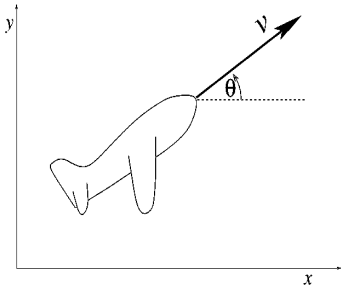
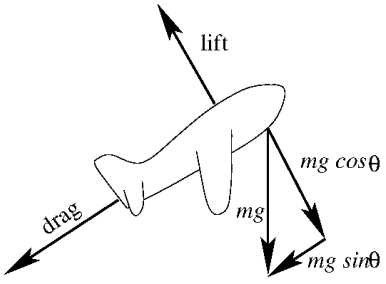
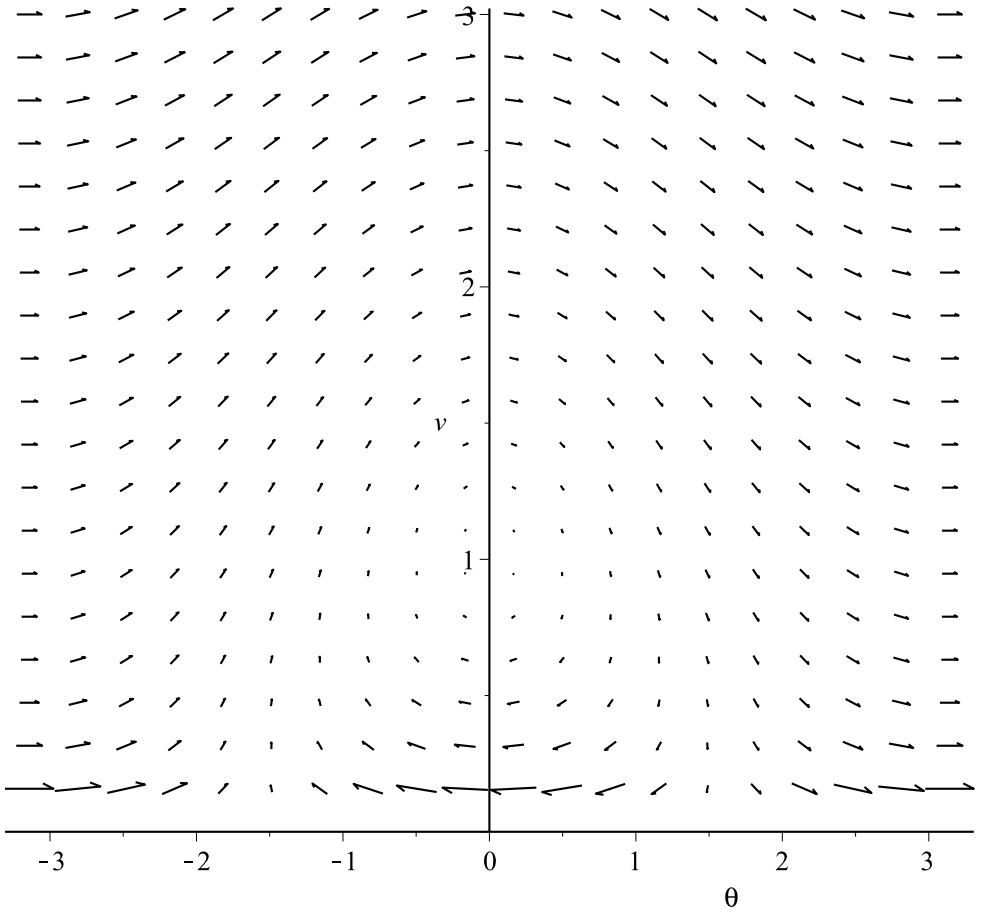
Want to describe an (unpowered) glider.
Determined by θ = angle of nose with horizontal, and v = forward velocity in the direction of θ



