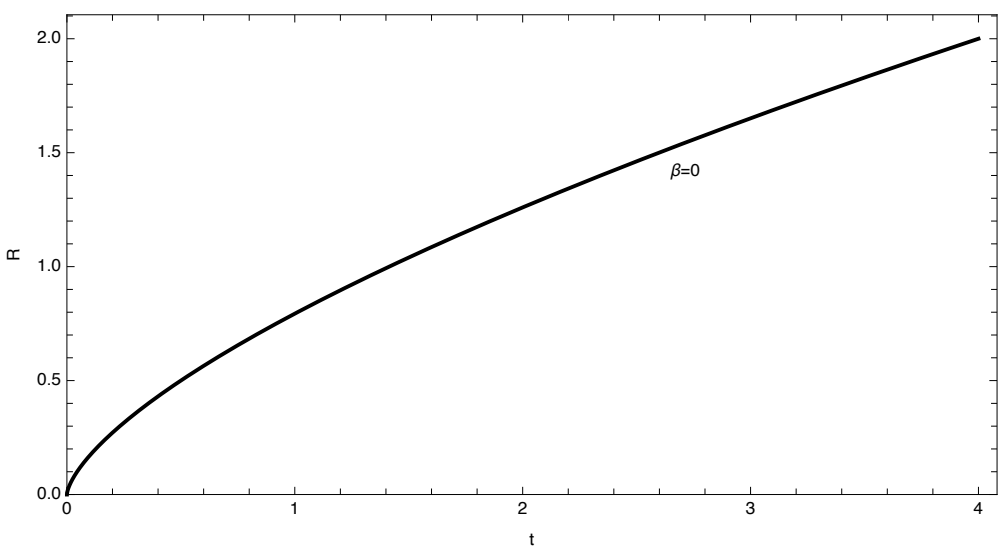
Cosmology: Homework 1

Problem 4. Parametric plot: $\gamma(\eta) = (R(\eta), t(\eta))$.
Case $\beta = 0$ $(E = 0)$

In[1]:=
```
params = {α → 1, β → 1};
```

In[2]:=
```
figPlotE0 = ParametricPlot[{α/2 {η^3, η^2}} /. params, {η, 0, 2}, PlotRange → {{0, 4}, {0, 2}},
  PlotStyle → {Black, Thick},
  Frame → True, (*PlotLabel→"Evolution of R(t)(E=0)",*)
  FrameLabel → {"t", "R"}, LabelStyle → (FontFamily → "Helvetica"),
  PlotLabels → Placed[{"β=0"}, Scaled[0.7]]]
```

