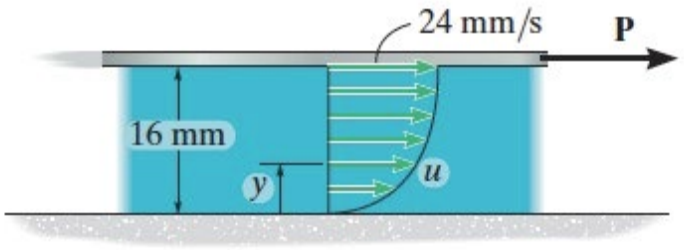
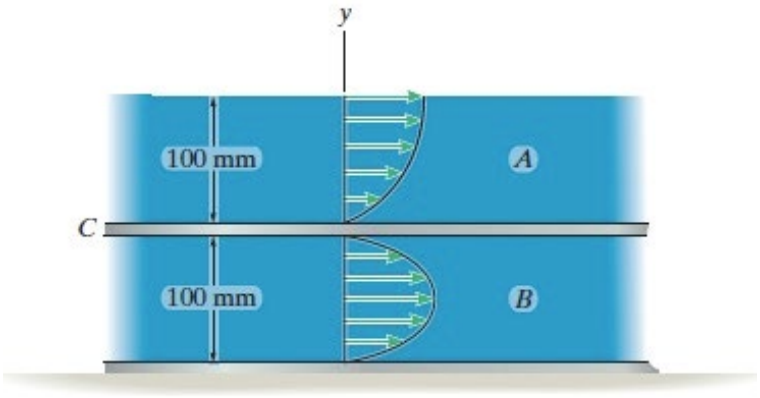
Homework 1

Questions No.	1	2	3	4	Total
Score	20%	30%	30%	20%	100%

Q1.1 When the force **P** is applied to the plate, the velocity profile for a Newtonian fluid that is confined under the plate is approximated by $u = (12y^{1/4})mm/s$, where y is in mm. Determine the minimum shear stress within the fluid. Take $\mu = 0.5 \times 10^{-3} N \cdot s/m^2$.

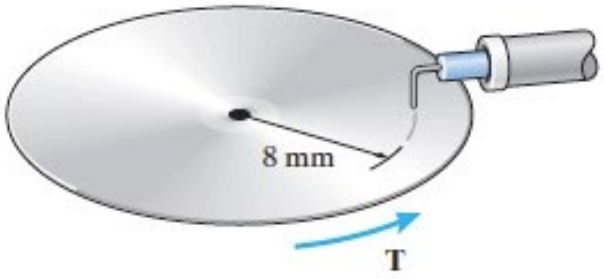


Q1.2 Water at *A* has a temperature of 15°C and flows along the top surface of the plate *C*. The velocity profile is approximated as $u_A = 10sin(2.5\pi y)m/s$, where y is in meters. Below the plate the water at *B* has a temperature of 60°C and a velocity profile of $u_B = 4 \times 10^3(0.1y - y^2)$, where y is in meters. The coordinate origin of the velocity profile was on C plate. Determine the resultant force per unit length of plate C the flow exerts due to viscous friction. The plate is 3m wide. ($T = 15°C$, $\mu = 1.15 \times 10^{-3} N \cdot s/m^2$. $T = 60°C$, $\mu = 0.470 \times 10^{-3} N \cdot s/m^2$.)



Q1.3 The read-write head for a hand-held music player has a surface area of $0.44\,mm^2$. The head is held $0.04\,\mu m$ above the disk, which is rotating at a constant rate of $1800\,rpm$. Determine the torque **T** that must be applied to the disk to overcome the frictional shear resistance of the air between the head and the disk. The surrounding air is at standard atmospheric pressure at a temperature of 20 °C. Assume the velocity profile is linear.

(For air at $T = 20$ °C and standard atmospheric pressure, $\mu = 18.1 \times 10^{-6}\,N \cdot s/m^2$.)



Q1.4 Many camera phones now use liquid lenses as a means of providing a quick auto-focus. These lenses work by electrically controlling the internal pressure within a liquid droplet, thereby affecting the angle of the meniscus of the droplet, and so creating a variable focal length. To analyze this effect, consider a segment of a spherical droplet that has a basic diameter of $3\,mm$. The pressure in the droplet is controlled through a tiny hole under $105\,Pa$. If the tangent at the surface is 30 °, determine the surface tension at the surface that holds it in place.