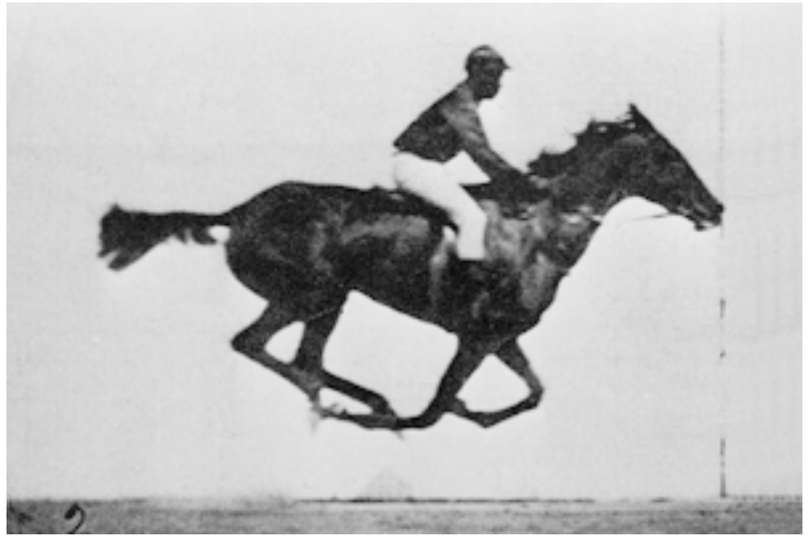
Welcome
BIOMECHANICS
BIOL 427

http://courses.washington.edu/biomechs

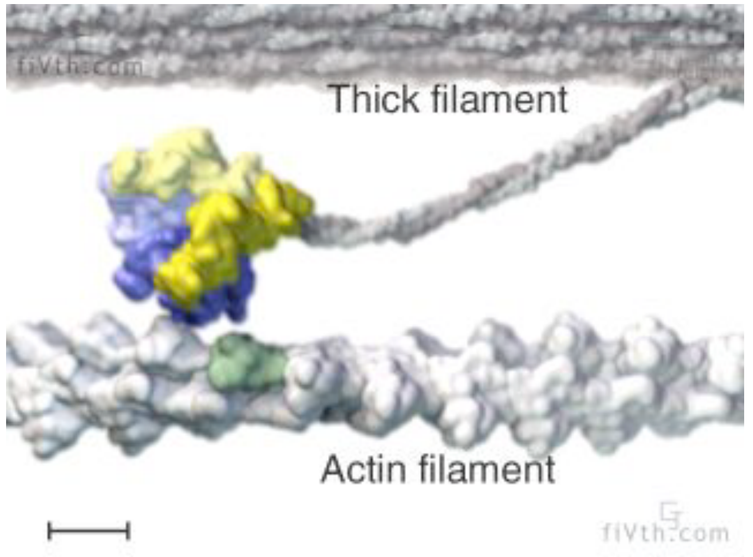


Lecture 1: An introduction to Biomechanics: Jumping right in.

- What's the course/biomechanics about?
- How is the course organized?
- What physics basics need I review?
- Jumping right into it: ballistic bodies.

molecular
cellular

tissue



Physical principles underlying biological processes and mechanisms (movement, design, architecture, materials, transport).

Many levels of biological organization:

organism

Lecture 1: An introduction to Biomechanics: Jumping right in.

- What's the course/biomechanics about?
- How is the course organized?
- What physics basics need I review?
- Jumping right into it: ballistic bodies.

Physical principles underlying biological processes and mechanisms (movement, design, architecture, materials, transport).

