公式推导

In[42]:=
```
Clear["Global`*"];
清除
q1 = θ1[t];
q2 = θ2[t];
v = f'[t];
```

In[46]:=
```
T1 = m1/2 ((L1 ∂t q1 Cos[q1] + v)^2 + (L1 ∂t q1 Sin[q1])^2) // FullSimplify;
                                                    完全简化

T2 = m2/2 ((L1 ∂t q1 Cos[q1] + L2 ∂t q2 Cos[q2] + v)^2 + (L1 ∂t q1 Sin[q1] + L2 ∂t q2 Sin[q2])^2) //
    FullSimplify;
    完全简化
T = (T1 + T2) // FullSimplify;
                 完全简化
```

In[49]:=
```
T // TraditionalForm
     传统格式
```

Out[49]//TraditionalForm=

$$\frac{1}{2}\left(\mathrm{m1}\left(2\,\mathrm{L1}\, f'(t)\,\theta 1'(t)\cos(\theta 1(t))+f'(t)^2+\mathrm{L1}^2\,\theta 1'(t)^2\right)+\mathrm{m2}\left((f'(t)+\mathrm{L1}\,\theta 1'(t)\cos(\theta 1(t))+\mathrm{L2}\,\theta 2'(t)\cos(\theta 2(t)))^2+(\mathrm{L1}\,\theta 1'(t)\sin(\theta 1(t))+\mathrm{L2}\,\theta 2'(t)\sin(\theta 2(t)))^2\right)\right)$$

In[50]:=
```
V = -m1 g L1 Cos[q1] - m2 g (L1 Cos[q1] + L2 Cos[q2]) // FullSimplify;
             余弦            余弦           余弦        完全简化
L = T - V // FullSimplify;
             完全简化
L // TraditionalForm
     传统格式
```

Out[52]//TraditionalForm=

$$\frac{1}{2}\left((\mathrm{m1}+\mathrm{m2})\left(2\,\mathrm{L1}\, f'(t)\,\theta 1'(t)\cos(\theta 1(t))+f'(t)^2+\mathrm{L1}^2\,\theta 1'(t)^2\right)+2\,\mathrm{L2}\,\mathrm{m2}\,\theta 2'(t)\,(f'(t)\cos(\theta 2(t))+\mathrm{L1}\,\theta 1'(t)\cos(\theta 1(t)-\theta 2(t)))+\mathrm{L2}^2\,\mathrm{m2}\,\theta 2'(t)^2\right)+g\,\mathrm{L1}\,(\mathrm{m1}+\mathrm{m2})\cos(\theta 1(t))+g\,\mathrm{L2}\,\mathrm{m2}\cos(\theta 2(t))$$

In[53]:=
```
eq1 = ∂t (∂(∂tq1) L) - ∂q1 L == 0 // FullSimplify;
                                    完全简化
eq2 = ∂t (∂(∂tq2) L) - ∂q2 L == 0 // FullSimplify;
                                    完全简化
eq1 // TraditionalForm
       传统格式
eq2 // TraditionalForm
       传统格式
```

Out[55]//TraditionalForm=

$$\mathrm{L1}\left((\mathrm{m1}+\mathrm{m2})\,(f''(t)\cos(\theta1(t))+g\sin(\theta1(t))+\mathrm{L1}\,\theta1''(t))+\mathrm{L2}\,\mathrm{m2}\,\theta2'(t)^2\sin(\theta1(t)-\theta2(t))+\mathrm{L2}\,\mathrm{m2}\,\theta2''(t)\cos(\theta1(t)-\theta2(t))\right)=0$$

Out[56]//TraditionalForm=

$$\mathrm{L2}\,\mathrm{m2}\left(f''(t)\cos(\theta2(t))+g\sin(\theta2(t))-\mathrm{L1}\,\theta1'(t)^2\sin(\theta1(t)-\theta2(t))+\mathrm{L1}\,\theta1''(t)\cos(\theta1(t)-\theta2(t))+\mathrm{L2}\,\theta2''(t)\right)=0$$

一个例子

In[57]:=
```
case = {m1 → 2, m2 → 1, g → 9.8, f'[t] → 3 t + 1, f''[t] → 3, L1 → 0.5, L2 → 0.3};
equation = {eq1, eq2} /. case // FullSimplify;
                                 完全简化
AppendTo[equation, θ1[0] == 10 * π/180];
附加
AppendTo[equation, θ2[0] == 20 * π/180];
附加
AppendTo[equation, θ1'[0] == 2];
附加
AppendTo[equation, θ2'[0] == 1];
附加
```

