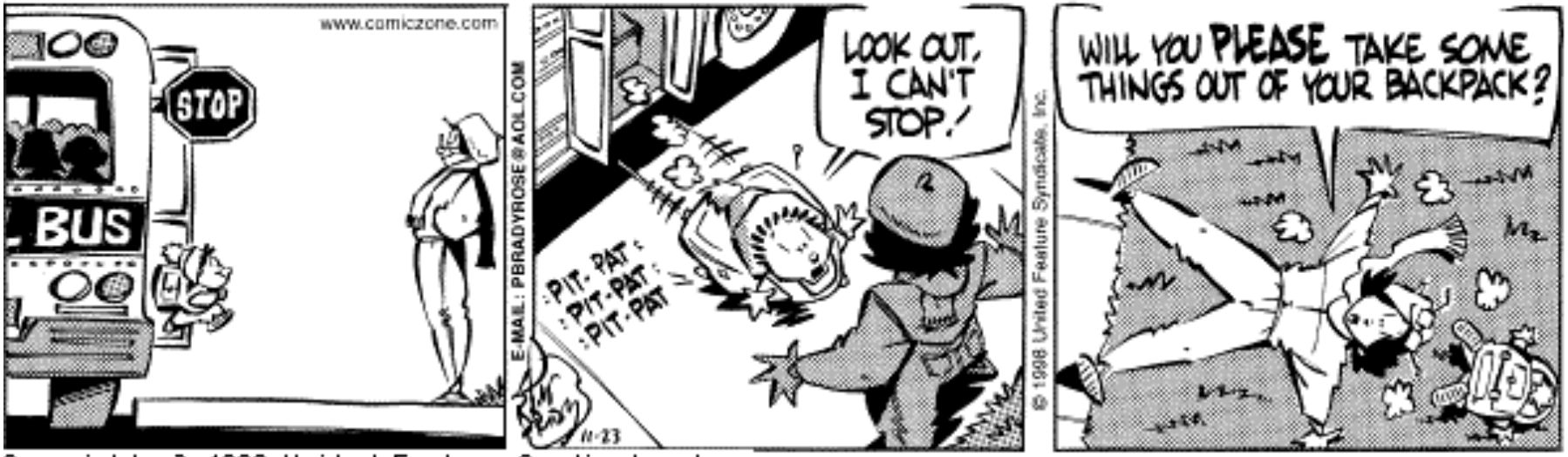
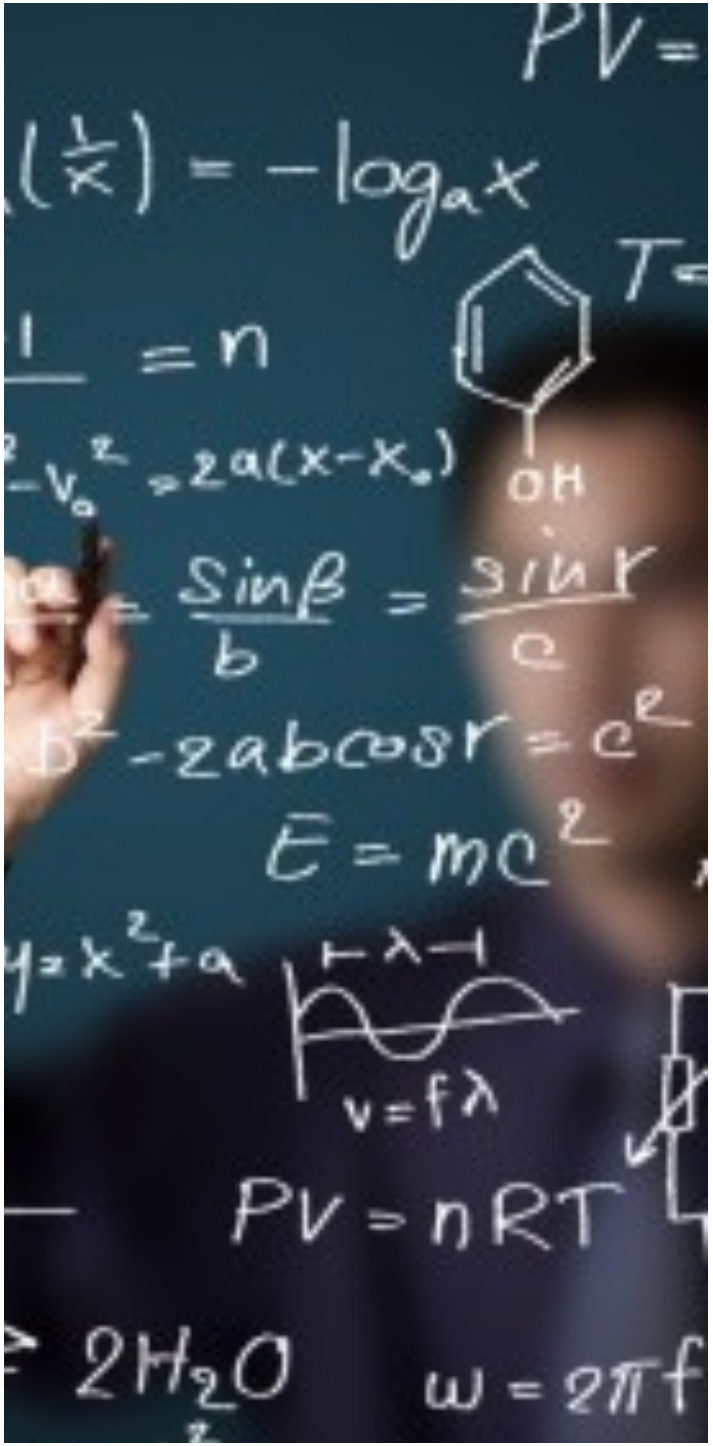
- **Theme Music: Aimee Mann**

