In[ ]:=

```
(* Assignment 1 *)      Due : 11.00 pm, 16.12 × .22
(*
See the data given below and perform the following:

1. Plot y as a function of t in the range -10 to 100:
   {t, -10, 100, del_t}. You must use the function "ListLinePlot".

2. Set the step size, del_t to 2, 1 and 0.1 and note
   if the plot changes with del_t.

3. Discuss the reason for the same.
*)
```

In[ ]:=

```
t0 = 3.15 * 10^1;
xht = 2.01 * 10^5;
xcp = 3.08 * 10^3;
xhl = -1.05 * 10^4;
p0 = 1.15 * 10^-4;
h0 = 5.25 * 10^-5;
k0 = 1.25 * 10^4;
r0 = 2.25;
n0 = 2.75 * 10^2;
```

In[ ]:=

$$x1 = e^{\left(-\frac{\left(\frac{1}{n0+t}-\frac{1}{n0+t0}\right) xht}{r0}+\frac{xcp\left(-1+\frac{n0+t0}{n0+t}+Log\left[\frac{n0+t}{n0+t0}\right]\right)}{r0}\right)};$$

$$x2 = k0\ e^{-\frac{\left(\frac{1}{n0+t}-\frac{1}{n0+t0}\right) xhl}{r0}};$$

$$x3 = 1 + x1 + x2\ (p0 - h0);$$

$$x4 = -h0\ (1 + x1);$$

$$y = \frac{-x3+\sqrt{(x3)^2-4\ x2\ x4}}{2\ x2};$$

In[ ]:=

```
(*Answer*)
```

In[∘]:=

```
Clear["Global`*"]
(*Given constants*)
t0 = 3.15 * 10^1;
xht = 2.01 * 10^5;
xcp = 3.08 * 10^3;
xhl = -1.05 * 10^4;
p0 = 1.15 * 10^-4;
h0 = 5.25 * 10^-5;
k0 = 1.25 * 10^4;
r0 = 2.25;
n0 = 2.75 * 10^2;
(*Defining x1, x2, x3, x4 and y*)
```

$$x1[t\_] := e^{\left(-\frac{\left(\frac{1}{n0+t}-\frac{1}{n0+t0}\right) xht}{r0}+\frac{xcp\left(-1+\frac{n0+t0}{n0+t}+Log\left[\frac{n0+t}{n0+t0}\right]\right)}{r0}\right)}$$

$$x2[t\_] := k0\ e^{-\frac{\left(\frac{1}{n0+t}-\frac{1}{n0+t0}\right) xhl}{r0}}$$

```
x3[t_] := 1 + x1[t] + x2[t] (p0 - h0)
x4[t_] := -h0 (1 + x1[t])
```

$$y[t\_] := \frac{-x3[t] + \sqrt{(x3[t])^2 - 4\ x2[t] \times x4[t]}}{2\ x2\ [t]}$$

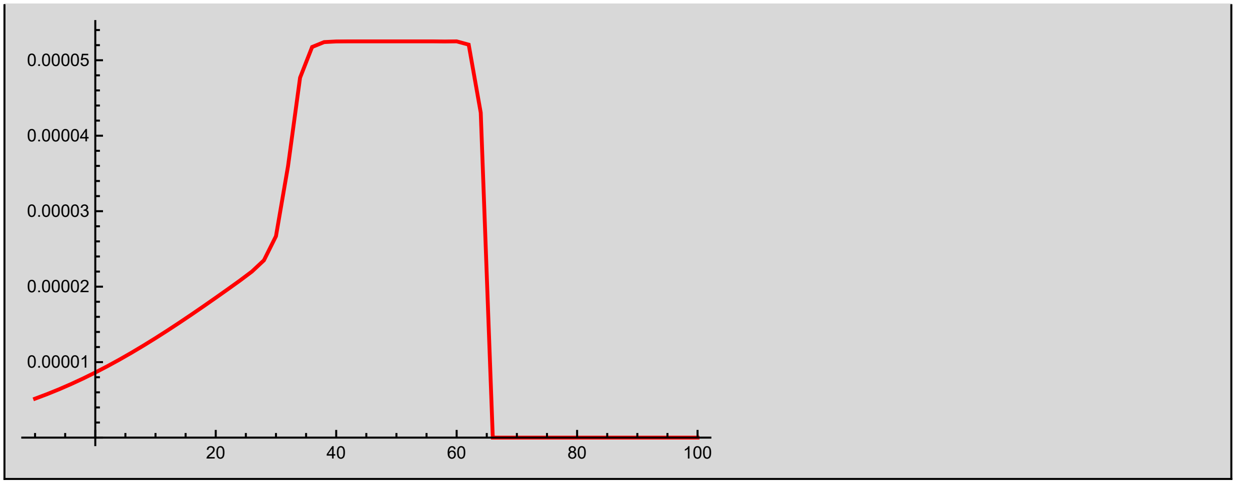
In[∘]:=

```
"Graph with del_t = 2:- "
data1 = Table[{t, y[t]}, {t, -10, 100, 2}];
ListLinePlot[data1, PlotStyle → {Thick, Red}]
```