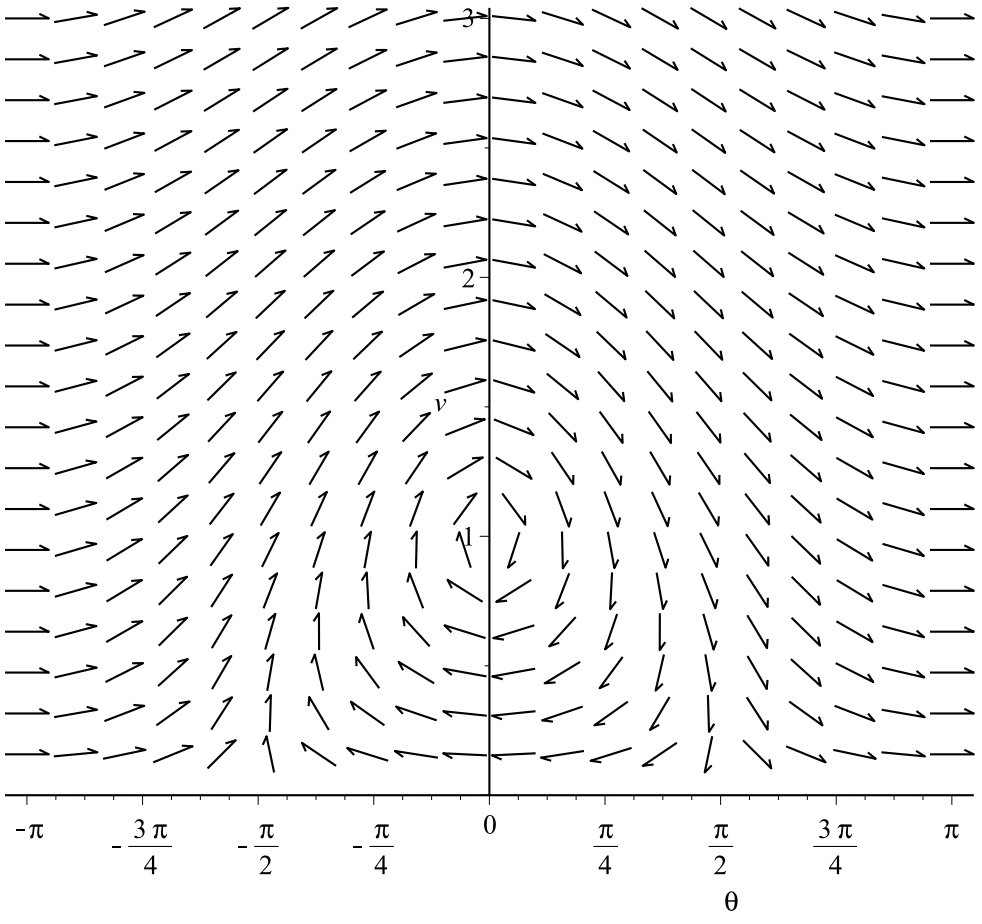


$$\frac{dv}{dt} = -\sin\theta - R \cdot v^2 \qquad \frac{d\theta}{dt} = v - \frac{\cos\theta}{v}$$

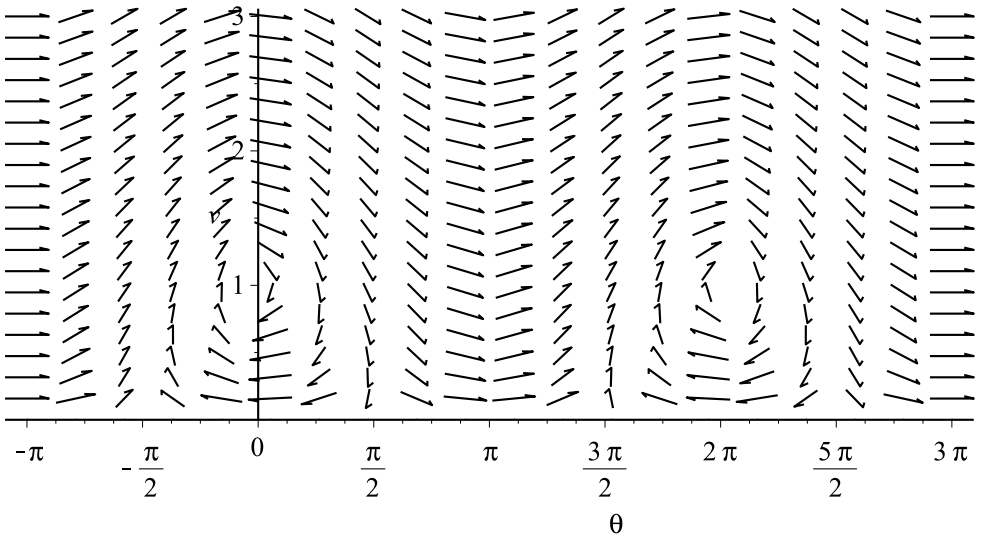
```
> with(plots):
> fieldplot( [v-cos(theta)/v, -sin(theta)], theta=-Pi..Pi, v=0..3);
```




```
> fieldplot( [v-cos(theta)/v, -sin(theta)], theta=-Pi..Pi, v=0..3,
  tickmarks=[piticks,default], fieldstrength=fixed);
```




```
> fieldplot( [v-cos(theta)/v, -sin(theta)], theta=-Pi..3·Pi, v=0..3, tickmarks=[piticks,
      default], fieldstrength=fixed);
```




```
> D(ln);
```

