

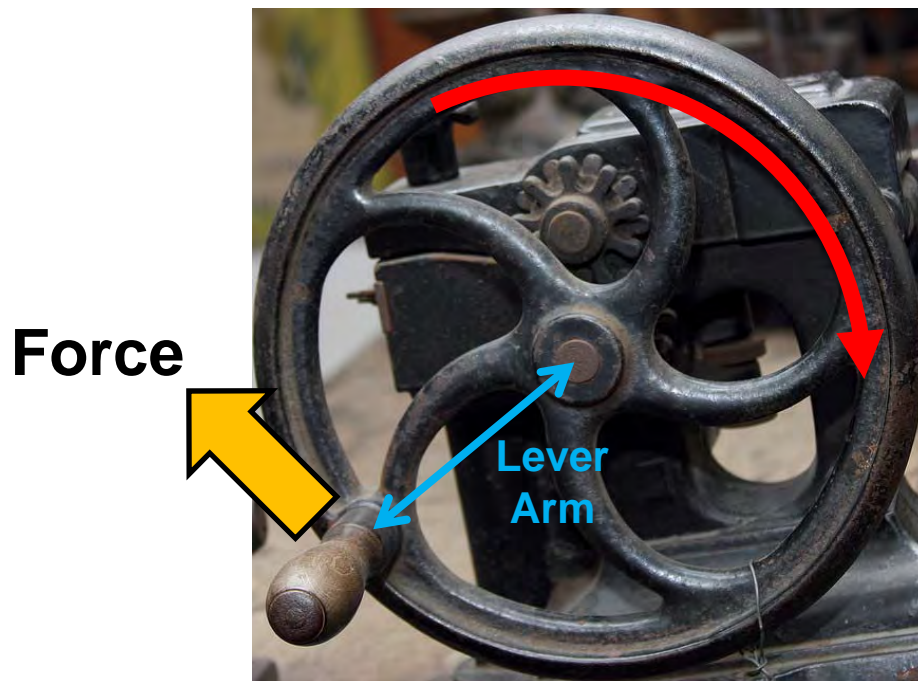
Torque



National Science Foundation
WHERE DISCOVERIES BEGIN

Torque

When a force causes a rotation, we identify this as a *torque*.



