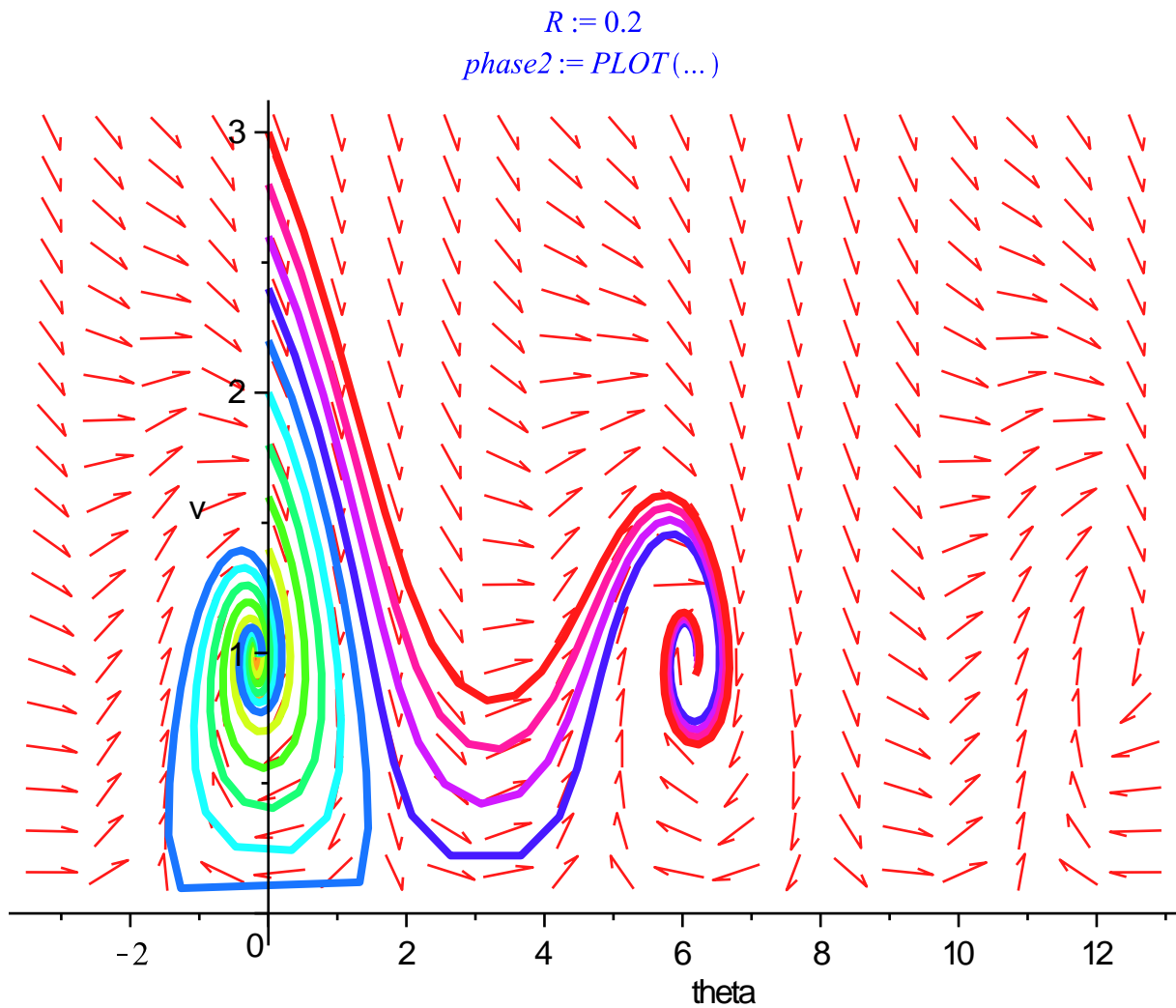


```
> with(DEtools):
> phug:= [ D(theta)(t) = v(t) - cos(theta(t))/v(t),
           D(v)(t) = -sin(theta(t)) - R*v(t)^2];
```

