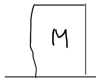
①

1-14-70

$M = 80\ kg$



$\rho = 955\ kg/m^3$

a) Find V

$$M = V\rho \rightarrow V = \frac{M}{\rho} = \frac{80\,kg}{955\ kg/m^3} \approx 0{,}0838\ m^3$$

b) Find F_B due to air

$\rho_{air} = 1{,}29\ kg/m^3$ the weight of the air the man displaces is $gV\rho_{air}$

$$\rightarrow F_B = W_{air} = gV\rho_{air} = 9{,}81\ m/s^2 \cdot 0{,}0838\ m^3 \cdot 1{,}29\ \frac{kg}{m^3}$$
$$= 1{,}06\ N$$

c) $$\frac{F_B}{W_M} = \frac{gV\rho_{air}}{gM} = \frac{gV\rho_{air}}{gV\rho} = \frac{\rho_{air}}{\rho} = \frac{1{,}29}{955} = 1{,}35 \cdot 10^{-3}$$

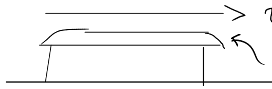
②

1-14-86

wind blows over a house with roof area $A = 220\ m^2$, with speed $v = 45\ m/s$

$P_0 = 8{,}89 \cdot 10^4\ N/m^2$

we use Bernoullis equation and compare to wind still



$v = 45\ m/s$

$A = 220\ m^2$

$+0$

$$P + \frac{1}{2}\rho v^2 = \text{Const.} \rightarrow P_0 = P + \frac{1}{2}\rho v^2$$

where p is the pressure on the roof during the wind is blowing

$$\rightarrow P = P_0 - \frac{1}{2}\rho v^2$$
$$= 8{,}89 \cdot 10^4\ \frac{N}{m^2} - \frac{1}{2}\, 1{,}14\ \frac{kg}{m^3} \cdot \left(45\ m/s\right)^2 = 8{,}775 \cdot 10^4\ \frac{N}{m^2}$$

Like an upward force on the roof

$$F = (P_0 - P) \cdot A = \frac{\rho v^2}{2} A = 254\ kN$$

③

1-14-96

Laminar flow through a pipe with fixed cross section, use Eq. (14.19)

$$Q = \frac{(P_2 - P_1)\pi r^4}{8\eta l}$$

Q is the flow rate. we have to find a) how much the flow decreases if the pipe is made narrower $\frac{\Delta r}{r} = -0{,}0500$ and b) how much it is increased if $\frac{\Delta r}{r} = +0{,}0500$

If the variation of the radius r is very small, we could have used a linear approximation built on the derivative

$$\Delta Q = \frac{(P_1 - P_2)}{8\eta l} 4\pi r^3 \Delta r = \frac{(P_1 - P_2)}{8\eta l}\pi r^4 \left(\frac{4\Delta r}{r}\right)$$
$$= Q\left(\frac{4\Delta r}{r}\right)$$

but the variation is not small here, and the authors of the book want a better estimate

④

$$\Delta Q = \frac{(P_1 - P_2)}{8\eta l}\pi (r + \Delta r)^4 = \frac{(P_1 - P_2)}{8\eta l}\pi r^4 \left\{1 + \frac{\Delta r}{r}\right\}^4$$
$$= Q\left\{1 + \frac{\Delta r}{r}\right\}^4$$

$$\rightarrow \frac{\Delta Q}{Q} = \left\{1 + \frac{\Delta r}{r}\right\}^4$$

if $\frac{\Delta r}{r} = -0{,}0500 \rightarrow \frac{\Delta Q}{Q} = 0{,}815$

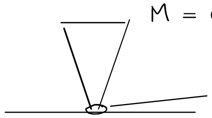
$\sim$ 19% decrease

and if $\frac{\Delta r}{r} = +0{,}0500 \rightarrow \frac{\Delta Q}{Q} = 1{,}216$

$\sim$ 22% increase

Beyond a linear approximation, the results are not symmetric!

1-14-104



$M = 0{,}001$ kg

$r = 0{,}200$ mm $= 0{,}0002$ m

$$P = \frac{gM}{\pi r^2} = \frac{9{,}81\ \text{m/s}^2\ \ 0{,}001\ \text{kg}}{\pi\,(0{,}0002)^2\ \text{m}^2} = 7{,}8 \cdot 10^4\ \frac{\text{N}}{\text{m}^2}$$

$$= 7{,}8 \cdot 10^4\ \text{Pa}$$

which is a huge pressure only applied to a small area probably causing wear and tear. It is probably not fair to compare it to the standard air pressure at sea level $1.013 \cdot 10^5$ Pa

that is homogeneous to the surface of the record, and does not scratch it like the needle