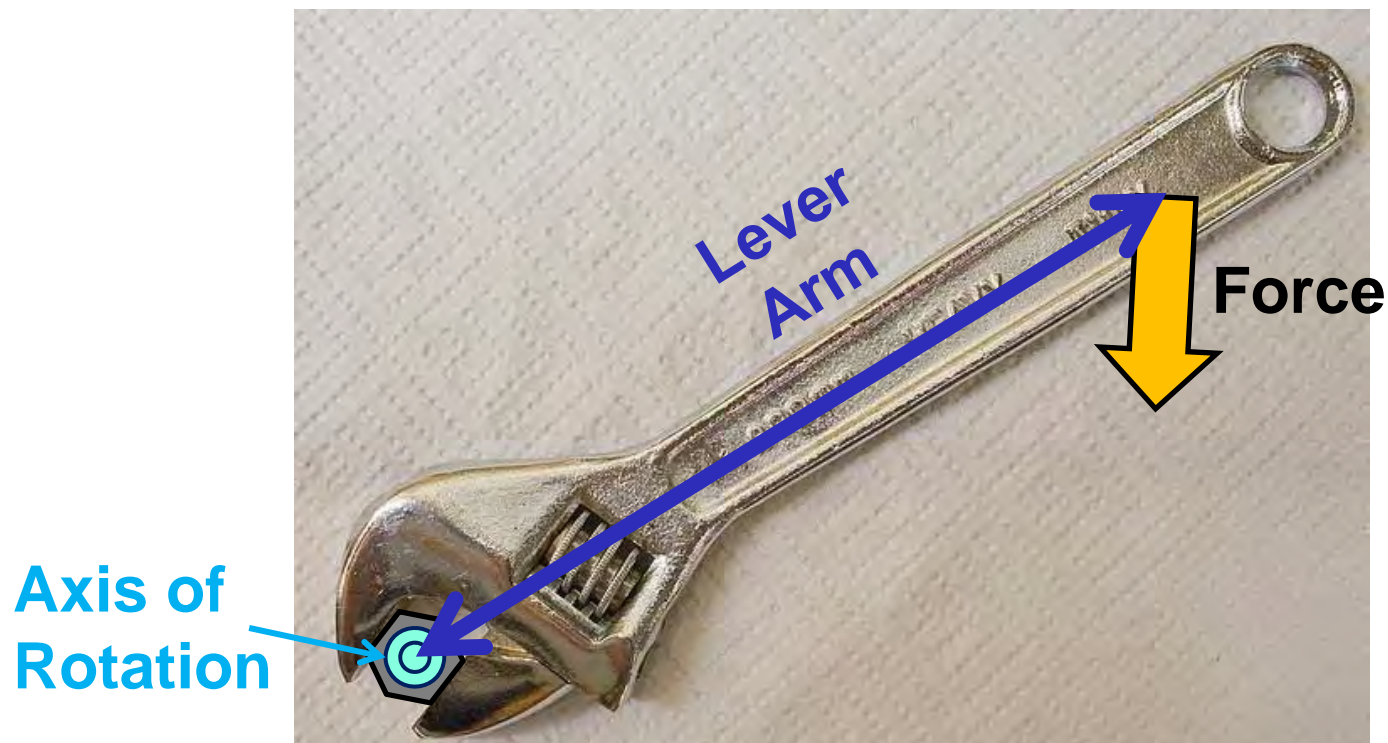
<http://www.flickr.com/photos/lwr/>

Torque depends on:

- Magnitude of the force
- Direction of the force
- Length of the lever arm

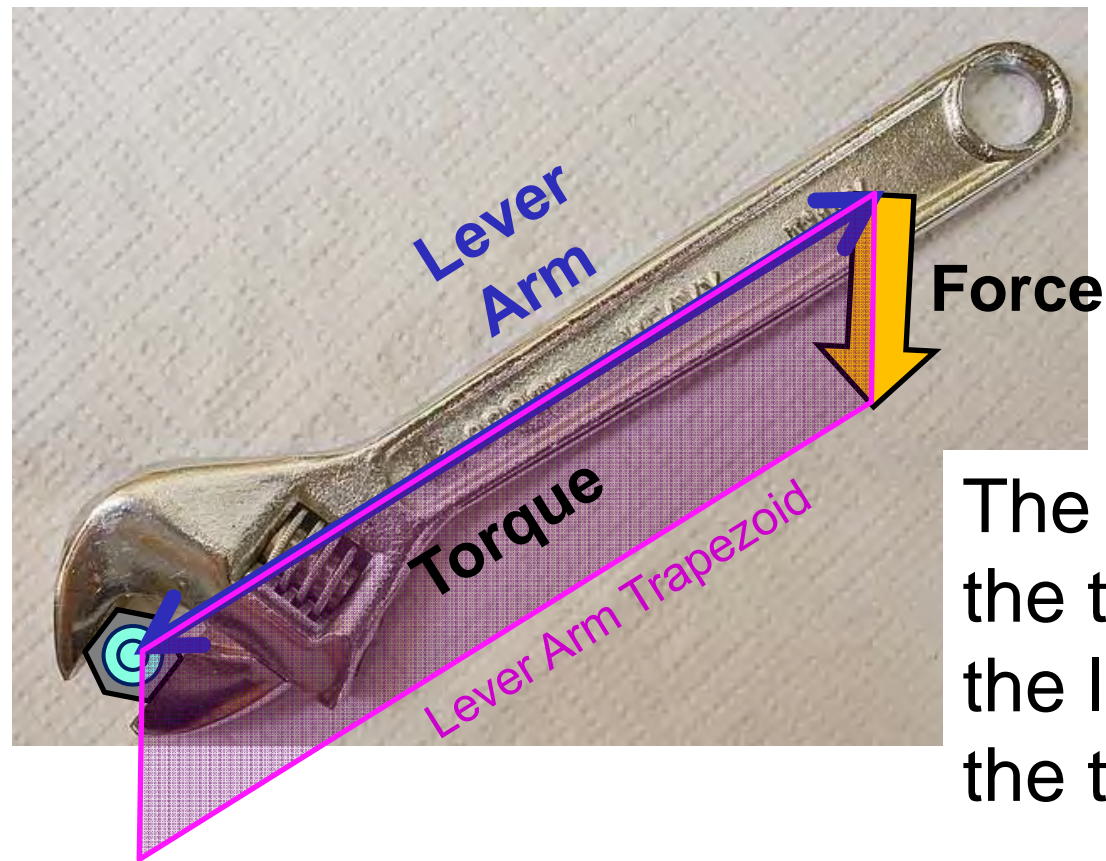
Lever Arm

Lever arm is the distance from axis of rotation to where the force is applied.