$$z \to \frac{1}{z} \tag{1}$$

```
> D(cos)(3*x);
```

$$-\sin(3\,x) \tag{2}$$

```
> diff(cos(t), t);
```

$$-\sin(t) \tag{3}$$

```
> eval(%, t=3*x);
```

$$-\sin(3\,x) \tag{4}$$

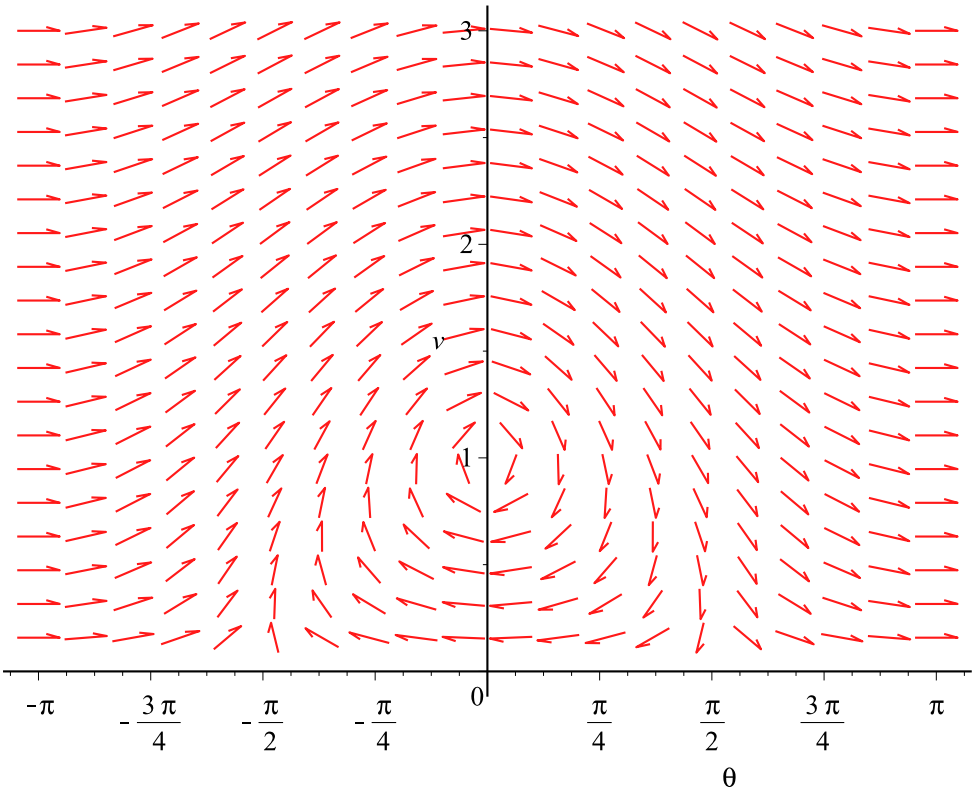
```
> with(DEtools):
> phug:=R-> [ diff(theta(t),t)=v(t)-cos(theta(t))/v(t),
            diff(v(t),t)    = -sin(theta(t)) - R*(v(t))^2 ];
```

$$phug := R \to \left[\frac{d}{dt}\,\theta(t) = v(t) - \frac{\cos(\theta(t))}{v(t)},\ \frac{d}{dt}\,v(t) = -\sin(\theta(t)) - R\,v(t)^2 \right] \tag{5}$$