  Momentum

- **Cartoon: Pat Brady**

  Rose is Rose





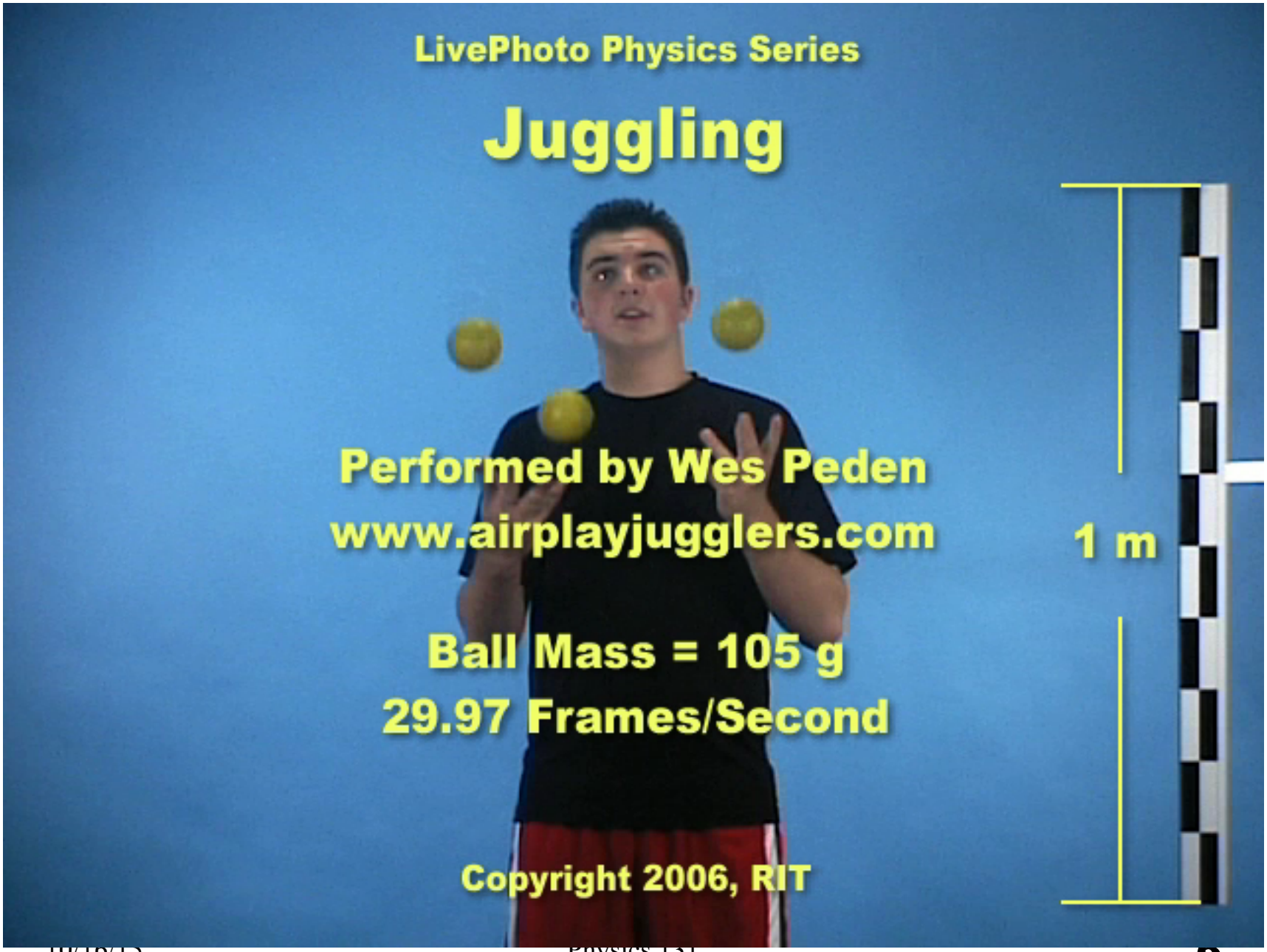
The Equation of the Day

The Impulse-Momentum Theorem

$$\Delta\left(m_A\vec{v}_A\right)=\vec{F}_A^{net}\Delta t$$

Makeup Exam 1

- Thursday, 10/22
  - Either 4-5 or 5-6.
  - You may come at either time.
  - If you show up and look at a copy of the exam, you are considered to have taken the test.
- Physics, room 0405


LivePhoto Physics Series
Juggling
Performed by Wes Peden
www.airplayjugglers.com
Ball Mass = 105 g
29.97 Frames/Second
Copyright 2006, RIT
1 m

