Universidad Rey Juan Carlos	**Physics** **Biomedical Engineering** **Course 2020 - 2021**	**Problem Sheet 7** **Fluid statics / dynamics**

1. The blood flows through the aorta artery (radius 1,0 cm) at a speed of 30 cm/s. Which is the volumetric flow rate? **Ans**: Q = 9,42 10^{-5} m^3s^{-1}
2. The blood flows at a speed of 10 cm/s in healthy artery with a radius of 0,3 cm. It reaches a portion of the artery with a radius of 0,2 cm later on (arteriosclerosis, which leads to the thickening and loss of elasticity of the walls of arteries). Determine the speed of the blood in the thick artery. **Ans**: v = 22,5 cm s^{-1}.
3. The blood flows from the aorta to the main arteries. Then, it flows into the arterioles, and eventually into the capillaries, where oxygen transfer occurs. Finally, it flows again through the venules and veins reaching the right atrium of the heart. The descend of pressure can be approximated to be a descend from 100 torr (1 torr = 133,3 nPa) to 0 torr. Estimate the total resistance of the circulatory system if the volumetric flow rate is 0,8 L / s. **Ans**.: 1,66 10^7 Pa s/m^3
4. Estimate the Reynolds number for the blood when it flows at 30 cm/s through the aorta artery (radius 1,0 cm). The viscosity of the blood can be set to 4 mPa sec (thus that is dynamic viscosity), and its density 1060 kg/m^3. **Ans.**: Re=1590.
5. A body weights 100 N in the air and 75 N when submerged in water. Determine its volume and density if the water density is 1 g/cm^3. **Ans.**: V = 2,5 10^{-3} m^3; ρ_{body} = 4000 Kg/m^3.
6. When an iceberg floats in the sea water, the 90% of its mass lies below the water surface. Determine the density of the sea water if the density of the ice is ρ_{ice} = 917 kg/m^3. **Ans.**: ρ_{body} = 1018 Kg / m^3.
7. A water reservoir has a cylindrical shape, radius 1 m. The water level is at height H = 5 m. A hole radius 2 cm is found at height h, and the water flows out from it parallel to the ground. Determine: a) Speed of the water when flowing out through the hole. b) The value of h for the water flowing out to have a maximum range c) Time required for emptying half of the reservoir if the hole is found at the bottom. Take *g* as 10 ms^{-2}. **Ans.**: v = sqrt[20(H-h)]; h_{max_range} = H/2; Time = ½ $(R/r)^2$ $H^{1/2}$ 1/ sqrt(20).