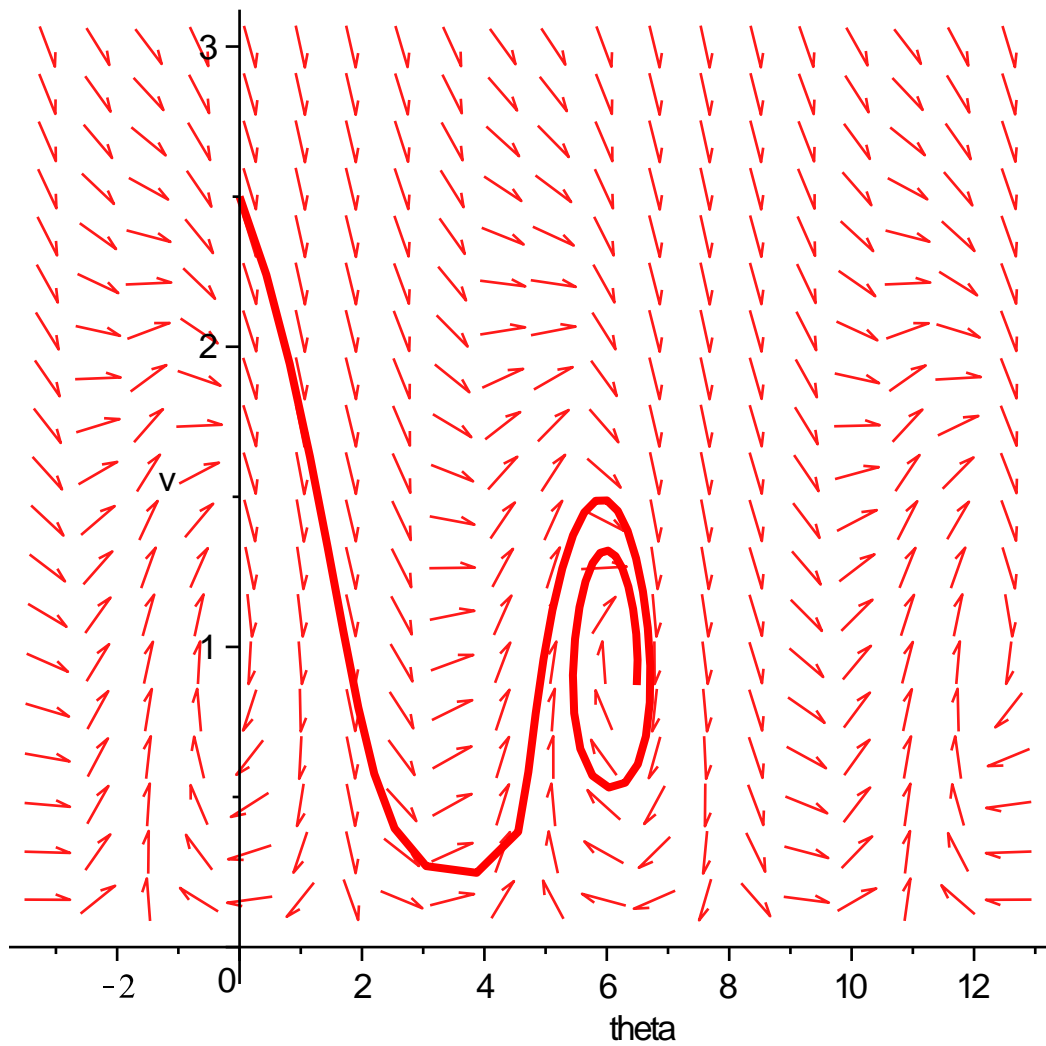
$$phug := \left[ D(\theta)(t) = v(t) - \frac{\cos(\theta(t))}{v(t)}, D(v)(t) = -\sin(\theta(t)) - R v(t)^2 \right]$$

(1)

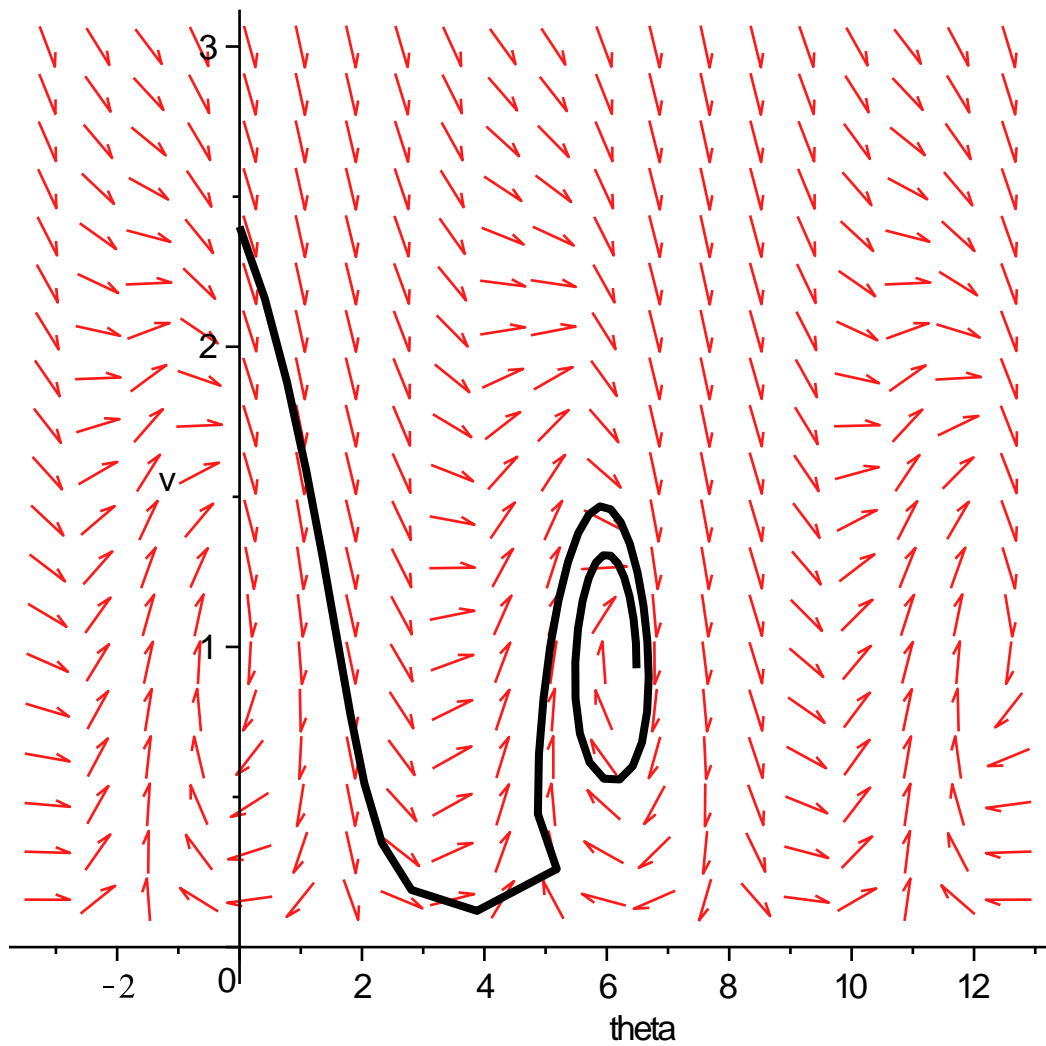
```
> R:=.2;
phase2:=DEplot( phug, [theta(t), v(t)], t=0..10,
                theta=-Pi..4*Pi, v=0..3,
                [seq([theta(0)=0, v(0)=i],i=1..3,0.2)],
                linecolor=[seq(COLOR(HUE,i),i=0..1,.1)]);
phase2;
```



