

```
In[12]:= ClearAll["Global`*"]; y[t_] := Y[t] + R Cos[θ[t]];
x[t_] := R Sin[θ[t]];
T = m (x'[t]^2 + y'[t]^2) + (1/2) M Y'[t]^2;
U = 2 m g y[t] + M g Y[t];
lag = T - U
```

$$\text{Out[16]} = -g M Y[t] - 2 g m (R \cos[\theta[t]] + Y[t]) + \frac{1}{2} M Y'[t]^2 + m (R^2 \cos[\theta[t]]^2 \theta'[t]^2 + (Y'[t] - R \sin[\theta[t]] \theta'[t])^2)$$

```
In[17]:= FullSimplify[lag]
```

$$\text{Out[17]} = -g (2 m + M) Y[t] + \left(m + \frac{M}{2}\right) Y'[t]^2 - 2 m R \sin[\theta[t]] Y'[t] \theta'[t] + m R (-2 g \cos[\theta[t]] + R \theta'[t]^2)$$

```
In[18]:= lagWithConstraint = lag + λ Y[t];
```

```
FullSimplify[
  D[D[lagWithConstraint, Y'[t]], t] == D[lagWithConstraint, Y[t]]
]
```

$$\text{Out[19]} = (2 m + M) (g + Y''[t]) == \lambda + 2 m R (\cos[\theta[t]] \theta'[t]^2 + \sin[\theta[t]] \theta''[t])$$

```
In[20]:= FullSimplify[
```

```
  D[D[lagWithConstraint, θ'[t]], t] == D[lagWithConstraint, θ[t]]
]
```

$$\text{Out[20]} = m R^2 \theta''[t] == m R \sin[\theta[t]] (g + Y''[t])$$

```

In[21]:= ClearAll["Global`*"];
 $\phi$  = 0;  $\omega t$  = 1;
Manipulate[
  r = 1; xc = r Cos[ $\omega t$ ]; yc = r Sin[ $\omega t$ ];
  c = {xc, yc}; a = {0, 0}; b = 2 c;
  xyrelative = r {Cos[ $\omega t$  +  $\phi$ ], Sin[ $\omega t$  +  $\phi$ ];
  Graphics[{
    Circle[c, r],
    Line[{a, b}],
    Disk[c + xyrelative, 0.05 r],
    Dashed,
    Line[{c, c + xyrelative}]
  ],
  PlotRange → {{-2.1, 2.1}, {-2.1, 2.1}},
  PlotRangeClipping → True, Frame → True],
{ $\phi$ , 0, 2  $\pi$ }, { $\omega t$ , 0, 2  $\pi$ },
LabelStyle → Large]

```

Out[23]=

