In[1]:=
```
x1[t] = L1 Sin[ang1[t]]
y1[t] = -L1 Cos[ang1[t]]
x2[t] = x1[t] + L2 Sin[ang2[t]]
y2[t] = y1[t] - L2 Cos[ang2[t]]
```

Out[1]= $L1 \sin[ang1[t]]$

Out[2]= $-L1 \cos[ang1[t]]$

Out[3]= $L1 \sin[ang1[t]] + L2 \sin[ang2[t]]$

Out[4]= $-L1 \cos[ang1[t]] - L2 \cos[ang2[t]]$

In[7]:=
```
T1 = 1/2 M1 (D[x1[t], t]^2 + D[y1[t], t]^2)
```

Out[7]= $\frac{1}{2} M1 \left(L1^2 \cos[ang1[t]]^2 ang1'[t]^2 + L1^2 \sin[ang1[t]]^2 ang1'[t]^2\right)$

In[8]:=
```
U1 = M1 g (y1[t] + L1)
```

Out[8]= $g M1 (L1 - L1 \cos[ang1[t]])$

In[9]:=
```
T2 = 1/2 M2 (D[x2[t], t]^2 + D[y2[t], t]^2)
```

Out[9]= $\frac{1}{2} M2 \left((L1 \cos[ang1[t]] ang1'[t] + L2 \cos[ang2[t]] ang2'[t])^2 + (L1 \sin[ang1[t]] ang1'[t] + L2 \sin[ang2[t]] ang2'[t])^2\right)$

In[10]:=
```
U2 = M2 g (L1 + L2 + y2[t])
```

Out[10]= $g M2 (L1 + L2 - L1 \cos[ang1[t]] - L2 \cos[ang2[t]])$

In[11]:=
```
L = T1 + T2 - (U1 + U2)
```

Out[11]= $-g M1 (L1 - L1 \cos[ang1[t]]) - g M2 (L1 + L2 - L1 \cos[ang1[t]] - L2 \cos[ang2[t]]) + \frac{1}{2} M1 \left(L1^2 \cos[ang1[t]]^2 ang1'[t]^2 + L1^2 \sin[ang1[t]]^2 ang1'[t]^2\right) + \frac{1}{2} M2 \left((L1 \cos[ang1[t]] ang1'[t] + L2 \cos[ang2[t]] ang2'[t])^2 + (L1 \sin[ang1[t]] ang1'[t] + L2 \sin[ang2[t]] ang2'[t])^2\right)$

In[12]:=
```
E1 = D[L, ang1[t]] - D[D[L, ang1'[t]], t]
```

Out[12]=
$$
\begin{aligned}
&-g\,L1\,M1\,\text{Sin}[\text{ang1}[t]] - g\,L1\,M2\,\text{Sin}[\text{ang1}[t]] + \\
&\frac{1}{2}M2\,(-2\,L1\,\text{Sin}[\text{ang1}[t]]\,\text{ang1}'[t]\,(L1\,\text{Cos}[\text{ang1}[t]]\,\text{ang1}'[t] + L2\,\text{Cos}[\text{ang2}[t]]\,\text{ang2}'[t]) + \\
&\quad 2\,L1\,\text{Cos}[\text{ang1}[t]]\,\text{ang1}'[t]\,(L1\,\text{Sin}[\text{ang1}[t]]\,\text{ang1}'[t] + L2\,\text{Sin}[\text{ang2}[t]]\,\text{ang2}'[t])) - \\
&\frac{1}{2}M1\,\left(2\,L1^2\,\text{Cos}[\text{ang1}[t]]^2\,\text{ang1}''[t] + 2\,L1^2\,\text{Sin}[\text{ang1}[t]]^2\,\text{ang1}''[t]\right) - \\
&\frac{1}{2}M2\,\left(-2\,L1\,\text{Sin}[\text{ang1}[t]]\,\text{ang1}'[t]\,(L1\,\text{Cos}[\text{ang1}[t]]\,\text{ang1}'[t] + L2\,\text{Cos}[\text{ang2}[t]]\,\text{ang2}'[t]) + \right. \\
&\quad 2\,L1\,\text{Cos}[\text{ang1}[t]]\,\text{ang1}'[t]\,(L1\,\text{Sin}[\text{ang1}[t]]\,\text{ang1}'[t] + L2\,\text{Sin}[\text{ang2}[t]]\,\text{ang2}'[t]) + \\
&\quad 2\,L1\,\text{Cos}[\text{ang1}[t]]\,\left(-L1\,\text{Sin}[\text{ang1}[t]]\,\text{ang1}'[t]^2 - L2\,\text{Sin}[\text{ang2}[t]]\,\text{ang2}'[t]^2 + \right. \\
&\qquad \left. L1\,\text{Cos}[\text{ang1}[t]]\,\text{ang1}''[t] + L2\,\text{Cos}[\text{ang2}[t]]\,\text{ang2}''[t]\right) + \\
&\quad \left. 2\,L1\,\text{Sin}[\text{ang1}[t]]\,\left(L1\,\text{Cos}[\text{ang1}[t]]\,\text{ang1}'[t]^2 + L2\,\text{Cos}[\text{ang2}[t]]\,\text{ang2}'[t]^2 + \right.\right. \\
&\qquad \left.\left. L1\,\text{Sin}[\text{ang1}[t]]\,\text{ang1}''[t] + L2\,\text{Sin}[\text{ang2}[t]]\,\text{ang2}''[t]\right)\right)
\end{aligned}
$$