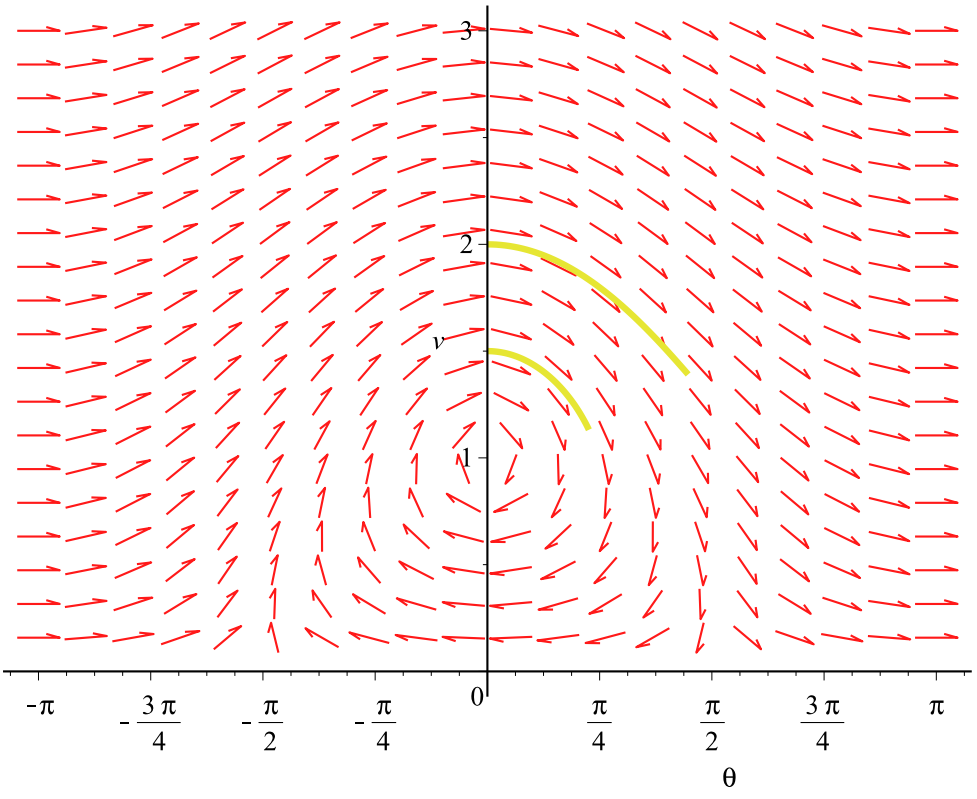
```
> phug(0);
```

$$\left[\frac{d}{dt}\,\theta(t) = v(t) - \frac{\cos(\theta(t))}{v(t)},\ \frac{d}{dt}\,v(t) = -\sin(\theta(t)) \right] \tag{6}$$

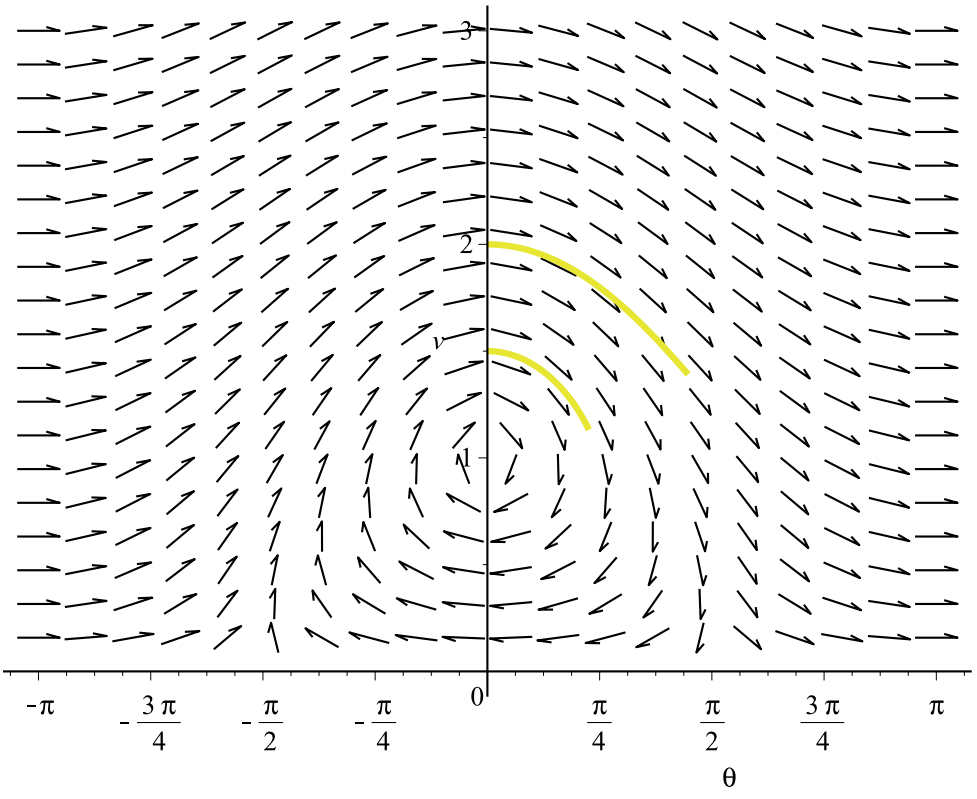
```
> DEplot( phug(0), [theta,v], t=0..1, theta=-Pi..Pi, v=0..3,
  tickmarks=[piticks,default]);
```



