Universidad Rey Juan Carlos	**Physics** **Biomedical Engineering** **Course 2020 - 2021**	**Problem Sheet 6** **Waves and Oscillations**

1. Determine the period of oscillation of a mass (m = 250 g) linked to two elastic springs, k_1 = 30 N/m and k_2 = 20 N/m. Neglect friction.
Ans: $\pi/5\sqrt{2}$ s

2. When we hang a mass m = 1 kg from a vertical spring, this spring stretches 0,42 m until it reaches its equilibrium position. Now, we stretch the spring 0,10 m below this equilibrium point. Finally, we release the mass, leaving it oscillating freely. Neglect friction. a) Calculate the period of oscillation. b) Determine the equation of motion for the mass. **Ans**: a) 1,30 s; b) y (t) = –0,1 cos(4,8 t) m

3. A mass 20 kg moves along X axis following a Simple Harmonic Motion. At t = 0, this mass is located at 4 m from origin (x = 0), and it has a velocity of 15 m/s, and an acceleration of 100 m/s^2, both vectors pointing to the origin. Determine: a) Period of oscillation. b) Equation for position at any time. c) Force acting on the mass at t = π/10 s. **Ans**: a) T = 1,26 s; b) x(t) = 5,0·cos(5t + 0,64); c) F = 1500 N.

4. A body linked to a spring follows a Simple Harmonic Motion (horizontally), with an amplitude of 6 cm. When the mass is at a distance 4 cm from equilibrium position, determine which fraction of the total energy is kinetic energy. **Ans**.: 5/9

5. A mass m_1, 0,5 kg, is on a horizontal plane, linked to a spring of elastic coefficient k = 600 N/m. It is at rest, and no friction is present. Another mass m_2, 0,5 kg, collides elastically with m_1. As a consequence, the system spring-mass oscillates following a Simple Harmonic Motion of amplitude 0,25 m. Which was the speed of the mass m_2 right before the collision? **Ans**: 8,7 m/s.

6. The equation of a transverse harmonic wave propagating in a rope is $y(x, t) = 0{,}45\cdot\sin(3t - 2x)$, in S.I. units. Calculate: a) The propagation speed, wavelength and period of the wave. b) The speed of oscillation of a point P located in x = 6 m at t = 3 s and t = 6 s.
Ans: a) 1,5 m/s, 3,1 m, 2,1 s; b) v(t=3) = 0, because at t=3 s the wave has not reached P yet; v(t=6) = 1,30 m/s

7. A harmonic wave propagates from left to right with a speed of 200 m/s. The amplitude is 4 m and the wavelength is 20 m. Which is the wave equation? **Ans**: $y(x, t) = 4\cdot\sin(20\pi t - 0{,}1\pi x + \varphi)$ m