This is the definition of the force of mortality for the G82M table.

```
>  m := t ->
  0.0005+0.00007585775*10^(0.038*t) ;
>
```

$$m := t \rightarrow 0.0005 + 0.00007585775\ 10^{(0.038\ t)}$$

This is the differential equation to solve to get the reserve of an endowment assurance with the premium payable in advance

```
> deq1   := diff(v(t),t) -
  (0.04+m(40+t))*v(t) + m(40+t)= 0;
```

$$deq1 := \left(\frac{d}{dt}\mathrm{v}(t)\right)$$
$$- (0.0405 + 0.00007585775\ 10^{(1.520 + 0.038\ t)})\ \mathrm{v}(t) + 0.0005$$
$$+ 0.00007585775\ 10^{(1.520 + 0.038\ t)} = 0$$

```
> tc1    := v(20) = 1;
```

$$tc1 := \mathrm{v}(20) = 1$$

```
> dsol1  := dsolve({deq1,tc1}, numeric,
  range=0..20);
```

dsol1 := **proc**(*x_rkf45*) ... **end proc**

v(0) is the premium payable in advance. It is also the endowment assurance function. Then we calulate the reserve at various other times

```
> dsol1(0);
```

$$[t = 0., \mathrm{v}(t) = 0.473294085198222803]$$

```
> dsol1(5);
```

$$[t = 5., \mathrm{v}(t) = 0.568459698654178892]$$

```
> dsol1(10);
```

$$[t = 10., v(t) = 0.683250177565070782]$$

```
> dsol1(15);
```

$$[t = 15., v(t) = 0.823599240414273570]$$

```
> dsol1(20);
```

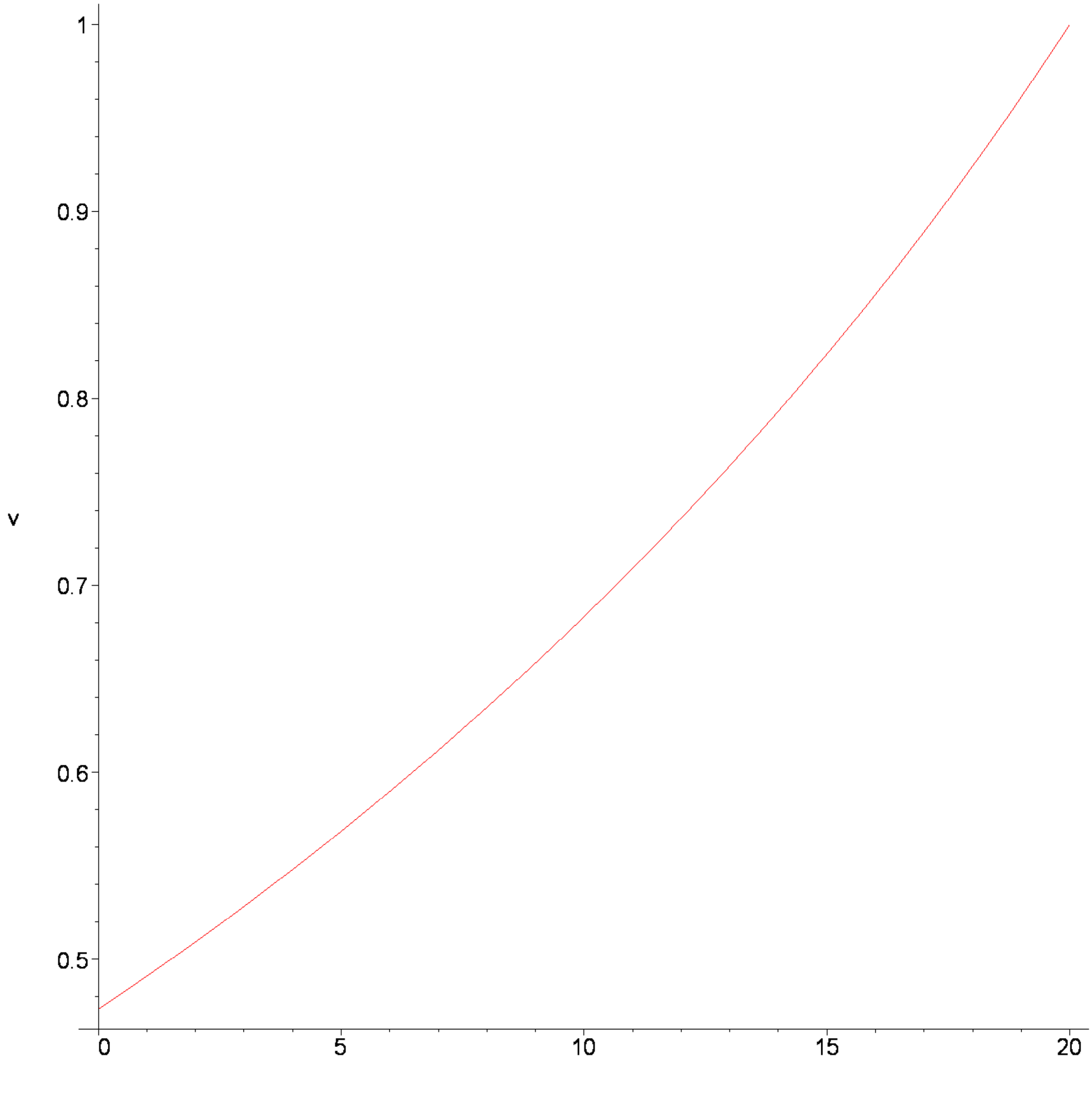
$$[t = 20., v(t) = 1.]$$

We can even plot it.

```
> with(plots);
Warning, the name changecoords has been redefined
```