In[13]:=
```
E2 = D[L, ang2[t]] - D[D[L, ang2'[t]], t]
```

Out[13]=
$$
\begin{aligned}
&-g\,L2\,M2\,\text{Sin}[\text{ang2}[t]] + \\
&\frac{1}{2}M2\,(-2\,L2\,\text{Sin}[\text{ang2}[t]]\,\text{ang2}'[t]\,(L1\,\text{Cos}[\text{ang1}[t]]\,\text{ang1}'[t] + L2\,\text{Cos}[\text{ang2}[t]]\,\text{ang2}'[t]) + \\
&\quad 2\,L2\,\text{Cos}[\text{ang2}[t]]\,\text{ang2}'[t]\,(L1\,\text{Sin}[\text{ang1}[t]]\,\text{ang1}'[t] + L2\,\text{Sin}[\text{ang2}[t]]\,\text{ang2}'[t])) - \\
&\frac{1}{2}M2\,\left(-2\,L2\,\text{Sin}[\text{ang2}[t]]\,\text{ang2}'[t]\,(L1\,\text{Cos}[\text{ang1}[t]]\,\text{ang1}'[t] + L2\,\text{Cos}[\text{ang2}[t]]\,\text{ang2}'[t]) + \right. \\
&\quad 2\,L2\,\text{Cos}[\text{ang2}[t]]\,\text{ang2}'[t]\,(L1\,\text{Sin}[\text{ang1}[t]]\,\text{ang1}'[t] + L2\,\text{Sin}[\text{ang2}[t]]\,\text{ang2}'[t]) + \\
&\quad 2\,L2\,\text{Cos}[\text{ang2}[t]]\,\left(-L1\,\text{Sin}[\text{ang1}[t]]\,\text{ang1}'[t]^2 - L2\,\text{Sin}[\text{ang2}[t]]\,\text{ang2}'[t]^2 + \right. \\
&\qquad \left. L1\,\text{Cos}[\text{ang1}[t]]\,\text{ang1}''[t] + L2\,\text{Cos}[\text{ang2}[t]]\,\text{ang2}''[t]\right) + \\
&\quad \left. 2\,L2\,\text{Sin}[\text{ang2}[t]]\,\left(L1\,\text{Cos}[\text{ang1}[t]]\,\text{ang1}'[t]^2 + L2\,\text{Cos}[\text{ang2}[t]]\,\text{ang2}'[t]^2 + \right.\right. \\
&\qquad \left.\left. L1\,\text{Sin}[\text{ang1}[t]]\,\text{ang1}''[t] + L2\,\text{Sin}[\text{ang2}[t]]\,\text{ang2}''[t]\right)\right)
\end{aligned}
$$

