Computing project Part III

Assignment 7 − Asymmetric Top

Just copy from assignment 6 and adjust I1, I2 and I3.

```
In[25]:= ωdot[ω_] := {((I2 - I3) / I1) ω[[2]] ω[[3]],
            ((I3 - I1) / I2) ω[[1]] ω[[3]], ((I1 - I2) / I3) ω[[1]] ω[[2]]};

In[26]:= imax = 1000;

In[27]:= t0 = 0;
         dt = 0.01;
         T = Table[t0, {i, 1, imax}];

In[30]:= I1 = 1;
         I2 = 1.5;
         I3 = 2;

In[33]:= EE = Table[0, {i, 1, imax}];
```

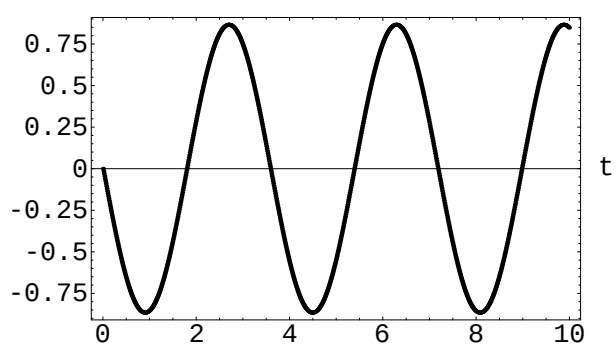
■ 1

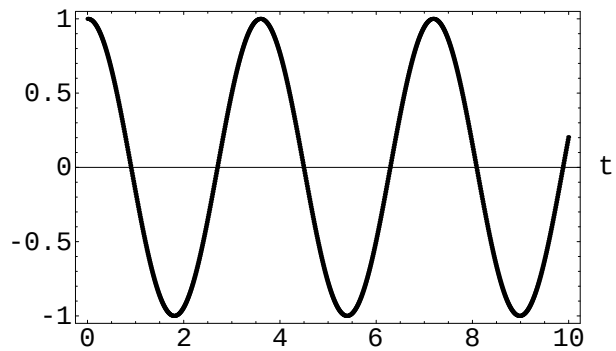
Here we expect similar behavior as for the symmetric top since ω is largest in the z direction, which is a stable direction.

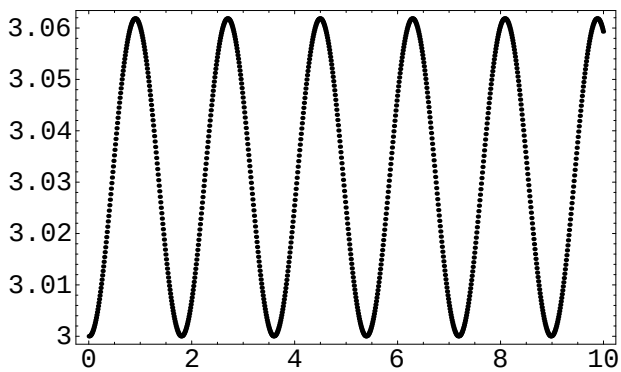
```
In[34]:= ω0 = {0, 1, 3};
         ω = Table[ω0, {i, 1, imax}];

In[36]:= Do[ T[[i]] = T[[i - 1]] + dt;
          ωpred = ω[[i - 1]] + ωdot[ ω[[i - 1]] ] dt;
          ω[[i]] = ω[[i - 1]] + (ωdot[ ω[[i - 1]] ] + ωdot[ ωpred ]) dt / 2;
          , {i, 2, imax}]

In[37]:= EE = I1 Transpose[ω][[1]]^2 + I2 Transpose[ω][[2]]^2 + I3 Transpose[ω][[3]]^2;
```

Plot $\omega 1$, $\omega 2$ and $\omega 3$ as function of time. Plot energy as function of time.

