# **Problems to solve**:

<u>From the textbook - **Physics I - seminars**, Pekárek S., Murla M.</u>

Kinematics: 1-1, 1-2, 1-5, 1-11, 1-12, 1-16, 1-17, 1-23, 1-24
Dynamics: 1-38, 1-39, 1-42, 1-44, 1-52, 1-53, 1-54
Motion in a Rotating system: 1-55, 1-56
Work and Energy: 1-59, 1-60, 1-66, 1-67, 1-71, 1-77, 1-81, 1-82, 1-84
System of particles: 1-88, 1-90, 1-97, 1-99
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Oscillations (Physics II textbook): 1-2, 1-5, 1-19, 1-23, 1-30, 1-32, 1-33

**<u>Problem 1</u>**

A jet plane starts moving on 1800 meters long runway. What is the minimum acceleration needed for successful takeoff of the plane if the minimum takeoff speed is $v_1$= 360 km/h?

[2.78 m.s$^{-2}$]

**<u>Problem 2</u>**

A startled armadillo jumps straight up from the ground.
At the moment $t$=0.2 seconds it reaches the height of h=0.544 m.
($g$= 9.81 m.s$^{-2}$)

a) What is its initial velocity? [3.701 m.s$^{-1}$]
b) What is its velocity at the height $h$=0.544 m? [1.739 m.s$^{-1}$]
c) What is maximum height of the jump? [0.698 m]

**<u>Problem 3</u>**

What is the rotation period of a funfair centrifuge of radius 5 meters, if the resulting acceleration $a$ acting on the slightly scared passenger is equal to the acceleration due to the gravity $g$ and its direction is upwards? The axis of the centrifuge is horizontal and $g$=9.81 m.s$^{-2}$.

[3.17 s]

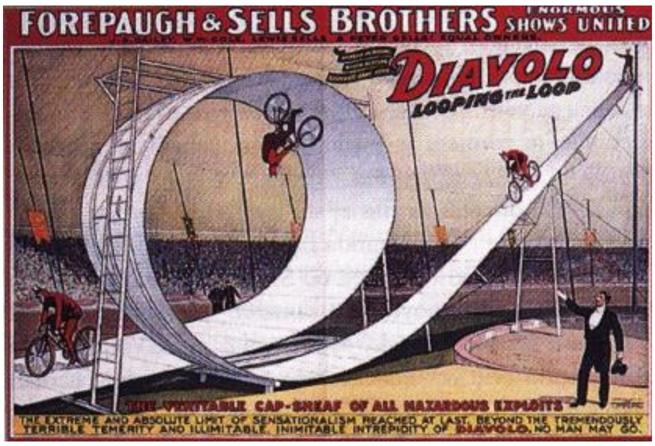
**<u>Problem 4</u>**

A body starts moving from the rest along a linear path with acceleration, which linearly increases from zero to the value $a_1$=0.5 m.s$^{-2}$ at the moment $t_1$=90 s. Calculate the path traveled by the body until the moment $t_1$.

[675 m]

**<u>Problem 5</u>**

A biker Diavolo wants to pass along a circular loop, which is shown on the picture. Radius of the loop is $R$=2.7 m. Calculate minimum velocity required at the uppermost point of the loop to successfully pass the entire path.
[5.15 m.s$^{-1}$]



**Problem 6**

A flywheel rotates with frequency $n$=1500 rpm (revolutions per minute). We start to decelerate the flywheel at the moment $t_0$=0 s so that it stops at $t_1$=30 s. Calculate the angular acceleration **ε** and the number of revolutions ***N*** that the flywheel performs until it stops.

[5/3*π $s^{-2}$, 375 revolutions]

**Problem 7**

Calculate the magnitude of the Coriolis' force by which a train acts on rails. The mass of the train is $m=5.10^5$ kg, its velocity is $v$=72 km/h and it moves from the north to the south at the latitude φ= 50°. [1110.8 N]

**Problem 8**

A homogenous horizontal bar of mass $m$=5000 kg lies on two supports situated at ends of the bar. Length of the bar is $l$=10 m. At the distance $x$=2 m from the left end is placed a body of mass $m_1$= 1 ton. Calculate reaction forces in both supports.

( g= 9.81 $m.s^{-2}$ ) [32 373 N, 26 487 N]

**Problem 9**

A wagon moves on a horizontal linear rail. We are slowing it down with a force, which is equal to 1/10 of its weight. Calculate the time necessary for its stopping (calculated from the beginning of its slowing down), and the distance travelled from the beginning of slowing down until the stopping. The initial velocity of the wagon is 72 km/h. ($g$ = 9.81 $m/s^{-2}$).

[20 s, 200 m]

**Problem 10**

A moment of inertia of an electromotor rotor is $J$=2 $kg.m^2$ and its mass is $m$=110 kg. The rotor performs 20 revolutions per second. What is its kinetic energy?

[15.8 kJ]

**Problem 11**

What mechanical work is needed to accelerate a train from 36 km/h to 54 km/h? The mass of the train is $m$= 300 tons. All types of friction can be neglected.

[18.75 MJ]

**Problem 12**

What is the frequency of a simple harmonic oscillator represented by a particle of mass $m$=2 g, if the amplitude of oscillations is $A$=10 cm and the total energy of the particle is W=1 J? [50.35 Hz]

**Problem 13**

What is the logarithmic decrement of damping Λ of damped harmonic oscillator, if its mechanical energy decreases to the 50% of its initial value during first 10 seconds? The period of oscillations is $T$=2 s. [0.0693]

**Problem 14**

A body hanging on a spring oscillates with period T=0.5 s. We stop oscillations manually and we remove the body from the spring. Due to this removal the length of the spring is shortened by *x* . Calculate the *x*. [6.2 cm]

**Problem 15**

An amplitude of oscillations of damped harmonic oscillator drops to 40% of its initial value during two successive displacements on the same side. Period of oscillations is T=0.5 s. Calculate the damping coefficient $\delta$ and the logarithmic decrement of damping $\Lambda$.

[1.833 $s^{-1}$, 0.916]

**Problem 16**

If we hang a mass on a vertical spring, then the spring extends by 4 cm. The mass of the spring can be neglected. What will be the frequency of oscillations if we give vertical impulse to the system? [2.51 Hz]

**Problem 17**

How long does it take until the energy of damped harmonic oscillator drops to one millionth of its original value? The frequency of oscillations is *f*=435 Hz and the logarithmic decrement of damping is $\Lambda = 8.10^{-4}$. [19.84 s]