Out[2]=

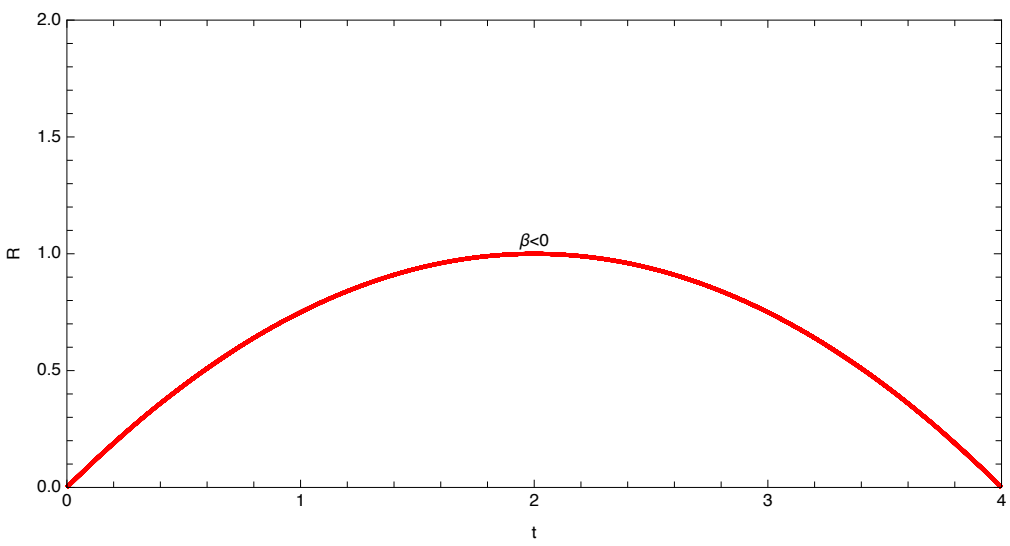


In[3]:= Case $\beta < 0$ $(E < 0)$

Out[3]= Case $\beta < 0$

In[4]:=
```
figPlotEN = ParametricPlot[
  {α/β {2 + 2/Sqrt[β] Sin[Sqrt[β]/2 η], Cos[Sqrt[β]/2 η]^2}} /. params, {η, -100, 100}, PlotRange → {{0, 4}, {0, 2}},
  PlotStyle → {Red, Thick},
  Frame → True, (*PlotLabel→"Evolution of R(t)(E<0)",*)
  FrameLabel → {"t", "R"}, LabelStyle → (FontFamily → "Helvetica"),
  PlotLabels → Placed[{"β<0"}, Above]]
```

Out[4]=

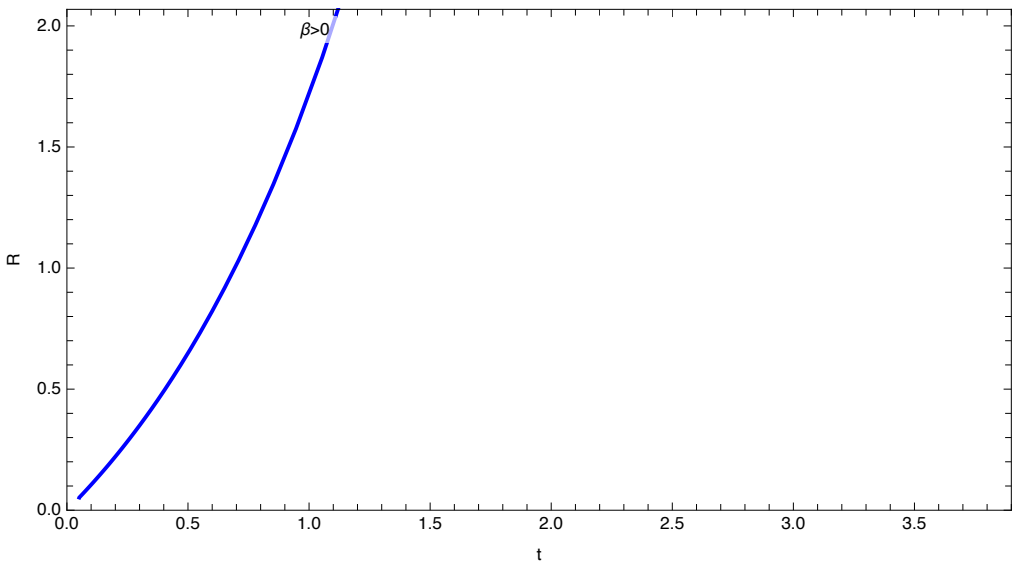


In[5]:= Case $\beta > 0$ $(E > 0)$

Out[5]= Case $\beta > 0$

In[6]:=
```
figPlotEP = ParametricPlot[{{-Log[1 - β Exp[α η]]/β, α Exp[α η]/(1 - β Exp[α η])}} /. params, {η, -3, 0}, PlotRange → {{0, 3.9}, {0, 2}},
  PlotStyle → {Blue, Thick},
  Frame → True, (*PlotLabel→"Evolution of R(t)(E>0)"*)
  FrameLabel → {"t", "R"}, LabelStyle → (FontFamily → "Helvetica"),
  PlotLabels → Placed[{"β>0"}, Above]]
```

Out[6]=



Putting everything together

In[7]:=
```
Show[figPlotE0, figPlotEN, figPlotEP]
```

Out[7]=