

Center of Gravity



National Science Foundation
WHERE DISCOVERIES BEGIN

Creating “Weight”

One of the main challenges faced by animators is giving props and characters a sense of “weight.”

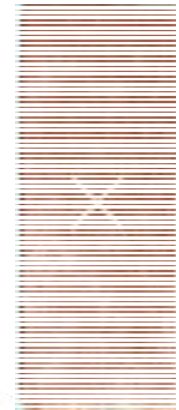
Understanding balance and weight shift is essential for creating believable poses and movement.



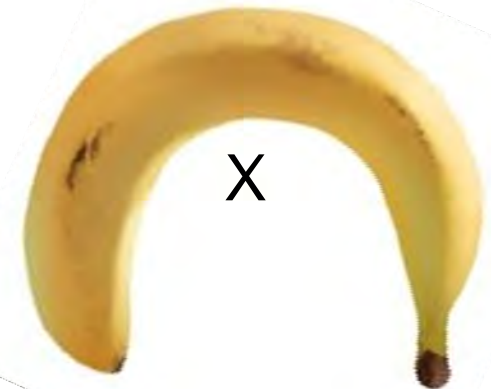
Center of Gravity

Center of gravity (CG) is the average position of an object's weight distribution.

For simple, uniform objects the center of gravity is located at the geometric center.



The center of gravity can be located outside of an object.



Center of Gravity vs. Center of Mass

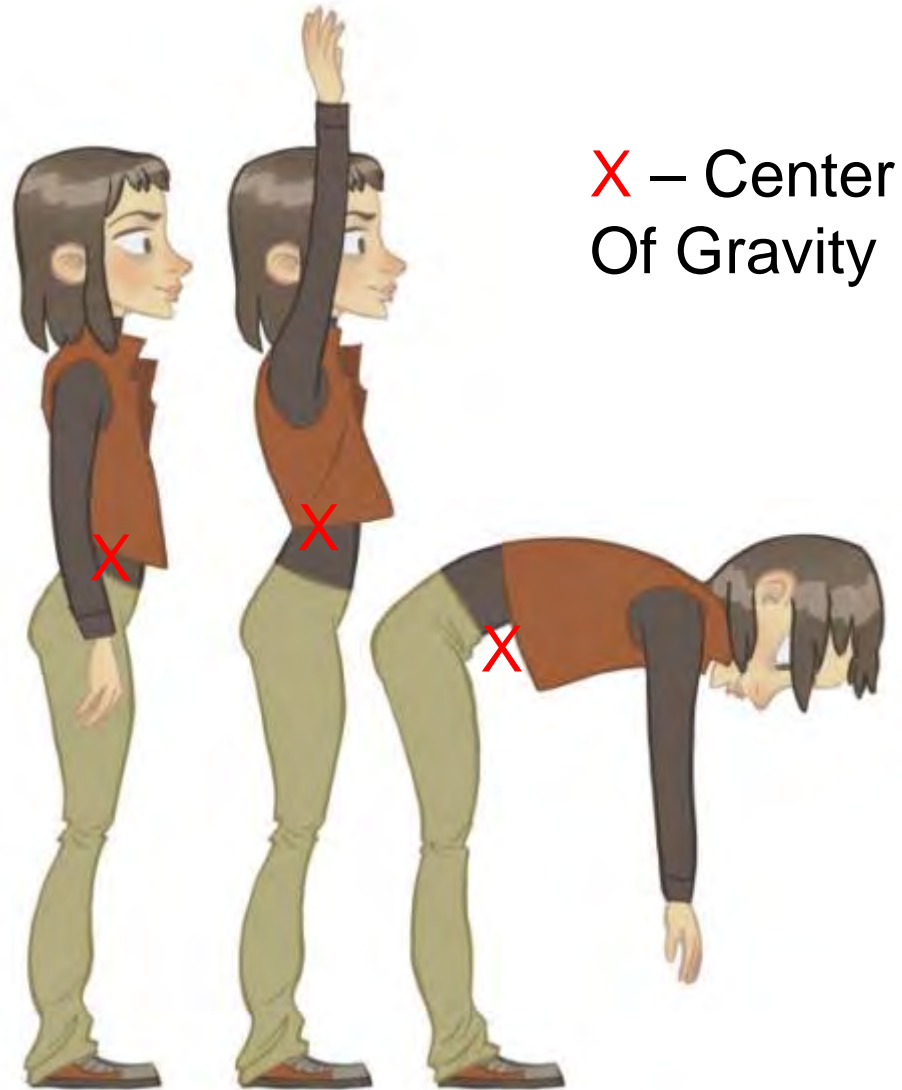
Unless you're talking about objects the size of planets and moons there's virtually no difference between the center of gravity and the center of mass.