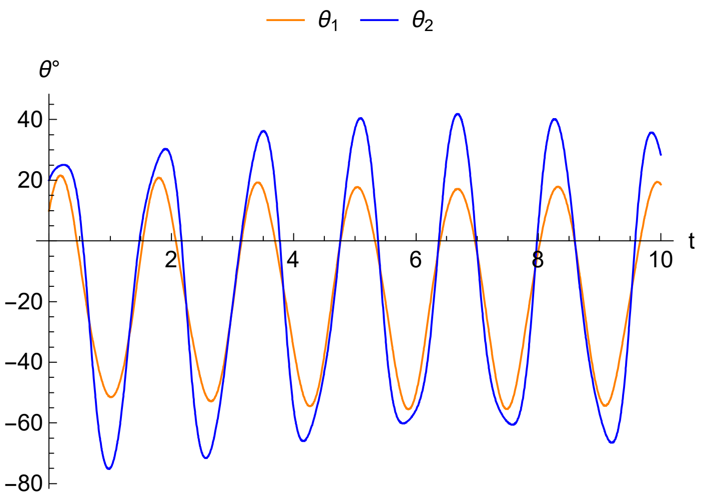
In[63]:=
```
res = NDSolve[equation, {θ1, θ2}, {t, 0, 10}];
      数值求解微分方程组
res
```

Out[64]=
```
{{θ1 → InterpolatingFunction[ Domain: {{0., 10.}} Output: scalar ],
  θ2 → InterpolatingFunction[ Domain: {{0., 10.}} Output: scalar ]}}
```

In[65]:=
```
α = θ1 /. res[[1]][[1]];
β = θ2 /. res[[1]][[2]];
```

In[67]:=
```
picture = Plot[{180/π α[t], 180/π β[t]}, {t, 0, 10}, AxesLabel → {"t", "θ°"},
          绘图                                          坐标轴标签
    LabelStyle → Directive[Medium],
    标签样式      指令       中
    PlotLegends → Placed[{"θ1", "θ2"}, Above], PlotStyle → {Orange, Blue},
    绘图的图例     放置                  上       绘图样式      橙色    蓝色
    PlotTheme -> "Classic"
    绘图主题
  ];
picture
```

Out[68]=



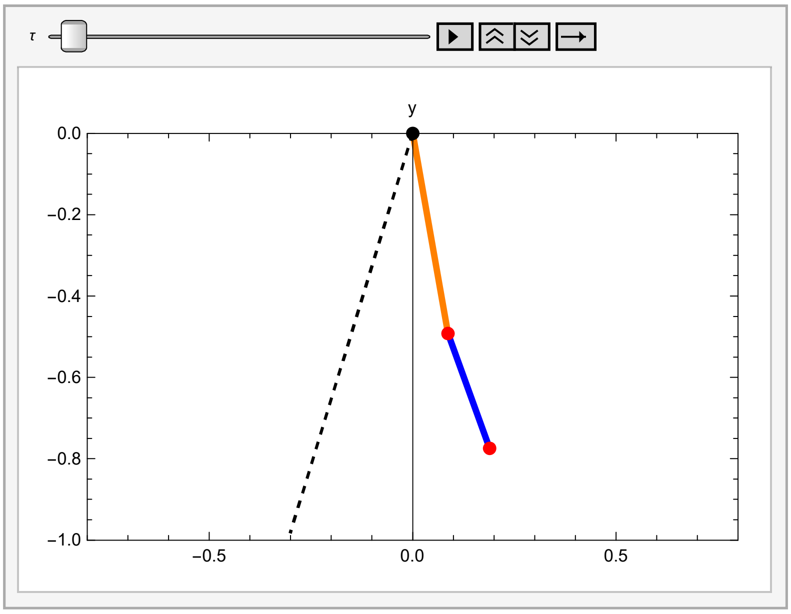
In[69]:=
```
Export["C:\\Users\\bcynuaa\\Desktop\\angle.png", picture];
导出    常量
Export["C:\\Users\\bcynuaa\\Desktop\\angle.pdf", picture];
导出    常量
```

In[71]:=
```
node0 = {0, 0};
node1 = {L1 Sin[α[t]], -L1 Cos[α[t]]} /. case;
            正弦          余弦
node2 = {L1 Sin[α[t]] + L2 Sin[β[t]], -L1 Cos[α[t]] - L2 Cos[β[t]]} /. case;
            正弦           正弦            余弦            余弦
```

In[74]:=
```
graph = Graphics[{
          ⌊图形
    {Thickness[0.01], Orange, Line[{node0, node1}]},
     ⌊粗细              ⌊橙色   ⌊线段
    {Thickness[0.01], Blue, Line[{node1, node2}]},
     ⌊粗细              ⌊蓝色 ⌊线段
    {Thickness[0.005], Black, Dashed, Line[{node0, -0.1 * {3, 9.8}}]},
     ⌊粗细               ⌊黑色  ⌊虚线   ⌊线段
    {PointSize[Large], Black, Point[node0]},
     ⌊点的大小   ⌊大     ⌊黑色  ⌊点
    {PointSize[Large], Red, Point[node1]},
     ⌊点的大小   ⌊大     ⌊红色 ⌊点
    {PointSize[Large], Red, Point[node2]}
     ⌊点的大小   ⌊大     ⌊红色 ⌊点
   },
   Frame → True,
   ⌊边框    ⌊真
   Axes → True,
   ⌊坐标轴 ⌊真
   AxesOrigin → node0,
   ⌊坐标轴原点
   PlotRange → {{-0.8, 0.8}, {-1, 0}},
   ⌊绘制范围
   AxesLabel → {"x", "y"}
   ⌊坐标轴标签
  ];
```