In[14]:=
```
Solve[{E1 == 0, E2 == 0}, {ang1''[t], ang2''[t]}]
```

Out[14]=
```
{{ang1''[t] → -((g M1 Cos[ang2[t]]^2 Sin[ang1[t]] + g M2 Cos[ang2[t]]^2 Sin[ang1[t]] -
          g M2 Cos[ang1[t]] Cos[ang2[t]] Sin[ang2[t]] + g M1 Sin[ang1[t]] Sin[ang2[t]]^2 +
          L1 M2 Cos[ang1[t]] Cos[ang2[t]]^2 Sin[ang1[t]] ang1'[t]^2 -
          L1 M2 Cos[ang1[t]]^2 Cos[ang2[t]] Sin[ang2[t]] ang1'[t]^2 +
          L1 M2 Cos[ang2[t]] Sin[ang1[t]]^2 Sin[ang2[t]] ang1'[t]^2 -
          L1 M2 Cos[ang1[t]] Sin[ang1[t]] Sin[ang2[t]]^2 ang1'[t]^2 +
          L2 M2 Cos[ang2[t]]^3 Sin[ang1[t]] ang2'[t]^2 -
          L2 M2 Cos[ang1[t]] Cos[ang2[t]]^2 Sin[ang2[t]] ang2'[t]^2 +
          L2 M2 Cos[ang2[t]] Sin[ang1[t]] Sin[ang2[t]]^2 ang2'[t]^2 -
          L2 M2 Cos[ang1[t]] Sin[ang2[t]]^3 ang2'[t]^2) /
        (L1 (M1 Cos[ang1[t]]^2 Cos[ang2[t]]^2 + M1 Cos[ang2[t]]^2 Sin[ang1[t]]^2 +
            M2 Cos[ang2[t]]^2 Sin[ang1[t]]^2 - 2 M2 Cos[ang1[t]] Cos[ang2[t]]
             Sin[ang1[t]] Sin[ang2[t]] + M1 Cos[ang1[t]]^2 Sin[ang2[t]]^2 +
            M2 Cos[ang1[t]]^2 Sin[ang2[t]]^2 + M1 Sin[ang1[t]]^2 Sin[ang2[t]]^2))),
  ang2''[t] → -((-g M1 Cos[ang1[t]] Cos[ang2[t]] Sin[ang1[t]] -
          g M2 Cos[ang1[t]] Cos[ang2[t]] Sin[ang1[t]] +
          g M1 Cos[ang1[t]]^2 Sin[ang2[t]] + g M2 Cos[ang1[t]]^2 Sin[ang2[t]] -
          L1 M1 Cos[ang1[t]]^2 Cos[ang2[t]] Sin[ang1[t]] ang1'[t]^2 -
          L1 M2 Cos[ang1[t]]^2 Cos[ang2[t]] Sin[ang1[t]] ang1'[t]^2 -
          L1 M1 Cos[ang2[t]] Sin[ang1[t]]^3 ang1'[t]^2 -
          L1 M2 Cos[ang2[t]] Sin[ang1[t]]^3 ang1'[t]^2 + L1 M1 Cos[ang1[t]]^3
           Sin[ang2[t]] ang1'[t]^2 + L1 M2 Cos[ang1[t]]^3 Sin[ang2[t]] ang1'[t]^2 +
          L1 M1 Cos[ang1[t]] Sin[ang1[t]]^2 Sin[ang2[t]] ang1'[t]^2 +
          L1 M2 Cos[ang1[t]] Sin[ang1[t]]^2 Sin[ang2[t]] ang1'[t]^2 -
          L2 M2 Cos[ang1[t]] Cos[ang2[t]]^2 Sin[ang1[t]] ang2'[t]^2 +
          L2 M2 Cos[ang1[t]]^2 Cos[ang2[t]] Sin[ang2[t]] ang2'[t]^2 -
          L2 M2 Cos[ang2[t]] Sin[ang1[t]]^2 Sin[ang2[t]] ang2'[t]^2 +
          L2 M2 Cos[ang1[t]] Sin[ang1[t]] Sin[ang2[t]]^2 ang2'[t]^2) /
        (L2 (M1 Cos[ang1[t]]^2 Cos[ang2[t]]^2 + M1 Cos[ang2[t]]^2 Sin[ang1[t]]^2 +
            M2 Cos[ang2[t]]^2 Sin[ang1[t]]^2 - 2 M2 Cos[ang1[t]] Cos[ang2[t]]
             Sin[ang1[t]] Sin[ang2[t]] + M1 Cos[ang1[t]]^2 Sin[ang2[t]]^2 +
            M2 Cos[ang1[t]]^2 Sin[ang2[t]]^2 + M1 Sin[ang1[t]]^2 Sin[ang2[t]]^2)))}}
```