Human Center of Gravity

Standing upright, your CG is roughly in the center of your body (at about 55% of your height).

Location of your CG will shift when you bend your torso, move your arms and legs, etc.



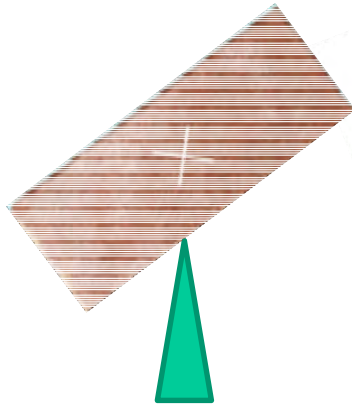
Balance & Center of Gravity

An object will balance if pivoted exactly above or below its center of gravity.

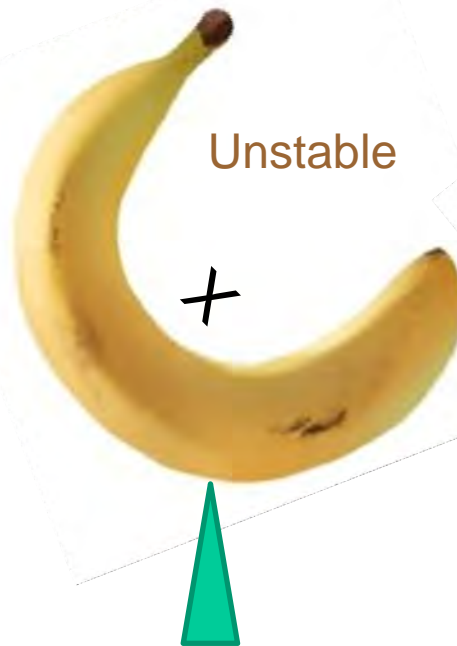
Unstable



Unstable



Unstable



Stable



Balance on a pivot is stable if CG is below the pivot.

Balanced Bird

These toy birds
can stably balance
on their beaks.



Balanced Bird

Where is the bird's center of gravity?



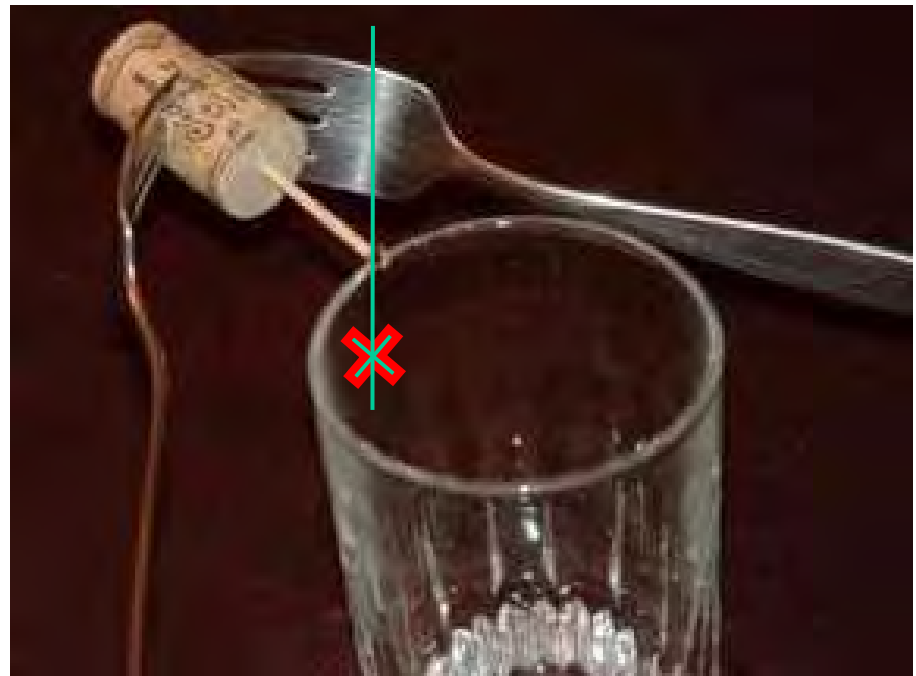
Point of support is the tip of the beak. Center of gravity must be directly above or below that point. Balance is stable so it must be below the beak.

