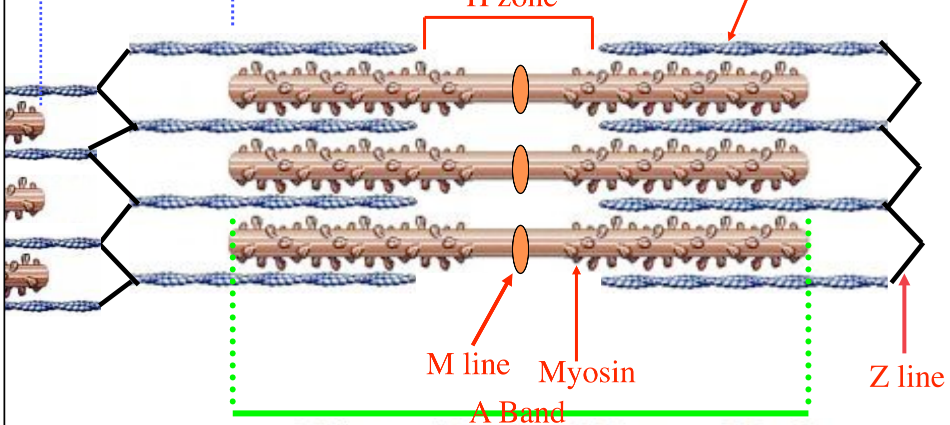
Sarcomere

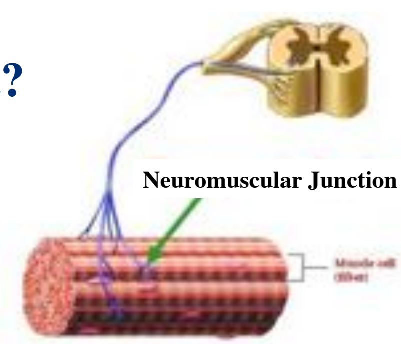


	Z Line	A Band	H Zone	I Band
Concentric action	→←	—	→←	→←
Eccentric action	←→	—	←→	←→

QUIZ

What is a motor unit?

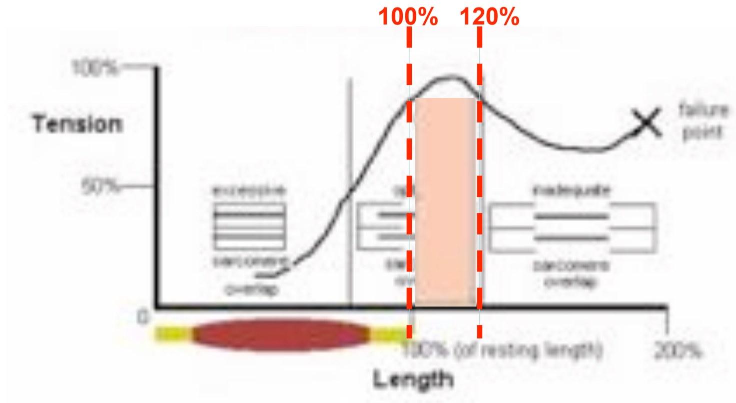
What's the smallest contractile unit of a muscle?