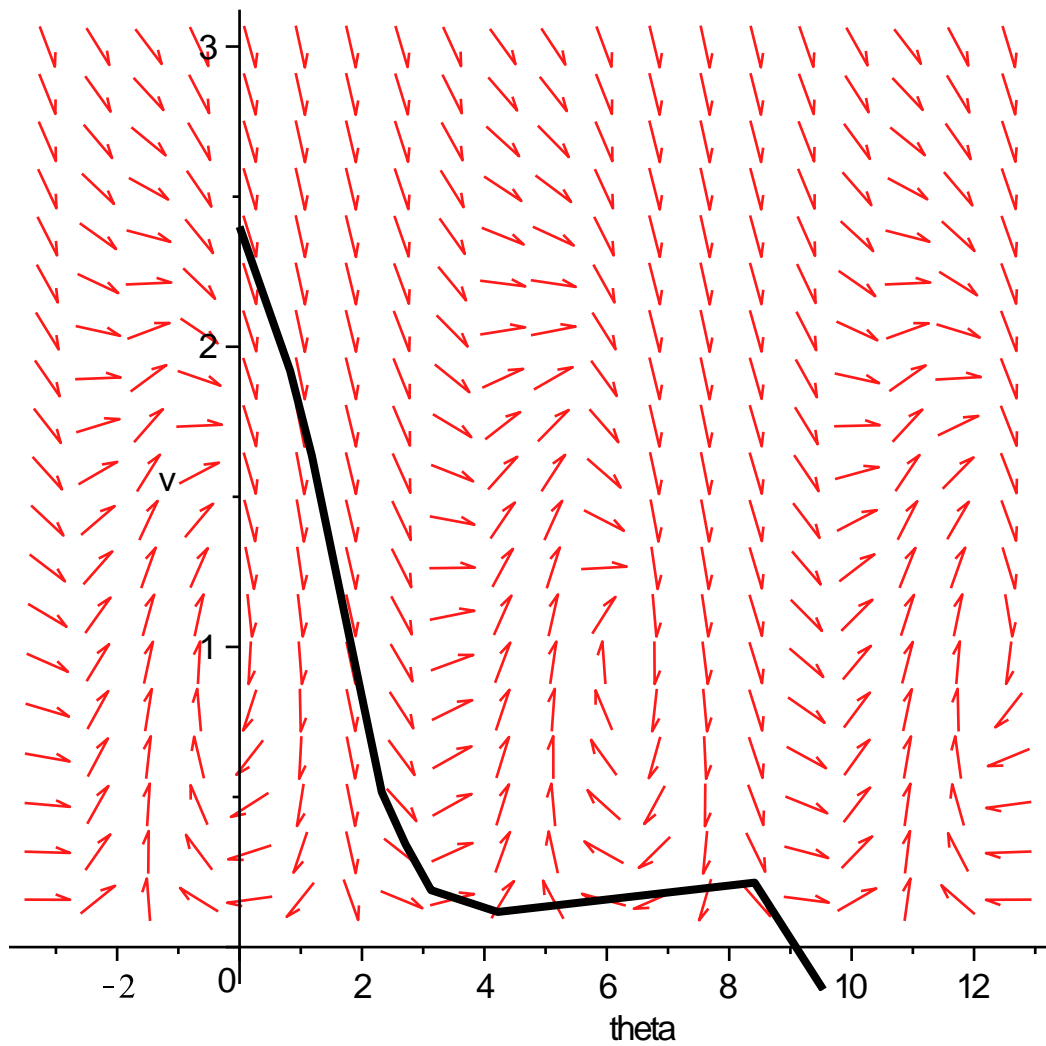
```
> DEplot( phug, [theta(t), v(t)], t=0..10,
           theta=-Pi..4*Pi, v=0..3,
           [[theta(0)=0, v(0)=2.5]],
           linecolor=[red], method=classical[foreuler]);
```



