Universidad Rey Juan Carlos	**Physics** **Biomedical Engineering** **Course 2020 - 2021**	**Problem Sheet 4** **Energy and Work**

1. A body of mass 5 kg, at rest, is raised up to a height of 2,5 m, by means of a vertical force of 60N. Determine: a) Work done by the force; b) Work done by the weight; c) Final kinetic energy of the body. **Ans**.: a) 150 J; b) –122,5 J; c) 27,5 J.

2. A block on the ground of mass 100 kg is pulled using a rope, forming an angle 53º with respect to the horizontal. The Tension of the rope is 540 N and the kinetic friction coefficient between the block and the ground is 0,5. If the block displacement is 2 m, calculate: a) Work done by Tension; b) Work done by friction force; c) Kinetic energy variation. **Ans.**: a) 648 J; b) –548 J; c) 100 J

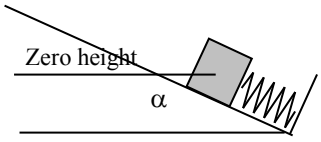
3. A body of mass 3 kg is pushed upwards from the base of an inclined plane of slope 37º respect to the horizontal. With an initial velocity of 12 m/s, the body reaches a height of H mtrs. Then, it returns to the initial position at the base of the plane. The kinetic friction coefficient is 0,25 and g = 10 m/s^2. Determine a) Height H; b) Velocity in the final position; c) Work done by the weight and by the friction force, along the whole trajectory. **Ans.**: a) 5,4 m; b) 8,5 m/s; c) $W_{peso} = 0$; $W_{Fr} = -108$ J

4. A body of mass *m* is left to fall from a point at height H in a ramp of slope α. Which is the velocity *v* of the body when it reaches the base of the plane, neglecting friction? If the body arrives to the base with velocity v' = v/2, What is the work done by the friction force? What is the value of the friction coefficient? **Ans.**: $\sqrt{2gH}$; –3mgH/4; 3 tg α/4

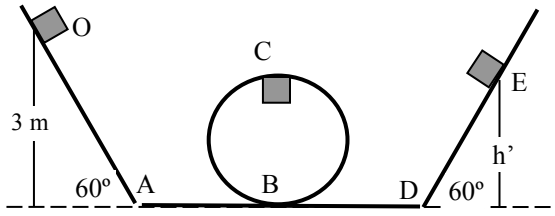
5. A body of mass 1 kg in a horizontal plane is pushed by a spring of elastic constant k = 4000 N/m; When the spring is compressed 5 cm, and then released, the body covers a distance of 1,25 m. How much is the friction coefficient body-ground? **Ans.**: 0,4

6. Two inclined planes (ramps) have the same maximum height, but different slope angle. We want to raise a mass M from the ground level up to H at constant speed. a) Determine which ramp will require more force and which will require more work (neglecting friction). b) Determine which ramp will require more work if both have the same kinetic friction coefficient. **Ans.:** Si α > β a) F(α) > F(β); W(α) = W(β); b) W(α) < W(β).

7. When the compressed spring of the figure (k = 2400 N/m, compressed 8 cm) is released, it launches a mass of 2 kg that slides on a ramp (α = 30º and μ = 0,2). When the spring recovers its normal length, the body detaches from it and continues climbing the ramp. If the 0 mtrs height level is taken with the initial position of the body, a) What is the speed of the body when it detaches from the spring? b) Which is the height reached by the body? **Ans.**: a) 2,6 m/s; b) 0,29 m



8. The figure shows two ramps (each one slope 60º, no friction), two horizontal planes (AB = BD = 1 m, with kinetic friction coefficient μ = 0.1), and a vertical circle (R = 1 m, no friction). A body of mass m = 300 g is left without initial speed in point O, and it covers trajectory OABCDE. When point O is at height of 3 m, calculate the speed of the particle in A, B, C and D. What is the reaction at B and C? What is the height the body reaches in ramp DE?



Ans.: $v_A = 7{,}67$ m/s; $v_B = 7{,}54$ m/s; $v_C = 4{,}20$ m/s; $v_D = 7{,}41$ m/s; $\vec{N}_B = +20{,}0 \cdot \vec{j}$ N; $\vec{N}_C = -2{,}35 \cdot \vec{j}$ N; h' = 2,8 m

9. A bar of soap mass *m* slides on a semi-sphere radius *R*. The bar starts at rest from a point O located at the edge of the semi-sphere (horizontal edge). Once the bar reaches the bottom of the semi-sphere, it continues the motion, climbing up to the opposite side of the semi-sphere, until it reaches a point P that forms an angle α with respect the horizontal. Then, it falls down again. Determine the work done by the friction force during the motion between O and P. Calculate the friction force during that trajectory. **Ans.**: $W_{roz} = -mgR\,sen\alpha \quad F_{r\,med} = mg\,sen\alpha / (\pi - \alpha)$