Lever Arm Trapezoid

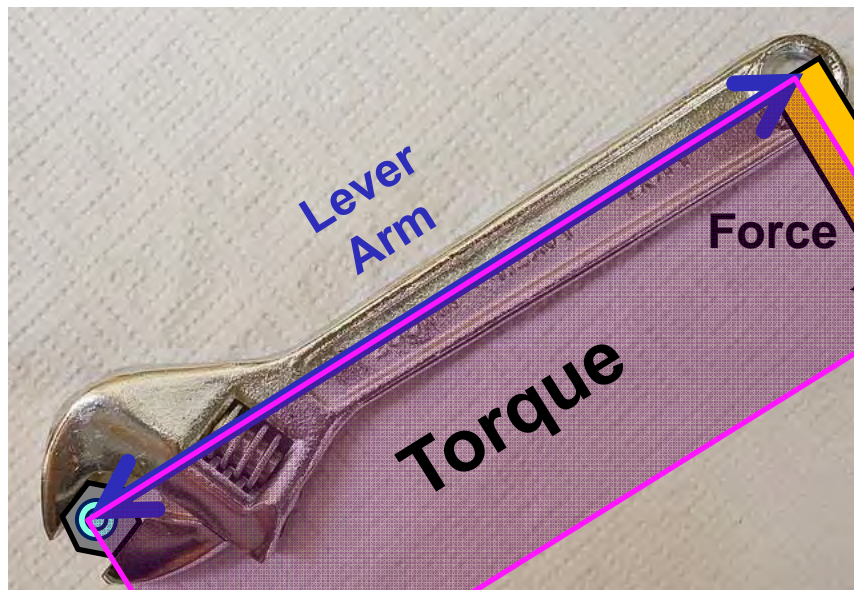
The magnitude of the torque is the area of the Lever Arm Trapezoid, as shown.



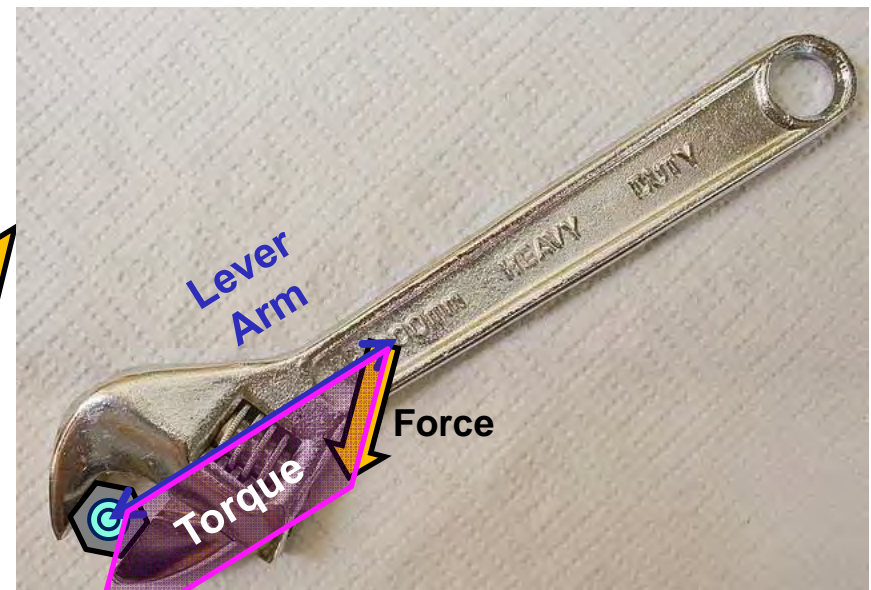
The larger the trapezoid, the larger the torque.

Maximizing Torque

Torque is largest when the lever arm is long, the force is large, and the two are perpendicular.