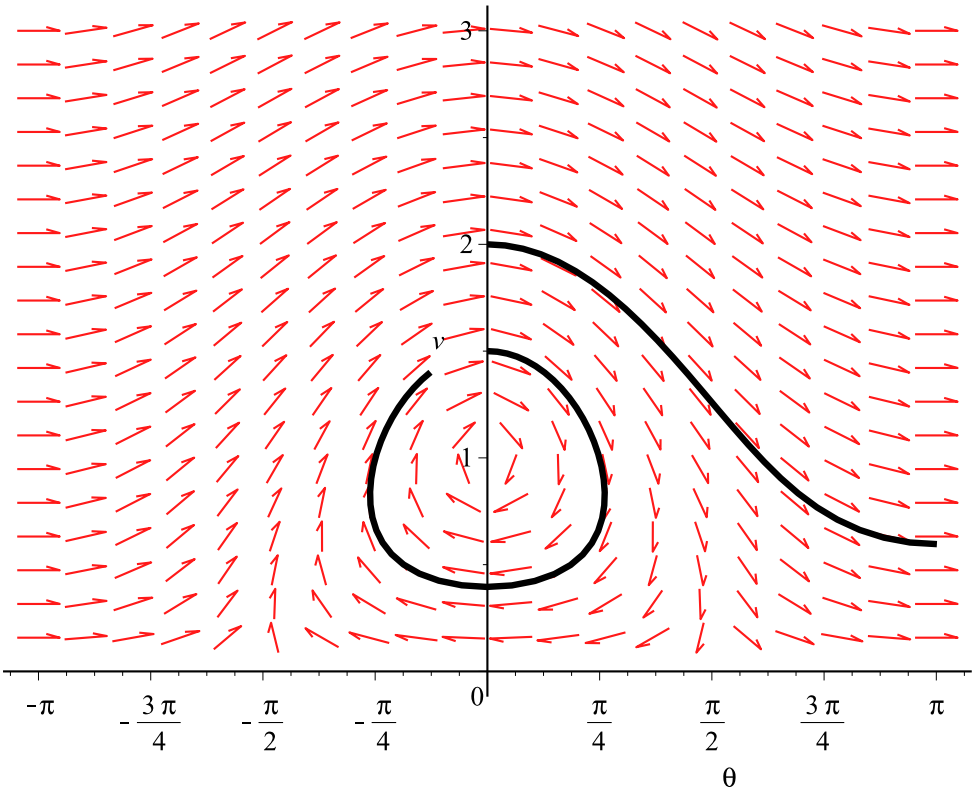

```
> DEplot( phug(0), [theta,v], t=0..1, theta=-Pi..Pi, v=0..3,
  [[theta(0)=0, v(0)=2], [theta(0)=0, v(0)=1.5]],
  tickmarks=[piticks,default]);
```



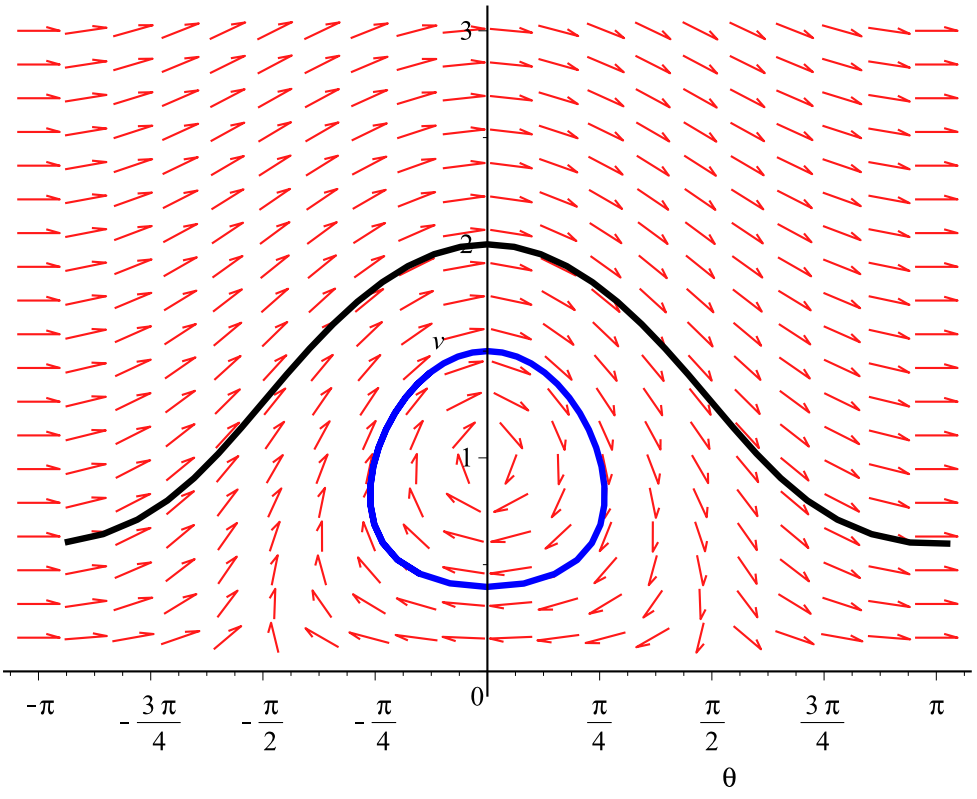

```
> DEplot( phug(0), [theta,v], t=0..1, theta=-Pi..Pi, v=0..3,
  [[theta(0)=0, v(0)=2], [theta(0)=0, v(0)=1.5]],
  tickmarks=[piticks,default], color=black);
```




```
> DEplot( phug(0), [theta,v], t=0..4, theta=-Pi..Pi, v=0..3,
  [[theta(0)=0, v(0)=2], [theta(0)=0, v(0)=1.5]],
  tickmarks=[piticks,default], linecolor=black);
```