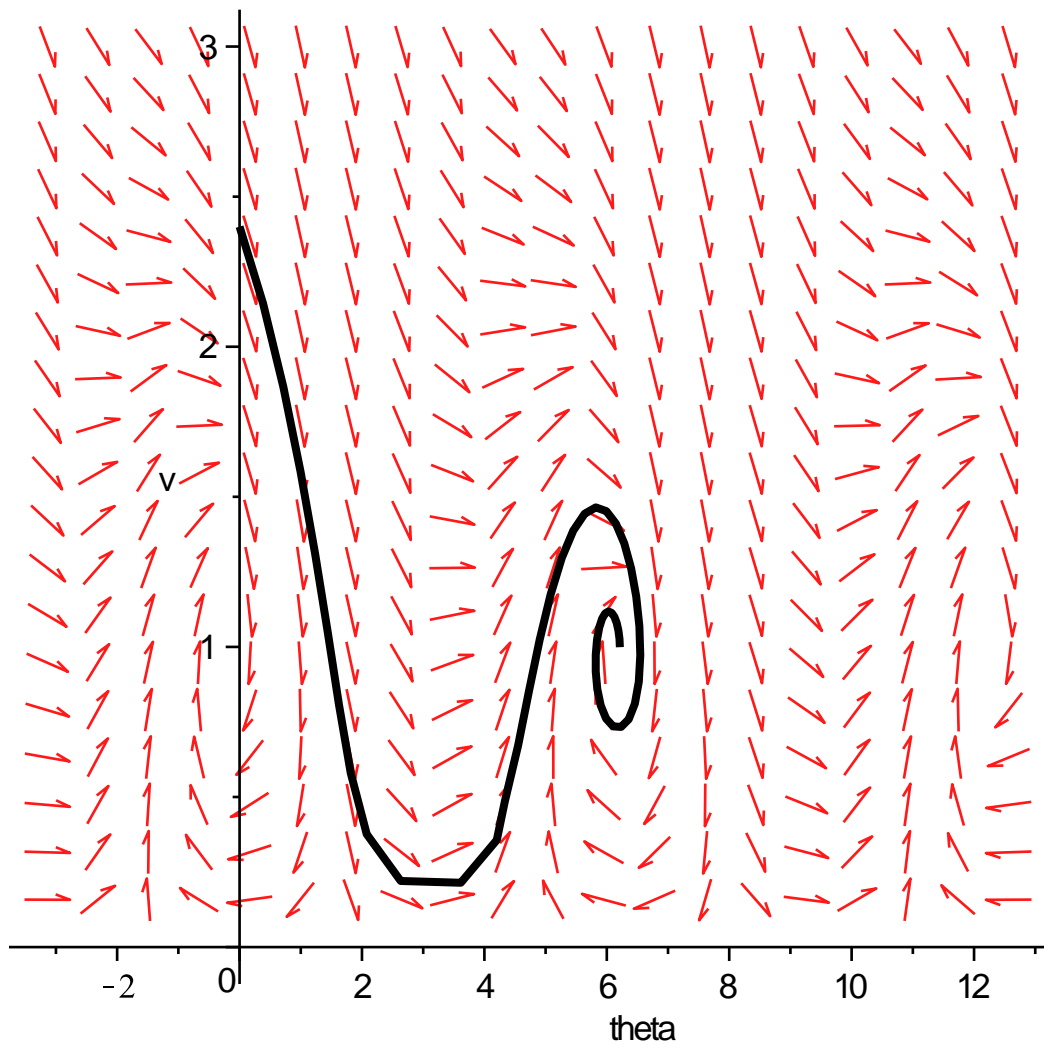
```
> DEplot( phug, [theta(t), v(t)], t=0..10,  
theta=-Pi..4*Pi, v=0..3,  
[[theta(0)=0, v(0)=2.4]],  
linecolor=[black], method=classical[foreuler]);
```



```
> DEplot( phug, [theta(t), v(t)], t=0..10,  
theta=-Pi..4*Pi, v=0..3,  
[[theta(0)=0, v(0)=2.4]],  
linecolor=[black], method=classical[foreuler], stepsize=1/2);
```