Foothold ideas: Momentum

- We define the momentum of an object, A:

$$\vec{p}_A = m_A \vec{v}_A$$

- This is a way of defining "the amount of motion" an object has.
- Our "delta" form of N2 becomes

$$\left\langle \vec{F}_A^{net} \right\rangle = m_A \frac{\Delta \vec{v}_A}{\Delta t} = m_A \left\langle \vec{a}_A \right\rangle$$

which we can rewrite as

$$\left\langle \vec{F}_A^{net} \right\rangle = \frac{\Delta\left(m_A \vec{v}_A\right)}{\Delta t} = \frac{\Delta \vec{p}_A}{\Delta t}$$

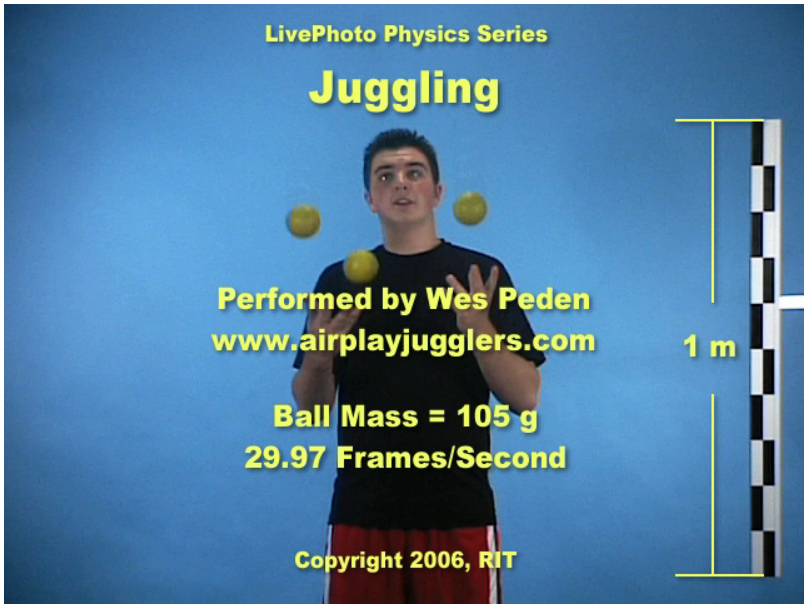
Foothold idea: The Impulse-Momentum Theorem

