

```
(%i1) kill(all);
(%o0) done
```

0.1 Eqs. (9,17)

```
(%i1) depends([beta, theta, phi, thetadot, phidot], t);
(%o1) [beta(t), theta(t), phi(t), thetadot(t), phidot(t)]
```

```
(%i2) E9: diff(beta,t)^2 = thetadot^2+sin(theta)^2*diff(phi,t)^2;
(%o2)  $\left(\frac{d}{dt} \text{beta}\right)^2 = \text{thetadot}^2 + \left(\frac{d}{dt} \phi\right)^2 \sin(\theta)^2$ 
```

```
(%i3) E17: thetadot = L[theta]/L[phi] * (diff(phi,t)*sin(theta)+thetadot
      L_theta*(phi*cos(theta)*thetadot+(d/dt phi)*sin(theta))
(%o3)  $\text{thetadot} = \frac{L_\theta \left( \phi \cos(\theta) \text{thetadot} + \left(\frac{d}{dt} \phi\right) \sin(\theta) \right)}{L_\phi}$ 
```

```
(%i4) E17a: solve(E17, thetadot);
(%o4) [ thetadot = -  $\frac{\left(\frac{d}{dt} \phi\right) L_\theta \sin(\theta)}{\phi L_\theta \cos(\theta) - L_\phi}$  ]
```

0.2 From eq. (17)

```
(%i5) thetadot: rhs(first(E17a));
(%o5)  $-\frac{\left(\frac{d}{dt} \phi\right) L_\theta \sin(\theta)}{\phi L_\theta \cos(\theta) - L_\phi}$ 
```

```
(%i6) E9a: ev(E9);
(%o6)  $\left(\frac{d}{dt} \text{beta}\right)^2 = \frac{\left(\frac{d}{dt} \phi\right)^2 L_\theta^2 \sin(\theta)^2}{(\phi L_\theta \cos(\theta) - L_\phi)^2} + \left(\frac{d}{dt} \phi\right)^2 \sin(\theta)^2$ 
```

```
(%i9) factor(%);
(%o9)  $\left(\frac{d}{dt} \text{beta}\right)^2 = \frac{\left(\frac{d}{dt} \phi\right)^2 (\phi^2 L_\theta^2 \cos(\theta)^2 - 2 \phi L_\phi L_\theta \cos(\theta) + L_\theta^2 + L_\phi^2) \sin(\theta)^2}{(\phi L_\theta \cos(\theta) - L_\phi)^2}$ 
```