A variety of approaches:

Modeling/Computing

$$F = ma$$

Experimental Data

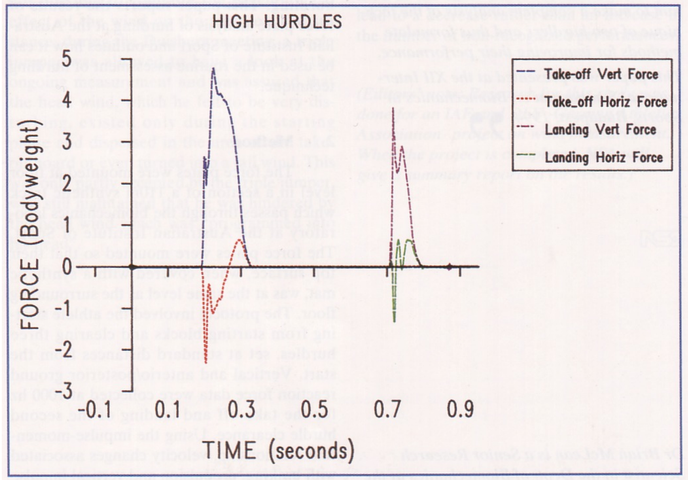


Figure 1: Force plate analysis high hurdles

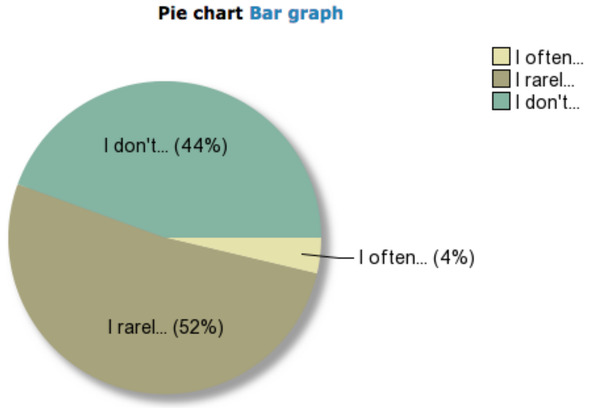
Lecture 1: An introduction to Biomechanics: Jumping right in.

- What's the course/biomechanics about?
- How is the course organized?
- What physics basics need I review?
- Jumping right into it: ballistic bodies.

http://courses.washington.edu/biomechs

Question
To what extent did having a textbook (Comparative Biomechanics) contribute to your learning in Biomechanics (BIO427)?

The book was critical for learning Biomechanics	0	0.00%
I often referred to the book	1	3.70%
I rarely referred to the book	14	51.85%
I don't think it really helped at all	12	44.44%



Lecture 1: An introduction to Biomechanics: Jumping right in.

- What's the course/biomechanics about?
- How is the course organized?
- What physics basics need I review?
- Jumping right into it: ballistic bodies.

Rule 1: Equations must be dimensionally correct! Mass, Length and Time (we commonly use S.I. units*)

