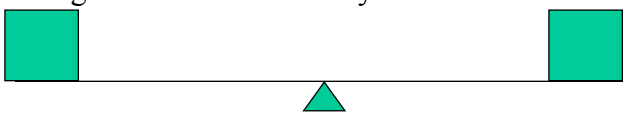
Center of Gravity

- When gravity acts on a body, every particle of which it is composed is attracted toward the earth. The resultant force is the body's weight.

- Through which point does this resultant force act?

CENTER OF GRAVITY (CG)

- Definitions:
  - Theoretical point at which all of the body's weight is considered to be concentrated
  - Point about which a body will balance
    - It is not necessarily the point about which there are equal amounts of weight. Rather, it is a "point" about which these weights are "balanced".
    - Example: teeter-totter CG location is dependent on weight distribution of body.



  - CG location is dependent on the weight and the distribution of this weight within the body.

- Human body:
  - Is the CG of the human body always in the same place?
  - In the anatomical position, the CG is near the waist.
    - Females: **53-56%** of standing height
    - Males: **54-57%** of standing height
  - The CG does NOT have to lie within the physical matter of the body:
    - tire, basketball, football helmet
  - In humans, the CG may also fall outside body's physical matter:
    - (e.g., high jumper, pole vaulter)

Long Jump

- Within which physical boundaries must the CG lie?

Linear Kinetics

- Force
  - Effect that one body has on another
  - A push or a pull applied to an object
  - That required to change the state of motion of an object (i.e., that which causes acceleration)

Force (Cause)  Acceleration (Effect)

Characteristics of Force

- Force is a vector quantity:
  - Magnitude & direction
- A third, unique characteristic:
  - The point of application (especially important relative to the determination of moments or torques)
- Therefore, to completely understand the influence of a net force, we must have knowledge of all three characteristics

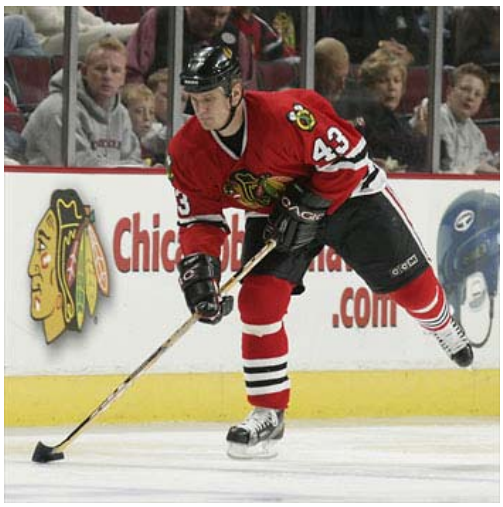
Newton's Laws of Motion

- First Law: Inertia
  - a body will continue in its state of motion unless acted upon by a net force.
- Second Law: $\Sigma F = ma$
  - Acceleration is proportional to the net force acting on a body.
- Third Law: Action-reaction
  - For every force there is an equal and opposite force.

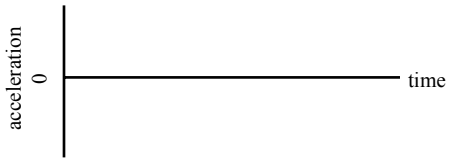
- Example:
  - What is the net force acting on the gymnast if she maintains this static position?
  - Draw and label each of the forces acting on the gymnast in this situation.
  - Identify each of the reaction forces.

Linear Kinetics Exercise

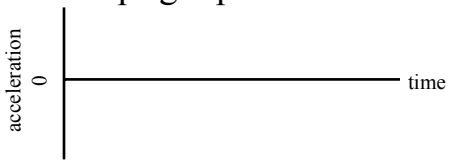
- Draw and label all of the **vertical forces** which are acting on this athlete.
- Express these forces in terms of Newton's 2nd Law.
- Under what circumstances will his body (CM) experience a positive acceleration?
- Under what circumstances will his body (CM) experience a negative acceleration?
- Under what circumstances will his body (CM) experience zero acceleration?



- Draw the acceleration-time curves of the CM during the following activities:
  - From a standing position, suddenly squat down and hold this position

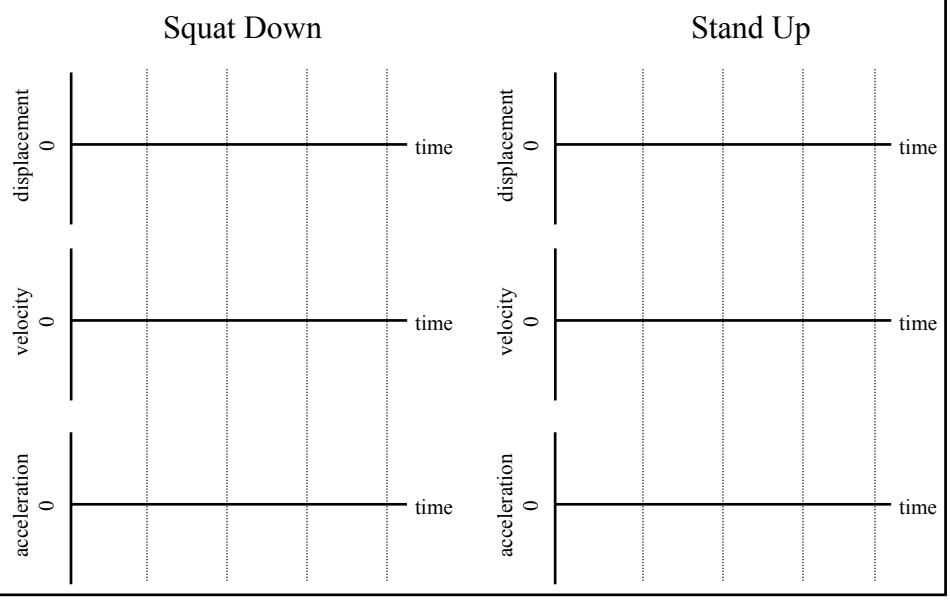


  - From a squatted position, suddenly stand back up and hold this upright position.



How well do you know it?

(can you do it backwards?)



Summary

- Positive Acceleration
  - increasing velocity in the upward direction
  - decreasing velocity in the downward direction
  - changing directions from downward to upward
- Negative Acceleration
  - decreasing velocity in the upward direction
  - increasing velocity in the downward direction
  - changing directions from upward to downward
- Zero Acceleration
  - constant velocity
  - peak velocities

Pressure

- Force applied to an object is rarely applied at a single point. Rather, it is distributed over an area.

Pressure = Force/Area

*Pressure = "**force per cross-sectional area**"*

Examples

- Lying down vs. standing
- High heels vs. tennis shoes
- Rock in your shoe
- Atmospheric pressure
- Catching a baseball with a mitt vs. barehanded

- What are differences in Force?
- What are the differences in surface or contact area?
- What are the resulting effects on pressure?