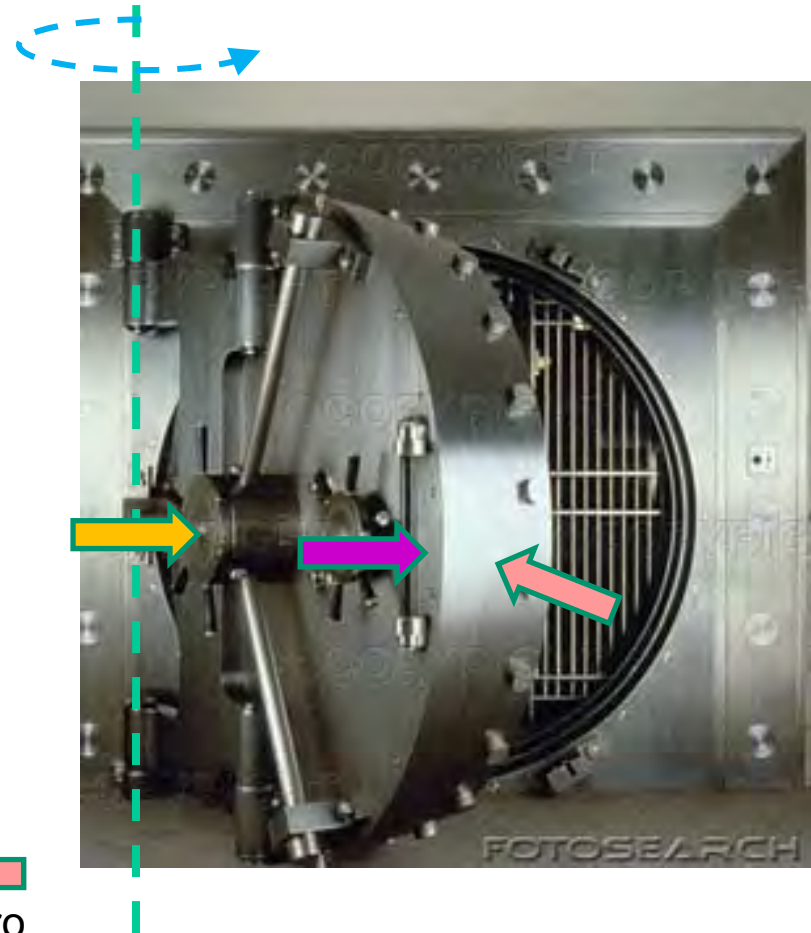
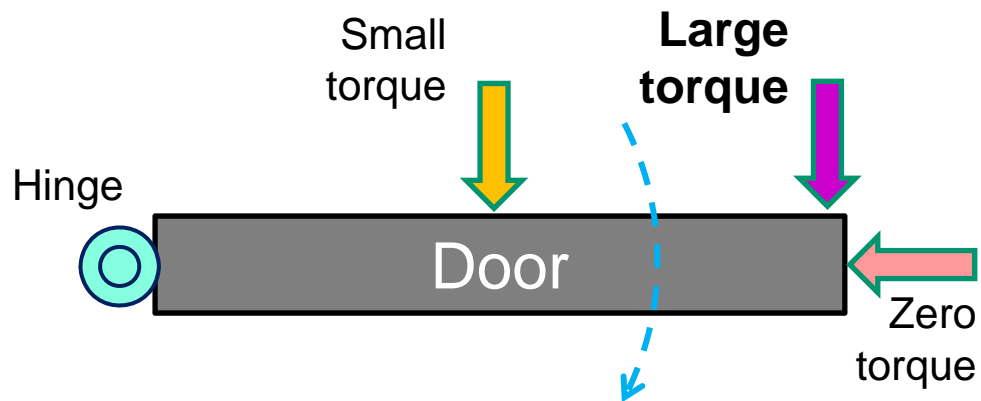
Large torque



