Lec25

Wednesday, November 18, 2020 7:53 AM

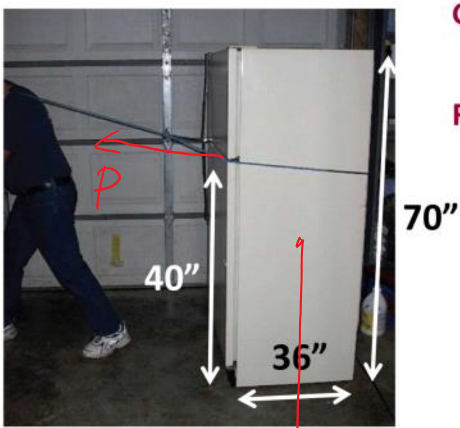
Lecture Objectives

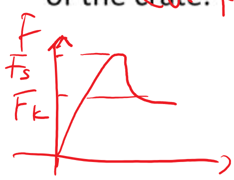
Friction

1

Given: Fridge weight = 250 lb and $\mu_s = 0.4$

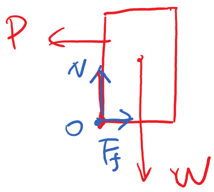
Find: The maximum horizontal force P that can be applied at without causing movement of the ~~crate~~. fridge





$\downarrow 250\ lb$

$$P = F_s = \mu_s \cdot W = 0.4 \times 250 = \boxed{100\ lb}$$

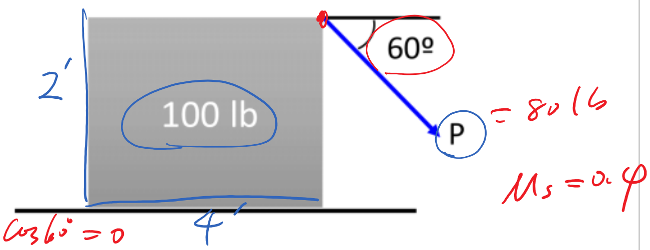


$$\Sigma M_o = P \cdot 40'' - W \cdot 18'' = 0$$

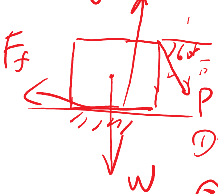
$$P = \frac{18'' \cdot 250}{40} = \frac{9 \times 25}{2} = 112.5\ lb$$

A 4'x2' 100 lb box with a wide base is pulled by a force P = 80 lb and μ_s = 0.4. Will the block remain stationary?

Yes



Sliding:



① $-\Sigma F_x = F_f - P\cdot\cos 60^\circ = 0$

② $\Sigma F_y = N - P\cdot\sin 60^\circ - W = 0$

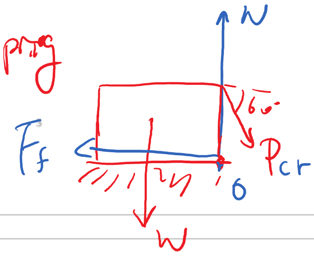
$N = 80\cdot\frac{\sqrt{3}}{2} + 100$ lb

$F_f = 80\cdot\frac{1}{2} = 40$ lb.

$F_s = \mu_s N = 0.4(40\sqrt{3}+100) = 67.7$ lb

$F_f < F_s$. no sliding

Tipping



$\Sigma M_o = W\cdot 2 - P_{cr}\cdot\frac{1}{2}\cdot 2 = 0$

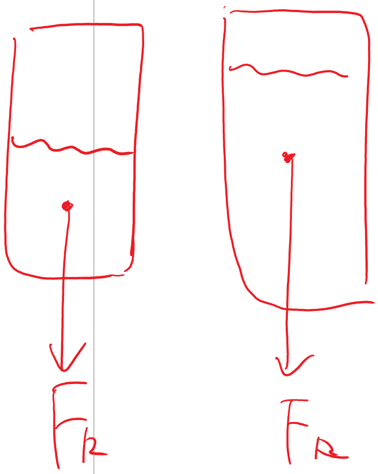
$P_{cr} = 200$ lb $> P = 80$ lb

no tipping

Center of gravity

To design the structure for supporting a water tank, we will need to know the weight of the tank and water as well as the locations where the resultant forces representing these distributed loads act.

How can we determine these resultant weights and their lines of action?



$F_R = W_w + W_t$

Center of gravity

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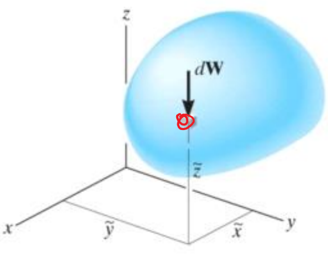
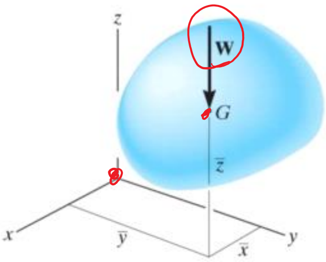
Center of gravity





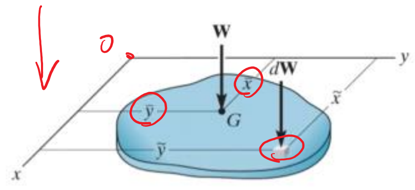
A body is composed of an infinite number of particles, and so if the body is located within a gravitational field, then each of these particles will have a weight dW.