[*animate*, *animate3d*, *animatecurve*, *arrow*, *changecoords*, *complexplot*, *complexplot3d*, *conformal*, *conformal3d*, *contourplot*, *contourplot3d*, *coordplot*, *coordplot3d*, *cylinderplot*, *densityplot*, *display*, *display3d*, *fieldplot*, *fieldplot3d*, *gradplot*, *gradplot3d*, *graphplot3d*, *implicitplot*, *implicitplot3d*, *inequal*, *interactive*, *listcontplot*, *listcontplot3d*, *listdensityplot*, *listplot*, *listplot3d*, *loglogplot*, *logplot*, *matrixplot*, *odeplot*, *pareto*, *plotcompare*, *pointplot*, *pointplot3d*, *polarplot*, *polygonplot*, *polygonplot3d*, *polyhedra_supported*, *polyhedraplot*, *replot*, *rootlocus*, *semilogplot*, *setoptions*, *setoptions3d*, *spacecurve*, *sparsematrixplot*, *sphereplot*, *surfdata*, *textplot*, *textplot3d*, *tubeplot*]

```
> odeplot(dsol1);
```



Let us now do the same with a temporary assurance

```
> deq2  := diff(v(t),t) -
  (0.04+m(40+t))*v(t) + m(40+t)= 0;
```

$$deq2 := \left(\frac{d}{dt}\mathrm{v}(t)\right)$$

$$- (0.0405 + 0.00007585775\ 10^{(1.520 + 0.038\ t)})\ \mathrm{v}(t) + 0.0005 + 0.00007585775\ 10^{(1.520 + 0.038\ t)} = 0$$

```
> tc2    := v(20) = 0;
```

$$tc2 := \mathrm{v}(20) = 0$$

```
> dsol2 := dsolve({deq2,tc2}, numeric,
  range=0..20);
```

$$dsol2 := \textbf{proc}(x\_rkf45)\ \ldots\ \textbf{end proc}$$

```
> dsol2(0);
```