Small torque

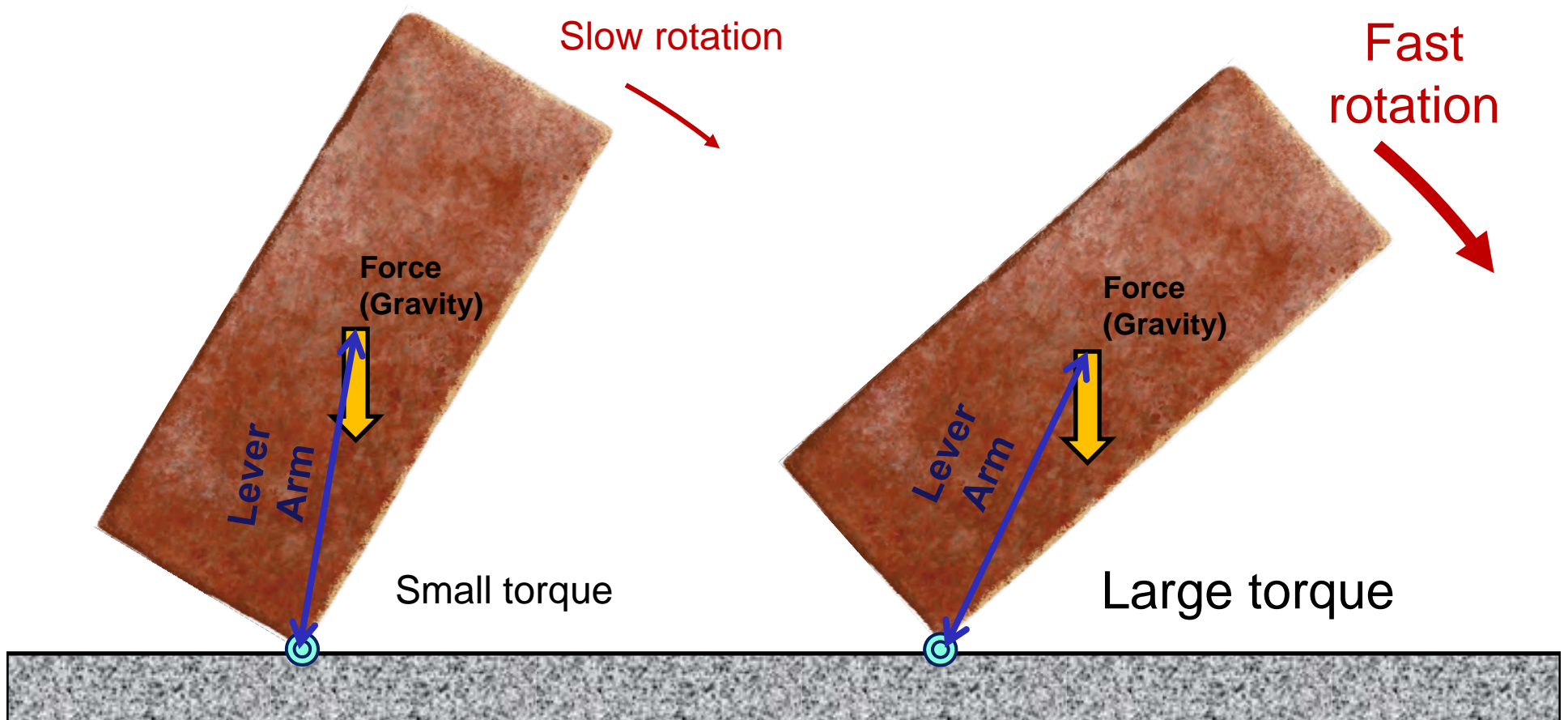
Opening or Closing a Door

For maximum torque, push perpendicular to the door at the edge opposite from the hinge.

