UNIVERSITY KARLRUHE - INTERNATIONAL DEPARTMENT

Pre-Semester Physics - Exercises   Summer 2009

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1. Exercise

A body of unknown mass is attached to an ideal string with force constant $D = 120\frac{N}{m}$. It is found to vibrate with a frequency of $f = 0.6\,Hz$.

(i) Find the angular velocity ω.

(ii) Find the period T.

(iii) Find the mass m of the body.

2. Exercise

The period of an oscillating particle is $8\,s$. At $t = 0$ the particle is at rest at $x = A = 10\,cm$.

(i) Find $x(t)$.

(ii) Sketch $x(t)$.

(iii) Find the distance travelled in the first second.

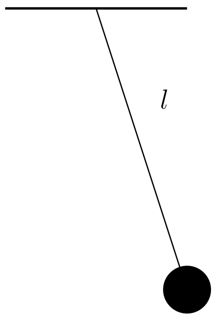
(iv) Find the velocity in the point $x = 0$.

3. Exercise

Find the length of a simple pendulum if the period is $5\,s$ at a point where $g = 9.81\frac{m}{s^2}$.

4. Exercise

Consider a physical pendulum consisting of a solid sphere with radius r and mass m suspended from a string. The distance from the center of the sphere (i.e. the center of mass of the sphere) to the point of support is l. The moment of inertia of a solid sphere is given by $\Theta = \frac{2}{5}mr^2$.



(i) Show, that period is given by (for small oscillations)

$$T = T_0\sqrt{1 + \frac{2r^2}{5l^2}} \quad \text{with} \quad T_0 = 2\pi\sqrt{\frac{l}{g}}\,.$$

(ii) Show that for $r \to 0$ the period of a mathematical pendulum is recovered.

5. Exercise (more advanced)

Solve the equation of motion for a damped oscillator

$$\ddot{x}(t) + 2\kappa\dot{x}(t) + \omega^2 x(t) = 0 \quad \text{with} \quad \omega = \sqrt{\frac{D}{m}} \quad \text{and} \quad 2\kappa = \frac{\gamma}{m}\,.$$

Make the ansatz

$$x(t) = e^{\lambda t}$$

and distinguish between the two cases

(i) $\kappa < \omega$

(ii) $\kappa > \omega$