In[15]:=
```
FullSimplify[%]
```

Out[15]=
```
{{ang1''[t] → -((g (2 M1 + M2) Sin[ang1[t]] + g M2 Sin[ang1[t] - 2 ang2[t]] + 2 M2
           Sin[ang1[t] - ang2[t]] (L1 Cos[ang1[t] - ang2[t]] ang1'[t]^2 + L2 ang2'[t]^2)) /
         (L1 (2 M1 + M2 - M2 Cos[2 (ang1[t] - ang2[t])]))),
  ang2''[t] → (2 Sin[ang1[t] - ang2[t]] ((M1 + M2) (g Cos[ang1[t]] + L1 ang1'[t]^2) +
          L2 M2 Cos[ang1[t] - ang2[t]] ang2'[t]^2)) /
        (L2 (2 M1 + M2 - M2 Cos[2 (ang1[t] - ang2[t])])))}}
```

In[18]:=
```
Experimental`OptimizeExpression[
 {-((g (2 M1 + M2) Sin[ang1[t]] + g M2 Sin[ang1[t] - 2 ang2[t]] +
        2 M2 Sin[ang1[t] - ang2[t]] (L1 Cos[ang1[t] - ang2[t]] ang1'[t]^2 + L2 ang2'[t]^2)) /
     (L1 (2 M1 + M2 - M2 Cos[2 (ang1[t] - ang2[t])]))), (2 Sin[ang1[t] - ang2[t]]
     ((M1 + M2) (g Cos[ang1[t]] + L1 ang1'[t]^2) + L2 M2 Cos[ang1[t] - ang2[t]] ang2'[t]^2)) /
    (L2 (2 M1 + M2 - M2 Cos[2 (ang1[t] - ang2[t])]))}, OptimizationLevel → 2]
```

Out[18]=
```
Experimental`OptimizedExpression[
 Block[{Compile`$1, Compile`$2, Compile`$3, Compile`$4,
   Compile`$5, Compile`$6, Compile`$7, Compile`$8, Compile`$9,
   Compile`$10, Compile`$11, Compile`$22, Compile`$23, Compile`$25,
   Compile`$26, Compile`$32, Compile`$20, Compile`$21}, Compile`$1 = 1/L1;
  Compile`$2 = 2 M1;
  Compile`$3 = ang1[t];
  Compile`$4 = ang2[t];
  Compile`$5 = -Compile`$4;
  Compile`$6 = Compile`$3 + Compile`$5;
  Compile`$7 = 2 Compile`$6;
  Compile`$8 = Cos[Compile`$7];
  Compile`$9 = -M2 Compile`$8;
  Compile`$10 = Compile`$2 + M2 + Compile`$9;
  Compile`$11 = 1/Compile`$10;
  Compile`$22 = ang1'[t];
  Compile`$23 = Compile`$22^2;
  Compile`$25 = ang2'[t];
  Compile`$26 = Compile`$25^2;
  Compile`$32 = 1/L2;
  Compile`$20 = Sin[Compile`$6];
  Compile`$21 = Cos[Compile`$6];
  {-Compile`$1 Compile`$11 (g (Compile`$2 + M2) Sin[Compile`$3] +
       g M2 Sin[Compile`$3 - 2 Compile`$4] + 2 M2 Compile`$20 (L1 Compile`$21
           Compile`$23 + L2 Compile`$26)), 2 Compile`$32 Compile`$11 Compile`$20
     ((M1 + M2) (g Cos[Compile`$3] + L1 Compile`$23) + L2 M2 Compile`$21 Compile`$26)}]]
```