Out[∘]=

```
Graph with del_t = 2:-
```

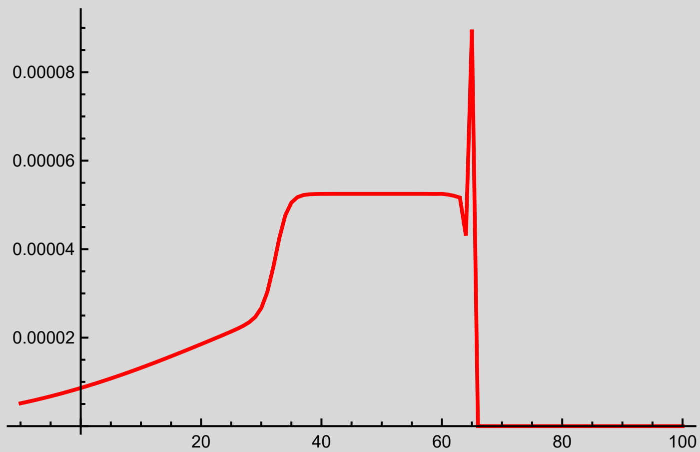
Out[∘]=



In[ ]:=
```
"Graph with del_t = 1:- "
data2 = Table[{t, y[t]}, {t, -10, 100, 1}];
ListLinePlot[data2, PlotStyle → {Thick, Red}]
```

Out[ ]=
```
Graph with del_t = 1:-
```

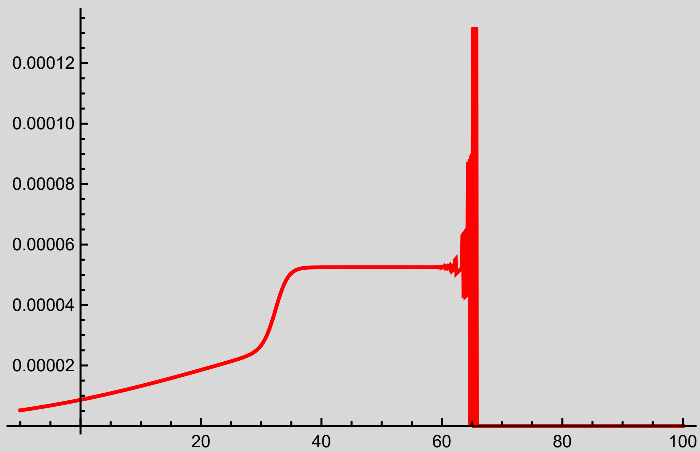
Out[ ]=



In[ ]:=
```
"Graph with del_t = 0.1:- "
data3 = Table[{t, y[t]}, {t, -10, 100, 0.1}];
ListLinePlot[data3, PlotStyle → {Thick, Red}]
```