$$[t = 0.,\ \mathrm{v}(t) = 0.0851927319189722809]$$

```
> dsol2(5);
```

$$[t = 5.,\ \mathrm{v}(t) = 0.0856986310995495188]$$

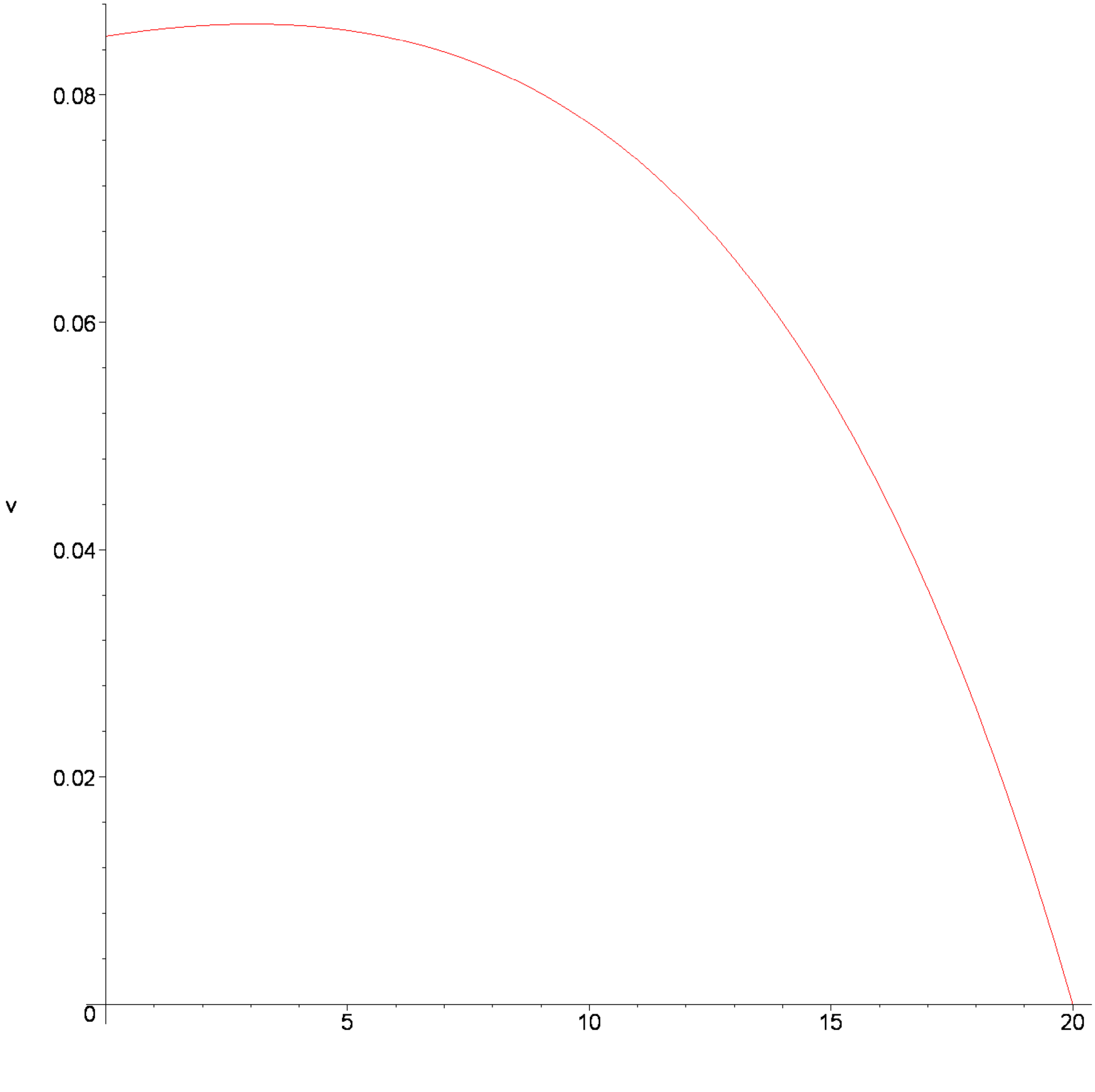
```
> dsol2(10);
```

$$[t = 10.,\ \mathrm{v}(t) = 0.0775266502567034528]$$

```
> dsol2(20);
```

$$[t = 20.,\ \mathrm{v}(t) = 0.]$$

```
> odeplot(dsol2);
```



Let us repeat with a continuous premium and a sum assured of 1000

```
> deq3  := diff(v(t),t) -
  (0.04+m(40+t))*v(t) + 1000*m(40+t) -
  6.46985 = 0;
```

$$deq3 := \left(\frac{d}{dt}\, \mathrm{v}(t)\right)$$

$$-\left(0.0405+0.00007585775\,10^{(1.520+0.038\,t)}\right)\mathrm{v}(t)-5.96985$$
$$+0.07585775000\,10^{(1.520+0.038\,t)}=0$$

```
> tc3    := v(20) = 0;
```

$$tc3 := \mathrm{v}(20)=0$$

```
> dsol3 := dsolve({deq3,tc3}, numeric,
  range=0..20);
```

$$dsol3 := \mathbf{proc}(x\_rkf45)\ \ldots\ \mathbf{end\ proc}$$

```
> dsol3(0);
```