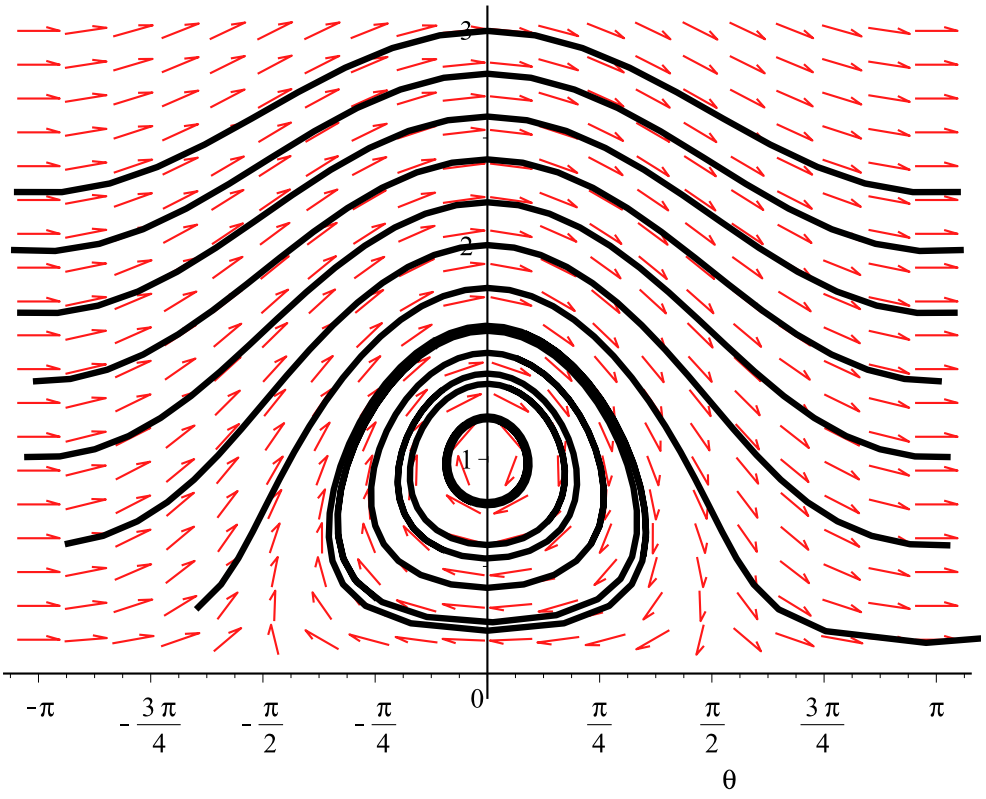

```
> DEplot( phug(0), [theta,v], t=-2..4, theta=-Pi..Pi, v=0..3,
  [[theta(0)=0, v(0)=2], [theta(0)=0, v(0)=1.5]],
  tickmarks=[piticks,default], linecolor=[black, blue]);
```




```
> DEplot( phug(0), [theta,v], t=-2..4, theta=-Pi..Pi, v=0..3,
  [seq([theta(0)=0, v(0)=speed], speed=0..3, .2)],
  tickmarks=[piticks,default], linecolor=black);
```