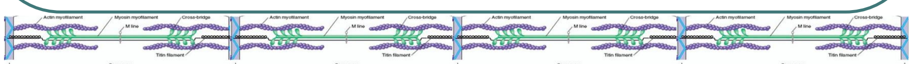


	Z Line	A Band	H Zone	I Band
Concentric action				
Eccentric action				

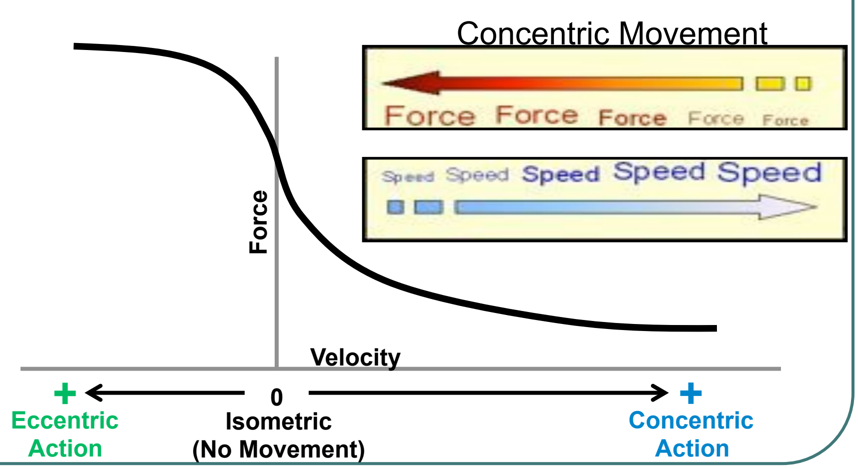
Muscle Length-tension relationship

Tension = Magnitude of a Force





Maximal Contraction Force-Velocity Relationship



Quiz

What percent (range) of resting length in muscle generates the greatest tension?

In your own words, how does Sarcomere Length effect tension (force production)?

Draw the Force-Velocity Relationship

Key Concepts

Weight: The effect gravity has on a given mass

Force = Mass x Acceleration

Body Weight = Mass x $Acceleration_{gravity}$

Example:

Mass: 80 kg
$Accel_{grav}$: 9.81 m/s/s

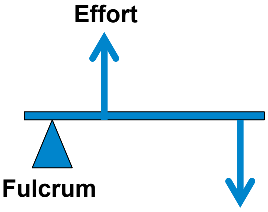
Answer: 785 Kg m/s^2

785 Newtons

Quiz

- What is the body weight of a person who has a mass of 60 kg here on earth?

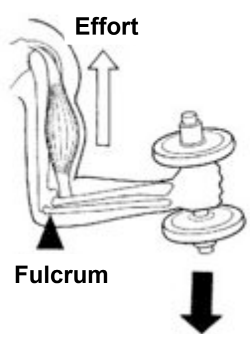
Principles of Levers



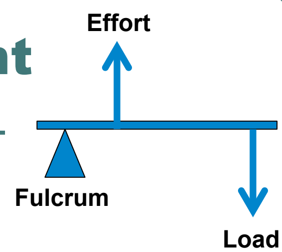
To have movement levers must be engaged

Levers have:

1. Axis of Rotation
2. Muscular Effort
3. Resistance

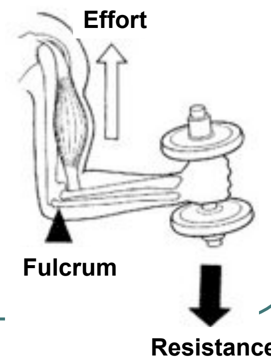


Principles of Movement



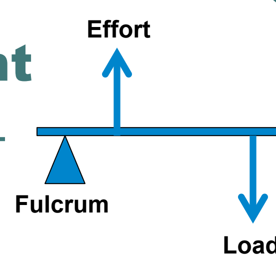
Mechanical Aspects

1. Rotary Force
2. Stabilizing Force
3. Total Muscular Force



Basic Components of Force:
Direction and Magnitude

Principles of Movement



Mechanical Aspects

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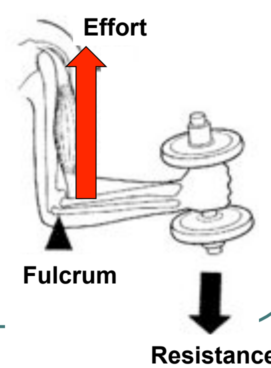
2. Stabilizing Force
3. Total Muscular Force



Basic Components of Force:
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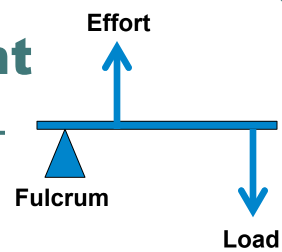

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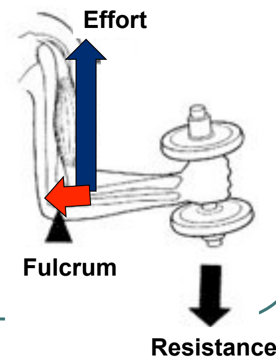

Basic Components of Force:
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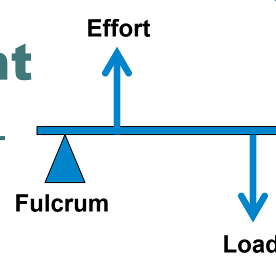
Principles of Movement



