

1. Kinematics and Kinetics

- (a) What is the (general) $x(t)$ dependence for a linear motion with a constant acceleration?
- (b) Give the (general) $x(t)$ dependence for an uniform motion.
- (c) At what distance s will a mass point again touch the ground if it is shot from it with a velocity v_0 at an angle α from the horizontal?
- (d) What would be the maximum height h of the mass of the last question?
- (e) State and explain the content of Newton's laws.
- (f) Consider a mass point with mass m on an inclined plane (which has an angle α with respect to the horizontal). Write down the force (due to gravity) acting on the body.
- (g) What is the acceleration of the mass in the last question?
- (h) Consider two masses m_1, m_2 at the ends of a rope which lies over a pulley (Atwood's machine). Determine the acceleration of the system and the tension force.
- (i) How does the acceleration change if the mass m_1 is put on an inclined plane with angle α ?
- (j) What ratio of the masses is need so that they stay at rest (if again one is put on an inclined plane)?

2. Energy and Collisions

- (a) What is the time derivative of the energy of a closed system?
- (b) At what height h will a mass m stop on an inclined plane when it is moving towards it with velocity v ?
- (c) What would be the maximum compression of a spring with spring constant D on an inclined plane with angle α if a mass m is falling on it from a height h ?
- (d) Which conditions (i.e. two equations) have to be fulfilled for a total elastic collision of two particles?
- (e) Give in general the conditions (i.e. two equations) for a total inelastic collision of two particles.
- (f) What would be the final velocity v' of a mass m_1 after a total elastic collision with a mass m_2 ?

- (g) How fast would be the second mass in the last question if only the first mass moves with velocity v before the collision?

3. Rigid body and Oscillations

- (a) State the velocity v of a particle moving in a circle with radius r and period T .
- (b) What is the moment of inertia of a system composed of a ring with radius r , mass m_r and moment of inertia Θ_r surrounding a point mass m_p with respect to the position of the point mass (i.e. the center of the ring)?
- (c) How would it change if the system would be rotated around an axis parallel to the original one, but at the edge of the ring?
- (d) Where lies the center of mass of a system composed of an uniform rod of length ℓ with mass m_r and a point mass m at the end of the rod?
- (e) Using a conservation law, determine the angular velocity ω of a physical pendulum with moment of inertia Θ and mass m at the vertical position if its center of mass is released at a height h .
- (f) Write down the equation of motion for a harmonic oscillator in general and give the general solution.
- (g) Give the equations of motion for a simple pendulum and a physical pendulum. In both cases write down the solutions for small angles.
- (h) What is the reduced length of a physical pendulum with moment of inertia Θ , mass m and distance ℓ between the center of mass and the axis of rotation?