PHYS 5120: Homework 1

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1. The Linear and nonlinear pendulums

1.1 Solution

The equation of motion is in the format of:

$$\frac{\mathrm{d}^2\theta}{\mathrm{d}t^2} + \frac{g}{\ell}\theta = 0$$

And the solution of the differential equation is:

$$\theta = A\cos(\sqrt{\frac{g}{\ell}}t + \delta)$$

There are two parameters A, δ in the solution because we do not know the initial condition $\theta(t=0), \dot{\theta}(t=0)$.

The swing period is:

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

1.2 Solution

```
# use the following command to find help message
python pendulum.py -h
# the python command to run
python -O pendulum.py -s 0.01 -t 300 -a 6
```

The numerical solution is that: Figure1

1.3 Solutiom

After I solve the energy time relationship, I find that the energy is oscillating and it does not obey the energy conservation law. When I increase the timestep, the oscilation becomes more rapid. The exact energy is shown in the plot.

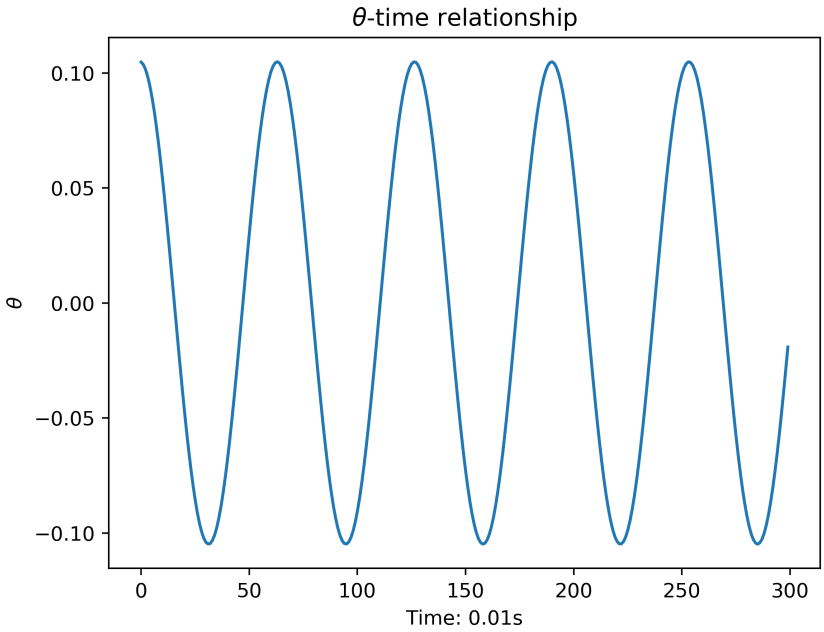

Figure 1: theta time relationship

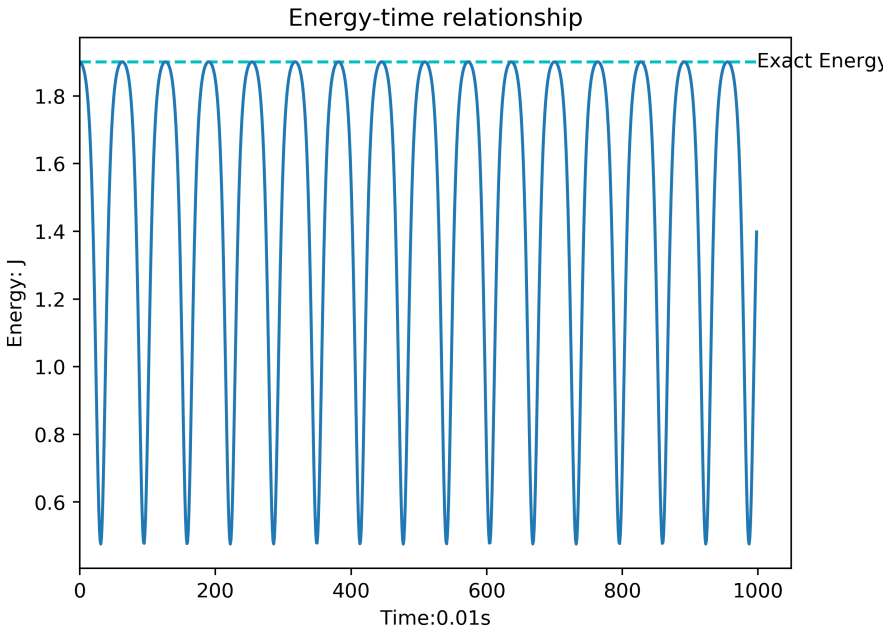

Figure 2: energy time relationship

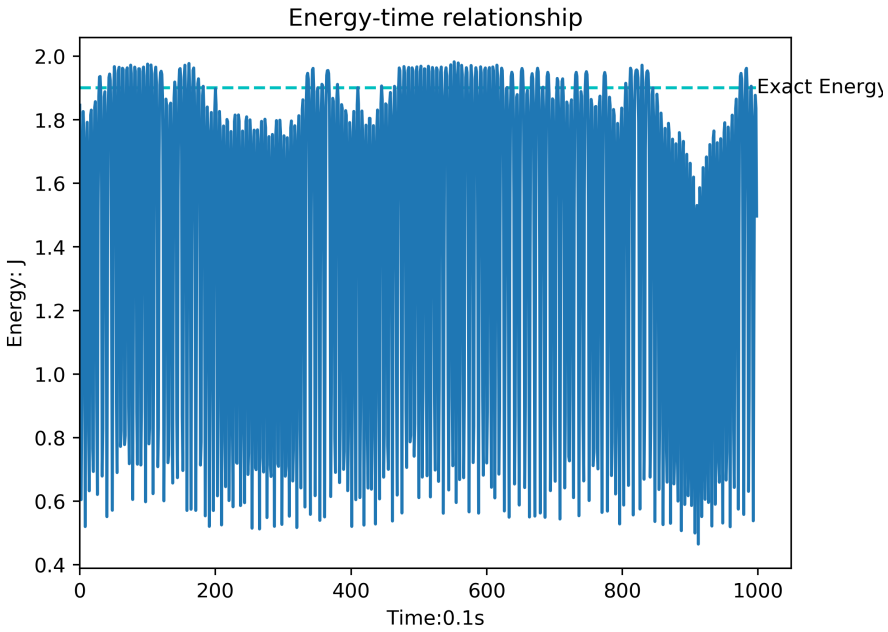

Figure 3: energy time relationship