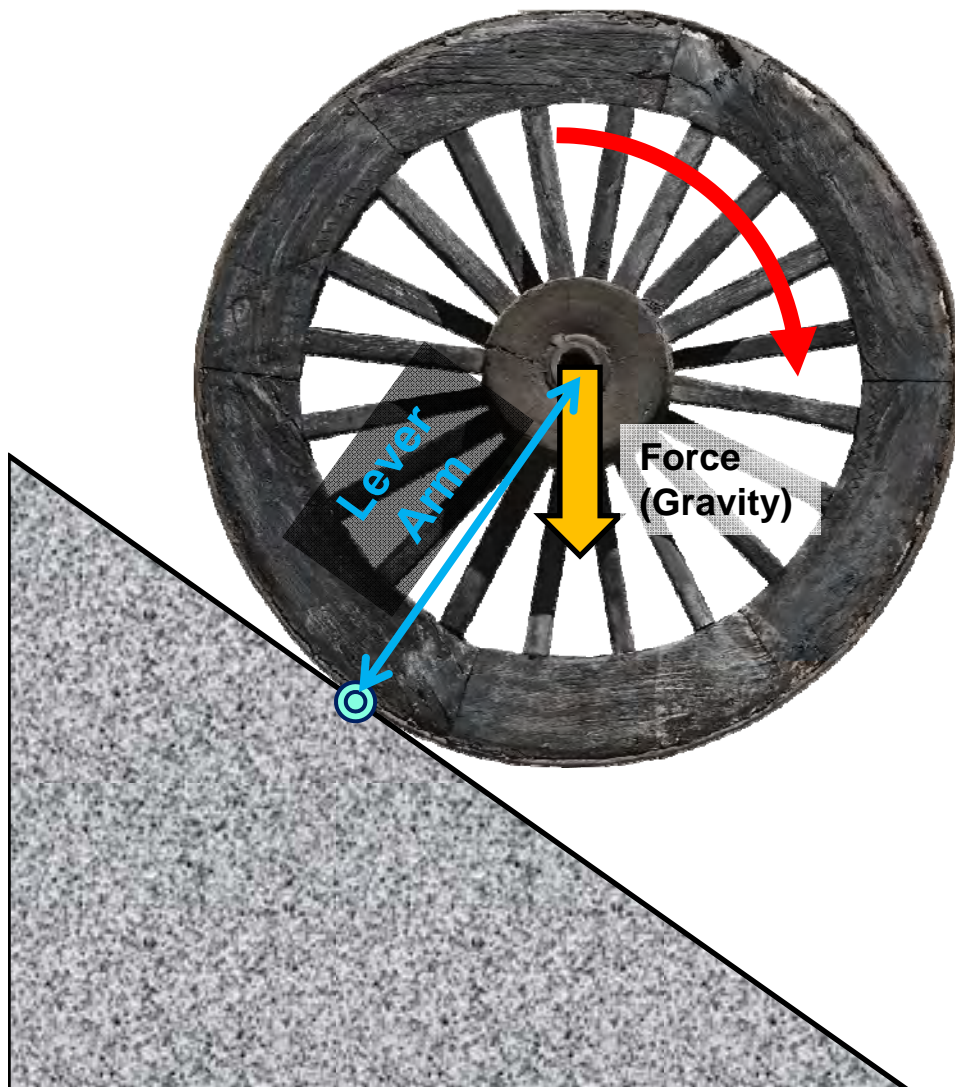


Tipping & Torque

The brick tips over faster with the larger torque.



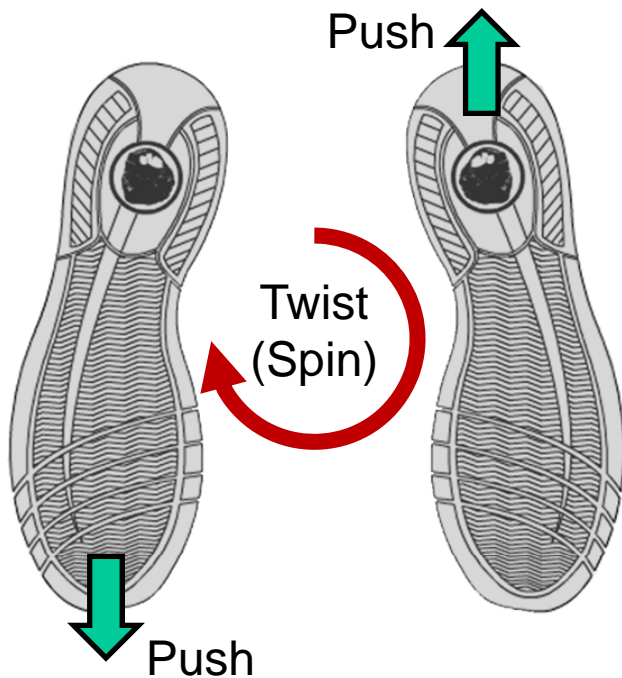
Rolling Downhill



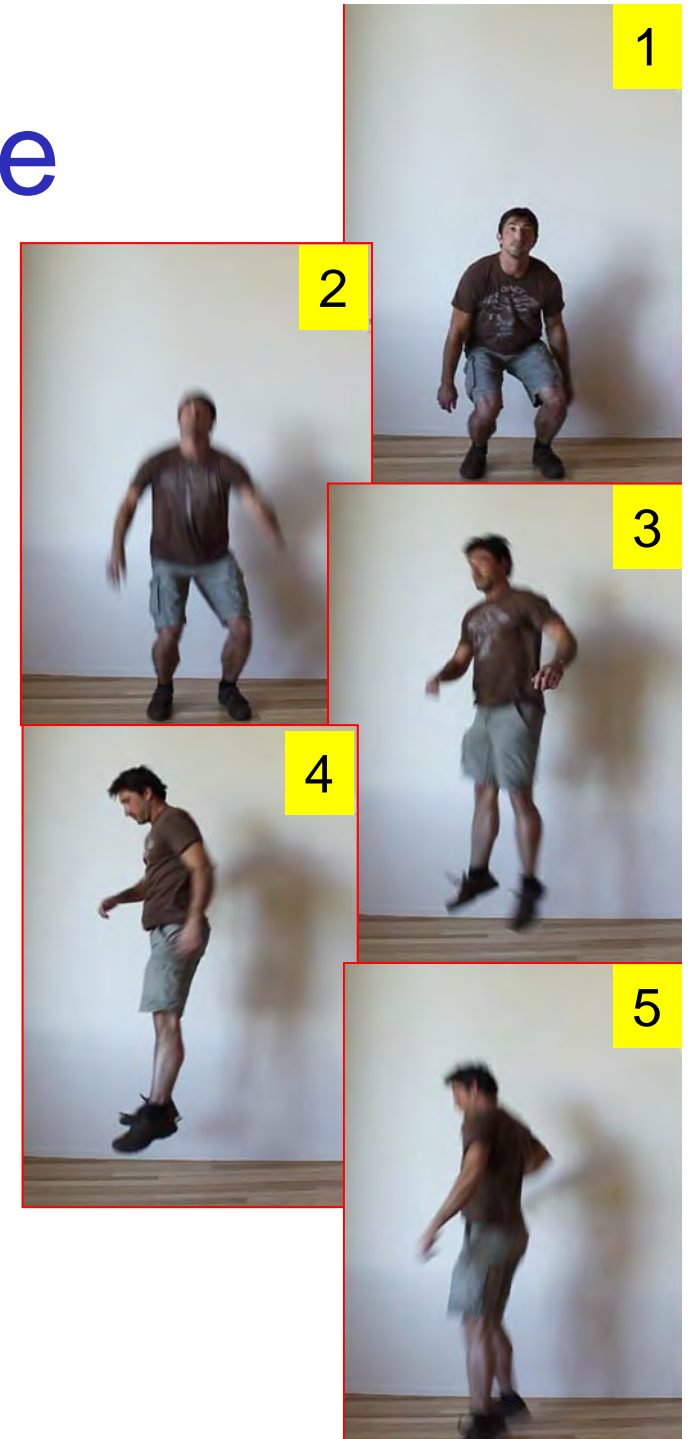
Wheels slow out rolling downhill (and slow in rolling uphill) due to the torque produced by the force of gravity.