Out[ ]=
```
Graph with del_t = 0.1:-
```

Out[ ]=



In[ ]:=

```
(*Reason:- *)
"The function ListLinePlot just plots all points
  mentioned above in the table and joins consecutive points with a
straight line (as can be seen be ListPlot
  vs ListLinePlot for y=x^2 for a small number of points."
"The number of points plotted is the most for del_t=0.1 and the least
  for del_t=2 (We can see this by displaying data1, data2 and data3).
So,since the points joined become closer and closer, we get
  a more accurate representation as del_t changes from 2 to 0.1."
"Also, the function dies down to zero after points around t=66
  because mathematica, due to precision, approximates '(x3[t])^2-4
  x2[t]  x4[t]'  to (x3[t])^2 as seen by the table diplayed below."
datx = Table[{t, (x3[t])^2, (x3[t])^2 - 4 x2[t] × x4[t]}, {t, -10, 100, 0.1}];
(*Please erase the semicolon while running*)
(*Note that the values of the second and third column are exactly the same wherever
  the graphs go to 0 even after copy-pasting the values from the output*)
(* Copy pasted values at t=
 65.8 and at t= 65:- {65.8`,8.685812719408483`*^31,8.685812719408483`*^31}
     {65.`,1.3329189052305661`*^31,1.3329189052305663`*^31}
     Note that the values at t=65 are not exactly the same,
though they may seem so by looking at the output*)
```

Out[ ]=

```
The function ListLinePlot just plots all points
  mentioned above in the table and joins consecutive points with a
straight line (as can be seen be ListPlot
  vs ListLinePlot for y=x^2 for a small number of points.
```

Out[ ]=

```
The number of points plotted is the most for del_t=0.1 and the least
  for del_t=2 (We can see this by displaying data1, data2 and data3).
So,since the points joined become closer and closer, we
  get a more accurate representation as del_t changes from 2 to 0.1.
```

Out[ ]=

```
Also, the function dies down to zero after points around t=66
  because mathematica, due to precision, approximates '(x3[t])^2-4
  x2[t]  x4[t]'  to (x3[t])^2 as seen by the table diplayed below.
```

In[ ]:=

```
(*Importance of t_*)
Clear["Global`*"]
t0 = 3.15 * 10^1;
xht = 2.01 * 10^5;
xcp = 3.08 * 10^3;
xhl = -1.05 * 10^4;
p0 = 1.15 * 10^-4;
h0 = 5.25 * 10^-5;
k0 = 1.25 * 10^4;
r0 = 2.25;
n0 = 2.75 * 10^2;
```

$$x1 = e^{\left(-\frac{\left(\frac{1}{n0+t}-\frac{1}{n0+t0}\right) xht}{r0}+\frac{xcp \left(-1+\frac{n0+t0}{n0+t}+Log\left[\frac{n0+t}{n0+t0}\right]\right)}{r0}\right)};$$

$$x2 = k0\, e^{-\frac{\left(\frac{1}{n0+t}-\frac{1}{n0+t0}\right) xhl}{r0}};$$

```
x3 = 1 + x1 + x2 (p0 - h0);
x4 = -h0 (1 + x1);
```

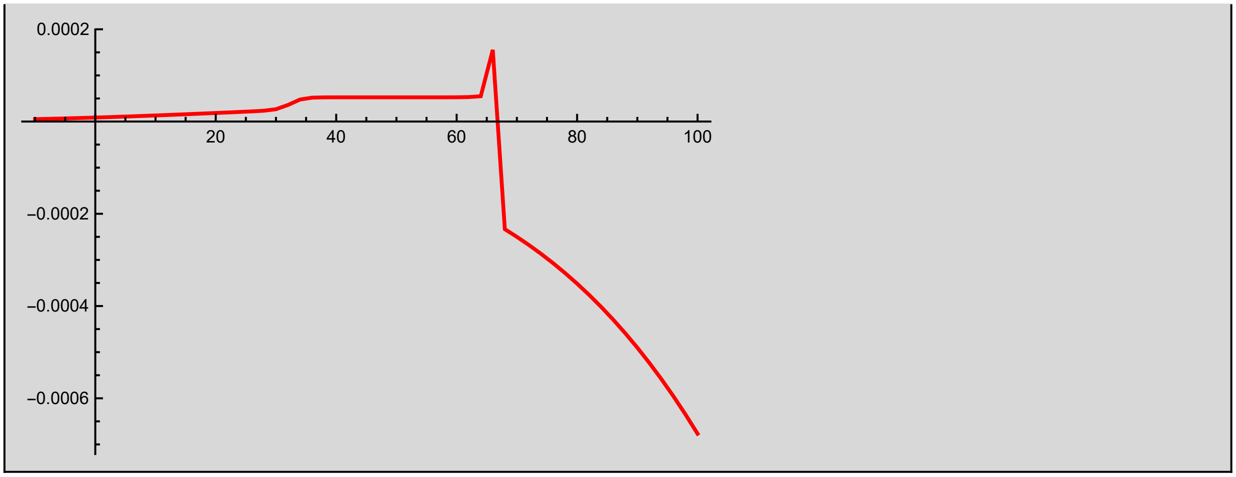
$$g = \frac{-x3+\sqrt{(x3)^2-4\ x2\ x4}}{2\ x2};$$

```
"Graph with del_t = 2:- "
data1 = Table[{t, g}, {t, -10, 100, 2}];
ListLinePlot[data1, PlotStyle → {Thick, Red}]
"Graph with del_t = 1:- "
data2 = Table[{t, g}, {t, -10, 100, 1}];
ListLinePlot[data2, PlotStyle → {Thick, Red}]
"Graph with del_t = 0.1:- "
data3 = Table[{t, g}, {t, -10, 100, 0.1}];
ListLinePlot[data3, PlotStyle → {Thick, Red}]
"As we can see, not using [t_] to define functions is very
  unreliable as it does not give a correct result on evaluation"
"The result is incorrect since our function is always
  positive as seen on analysis of x1(+ve), x2(+ve), x3(+ve),
  x4(-ve), but y becomes negative for del_t=2 and del_t=1"
"Thus, we can conclude that [t_] is absolutely essential when defining any function"
```

