Fluids - 1

You are asked to design a water pump that will power a water-jet-pack (pictured). The pump sends pressurized (fresh) water through a feeding tube of constant inner diameter $D = 0.25$ m. The feeding tube connects to the jet pack, which ejects the water through 4 exit nozzles into the open atmosphere. The inner diameter of all 4 exit nozzles is $D = 0.1$ m and the water is always ejected normal to each nozzle's cross-sectional area. When the user is hovering in the air (pictured), the two exit nozzles connected to the legs point directly downward, while the two exit nozzles at the arms point at an angle of 30° with respect to the vertical feeding tube.

(a) If it is desired for the jet-pack to eject water at a uniform speed of 3 m/s out of all 4 nozzles at the same time, at what uniform speed does the jet-ski need to be able to pump water up the feeding tube? Assume steady, incompressible, plug-like flow. **(20 points)**

(b) The person operating the jet-pack has a mass of 90 kg, the jet pack itself has a total mass of 25 kg, and the mass of the vertically-oriented feeding tube is dominated by the water inside (the solid tubing itself is negligibly light). If it is desired for a person to be able to hover at a maximum height of 25 m above the water level, at what gage pressure does the jet-ski need to be able to pump water into the feeding tube? **(70 points)**

(c) Assume the water steadily supplied into the pump has a gage pressure of zero and the same inner diameter of $D = 0.25$ m. Also assume the inlet and outlet of the pump are at the same elevation (i.e. the free surface of the lake). If the pump has an efficiency of 75%, what is the pump's required power supply? **(10 points)**