Wings are weighted so CG is located as shown.

Balanced Forks

Two forks stuck in a cork will balance on a toothpick or a match, as in the photo.

Burn the match; it goes out at glass' rim.



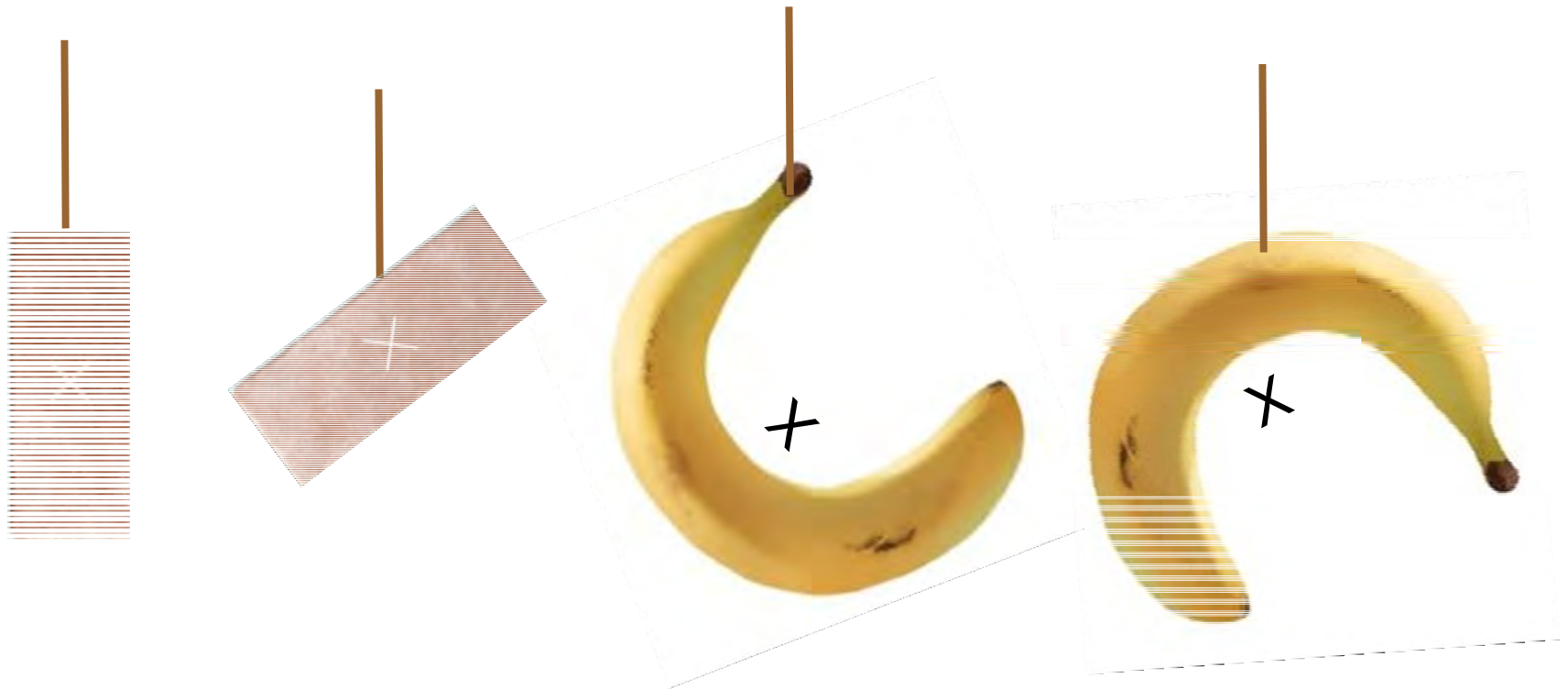
Stays in balance because CG is right under the rim.