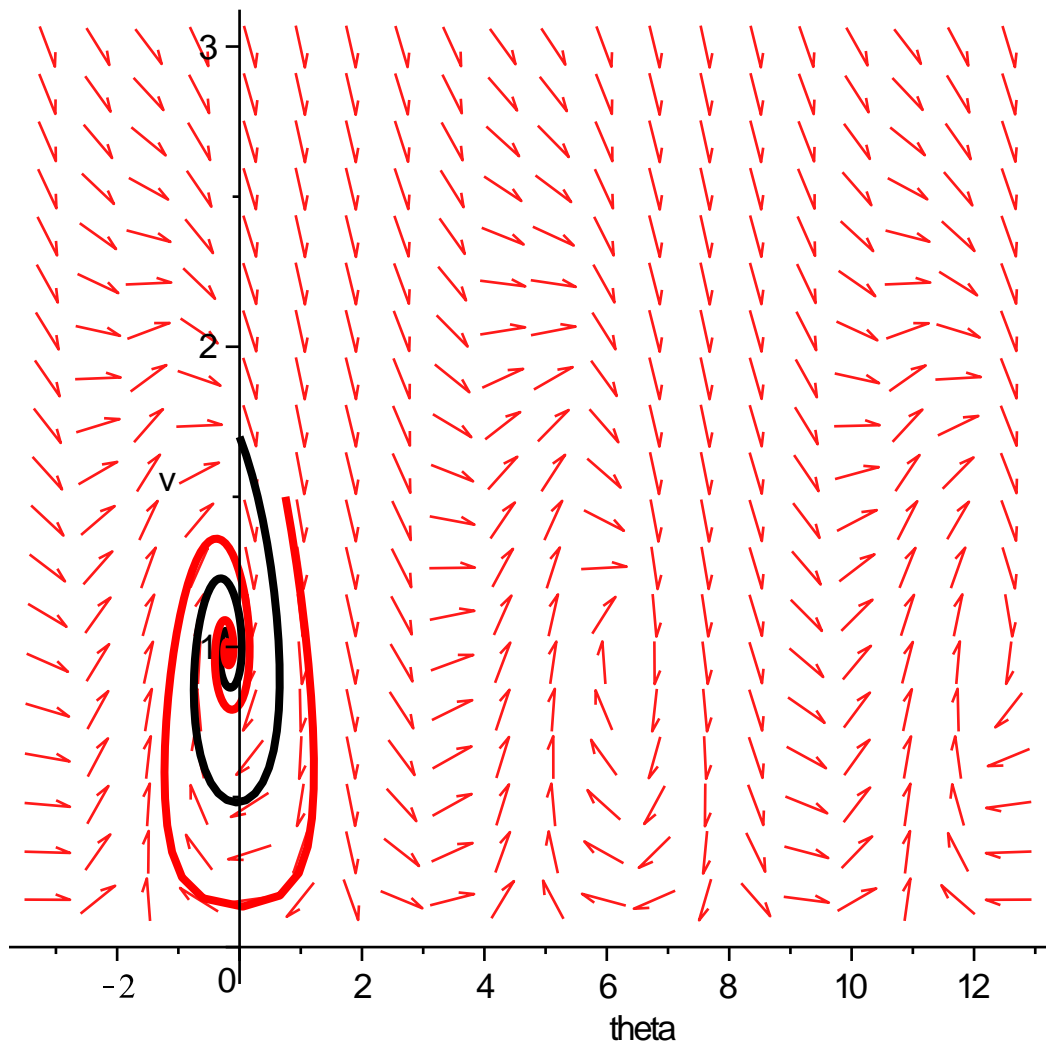
```
> DEplot( phug, [theta(t), v(t)], t=0..10,  
theta=-Pi..4*Pi, v=0..3,  
[[theta(0)=0, v(0)=2.4]],  
linecolor=[black], method=classical[rk4], stepsize=1/2);
```