Out[ ]=

```
Graph with del_t = 2:-
```

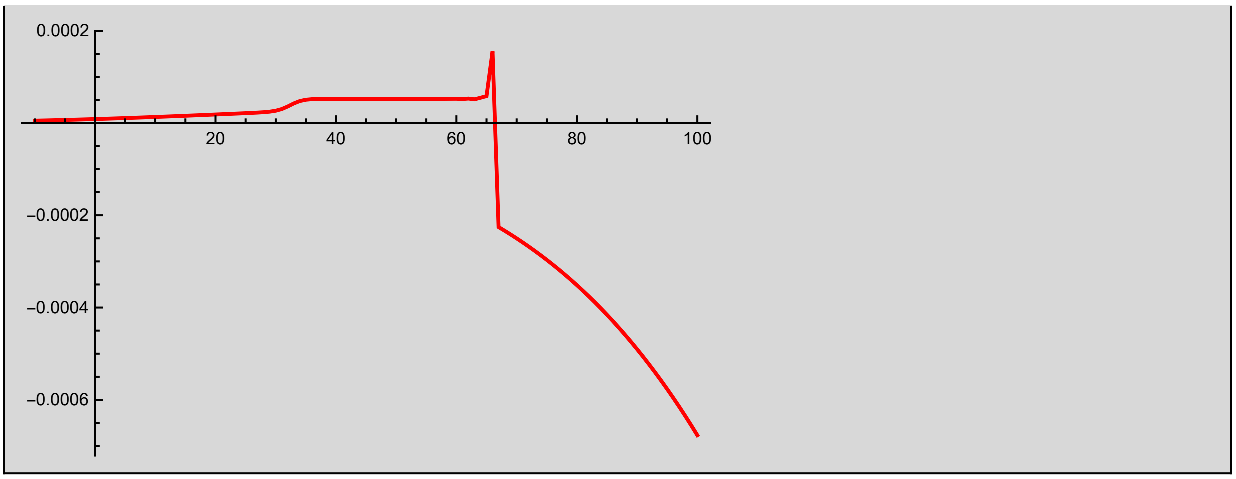
Out[ ]=



Out[ ]=

Graph with del_t = 1:-

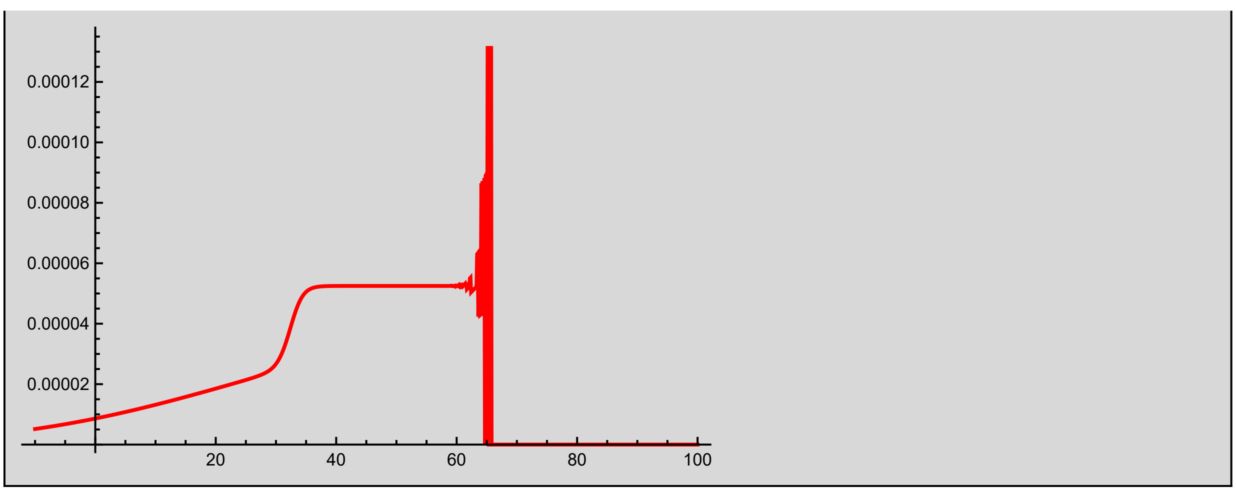
Out[ ]=



Out[ ]=

Graph with del_t = 0.1:-

Out[ ]=



Out[ ]=

```
As we can see, not using [t_] to define functions is
  very unreliable as it does not give a correct result on evaluation
```

Out[ ]=

```
The result is incorrect since our function is always positive as seen on analysis of
  x1(+ve), x2(+ve), x3(+ve), x4(-ve), but y becomes negative for del_t=2 and del_t=1
```

Out[ ]=

```
Thus, we can conclude that [t_] is absolutely essential when defining any function
```

In[ ]:=

```
"Using infinite precision does not allow
  the graph to die down to zero and the graph looks like:-"
Clear["Global`*"]
t0 = 315 / 10;
xht = 201000;
xcp = 3080;
xhl = -10500;
p0 = 115 / 1000000;
