Problems to solve:

From the textbook - **Physics I - seminars**, Pekárek S., Murla M.
1-1, 1-2, 1-5, 1-12, 1-17, 1-36, 1-56, 1-59, 1-60, 1-66, 1-67, 1-88, 1-90, 1-97, 1-108

Problem 1

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}]

Problem 2

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]

Problem 3

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]

Problem 4

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]

Problem 5

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 sledge goes down a hill represented by an inclined plane with angle α= 10°. The motion on the inclined plane between points A and B is uniformly accelerated and the path is AB= s_1= 1000 m. After reaching the point B at the foot of the hill the sledge continues moving on a horizontal plane and stops at the point C. The horizontal path is BC= s_2= 100 m. Calculate the coefficient of friction. [0.16]

Problem 9

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 10

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 11

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 12

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 13

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 14

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 15

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 16

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 δ and the logarithmic decrement of damping Λ.

[1.833 s^{-1}, 0.916]

Problem 17

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 18

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]

Problem 19

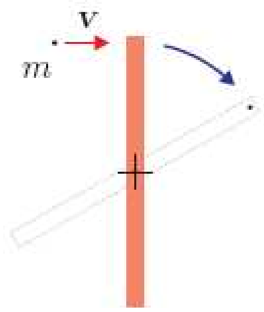
A bullet of mass m=10 g was fired in horizontal direction at a box of mass M=2 kg filled by sand. The bullet remained inside the box and the box was due to the hit shifted by 25 cm on a horizontal plane. The coefficient of friction between the box and the plane is μ=0.2. Calculate the velocity of the bullet and the time of motion of the box.

[199 $m.s^{-1}$, 0.505 s]

Problem 20

A wooden bar of mass M=2 kg and length l=1 m is placed on a pivot, which is situated in the middle of the bar, so that the bar can rotate around the pivot. A bullet hits the bar on its end and remains in the wood. Vector of bullet velocity is perpendicular to the axis of rotation. Velocity of the bullet is v=200 $m.s^{-1}$ and its mass is m=10 g. What is the angular velocity of the bar after the hit?

[5.91 s^{-1}]



Problem 21

A transverse sinusoidal wave is generated at one end of a long horizontal string by a bar which moves up and down through the distance of 0.5 m. The motion is continuous and is repeated regularly 120 times per second. The wave travels at speed 19 m/s. Find velocity of oscillations of a particle at the distance of 62 cm from the origin.

[u=1.85cos(24-740t) $m.s^{-1}$]

Problem 22

Two waves traveling in opposite directions on a string fixed at x=0 are described by functions:

$$y_1 = 0.2\sin(2x - 4t) \quad \text{and} \quad y_2 = 0.2\sin(2x + 4t)\,.$$

Write the equation of the standing wave and find the amplitude of the wave at the distance of 0.45 m.

[0.313 m]

Problem 23

Spherical waves propagate from a point source whose power output is constant. How the wave intensity depends on the distance from the source. The medium is assumed to be homogeneous and isotropic.