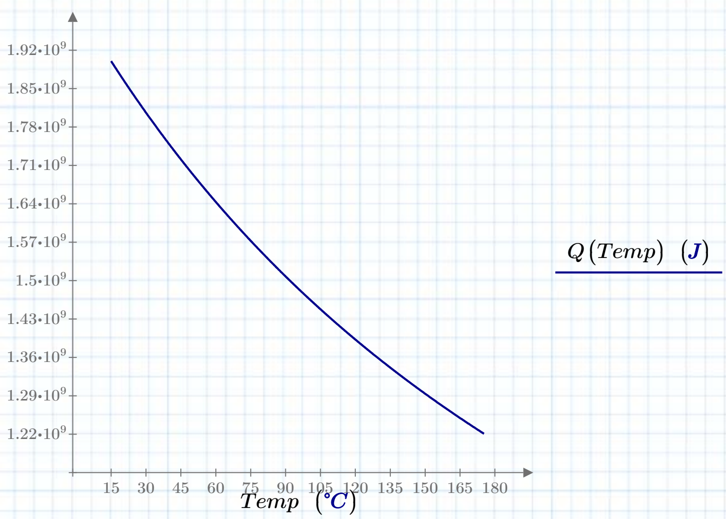
$$Temp := 15\ °C, 15.1\ °C \,..\, T_{hot\_air}$$

$$mass(Temp) := \frac{Pressure(0\ ft)}{R \cdot Temp} \cdot V_{balloon}$$

The total amount of air (mass) that can fit in the balloon decreased as temp increase



$$Q(Temp) := mass(Temp) \cdot .1\ °C \cdot Cp_{air}$$



$$\sum_{n=15}^{175} Q(n\ °C) = \left(2.434 \cdot 10^{11}\right)\ J$$

$$Q_{aprox} := mass(15\ °C) \cdot \left(T_{hot\_air} - 15\ °C\right) \cdot Cp_{air} = \left(1.115 \cdot 10^{9}\right)\ J$$