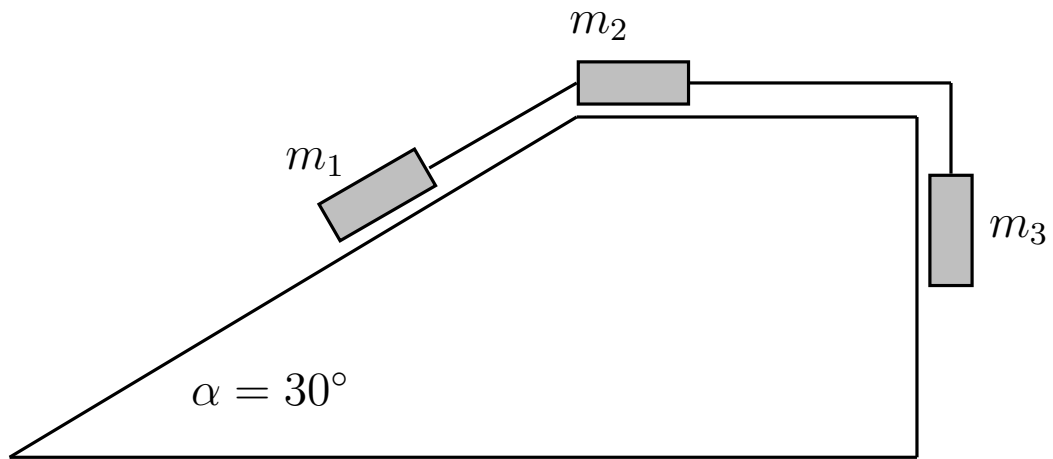


1. Exercise:

Three masses  $m_1 = m_3 = 1 \text{ kg}$  and  $m_2 = 10 m_1$  are arranged as shown in the figure below. They are all exposed to the gravitational force ( $g = 10 \frac{\text{m}}{\text{s}^2}$ ). The mass  $m_3$  is positioned at a height of  $h = 0.5 \text{ m}$ . Neglect friction!



- (a) Draw all elementary forces acting on the masses in the picture with straight arrows. Be careful to distinguish different tension forces.
- (b) Decompose the forces in the picture into forces where the bodies can move by drawing dashed arrows.
- (c) Specify a coordinate system  $x_1, x_2, x_3$  for each mass by drawing an arrow along the moving direction.
- (d) State the forces in which direction the body can move as formulas.

$F_{D,1} =$
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$F_{D,2} =$
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$F_{D,3} =$
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(e) Write down the equations of motion for each mass.

$$m_1 a_1 =$$

$$m_2 a_2 =$$

$$m_3 a_3 =$$

(f) How are the positions connected?

$$x_1 = \quad x_2 = \quad x_3$$

(g) Replace in the equations of motion the acceleration of the different masses by the common acceleration of the system.

$$m_1 a =$$

$$m_2 a =$$

$$m_3 a =$$

(h) Solve two of the equation of motions to get the tension forces.

$$F_{T,12} =$$

$$F_{T,23} =$$

(i) Put them into the last equation and determine the acceleration  $a$  of the system.

$$a =$$

(j) What motion performs the mass  $m_3$ ?

uniform motion

motion with constant acceleration

circular motion

- (k) How is the distance traveled of the mass  $m_3$  connected to the acceleration of the system? Specify all constants of the motion.

$$x_3(t) =$$

- (l) Find the time  $t$ , the mass  $m_3$  needs to hit the ground.

$$t =$$

- (m) Put the determined acceleration into the two equation of motions you solved for the tension forces in order to answer the question “What is the tension force in the two ropes?”

$$F_{T,12} =$$

$$F_{T,23} =$$

- (n) What ratio of  $m_1$  and  $m_3$  is needed, such that  $m_2$  stays at rest?

$$\frac{m_1}{m_3} =$$