Exercises in Introductory Physics I

Exercise Sheet 5
due to 20.11.23, 11:59 AM

Newton's Law

1. Consider a system of masses as shown in Figure 1. Note that the two ropes ($\overline{ABCM}$ and $\overline{Bm}$) are fixed at the point B. The mass $m = 20\,\text{kg}$.

   a) Find the mass M required to fulfil the two following conditions (1P):

      i) the rope tension T in the rope section AB should be twice of that in the section $\overline{BCM}$ and

      ii) the angle $\widehat{ABC}$ should be 90°.

   b) Find the force exerted by the pulley C on the upper block? (1P)

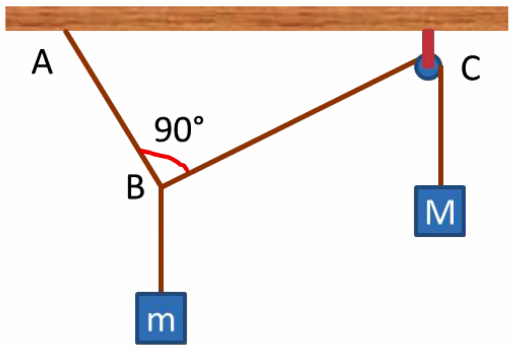

Figure 1: Masses on ropes

2. Three fixed masses are connected by cords that loop over frictionless pulleys (Figure 2). Mass 1 lies on a frictionless table. The masses are $m_1 = 7\,\text{kg}$, $m_2 = 5\,\text{kg}$ and $m_3 = 10\,\text{kg}$. What is the tension in the cord at the right, when the masses are released? (2P)

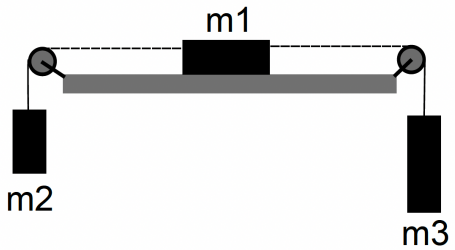

Figure 2: Pulleys

3. The kinetic friction coefficient between an object and a surface is 0.2. The surface is inclined under 45°. The object was given an initial velocity of $v_0 = 20\,\mathrm{m/s}$ (upwards along the surface).
   Find the height the object will attain. (1P)

4. A force F applied to an object in the horizontal direction can give rise to sliding motion. If a force is applied under a certain angle α to the horizontal direction (see Figure 3), sliding can only be achieved if $\alpha < \alpha_{cr}$.
   Find the critical angle α_{cr}. (1P)

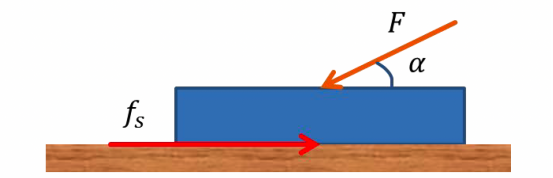

Figure 3: Sliding object

5. Two cords both having length l are connected to a metal rod A (Figure 4). The distance between the connection points is also l. On the other ends, both cords are fixed at a metal ball with mass m. The metal rod rotates with the angular frequency ω. Find (i) the tensions in the upper and lower cords and (ii) the angular frequency, such, that tension in the lower cord just becomes zero. (2P)

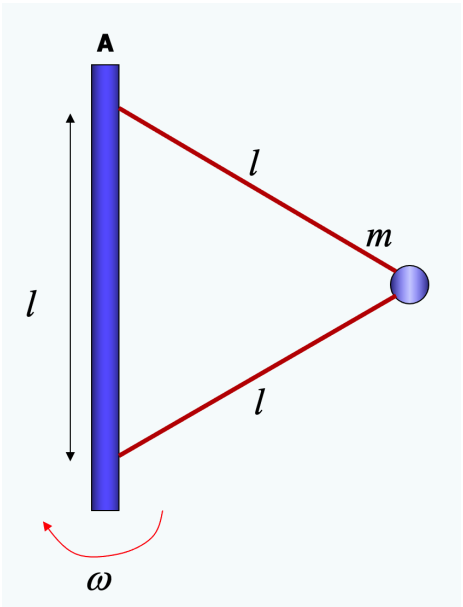

Figure 4: Rotating ball