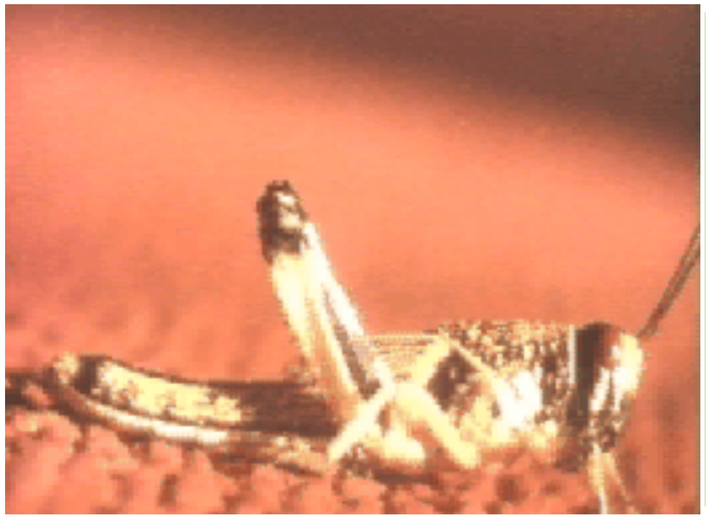
Rule 2: Units matter

Rule 3: scalar quantities are not the same as vector quantities

Physical quantity	**Symbol**	**Dimensions**	**SI Units**
distance	$\mathbf{x}$	L	m
Velocity	$\mathbf{v}$,d$\mathbf{x}$/dt	L T^{-1}	m s^{-1}
Acceleration	$\mathbf{a}$,d$\mathbf{v}$/dt,$d^2\mathbf{x}/dt^2$	L T^{-2}	m s^{-2}
Momentum	$\mathbf{M}$, m $\mathbf{v}$	M L T^{-1}	kg m s^{-1}
Force	$\mathbf{F}$, d(m$\mathbf{v}$)/dt	M L T^{-2}	Newton, kg m s^{-2}
Work	E	M L^2 T^{-2}	Joule, kg m^2 s^{-2}
Power	P, dE/dt	M L^2 T^{-3}	Watt, kg m^2 s^{-3}

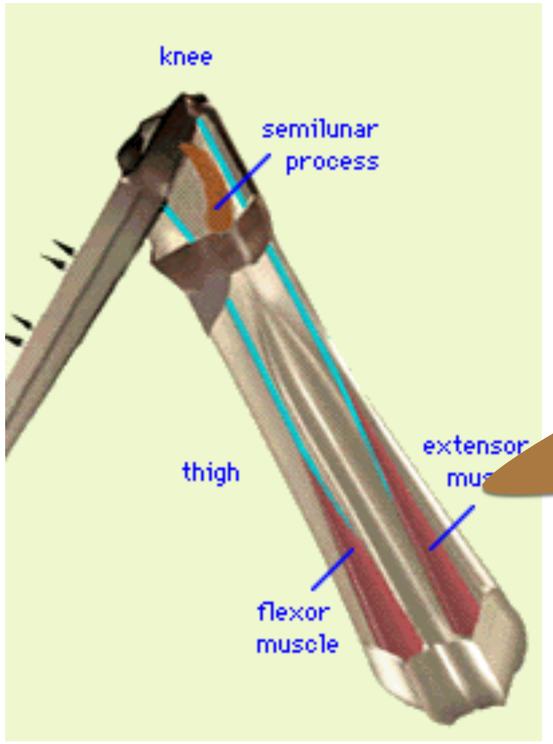
Lecture 1: An introduction to Biomechanics: Jumping right in.

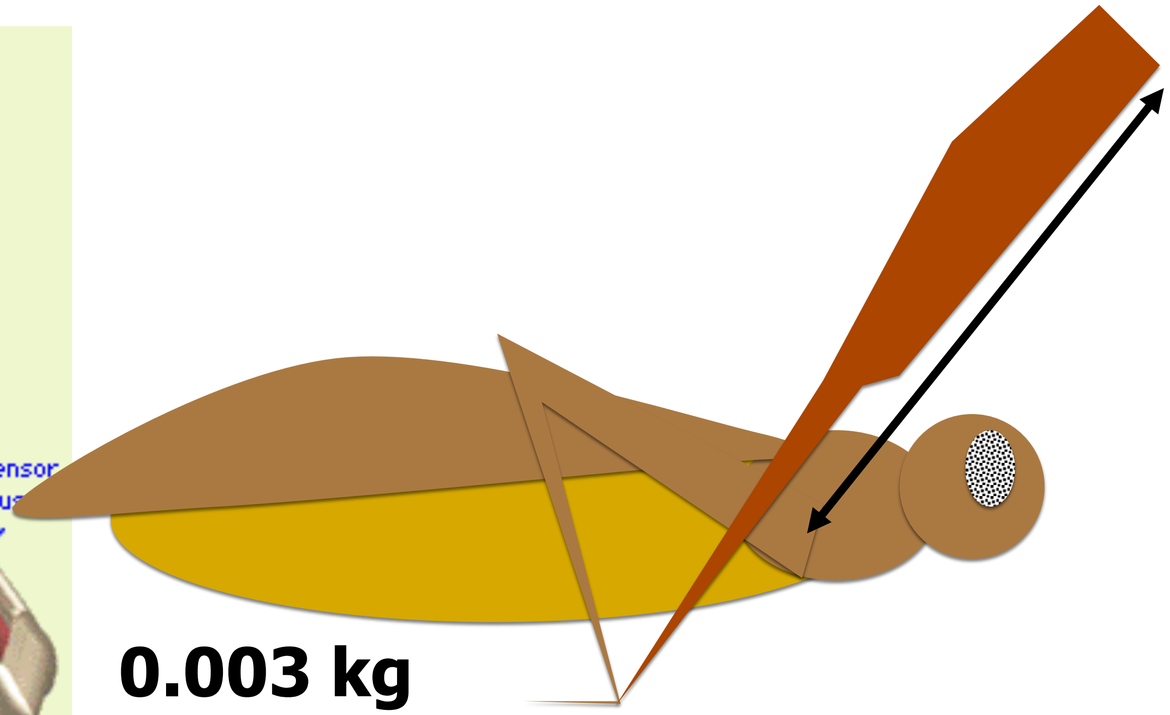
- What's the course/biomechanics about?
- How is the course organized?
- What physics basics need I review?
- Jumping right into it: ballistic bodies.