h0 = 525 / 10000000;
k0 = 12500;
r0 = 225 / 100;
n0 = 275;
```

$$\texttt{x1[t\_]} := e^{\left(-\frac{\left(\frac{1}{n0+t}-\frac{1}{n0+t0}\right)\,xht}{r0}+\frac{xcp\left(-1+\frac{n0+t0}{n0+t}+\mathrm{Log}\left[\frac{n0+t}{n0+t0}\right]\right)}{r0}\right)}$$

$$\texttt{x2[t\_]} := k0\, e^{-\frac{\left(\frac{1}{n0+t}-\frac{1}{n0+t0}\right)\,xhl}{r0}}$$

```
x3[t_] := 1 + x1[t] + x2[t] (p0 - h0)
x4[t_] := -h0 (1 + x1[t])
```

$$\texttt{y[t\_]} := \frac{-x3[t]+\sqrt{(x3[t])^2-4\ x2[t]\times x4[t]}}{2\ x2\ [t]}$$

```
"Graph with del_t = 2:- "
data1 = Table[{t, y[t]}, {t, -10, 100, 2}];
ListLinePlot[data1, PlotStyle → {Thick, Red}]
"Graph with del_t = 1:- "
data2 = Table[{t, y[t]}, {t, -10, 100, 1}];
ListLinePlot[data2, PlotStyle → {Thick, Red}]
"Graph with del_t = 1/10:- "
data3 = Table[{t, y[t]}, {t, -10, 100, 1 / 10}];
ListLinePlot[data3, PlotStyle → {Thick, Red}]
```