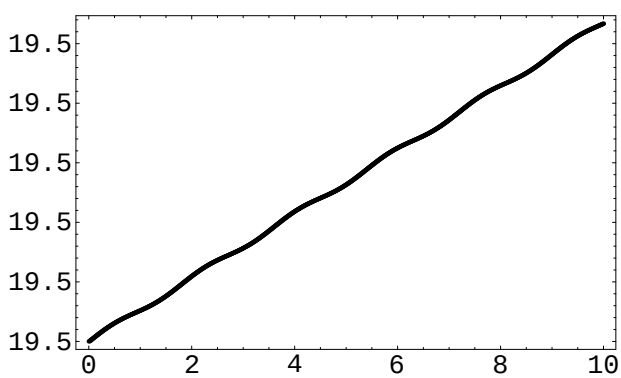
```
In[38]:= ListPlot[Transpose[{T, Transpose[ω][[1]]}], Frame → True, AxesLabel → {"t", "ω1"}];
         ListPlot[Transpose[{T, Transpose[ω][[2]]}], Frame → True, AxesLabel → {"t", "ω1"}];
         ListPlot[Transpose[{T, Transpose[ω][[3]]}], Frame → True, AxesLabel → {"t", "ω1"}];
```





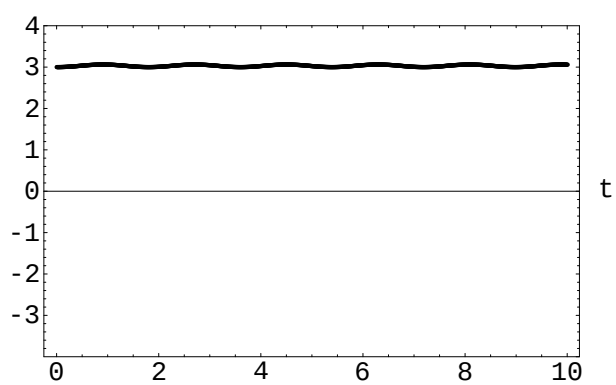



```
In[39]:= ListPlot[Transpose[{T, EE}], Frame → True, AxesLabel → {"T", "Energy"}];
```



What happened with $\omega 3$ there??. We expected $\omega 3$ to be constant but it seems as if al three components oscillate now. However, if you look closer at the scale of the plot of $\omega 3$, you discover that $\omega 3$ is nearly constant, rescaled:

```
In[40]:= ListPlot[Transpose[{T, Transpose[ω][[3]]}],
           Frame → True, AxesLabel → {"t", "ω1"}, PlotRange → {-4, 4}];
```



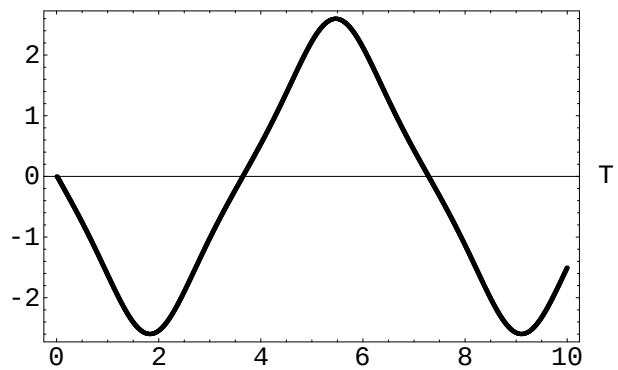
■ 2

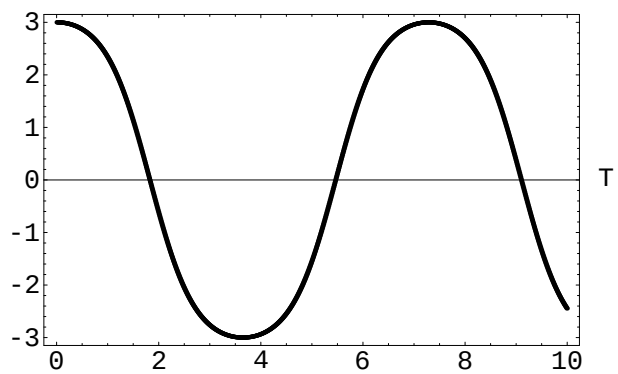
This is an unstable axis. Let's see what happens. We expect that $\omega 2$ will not remain constant.