Mechanical Aspects

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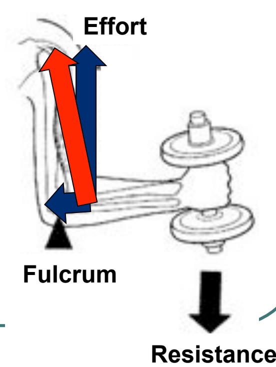


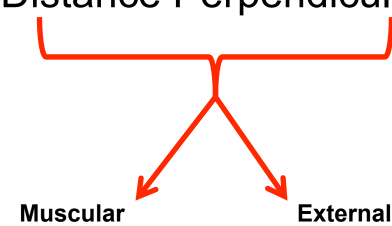
Basic Components of Force:
Direction and Magnitude

QUIZ

- Draw a lever arm including the following components:
  - Axis of Rotation
  - Muscular Effort
  - Resistance
- Include the following mechanical aspects:
  - Rotary Force
  - Stabilizing Force
  - Total Muscular Force

Torque

Torque = Force x Distance Perpendicular



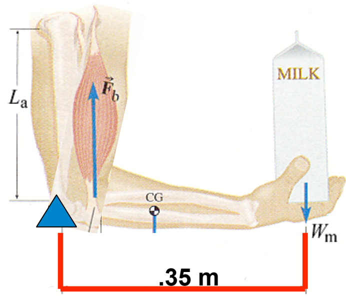
****To hold a weight with the elbow at 90°**
External Torque = Muscular Torque

External Torque = Muscular Torque
(Elbow at 90 Degrees)

External Torque = Resistance x Resistance Arm

Muscular Torque = Muscular Effort x Effort Arm

How much External Torque is generated by the 1.5 kg Milk held in the hand .35 m from the elbow?



$T_{external}$=F x $D_{\perp}$

$T_{external}$=1.5 kg x 9.81 m/s^2 x .35 m

$T_{external}$=14.72 N x .35 m 5.15 Nm

External Torque = Muscular Torque
(Elbow at 90 Degrees)

How much force must the biceps create to overcome the weight held in the hand?

$T_{external}$=$T_{muscular}$ ⟸ To hold steady at 90 Degrees

14.72 N x .35 m = Muscular Effort x Effort Arm

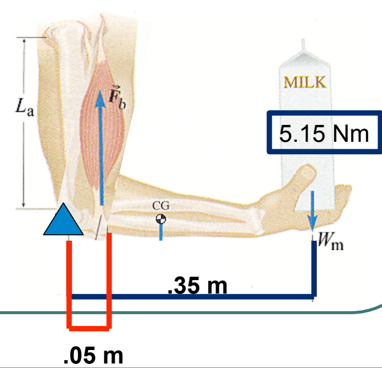
5.15 Nm = Muscular Effort x .05 m

103 N x .05 m = 5.15 Nm

$\frac{5.15 \text{ Nm}}{.05 \text{ m}}$ = Muscular Effort

103 N = Muscular Effort

>103 N



Quiz (Partner Collaboration!)

Diagram a lever arm with the muscular effort at 90 degrees .025m from the elbow

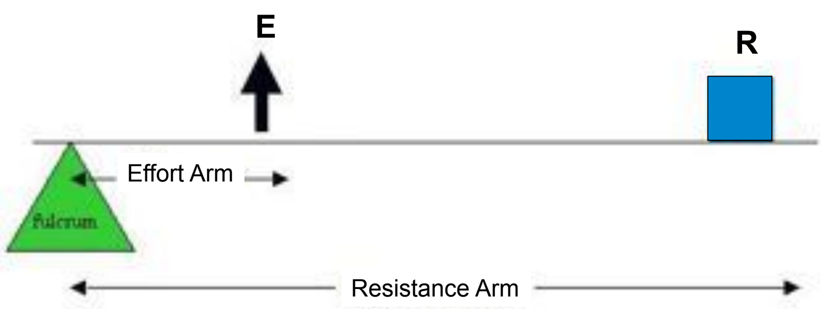
- How much external torque is generated by an object with a mass of 5 kg when it is held in the hand .4m from the elbow?
- How much force must the biceps generate to overcome the weight held in the hand?

Quiz

Diagram a lever arm with the muscular effort at 90 degrees .025m from the elbow

- How much external torque is generated by a 15 kg weight held in the hand .4m from the elbow?
- How much force must the biceps generate to overcome the weight held in the hand?

