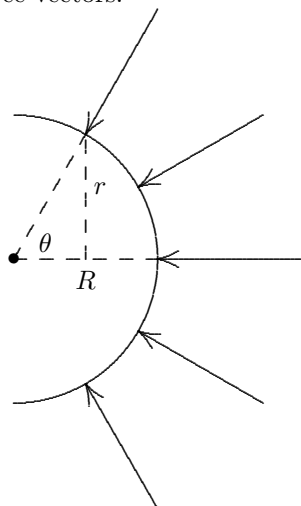


7. (a) The pressure difference results in forces applied as shown in the figure. We consider a team of horses pulling to the right. To pull the sphere apart, the team must exert a force at least as great as the horizontal component of the total force determined by “summing” (actually, integrating) these force vectors.



We consider a force vector at angle θ . Its leftward component is $\Delta p \cos \theta dA$, where dA is the area element for where the force is applied. We make use of the symmetry of the problem and let dA be that of a ring of constant θ on the surface. The radius of the ring is $r = R \sin \theta$, where R is the radius of the sphere. If the angular width of the ring is $d\theta$, in radians, then its width is $R d\theta$ and its area is $dA = 2\pi R^2 \sin \theta d\theta$. Thus the net horizontal component of the force of the air is given by

$$\begin{aligned} F_h &= 2\pi R^2 \Delta p \int_0^{\pi/2} \sin \theta \cos \theta d\theta \\ &= \pi R^2 \Delta p \sin^2 \theta \Big|_0^{\pi/2} = \pi R^2 \Delta p . \end{aligned}$$

- (b) We use $1 \text{ atm} = 1.01 \times 10^5 \text{ Pa}$ to show that $\Delta p = 0.90 \text{ atm} = 9.09 \times 10^4 \text{ Pa}$. The sphere radius is $R = 0.30 \text{ m}$, so $F_h = \pi(0.30 \text{ m})^2(9.09 \times 10^4 \text{ Pa}) = 2.6 \times 10^4 \text{ N}$.
- (c) One team of horses could be used if one half of the sphere is attached to a sturdy wall. The force of the wall on the sphere would balance the force of the horses.