Warning, plot may be incomplete, the following errors(s) were issued:

cannot evaluate the solution past the initial point, problem may be complex, initially singular or improperly set up




```
> DEplot( phug(0), [theta,v], t=0..1, theta=-Pi..Pi, v=0..3,
  [seq([theta(0)=0, v(0)=speed], speed=0..3, .2)],
  tickmarks=[piticks,default], linecolor=black);
```

Warning, plot may be incomplete, the following errors(s) were issued:

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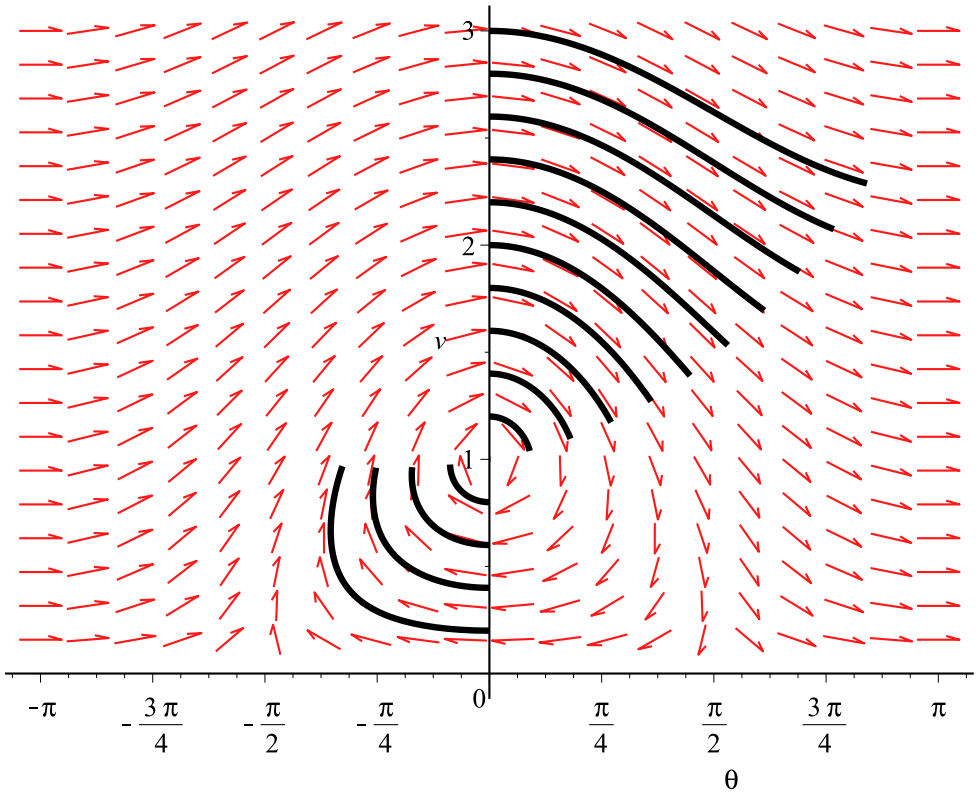
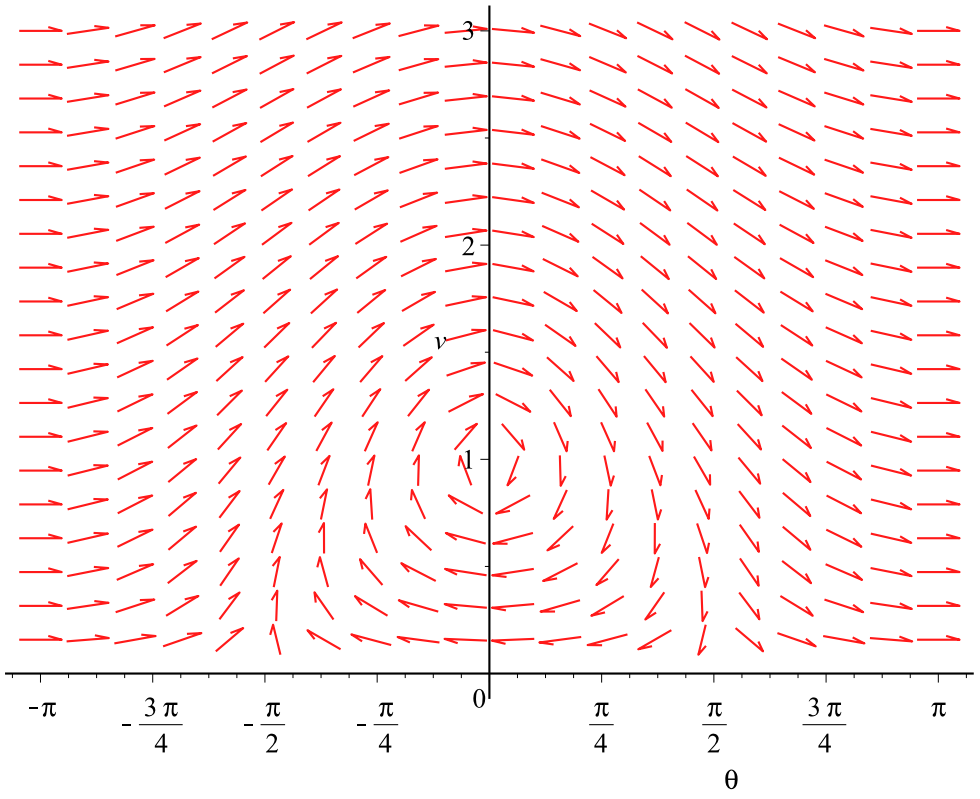