Mechanical Advantage



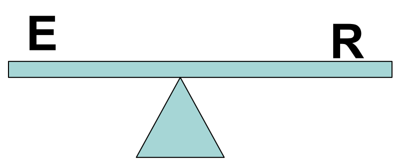
A ratio between the length of the effort arm and the resistance arm

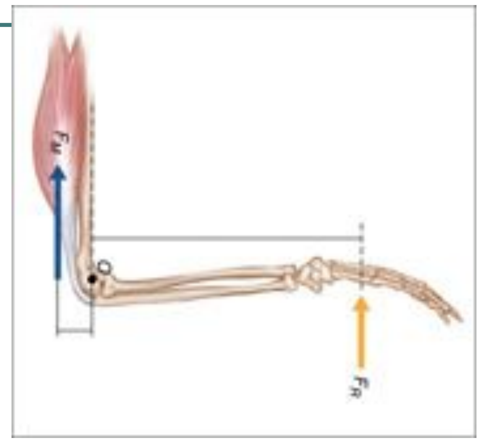
$$\textbf{Mechanical Advantage} = \frac{\text{Effort Arm}}{\text{Resistance Arm}}$$

Interpreting Mechanical Adv.

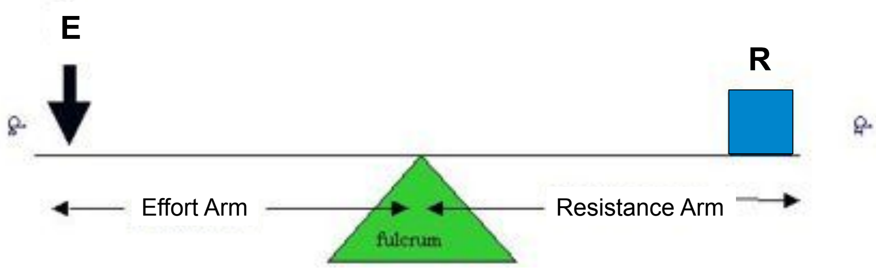
- If the MA ratio > 1.0
  - The required magnitude of force applied (effort) is **LESS** than the magnitude of the resistance
- If the MA ratio < 1.0
  - The required magnitude of force applied (effort) is **GREATER** than the magnitude of the resistance
  - Mechanical Disadvantage
    (less effective because more force required)

A First-Class Lever (The Forearm)





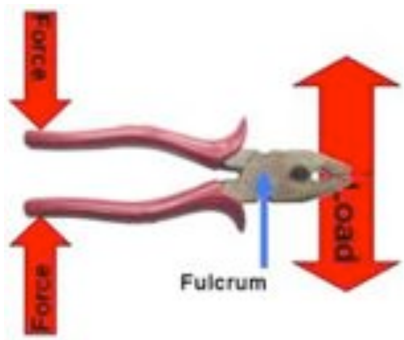
Mechanical Advantage



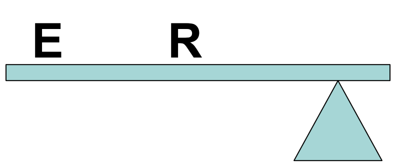
MA = EA/RA

If the lever stays balanced what does this tell me about the torques generated by the resistance and the effort?

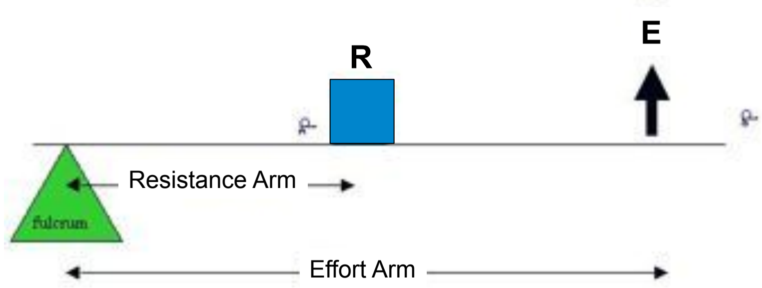
1st Class Levers



A Second-Class Lever (The Foot)