Distance?
Velocity?
Acceleration?
Force?
Work?
Power?

Some anatomy and data





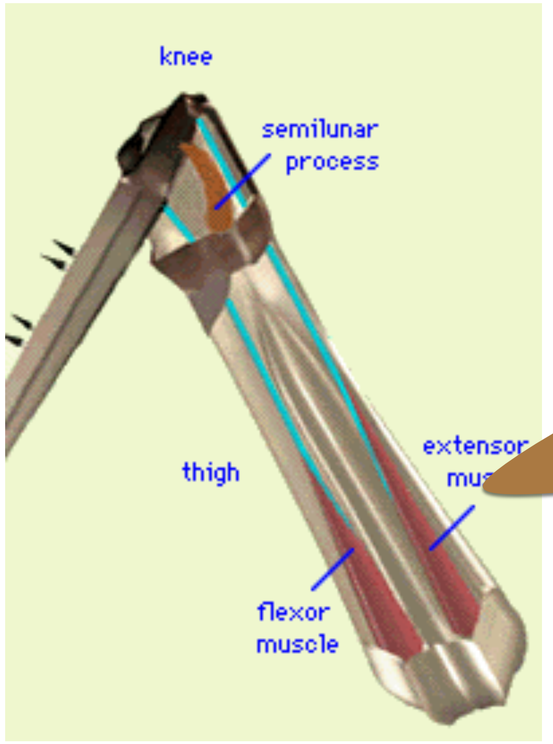
4 cm (0.04 m)

1/40 s (0.025 s)

u_o = 3.4 m/s

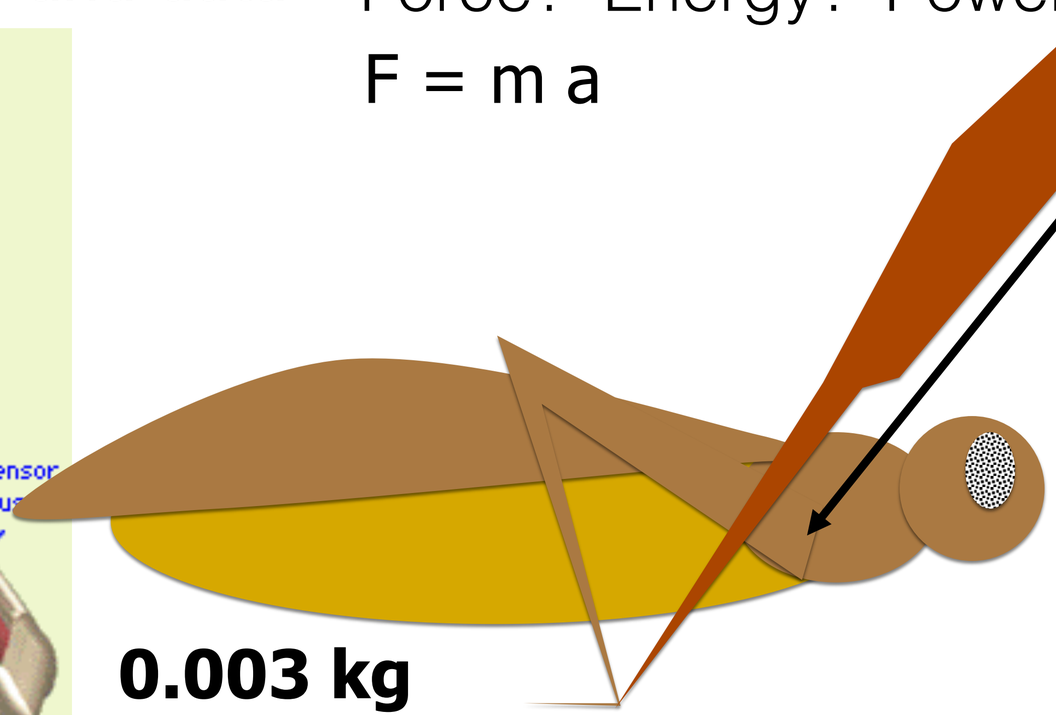
0.003 kg (3 g)