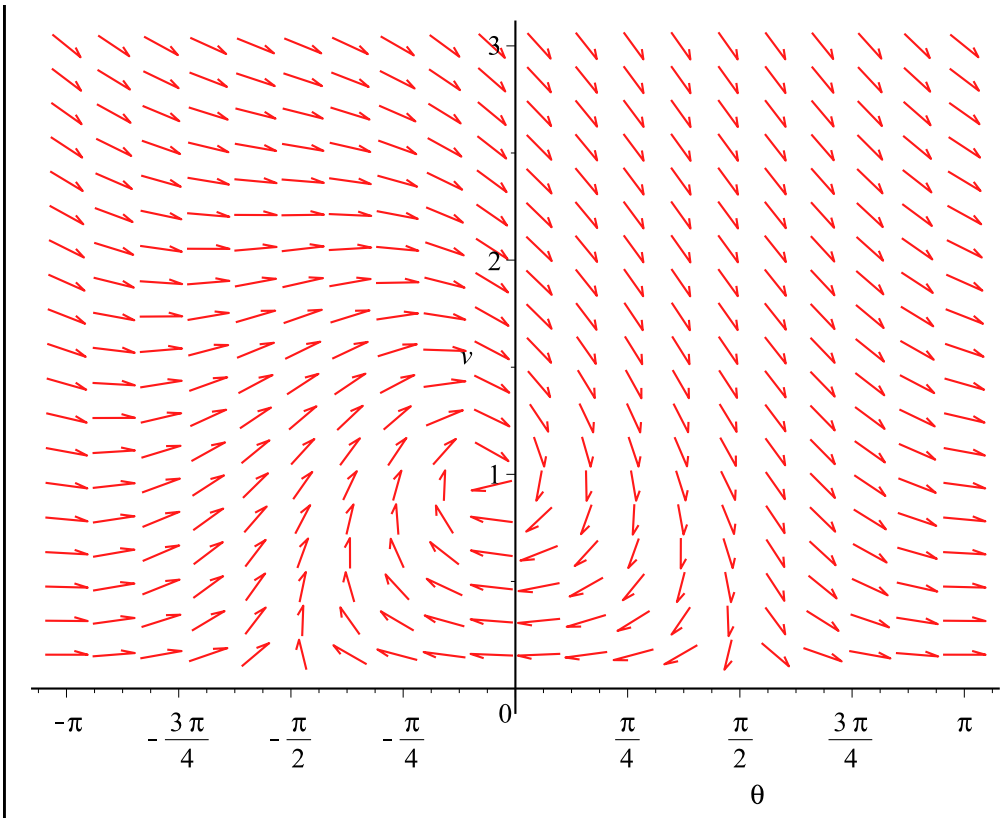

```
> DEplot( phug(0), [theta,v], t=0..4, theta=-Pi..Pi, v=0..3,
  [seq([theta(0)=0, v(0)=speed], speed=0..3, .2)],
  tickmarks=[piticks,default], linecolor=black, animatecurves=true)
  ;
```

Warning, plot may be incomplete, the following errors(s) were issued:
cannot evaluate the solution past the initial point, problem may be complex, initially singular or improperly set up




```
> DEplot( phug(0.2), [theta,v], t=0..10, theta=-Pi..Pi, v=0..3,
  [seq([theta(0)=0, v(0)=speed], speed=0..3, .2)],
  tickmarks=[piticks,default], linecolor=black, animatecurves=true)
  ;
```

Warning, plot may be incomplete, the following errors(s) were issued:
cannot evaluate the solution past the initial point, problem may be complex, initially singular or improperly set up


3
2
v
1
0
-π
-3π/4
-π/2
-π/4
π/4
π/2
3π/4
π
θ

>