- 1. The ball hung on the weightless rod (or a thread) oscillates at 0.25 Hz frequency. Amplitude is 5 cm, the initial phase $\varphi_0 = 45^\circ$. Acceleration of gravity $g = 10 \text{ m/s}^2$.
- **a.** Calculate how much time will pass since the beginning of oscillation when the ball will be at the maximum distance from the equilibrium position?
- **b.** Draw the graph of oscillations.
- **c.** Calculate the length of the pendulum.
- **d.** The pendulum is in the wagon which moves up on the inclined plane which is inclined at an angle of 40°. Calculate the period of the pendulum.
- e. What is potential energy of the oscillating ball after 1.5 s from the beginning of oscillation?

weightless rod initial phase equilibrium position the pendulum inclined plane

- 2. Figure shows the p-T diagram of 3 moles of monatomic ideal gas. The initial gas temperature is 400 K. R = 8.31 J/(mol·K), N_A = $6 \cdot 10^{23}$ mol⁻¹.
- **a.** Draw a diagram on p-V axes.
- **b.** Draw a diagram on V-T axes.
- **c.** Calculate the change in internal energy of the gas.
- **d.** Calculate the work done by the gas.
- e. What quantity of heat was given to the gas?
- f. How many gas molecules are under these conditions?



monatomic

3. An electron moves in a magnetic field. Its trajectory is a spiral line, with a radius R = 1 cm and step h = 3 cm. Induction of magnetic field B = 1 mT.

 $q_e = -1.6 \cdot 10^{-19} \text{ C}, m_e = 9.1 \cdot 10^{-31} \text{ kg}.$



- **a.** Calculate the velocity v_x of the electron.
- **b.** Calculate the velocity v_y of the electron
- **c.** Calculate the total velocity v of the electron.

4. Two copper balls are at a distance of 20 cm from each other. Their mass is equal to 1 kg each.

 $k = \frac{1}{4\pi\varepsilon_0} = 9 \cdot 10^9 m/F$, $q_e = -1.6 \cdot 10^{-19}$ C, $m_e = 9.1 \cdot 10^{-31}$ kg, $N_A = 6 \cdot 10^{23}$ mol⁻¹, G = 6.67 \cdot 10^{-11} Nm²/kg².



- **a.** Calculate the electrostatic force between these balls, if only $1 \cdot 10^{-10}$ % part of electrons of the first ball was moved to the second ball.
- **b.** Calculate the potentials of the balls.
- c. What strength of the electric field is created by the first ball at its surface?
- **d.** What strength of the electric field will be in the center of the line which is between the balls and connects them? Draw the strengths of the fields and their resultant.
- e. How many times the electrostatic force of interaction between two balls is greater than the gravitational force between them?

copper

strength of the electric field