$w = \int dw$

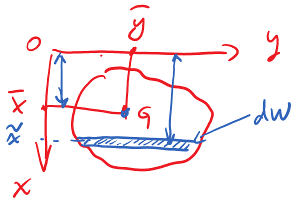
The **center of gravity (CG)** is a point, often shown as G, which locates the resultant weight of a system of particles or a solid body.

From the definition of a resultant force, the sum of moments due to individual particle weight about any point is the same as the moment due to the resultant weight located at G.

Center of gravity

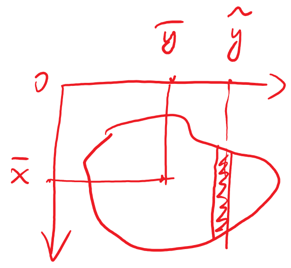


$$W = \int dW$$



$$W \cdot \bar{x} = \int \tilde{x}\, dW$$

$$\bar{x} = \frac{\int \tilde{x}\, dW}{\int dW}$$



$$\bar{y} = \frac{\int \hat{y}\, dW}{\int dW}$$

Center of Mass	Center of Volume	Center of Area
$\bar{x} = \dfrac{\int \tilde{x}\, dm}{\int dm}$	$\bar{x} = \dfrac{\int \tilde{x}\, dV}{\int dV}$	$\bar{x} = \dfrac{\int \tilde{x}\, dA}{\int dA}$
$\bar{y} = \dfrac{\int \tilde{y}\, dm}{\int dm}$	$\bar{y} = \dfrac{\int \tilde{y}\, dV}{\int dV}$	$\bar{y} = \dfrac{\int \tilde{y}\, dA}{\int dA}$
$\bar{z} = \dfrac{\int \tilde{z}\, dm}{\int dm}$	$\bar{z} = \dfrac{\int \tilde{z}\, dV}{\int dV}$	$\bar{z} = \dfrac{\int \tilde{z}\, dA}{\int dA}$

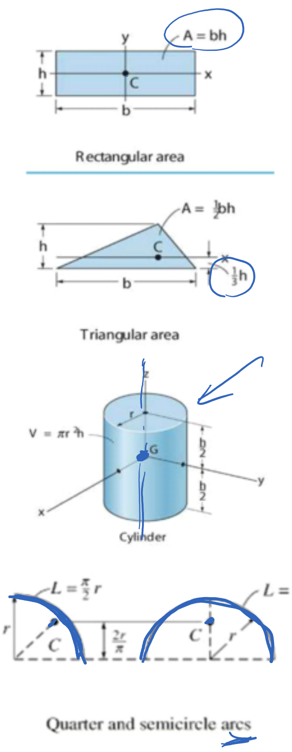
Centroid

The centroid, C, is a point defining the geometric center of an object.

The centroid coincides with the center of mass or the center of gravity only if the material of the body is homogeneous (density or specific weight is constant throughout the body).

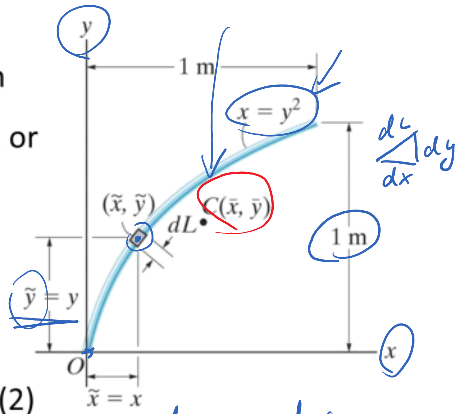
If an object has an axis of symmetry, then the centroid of object lies on that axis.

In some cases, the centroid may not be located on the object.



Centroid – Analysis Procedure

1. Select an appropriate coordinate system
2. Define the appropriate element (dL, dA, or dV)
3. Express (2) in terms of the coordinate system
4. Identify any symmetry
5. Express the moment arms (centroid) of (2)
6. Substitute (3) and (4) into the integral and solve



$y = \sqrt{x}$

$dy = \frac{dx}{2\sqrt{x}}$

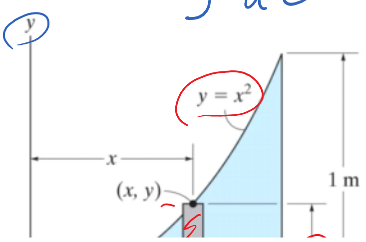
$dL = d f(x, y)$

$dx = 2y\,dy$

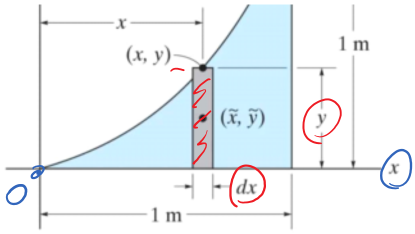
$dL = \sqrt{dx^2 + dy^2} = \sqrt{(1+4y^2)dy^2} = \sqrt{1+4y^2}\,dy$

$$\bar{y} = \frac{\int \tilde{y}\,dL}{\int dL} = \frac{\int_0^1 y\sqrt{1+4y^2}\,dy}{\int_0^1 \sqrt{1+4y^2}\,dy}$$

$$\bar{x} = \frac{\int \tilde{x}\,dL}{\int dL} =$$



Locate the centroid of the area.



$$dA = y\,dx = x^2 \cdot dx$$

$$\bar{x} = \frac{\int_0^1 x\, x^2\,dx}{\int_0^1 x^2\,dx} = \frac{\frac{1}{4}x^4\big|_0^1}{\frac{1}{3}x^3\big|_0^1} = \frac{3}{4}\ m$$