Mass Flux Through a Pipe

Calculate the mass flux of a laminar fluid of density ρ, viscosity ν and constant pressure gradient G passing through a cross section of a pipe of radius R. Choosing z as the symmetry axis for the pipe, the velocity of the fluid is given by

$$\boldsymbol{u}(\boldsymbol{r}) = u_{\mathrm{m}} \left(1 - \left(\frac{r}{R}\right)^2\right) \boldsymbol{k},$$

where r is the radial coordinate in the cross section and

$$u_{\mathrm{m}} = \frac{GR^2}{4\nu\rho}$$

is the maximum velocity of the fluid in the center of the pipe.