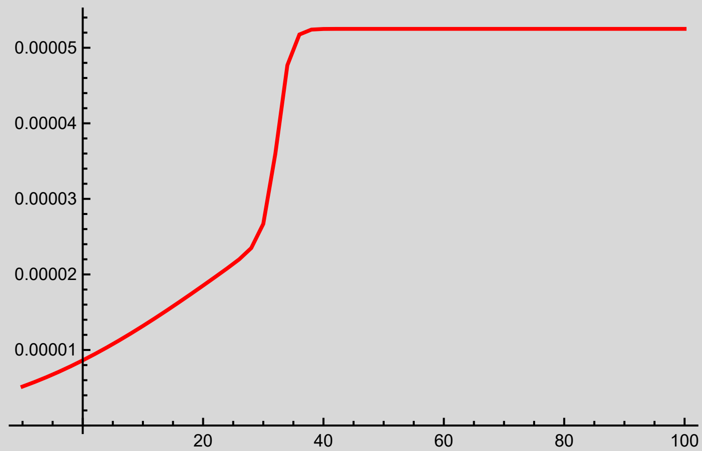
Out[ ]=

```
Using infinite precision does not allow
  the graph to die down to zero and the graph looks like:-
```

Out[ ]=

Graph with del_t = 2:-

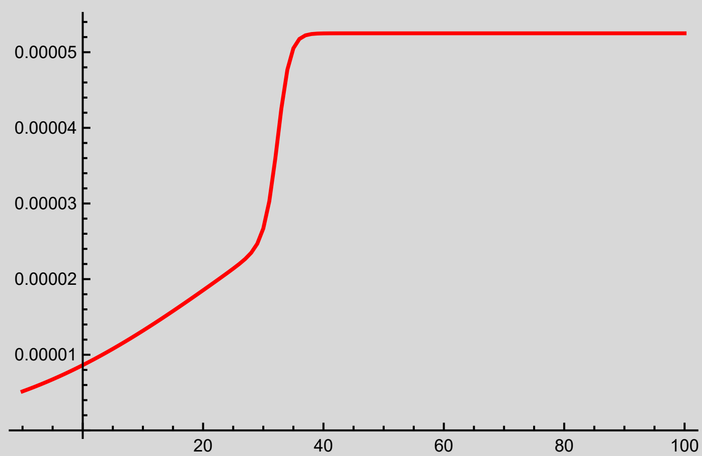
Out[ ]=



Out[ ]=

Graph with del_t = 1:-

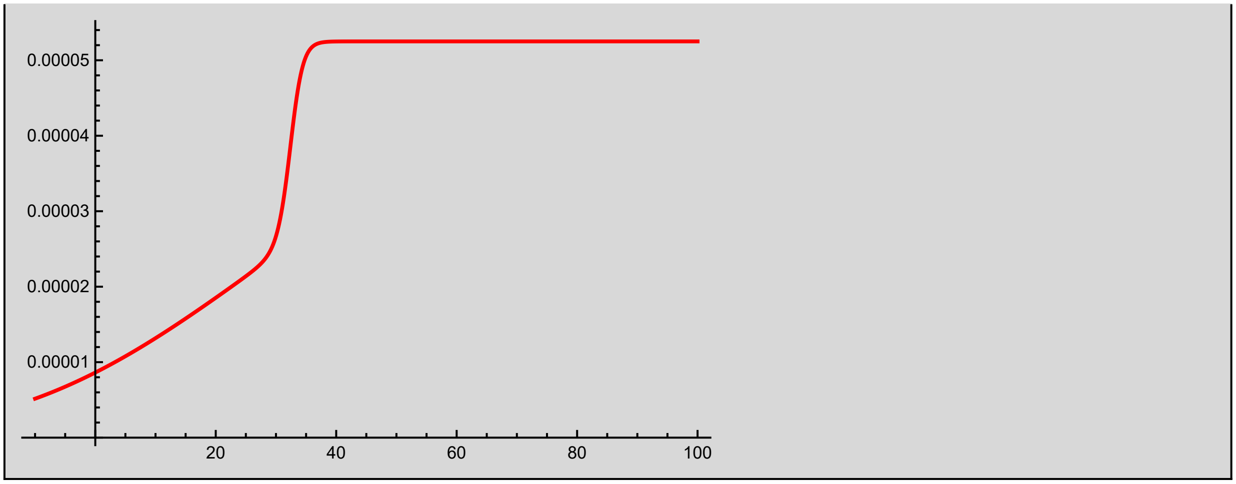
Out[ ]=



Out[ ]=

Graph with del_t = 1/10:-

Out[ ]=



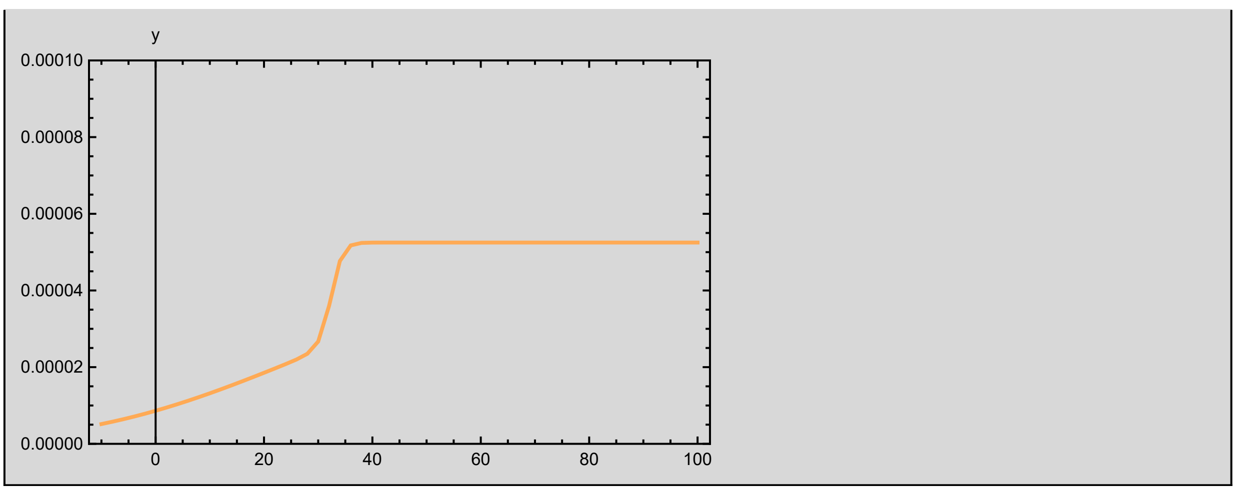
In[ ]:=

```
(*Functions for making the graph more presentable*)
"We can make the plots look more
  presentable by using the following inbuilt functions:-"
ListLinePlot[data1,
 PlotStyle → {Thick, Lighter[Orange]}, (*Plotstyle to change the look of the
  graph itself. Note that Lighter[] and Darker[] functions can be nested*)