Balanced Forks



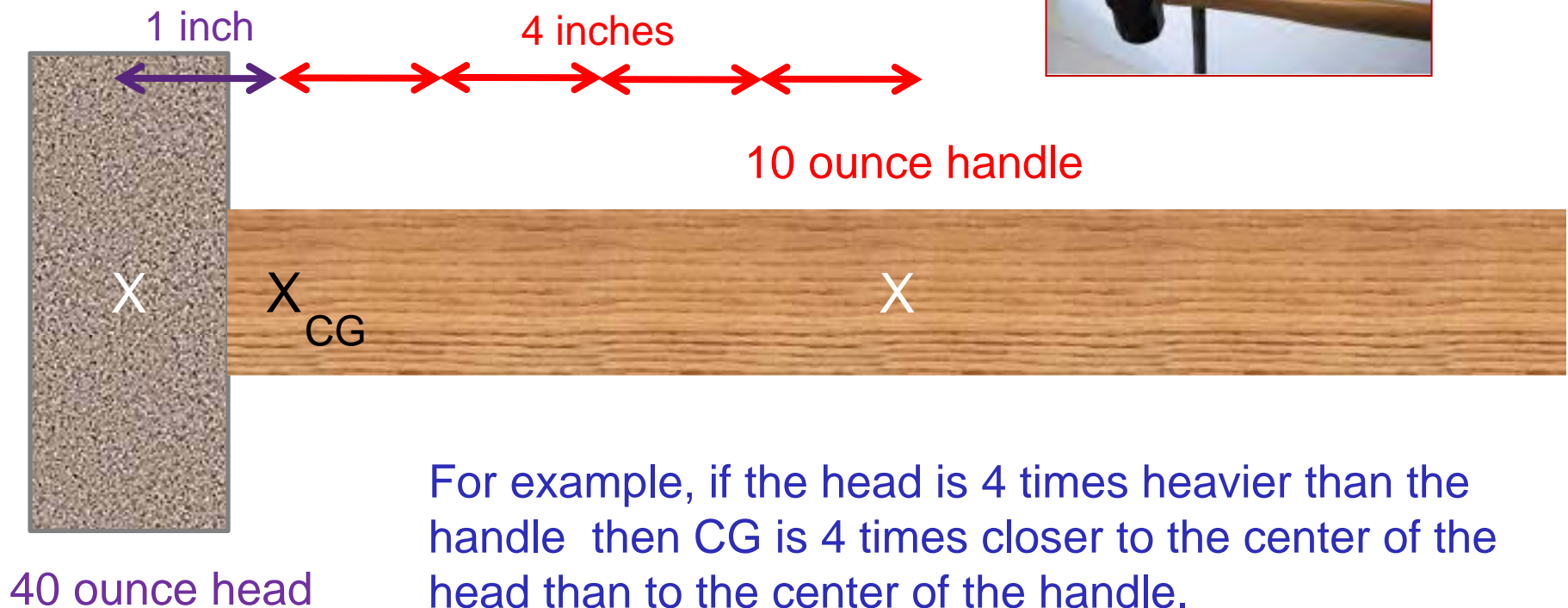
Hanging & Center of Gravity

Locate an object's CG by suspending it.
The object will hang such that the CG is directly below the point of suspension.



Weight Distribution & CG

The CG of a hammer is closer to the head since most of the weight is there.



Summary

- Center of gravity (CG) is the average location of an object's weight distribution.
- A human's CG is located roughly near the center of the torso but it shifts depending on the character's pose.
- The CG is located directly above or below a pivot point of balance.
- The CG is located directly below the point of suspension for a hanging object.