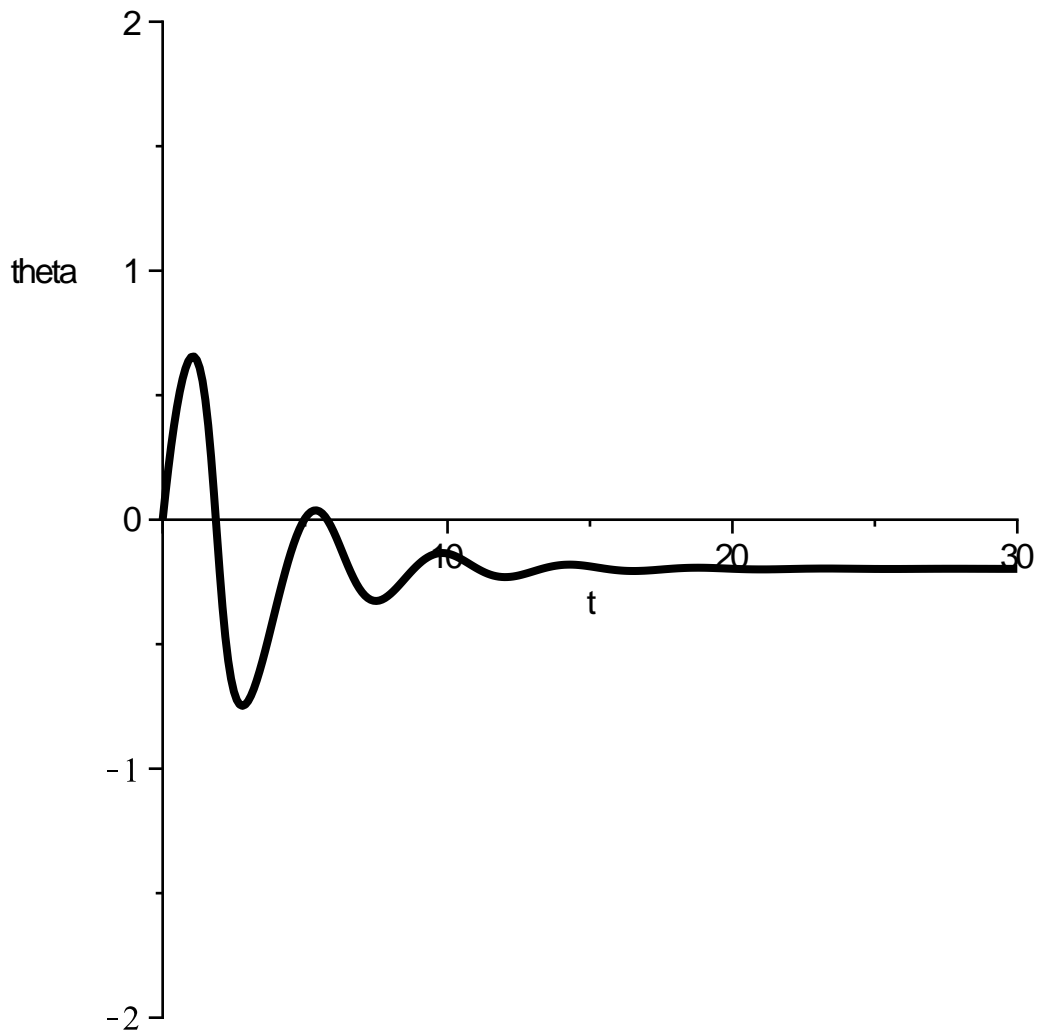
```
> DEplot( phug, [theta(t), v(t)], t=0..10,
  theta=-Pi..4*Pi, v=0..3,
  [[theta(0)=0, v(0)=2.4]],
  linecolor=[black], method=classical[rk4], stepsize=0.00001);
```

[Warning, computation interrupted](#)

```
> DEplot( phug, [theta(t), v(t)], t=0..20,
  theta=-Pi..4*Pi, v=0..3,
  [[theta(0)=0, v(0)=1.7],[theta(0)=.75, v(0)=1.5]], stepsize=
  0.1,
  linecolor=[black, red]);
```



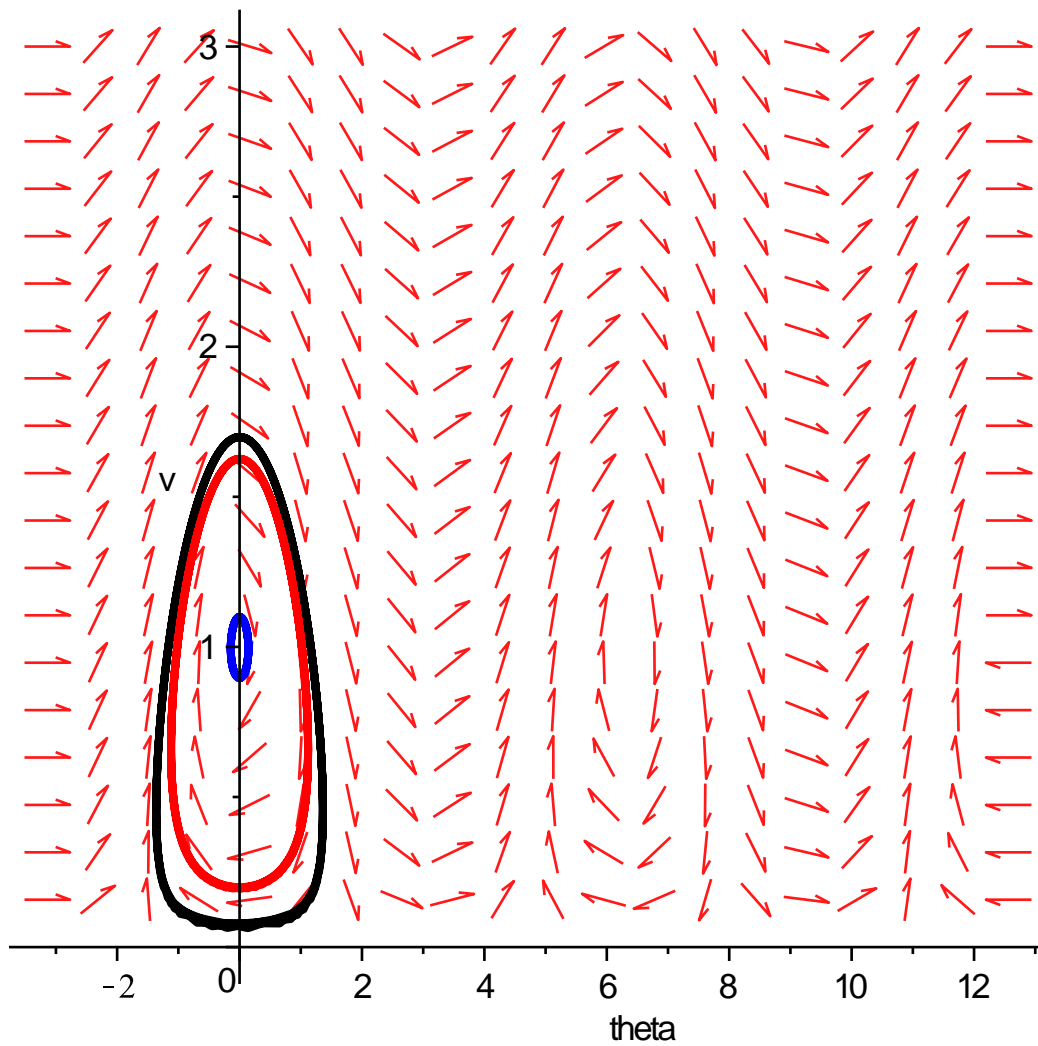
```
> DEplot( phug, [theta(t), v(t)], t=0..30,
  theta=-Pi..4*Pi, v=0..3,
  [[theta(0)=0, v(0)=1.7]],
  linecolor=[black], scene=[t,theta], view=[0..30,-2..2],
  stepsize=0.1);
```



```

> R:=0;
DEplot( phug, [theta(t), v(t)], t=0..20,
  theta=-Pi..4*Pi, v=0..3,
  [[theta(0)=0, v(0)=1.7],[theta(0)=.5, v(0)=1.5], [theta(0)=0, v
(0)=1.1]], stepsize=0.1,
  linecolor=[black, red,blue]);
  R:=0

