Simple Pendulum - approximate and exact

```
Clear["Global`*"];
Off[General::spell1];
```

■ Define the constants to some useful values (try changing these) and setup the initial conditions

```
val = {θ0 → Pi / 4, L → 1, g → 10, m → 1};

init1 = {θ1[0] == θ0, θ1'[0] == 0};

init2 = {θ2[0] == θ0, θ2'[0] == 0};
```

■ Define the approximate (small angle) equation of motion and solve for *θ*[t]

```
eq1 = m L θ1''[t] == - m g θ1[t];

eq1 = Append[init1, eq1] /. val;

dsol1 = DSolve[eq1, θ1[t], t]

plot1 = ParametricPlot[Evaluate[{t, θ1[t]} /. dsol1],
   {t, 0, 8}, PlotStyle → RGBColor[0, 0, 1], GridLines → Automatic,
   Frame → True, FrameLabel → {"t", "θ"}, RotateLabel → False];
```

■ Define the exact equation of motion and solve for *θ*[t]

```
eq2 = m L θ2''[t] == - m g Sin[θ2[t]];

eq2 = Append[init2, eq2] /. val;
```

```
dsol2 = NDSolve[eq2, θ2[t], {t, 0, 8}];

plot2 = ParametricPlot[Evaluate[{t, θ2[t]} /. dsol2],
   {t, 0, 8}, PlotStyle → RGBColor[1, 0, 0], GridLines → Automatic,
   Frame → True, FrameLabel → {"t", "θ"}, RotateLabel → False];
```

■ Now plot the two together (blue = SHM, red = exact solution)

```
Show[plot1, plot2];
```