Seminary exercise Nr. 3
Newton's laws and Conservation of energy

1. The force acting on a mass particle is constant (select your own invariables). Define the functions of velocity and position of the particle and plot all the functions in a graph.

2. The force acting on a mass particle is linearly decreasing (plot a force-versus-time graph). Find the expression of velocity and position and describe the obtained functions.

3. Consider a quadratic function of the position of a mass particle $x(t)=3+4t-2t^2$. Find the expression of velocity and acceleration (force) and describe the obtained functions.

4. The position vector of a mass particle is given by $x(t)=A+Bt^2$ and $y(t)=-Ct^2$, where A , B and C are constants (explain their meaning in physics). Find the components of the velocity and acceleration vectors and calculate their magnitudes. Describe the type of motion.

5. A small body of mass $1\,g$ moves linearly at a speed of $18\,ms^{-1}$. Due to a constant acting force, the speed of the body increased to $30\,ms^{-1}$ in $2.4\,s$. Find the magnitude of the acting force.

6. A small body of mass $1\,g$ moves linearly at a speed of $18\,ms^{-1}$. Due to a variable acting force, the speed of the body increased to $30\,ms^{-1}$ within $2.4\,s$. Find the expression of the acting force, considering that the force is linearly decreasing from maximal value at $t_0=0\,s$ and reached $0\,N$ at $t_1=2.4\,s$.

7. A $500\,kg$ rocket sled accelerates at a constant rate from rest to $1600\,kmh^{-1}$ in $1.8\,s$. What is the magnitude of the required net force?

8. A small ball was tossed vertically at a constant initial speed of $12\,ms^{-1}$. Calculate the maximum theoretical height that can be reached. Use the law of conservation of energy.

9. A rescue plane flies at a constant speed of $200\,kmh^{-1}$ and height of $0.5\,km$ over the sea level. A rescue bag is dropped to fall down directly to the point of a victim location. What is the final impact speed of the bag? Use the law of conservation of energy.

10. A block slides along a track from one level to a higher level after passing through an intermediate valley. The track is frictionless until the block reaches the higher level. Then a frictional force stops the block in a distance d . The initial speed of the block is $6\,ms^{-1}$, the height difference $1.1\,m$, and $\mu_k=0.60$. Find d .

11. A diesel engine with a pulling force of $40\,kN$ accelerates a train from rest on a straight-line railway at constant acceleration of $0.5\,ms^{-2}$. What is the total work done in $1\,min$?

12. A car of mass $1200\,kg$ moving at a constant speed of $100\,kmh^{-1}$ starts to brake with a constant deceleration. Due to this, the car stops at a distance of $80\,m$. Find the magnitude of the deceleration.

13. A drop hammer of mass $500\,kg$ was dropped from a height of $1\,m$. After it hits the formed material, the deceleration of the hammer takes $0.01\,s$. Calculate the average forming force acting during the material deformation.

14. A small cart of mass m moves without sliding down on an incline that leads into a cylindrical loop of radius r . From what height h must the cart go down to pass through the entire circular loop of the cylindrical surface? Neglect the moment of inertia and the rolling resistance of the wheels.