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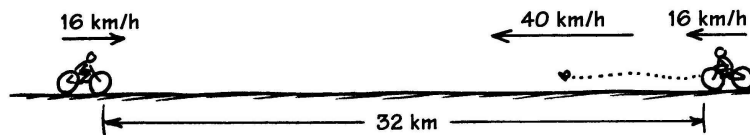http://adam.unibas.ch

Exercises and Complements for the Introduction to Physics I

for Students

of Biology, Pharmacy and Geoscience

Sheet 2 / September 26, 2017   Discussion of the Exercises: **03.10.2017/04.10.2017**

Exercise 6.

Two cyclists ride with $v = 16$ km/h towards each other. In the moment when the distance between them is 32 km a bee starts to fly with $v = 40$ km/h from the front wheel of one bike towards the front wheel of the other bike. As soon as the bee has reached the front wheel it turns and flies back. The bee continues this until it gets squashed, by the collision of the two bikes. How many kilometers is the bee flying back and forth between the two bikes?

Exercise 7.

The opponents of James Bond try to escape with a speedboat. '007' accelerates on his motorbike with a velocity v on the landing stage, which is 4 m above the water surface. His goal is to land on the opponent's boat, which is 5 m long, after the free flight. The 'landing place' is 50 cm above the water surface.
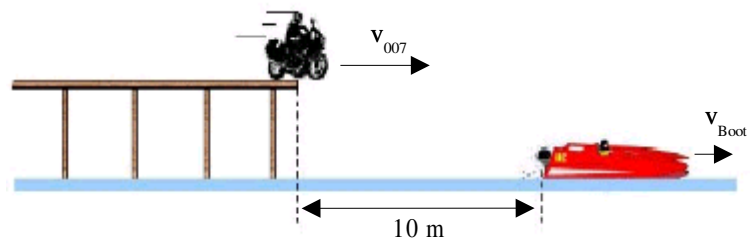
The illustration shows the moment of the jump. The speedboat has a velocity of 30 km/h, towards right.

What is the speed range which James Bond needs to have in the moment of the jump in order to land with the center of his motorbike on the boat?

Exercise 8.

The movement of a point is described by the following coordinates:

$$\begin{aligned} x(t) &= r \cdot \cos(\omega t) \\ y(t) &= r \cdot \sin(\omega t) \\ z(t) &= v_z \cdot t \end{aligned}$$

with $r = 1$ m, $\omega = 2\pi$ s^{-1} and $v_z = 0.2$ m/s. The motion starts at the time $t = 0$ and ends at $t = 10$ s.

(a) How big is the absolute value of the velocity $|\vec{v}|$ and of the acceleration $|\vec{a}|$ during the motion?

(b) Sketch the trajectory of the motion.

(c) What is the distance, which the point covers during its motion?

Exercise 9.

A vehicle drives with a speed of $v_0 = 30$ km/h in a 90-degree-curve with a radius of $R = 50$ m and accelerates uniformly. The maximum centripetal acceleration is $a_r = 3.86$ m/s^2.

(a) What is the velocity v_1 when the vehicle leaves the curve?

(b) Calculate the quantity and the direction of the maximum acceleration a.

Additional Exercise

A sphere starting from A can reach D via two different paths: (1) roll slightly down hill from A to B, followed by a free fall to D, or (2) first the free fall from A to C, followed by rolling on the inclined surface to D. The sphere is disengaged in A and has no initial speed. Apart from the gravitational force no other forces are acting (friction, aerodynamic drag, etc. can be neglected). Which path is the faster and why? Sketch the speed as a function of time for both cases.
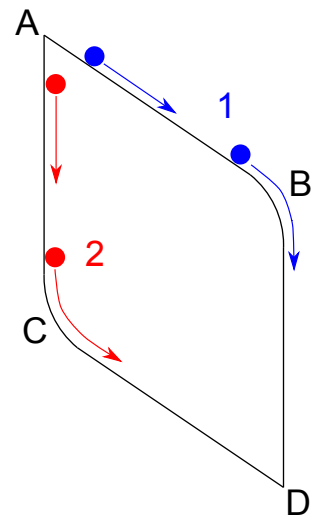
Solutions:

Exercise 6. 40 km

Exercise 7. $73 - 94$ km/h

Exercise 8. (a) 6.3 m/s and 39.5 m/s^2 (c) 62.9 m

Exercise 9. (a) 50 km/h   (b) 3.94 m/s^2