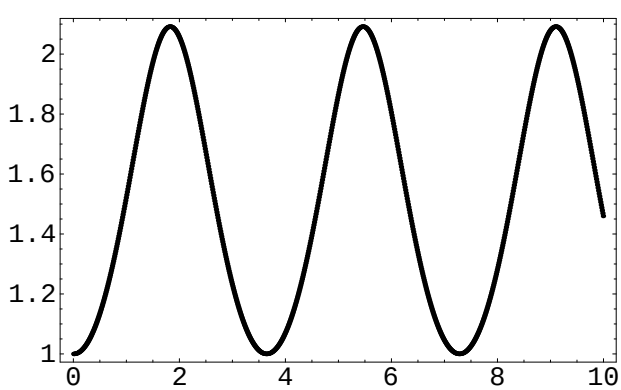
```
In[41]:= ω0 = {0, 3, 1};
         ω = Table[ω0, {i, 1, imax}];
```

Calculate ω, energy and plot $\omega 1$, $\omega 2$, $\omega 3$ and energy.

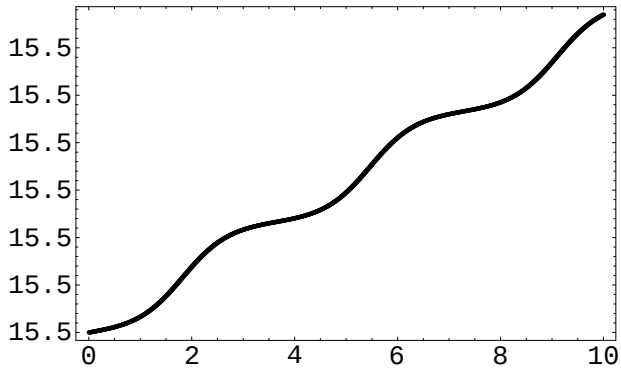
```
In[43]:= Do[ T[[i]] = T[[i - 1]] + dt;
          ωpred = ω[[i - 1]] + ωdot[ ω[[i - 1]] ] dt;
          ω[[i]] = ω[[i - 1]] + (ωdot[ ω[[i - 1]] ] + ωdot[ ωpred ]) dt / 2;
          , {i, 2, imax}]

In[44]:= EE = I1 Transpose[ω][[1]]^2 + I2 Transpose[ω][[2]]^2 + I3 Transpose[ω][[3]]^2;

In[45]:= ListPlot[Transpose[{T, Transpose[ω][[1]]}], Frame → True, AxesLabel → {"T", "ω1"}];
         ListPlot[Transpose[{T, Transpose[ω][[2]]}], Frame → True, AxesLabel → {"T", "ω1"}];
         ListPlot[Transpose[{T, Transpose[ω][[3]]}], Frame → True, AxesLabel → {"T", "ω1"}];
```







```
In[46]:= ListPlot[Transpose[{T, EE}], Frame → True, AxesLabel → {"T", "Energy"}];
```



$\omega 2$ 'turns around' at some point and is definetely not constant. Note that $\omega 3$ fluctuates but does not flip sign. Energy stays constant (when viewed at the right scale).