 Frame → True, (*It adds a border to the graph*)
 AxesLabel → {"t", "y"}, (*Used to name the axes*)
 PlotRange → {0, 0.0001} (*To define the range of the y axis*)]
```

Out[ ]=

```
We can make the plots look more presentable by using the following inbuilt functions:-
```

Out[ ]=

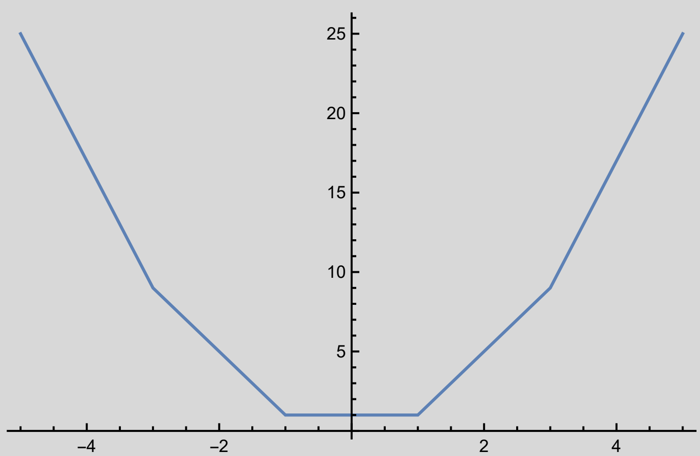


In[ ]:=

```
(*Working of ListLinePlot with y=x^2 as an example*)
Clear["Global`*"]
f[x_] := x^2
dataPara = Table[{x, f[x]}, {x, -5, 5, 2}];
ListLinePlot[dataPara]

(* Plotting this function with a smaller step
 size will yield a result that resembles the actual
 curve to a greater extent *)
dataPara1 = Table[{x, f[x]}, {x, -5, 5, 0.1}];
ListLinePlot[dataPara1]
```

Out[ ]=



Out[ ]=