

VISCOSITY

Similar to frictional forces between dry surfaces, the viscous force is a retarding force on an object when it tries to move through a fluid.

Viscosity arises when an object moving through a fluid, sets the fluid into motion. Newton's third law implies that the fluid must exert a reaction force on the object.

$$\vec{F}_{vis} = -C \vec{v}$$

proportional to the velocity of the object

opposite in direction to the velocity of object.

depends on the type of fluid and the geometry of the object

$$\vec{F}_{vis} = m \vec{a} = m \frac{d\vec{v}}{dt}$$

Assume this is the net force

$$\Rightarrow \boxed{m \frac{d\vec{v}}{dt} + C \vec{v} = 0}$$

Choose axis along direction of velocity \vec{v}

Assume object has velocity v_0 at $t=0$

What is the velocity $v(t)$?

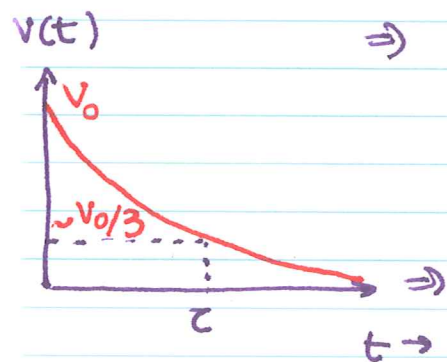
$$\frac{dv}{dt} + \frac{c}{m} v = 0.$$

$$\Rightarrow \frac{dv}{v} = - \frac{c}{m} dt$$

$$\Rightarrow \int_{v_0}^v \frac{dv}{v} = - \int_0^t \frac{c}{m} dt$$

$$\Rightarrow \ln\left(\frac{v}{v_0}\right) = - \frac{c}{m} t$$

$$\Rightarrow \frac{v}{v_0} = e^{-\frac{c}{m} t}$$



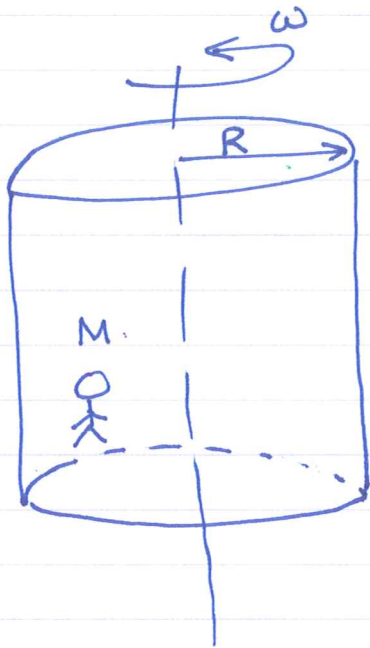
$$v(t) = v_0 e^{-ct/m}$$

characteristic time $\tau = m/c$

$$v(\tau) = v_0 e^{-1} = \frac{v_0}{e} \approx 0.37 v_0$$

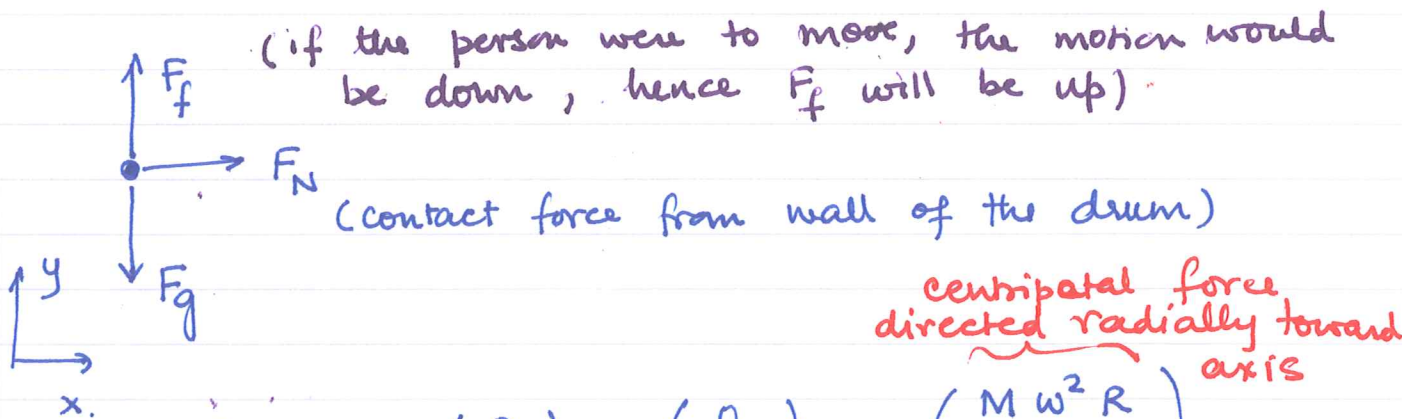
Spinning Terror

K&K



A large vertical drum spins so fast that everyone stays pinned against the wall — even when the floor drops away!

What is the minimum angular velocity ω which allows the floor to be dropped away safely?



$$\begin{pmatrix} F_N \\ 0 \end{pmatrix} + \begin{pmatrix} 0 \\ F_f \end{pmatrix} + \begin{pmatrix} 0 \\ -F_g \end{pmatrix} = \begin{pmatrix} M\omega^2 R \\ 0 \end{pmatrix}$$

$$\Rightarrow F_N = M\omega^2 R$$

$$F_f = F_g = Mg$$

$$\text{But } F_f \leq \mu_s F_N$$

$$\Rightarrow Mg \leq \mu_s F_N$$

$$Mg \leq \mu_s M \omega^2 R$$

$$\Rightarrow \omega^2 \geq \frac{g}{\mu_s R}$$

$$\Rightarrow \omega_{\min} = \sqrt{\frac{g}{\mu_s R}}$$

Minimum velocity of drum that ensures the person will not go through the floor :C

Check the numbers at COSI

Use wikipedia to get μ_s for cloth on the material the drum is made of.