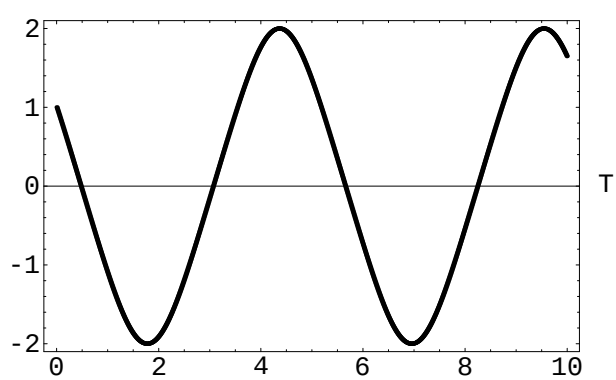
■ 3

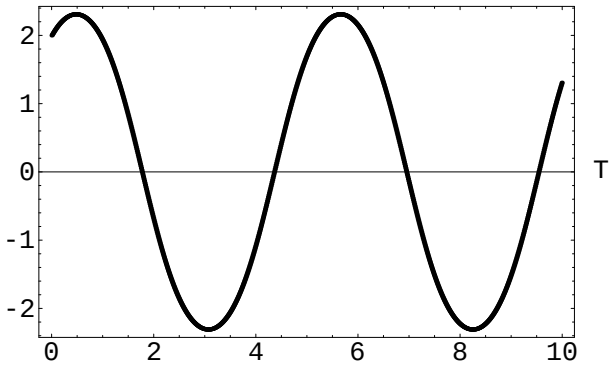
What determines the critical value? Hard too tell exactly as there is no clear cross−over from one to the other type of motion. It should happen roughly when $\omega 2$ is equal to $\omega 3$ (and $\omega 1$ smaller than the other two). At that point the oscillations of $\omega 2$ stop/start being harmonic and $\omega 3$ starts/stops being roughly constant.

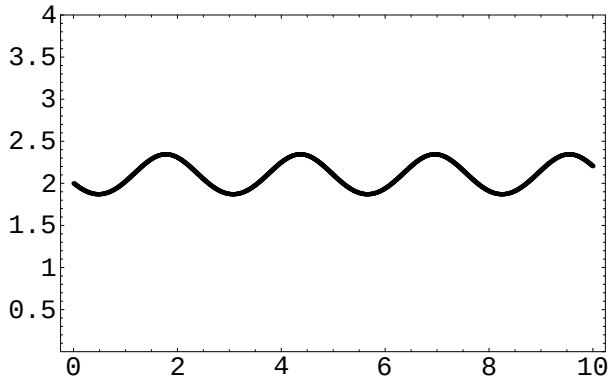
```
In[47]:= ω0 = {1, 2, 2};
         ω = Table[ω0, {i, 1, imax}];
```

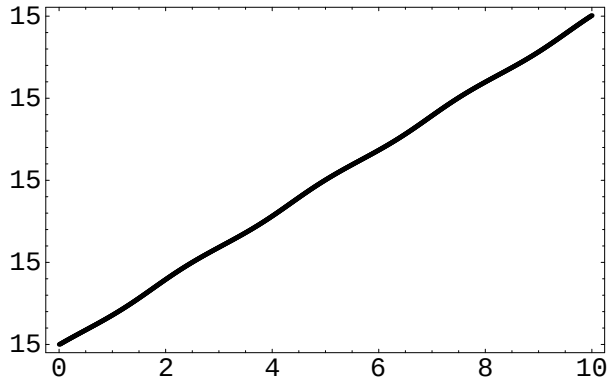
Calculate ω, energy and plot $\omega 1$, $\omega 2$, $\omega 3$ and energy.

```
In[49]:= Do[ T[[i]] = T[[i - 1]] + dt;
          ωpred = ω[[i - 1]] + ωdot[ ω[[i - 1]] ] dt;
          ω[[i]] = ω[[i - 1]] + (ωdot[ ω[[i - 1]] ] + ωdot[ ωpred ]) dt / 2;
          , {i, 2, imax}]

In[50]:= EE = I1 Transpose[ω][[1]]^2 + I2 Transpose[ω][[2]]^2 + I3 Transpose[ω][[3]]^2;

In[51]:= ListPlot[Transpose[{T, Transpose[ω][[1]]}], Frame → True, AxesLabel → {"T", "ω1"}];
         ListPlot[Transpose[{T, Transpose[ω][[2]]}], Frame → True, AxesLabel → {"T", "ω1"}];
         ListPlot[Transpose[{T, Transpose[ω][[3]]}],
          Frame → True, AxesLabel → {"T", "ω1"}, PlotRange → {0, 4}];
```








```
In[52]:= ListPlot[Transpose[{T, EE}], Frame → True, AxesLabel → {"T", "Energy"}];
```