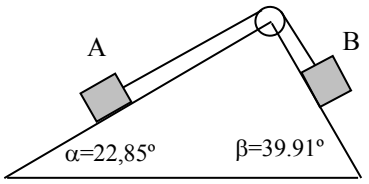
Universidad Rey Juan Carlos	**Physics** **Biomedical Engineering** **Course 2020 - 2021**	**Problem Sheet 3** **Particle Dynamics**

1. A body starts to move upwards on an inclined plane (ramp with angle α) with initial velocity v_0. If the friction coefficient is μ, determine the distance covered before stopping. What will be the speed of the body when it returns (if it does) to the base of the plane?

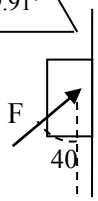
Ans: $s = \dfrac{v_0^2}{2(\mu\cos\alpha + sen\alpha)g}$; $v^2 = v_0^2 \dfrac{tg\alpha - \mu}{tg\alpha + \mu}$

2. A sled on the snow carrying two children is pulled by a rope forming an angle of 40º with respect horizontal. The mass of the two children (together) is 45 kg, and the mass of the sled is 5 kg. The static and kinetic friction coefficients are $\mu_s = 0{,}2$ and $\mu_k = 0{,}15$, respectively. Determine the friction force on the sled and the acceleration of the whole system when the tension of the rope is: a) 100 N, b) 140 N. **Ans**.: a) F_f = 76,6 N; at rest; b) F_f = 60,1 N; a = 0,94 m/s^2.

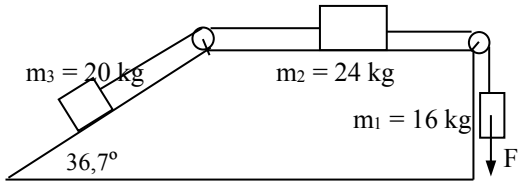
3. The bodies A and B have equal mass, m = 1 kg, and equal kinetic friction coefficient μ. They are tied together with a rope (negligible mass), and move from left to right at constant speed. Taking g = 9,84 m/s2. (a) Calculate the tension of the rope and the friction coefficient μ. (b) If we cut the rope, what is the acceleration of each body? (c) If A stops *after* 0,61 s we have cut the rope, what is the distance that B has covered during that time interval? **Ans**.: a) 5,2 N, μ = 0,15; b) –5,2 m/s^2 and 5,2 m/s^2; c) 2,9 m



4. The weight of the body of the figure is 88,9 N. The static friction coefficient between the body and the wall is 0,560. (a) What is the minimum force F required for keeping the body at rest? (b) What is the minimum force F required for moving it upwards? **Ans**.: a) 78,95 N;
b) 218,97 N



5. The two bodies in the figure are tied together with ropes and pulleys of negligible mass. The friction coefficient for bodies 2 and 3 is 0,2. The bodies were at rest, but once we pull body 1 with force F, the body 1 goes downwards with an acceleration a=1,5 m/s^2. a) Determine the value of F and tension T. b) If the force F only pulls for 1s, calculate the speed of the bodies 1,5 s once after the force is not pulling anymore. **Ans**: a) F = 90 N; $T_{1\text{-}2}$ = 266 N; $T_{2\text{-}3}$ = 1825 N; b) v = 0,5 m/s



6. A bucket containing water rotates in a vertical plane within a circle of Radius 1 m. Mass of water is 2 kg, mass of bucket is negligible. The speed of the bucket in the upper part of the circular trajectory is v_a. Determine the minimum value of v_a for avoiding the water to fall down. **Ans**: $v_{a\,min}$ = 3,130 *m/s*

7. A particle of mass *m* is suspended from a rope of length L, moving at constant speed *v,* following a horizontal circle of radius *r*. The rope forms an angle θ, with senθ = r/L. Calculate the tension of the rope and the particle speed. **Ans.**: T = mg/cosθ ; v^2 = g r tgθ

8. A section of a road has a superelevation that allows a car moving at 30 km/h turning around a curve with radius 400 m without sliding (friction is neglected). Determine the interval of speeds that allow driving without sliding when the static friction coefficient is 1. **Ans**: v_{min} = 0; v_{max} = 230 km/h

9. A mass *m* hangs from the roof of a car with a rope of length 30 cm. Determine the angle of the rope with the vertical, and the direction of displacement of the rope, when: a) the car moves straight forward with speed 110 km/h; b) turns around a curve 500 m radius, at 90 km/h; c) moves at 90 km/h straight forward,