$$[t=0.,\ \mathrm{v}(t)=0.0000253221630845956725]$$

```
> dsol3(5);
```

$$[t=5.,\ \mathrm{v}(t)=15.8986140946533788]$$

```
> dsol3(10);
```

$$[t=10.,\ \mathrm{v}(t)=26.2935540235772045]$$

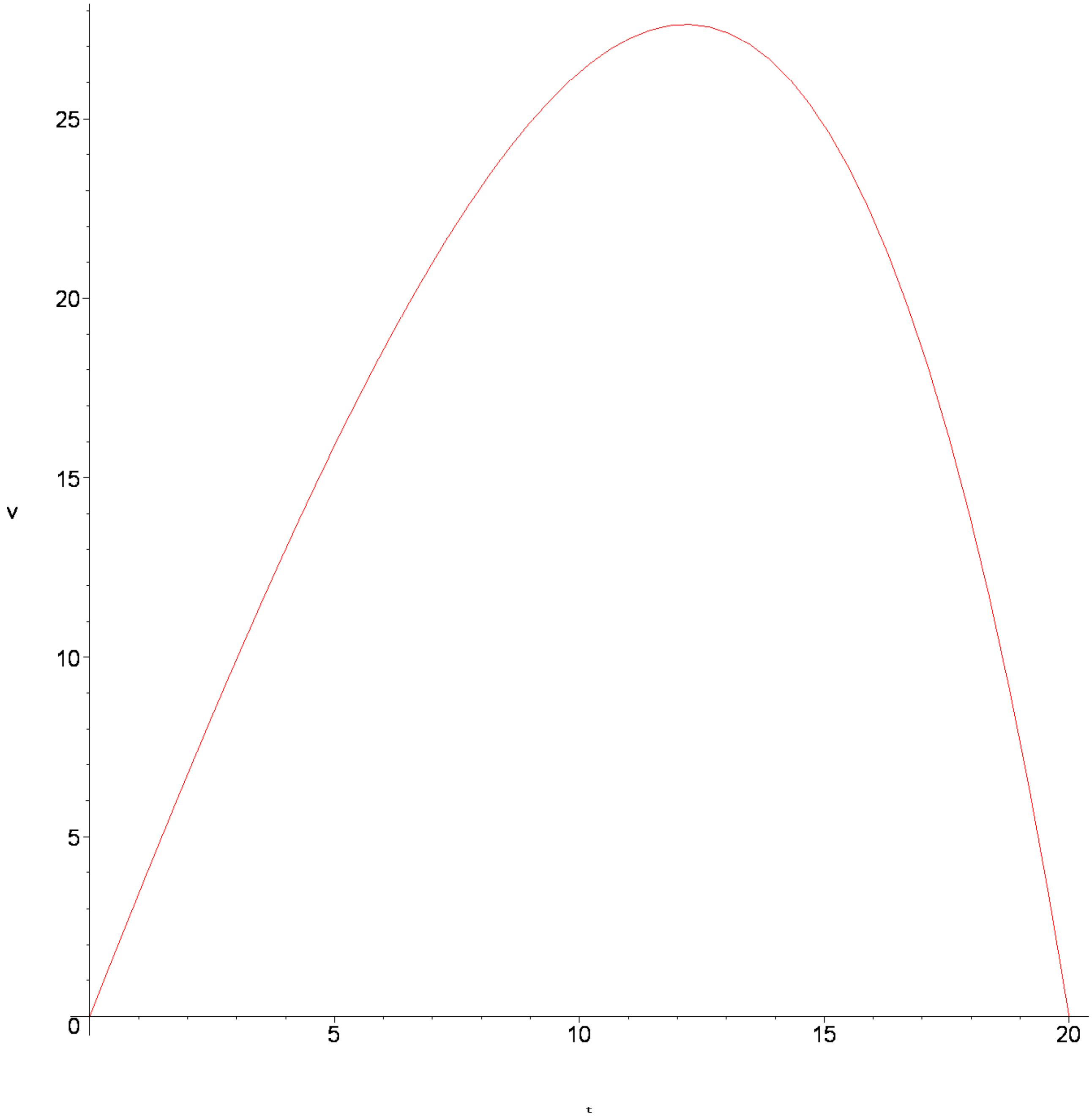
```
> dsol3(15);
```

$$[t=15.,\ \mathrm{v}(t)=24.8145038948122938]$$

```
> dsol3(20);
```

$$[t=20.,\ \mathrm{v}(t)=0.]$$

```
> odeplot(dsol3);
```



In our final example we will calculate the value of an annuity payable till time 20 at any time t.

```
> deq4  := diff(v(t),t) -
  (0.04+m(40+t))*v(t) + 1 = 0;
```

$$deq4 := \left(\frac{d}{dt}\,\mathrm{v}(t)\right) - \left(0.0405 + 0.00007585775\;10^{(1.520 + 0.038\,t)}\right)\mathrm{v}(t) + 1 =$$

0

```
> tc4    := v(20) = 0;
```

$$tc4 := \mathrm{v}(20) = 0$$

```
> dsol4 := dsolve({deq4,tc4}, numeric,
  range=0..20);
```

