University Karlruhe - International Department

Pre-Semester Physics - Exercises Summer 2009

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1. Exercise

A person stands on a cliff which has a height of $h_1 = 50\,m$ measured from the water surface. The sea itself has a depth of $h_2 = 10\,m$. The person drops a stone down the cliff, which is accelerated (due to gravity) by $g = 10\frac{m}{s^2}$. Assume the stone entering the water to propagate with the constant velocity from the point on when it is at the water surface.

(i) Find the time t that the stone needs to hit the ground of the sea.

(ii) Draw the $x(t)$ diagram.

(iii) Draw the $v(t)$ diagram.

2. Exercise

A car is racing along the street at a speed $v = 20\,\frac{m}{s}$. At some place there is a police car spotting racers. As the racer passes the police car it starts to catch up with the car driver. The police car accelerates with $a = 10\frac{m}{s^2}$.

(i) Find the time t the police car needs to catch up with the car driver!

(ii) Draw the $x(t)$ dependencies for the racer and the police car in one diagram.

3. Exercise

How to find out the depth h of a font (or the height of any other arbitrary object)? Drop for instance a stone into the font and measure the time t till you hear the impact. What depth h do you obtain for $t = 5s$? (Hint: Downwards the stone is again (compare with exercise one) accelerated with $g = 10\frac{m}{s^2}$. The acoustic velocity is $v_{ac} = 340\frac{m}{s}$. Find a quadratic equation for h.)

4. Exercise

A mass point is shot with an initial velocity of $20\frac{m}{s}$ at 45° from the horizontal.

(i) Find the total time the mass point is in the air.

(ii) Find the total horizontal distance traveled.

(iii) Find the maximum height of the mass point.

5. Exercise

The participants of the "Tour de France" ride on their bikes at a speed $v = 45\frac{km}{h}$. Suppose the stage has a distance of $d = 200\,km$. The wheels have a diameter of $d = 70\,cm$.

(i) How often do the wheels turn around during the leg?

(ii) Find the total time needed for the leg!

(iii) Find the angular velocity ω and the frequency f of the wheels!

6. Exercise

Consider two persons standing on a roundabout (i.e. a rotating plate with angular velocity ω), one person at the middle point and one person at the border. The one at the border likes to throw a ball to the person in the middle with some certain velocity v.

(i) In which direction (precisely: Give the angle to the line joining the person at the border and in the middle) does he have to throw the ball.

(ii) How long will it take, that the ball reaches the person in the middle?

(iii) Suppose the velocity v is fixed. What is the maximal angular velocity ω_m allowing the person at the border to reach the person in the middle with the ball.

(iv) If the person in the middle wants to throw back the ball to the person outside: In which direction does he have to throw it? How long will it take?

7. Exercise (more advanced)

Consider a path $\vec{x}(t)$ with $t \in [t_1, t_2]$ of a mass point. Often one is interested in the path length L, that the mass point covered during the time interval $[t_1, t_2]$. It is given by

$$L = \int_{t_1}^{t_2} |\dot{\vec{x}}(t)| dt$$

Consider now the path in two dimensions

$$\vec{x}(t) = \begin{pmatrix} e^t \cos(t) \\ e^t \sin(t) \end{pmatrix} \quad \text{with} \quad t \in [0, T]\,.$$

Sketch the path $\vec{x}(t)$ and calculate the path length L.

Exercises and solutions are available at:

www.tkm.uni-karlsruhe.de/∼hschmidt/physcourse.html