In[75]:=
```
animate = Animate[graph /. t → τ, {τ, 0, 10}, AnimationRunning → False];
          ⌊生成动画                                ⌊动画播放状态          ⌊假
animate
```

Out[76]=

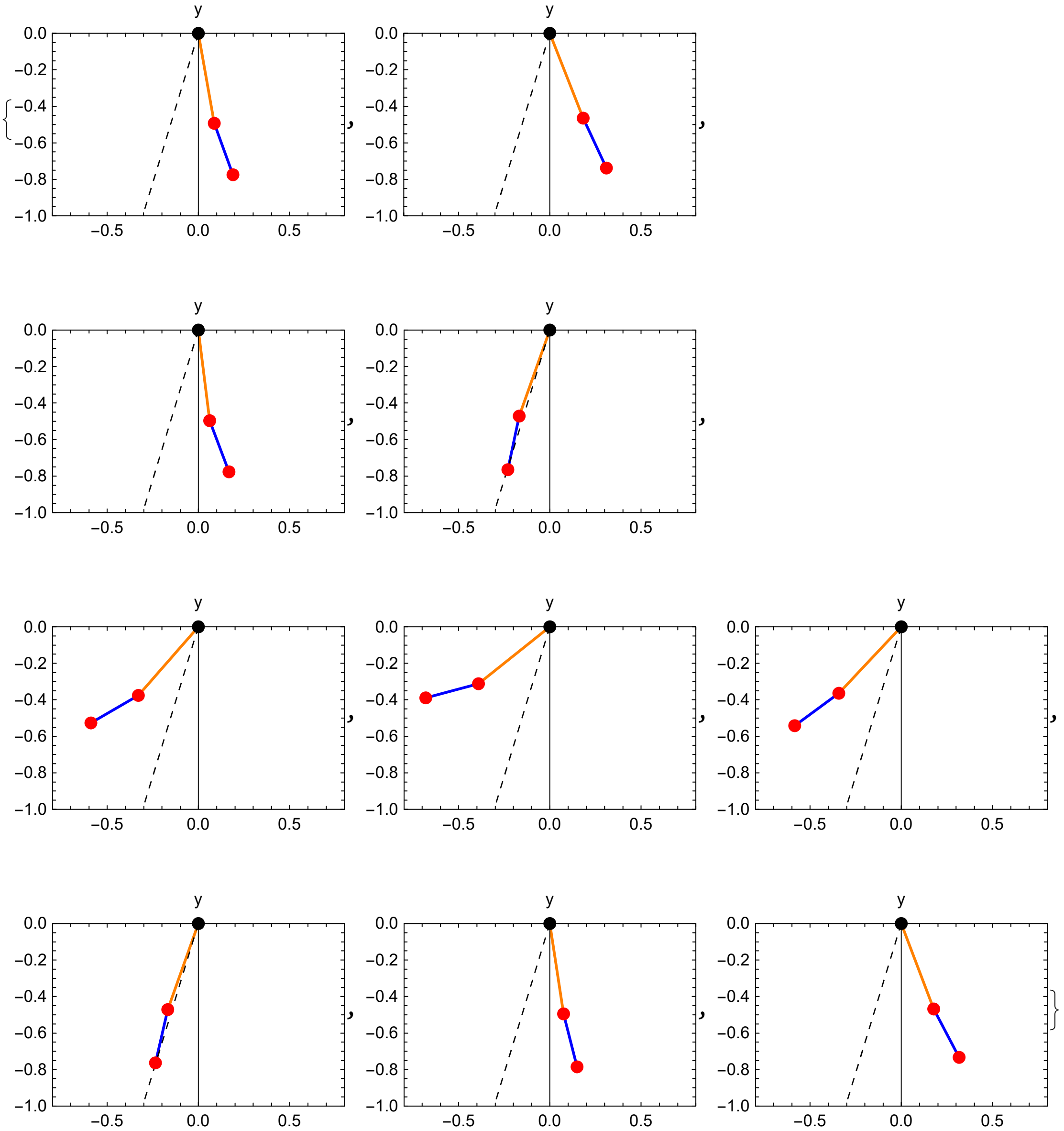


In[77]:=
```
Export["C:\\Users\\bcynuaa\\Desktop\\animate.gif", animate];
⌊导出    ⌊常量
```

In[78]:=
```
graphlist = {};
For[i = 0, i < 10, i++, AppendTo[graphlist, graph /. t → (0.2 i)]];
```
For循环　　附加

In[80]:=
```
graphlist
```

Out[80]=



In[81]:=
```
For[i = 0, i < 10, i++, Export[StringJoin[
    "C:\\Users\\bcynuaa\\Desktop\\", ToString[i], ".png"], graphlist[[i + 1]]]];
For[i = 0, i < 10, i++, Export[StringJoin["C:\\Users\\bcynuaa\\Desktop\\",
    ToString[i], ".pdf"], graphlist[[i + 1]]]];
```
For循环　　导出　　连接字符串　　常量　　转换为字符串