Some anatomy and data



Force? Energy? Power?

$F = m\,a$



0.003 kg (3 g)

4 cm (0.04 m)

1/40 s (0.025 s)

$u_o = 3.4$ m/s

Need the initial acceleration

$2\,a\,d = u_o^2$

$a = 145\ \text{m s}^{-2}$

$F = m\,a = 0.43$ N (both legs)

$= 0.21$ N (one leg)

Worksheet

Muscle force is 10 x the ground reaction **force** _____ (there is a lever arm)

Muscle **energy** (work) = F distance -> if the distance the muscle shortens is 3 10^-3 m (3 mm) how much energy? _____

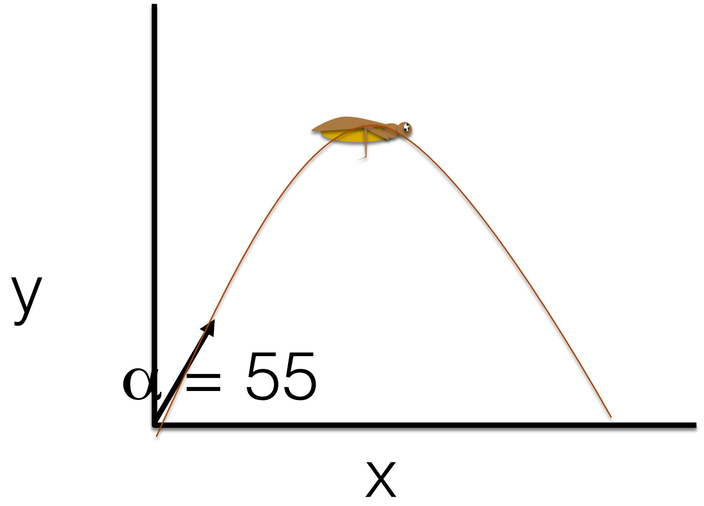
Power = energy/ time -> if the time is 1/40 of a second, how much power? _____

If the mass is 0.15 g (5% of body mass, 1.5 10^{-4} kg) how much power per mass (**mass specific power**)? _____

Human on a bicycle ergometer ~ 40 W/kg
Maximum single twitch in vertebrate muscle ~400 W/kg

No air resistance

It is *always* a parabola -- why?
does the mass matter to the trajectory?
does gravity matter (moon vs earth)?
does take-off speed matter?
does take-off angle matter?



$$x = tu_o Cos[\alpha]$$

$$y = tu_o Sin[\alpha] - \frac{gt^2}{2}$$

$$y_{\max} = \frac{(u_o Sin[\alpha])^2}{2g}$$

$$x_{\max} = 2u_o{}^2 Sin[\alpha] Cos[\alpha] / g$$

Lab next week!