```

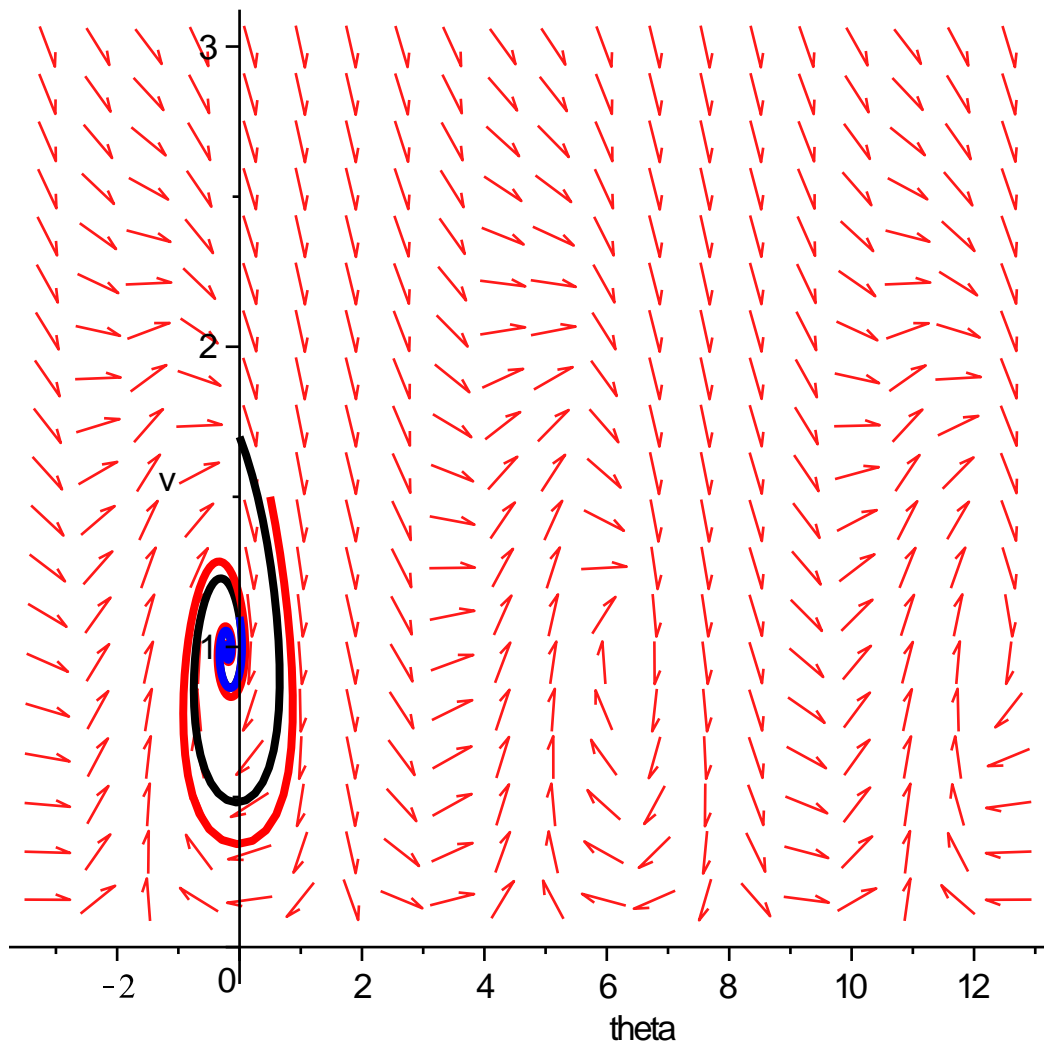


```

> R:=0.2;
DEplot( phug, [theta(t), v(t)], t=0..20,
  theta=-Pi..4*Pi, v=0..3,
  [[theta(0)=0, v(0)=1.7],[theta(0)=.5, v(0)=1.5], [theta(0)=0, v
(0)=1.1]], stepsize=0.1,
  linecolor=[black, red,blue]);
  R:=0.2