Twisting with a Torque

Spinning in the air is easy when you can create a torque by pushing off.



Push off while the feet are still on the ground.



Pirouettes



<http://www.youtube.com/watch?v=694S8oNXRZM>

Torque for a Pirouette

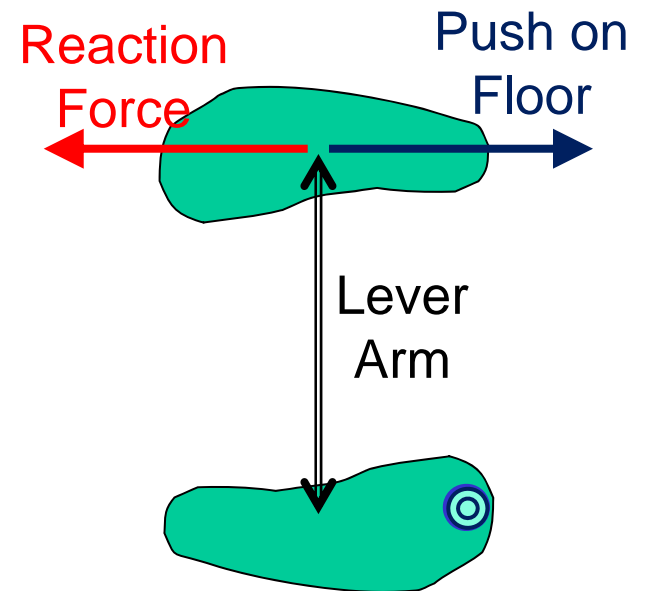
The farther the distance between the feet, the greater the lever arm so the greater the torque for creating the rotation.



Feet apart
(Easy)



Feet together
(Harder)



Fouetté (Whipped) Turns

A fouetté (or whipped) turn is executed with a quick thrust of the moving leg as it passes in front of or behind the supporting leg.

