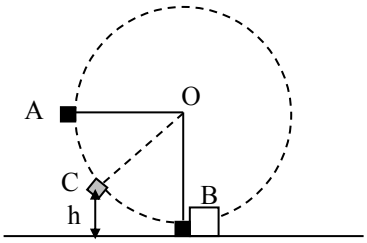
Universidad Rey Juan Carlos	**Physics** **Biomedical Engineering** **Course 2020 - 2021**	**Problem Sheet 5** **Dynamics of systems of particles**

1. Two bodies, masses 500 and 1000 kg, move at the same speed, 180 km/h. Determine their respective velocities after a frontal, inelastic collision **Ans**: 60 km/h

2. An artillery shell is fired forming an angle of 45º, initial speed 30 m/s. It explodes into two equal-mass fragments in the highest point of its trajectory. The first fragment continues in the direction of motion at velocity of 45 m/s. Determine what is the distance from firing point reached by the second fragment.
Ans: 40,35 m from firing point

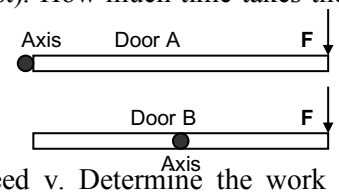
3. A body of mass *m* is on a horizontal plane at rest. Another body collides elastically with it at velocity *V* and it deviates an angle α. Calculate the velocities of both bodies after collision. **Ans**: $|\vec{v}_1| = V \cdot \cos\alpha$ with angle α; $|\vec{v}_2| = V \cdot sen\alpha$ with angle -(90º - α)

4. The simple pendulum of the figure has a mass m_1 = 20 kg, and it is tied to a rope of length 1,5 m. We leave this mass to fall down from position A. When it reaches position B, it collides elastically with other mass m_2 = 25 kg, initially at rest, no friction. Because of the collision, m_1 bounces back and reaches point C, at height *h*. Determine: a) Velocity of m_1 at point B before collision, and the tension of the rope at that precise instant. b) Velocities of m_1 and m_2 after collision. c) Kinetic energy Ek lost by m_1 during collision. d) Height h.
Ans: a) v = 5, 42 m/s; T = 588 N; b) v_1 = -0,60 m/s; v_2 = 4,82 m/s; c) ΔEk = -290,2 J; h = 18,5 mm.



5. Consider a pulley with mass 10 kg and radius 10 cm. Two masses, m_1 = 13 kg and m_2 = 7 kg, hang from an inextensible and weightless rope. Both masses at rest. Let g = 10 m/s^2 and the Moment of Inertia of the pulley ½ MR^2. Determine: a) Linear acceleration of the bodies and angular acceleration of the pulley; b) Kinetic energy of each body and the pulley after 2 secs. **Ans**.: a) 2,4 m/s^2, 24 rad/s^2; b) 149,76 J, 80,64 J, 9,22 J

6. The figure shows two identical doors seen from above.The same force F acts on the doors. The door A rotates around an axis located in its leftmost edge. The door B rotates around an axis located in its middle point. The door A rotates a given angle after 3 secs (initially at rest). How much time takes the door B to rotate the same angle? $I_A = (1/3)Ml^2$, $I_B = (1/12)Ml^2$. **Ans.:** 2,12 s



7. A cylinder (I = 1/2·m·R^2) rolls over a horizontal surface at speed v. Determine the work needed for stopping it **Ans.**: 3/4mv^2.

8. A solid sphere radius *R* and a solid cube are on top of a ramp, height *H*. The sphere rolls without slipping, the cube slides with no friction. The moment of inertia of the sphere is $I = 2/5 \cdot M \cdot R^2$.
a) Calculate the velocities of the bodies when reaching the zero-level height. b) Determine which body arrives the first to the base of the ramp.
Ans: v_{sphere} = *sqrt(10 g H/7); v_{cube}= sqrt(2gH)* b) The cube arrives the first.

9. A person (mass 91kg) jumps into a moving boat (mass 510 kg) with another person already on board (mass 75 kg). Initial speed of the boat is 11 m/s. What is the speed of the boat after the jump? **Ans**: 9,52 m/s