```

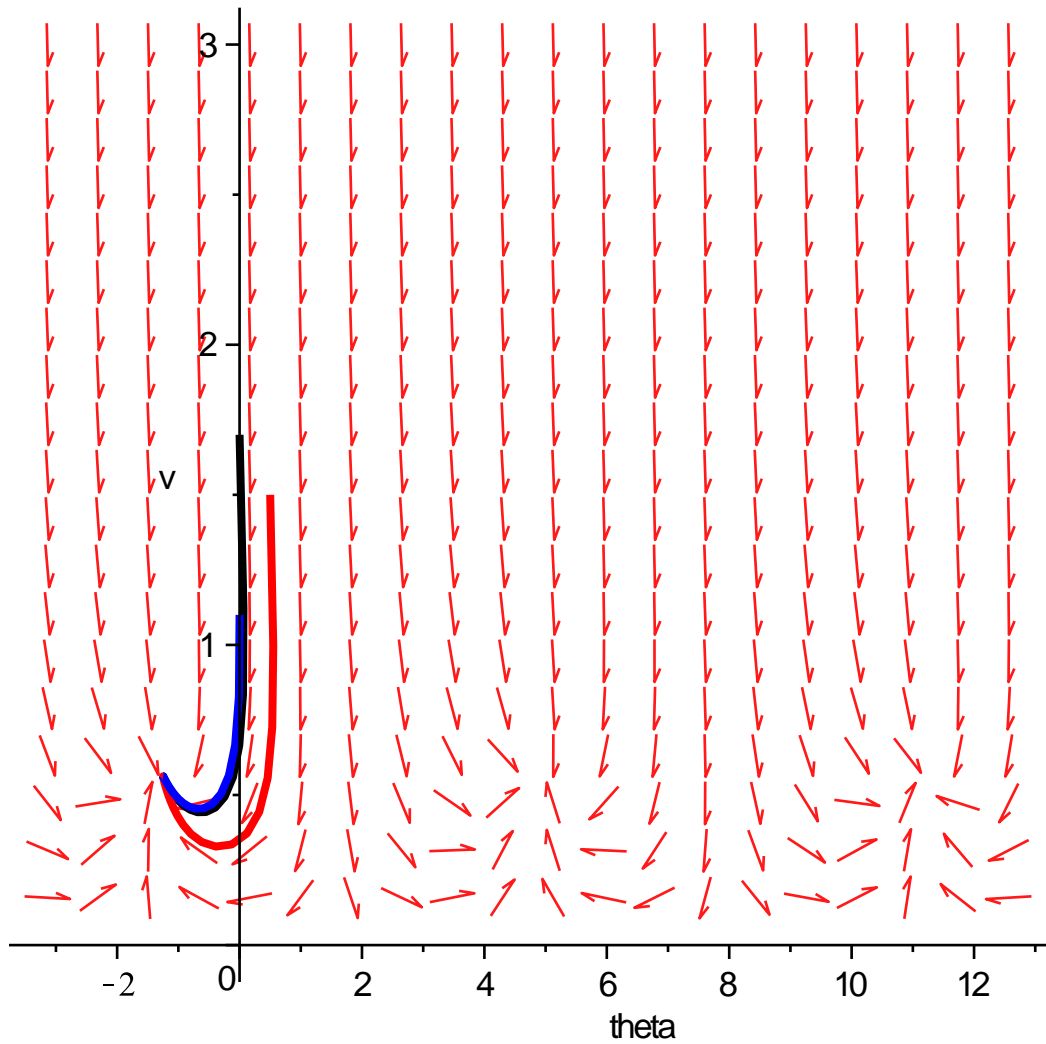




```

> R:=3;
DEplot( phug, [theta(t), v(t)], t=0..20,
  theta=-Pi..4*Pi, v=0..3,
  [[theta(0)=0, v(0)=1.7],[theta(0)=.5, v(0)=1.5], [theta(0)=0, v
(0)=1.1]], stepsize=0.1,
  linecolor=[black, red,blue]);
  R:=3

```



```

> R:=-0.1;
DEplot( phug, [theta(t), v(t)], t=-10..20,
  theta=-Pi..4*Pi, v=0..3,
  [[theta(0)=0, v(0)=1.7],[theta(0)=.5, v(0)=1.5], [theta(0)=0, v
(0)=1.1]], stepsize=0.1,
  linecolor=[black, red,blue]);
  R:=-0.1

```