$dsol4$:= **proc**(x_rkf45) ... **end proc**

```
> dsol4(0);
```

$$[t = 0., \mathrm{v}(t) = 13.1676469040276238]$$

```
> dsol4(5);
```

$$[t = 5., \mathrm{v}(t) = 10.7885063366665968]$$

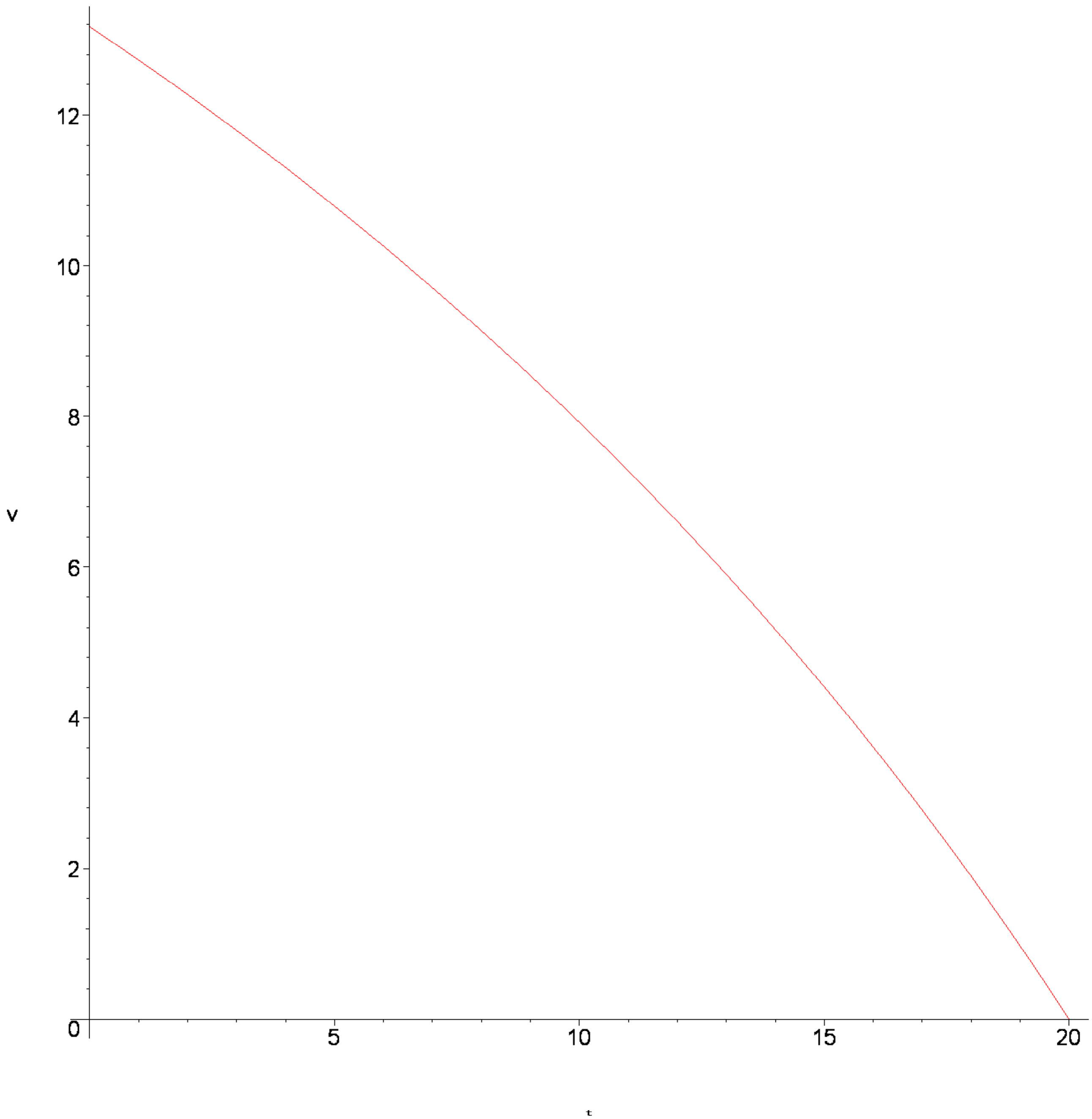
```
> dsol4(10);
```

$$[t = 10., \mathrm{v}(t) = 7.91873959467779365]$$

```
> dsol4(15);
```

$$[t = 15., \mathrm{v}(t) = 4.41001767739358819]$$

```
> odeplot(dsol4);
```


12
10
8
v
6
4
2
0
5
10
15
20
t

>