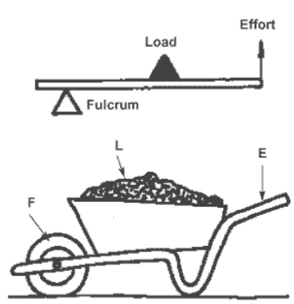


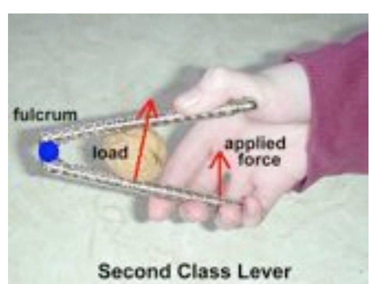
Mechanical Advantage



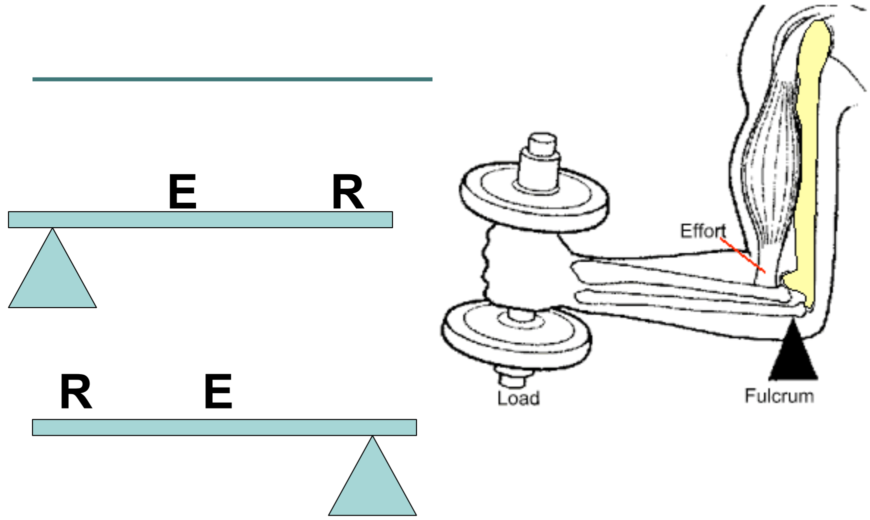
Mechanical Advantage = $\frac{\text{Effort Arm}}{\text{Resistance Arm}}$

2nd Class Levers

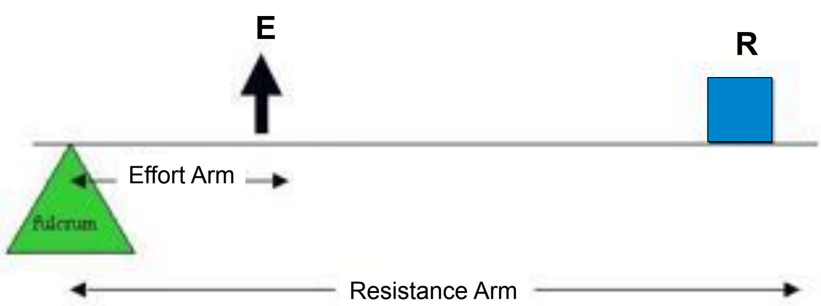




A Third-Class Lever (The Forearm)

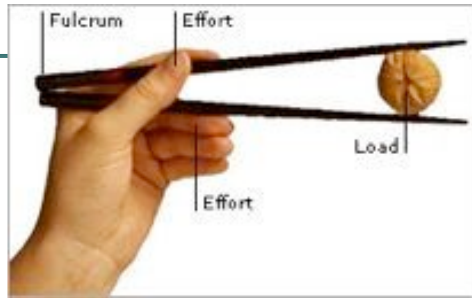


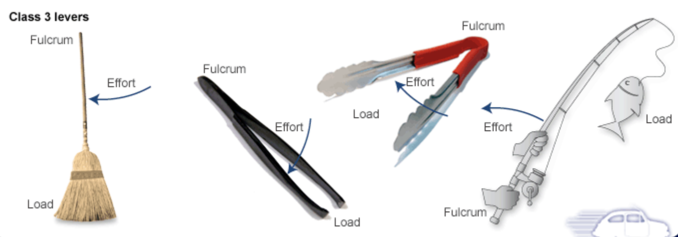
Mechanical Advantage



Mechanical Advantage = $\frac{\text{Effort Arm}}{\text{Resistance Arm}}$

3rd Class Levers





First Class Lever

Second Class Lever

Third Class Lever