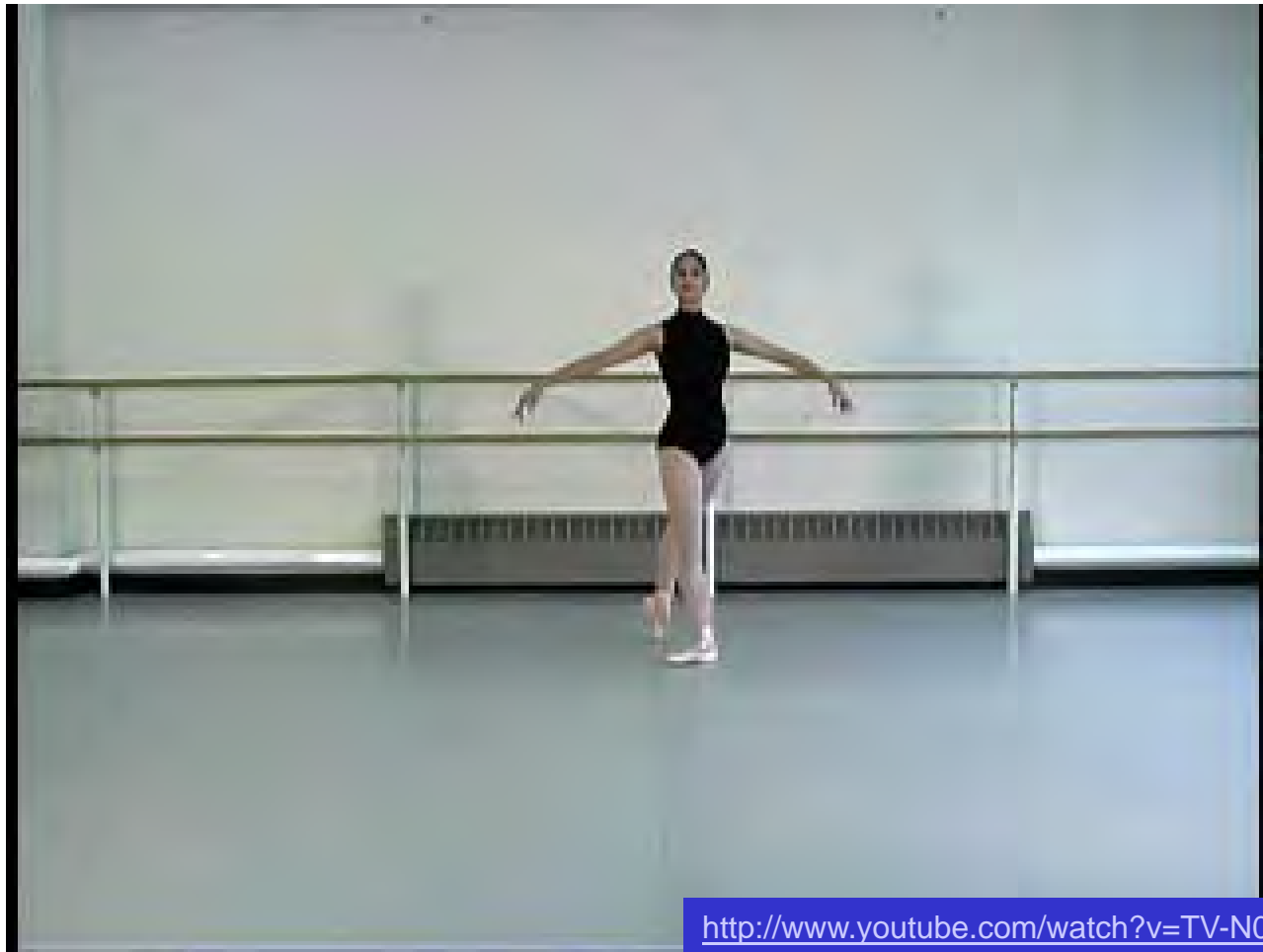


Ballet



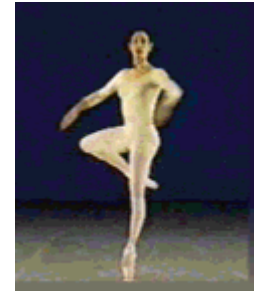
Taekwondo

Fouetté (Whipped) Turns



<http://www.youtube.com/watch?v=TV-N0QWyeac>

Torque for Fouetté Turns

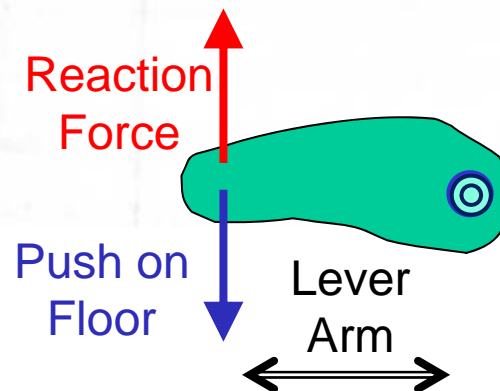


Push off while swinging right leg

Lower heel to the floor



Lift heel and return to point



The torque first creates a rotation of the arm & leg, then whole body rotates together

Anchors Aweigh (1945)

The musical Anchors Aweigh has a famous scene in which Gene Kelly dances with Jerry the Mouse.

The scene climaxes with a series of fouetté turns.



Summary

- A torque is when a force causes rotation.
- Magnitude of torque depends on direction and magnitude of the force and on the lever arm.
- The larger the lever arm (distance between the axis of rotation and the applied force) the larger the resulting torque.
- Characters can spin by creating a torque with their feet, pushing off on the floor.