- Newton 2 $\vec{a}_A = \vec{F}_A^{net} / m_A$
- Put in definition of *a* $\frac{d\vec{v}_A}{dt} = \frac{\vec{F}_A^{net}}{m_A}$
- Multiply up by Δt $m_A \Delta \vec{v}_A = \left\langle \vec{F}_A^{net} \right\rangle \Delta t$
- Define Impulse $\vec{\mathcal{J}}_A^{net} = \left\langle \vec{F}_A^{net} \right\rangle \Delta t$
- Combine to get Impulse-Momentum Theorem for any object A

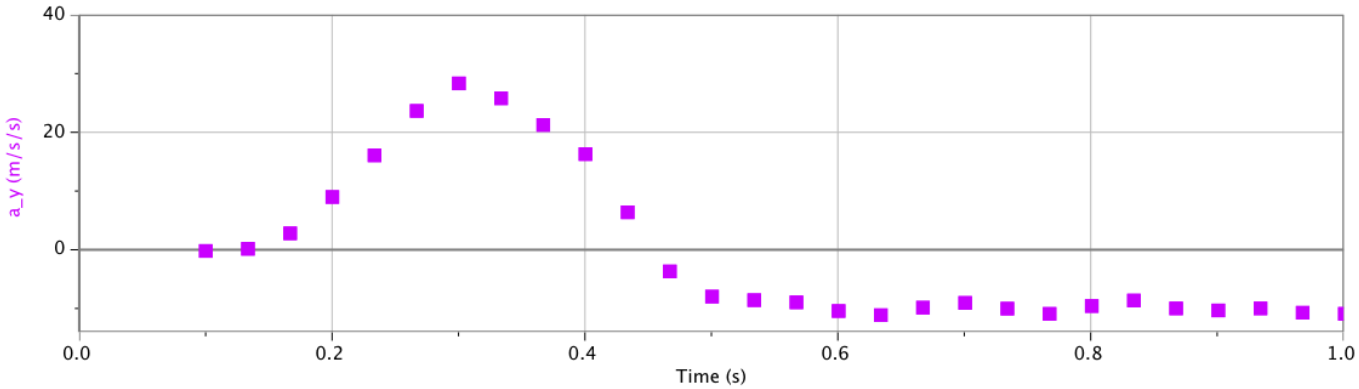
$$\Delta \vec{p}_A = \vec{\mathcal{J}}_A^{net}$$

Rethinking the juggler

- As the juggler throws the ball up, the ball rises, and then falls, how is momentum added to or taken away from the ball?

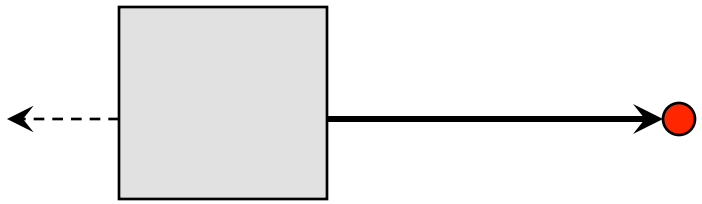


$$\Delta\left(m_B \vec{v}_B\right) = \left\langle \vec{F}_B^{net} \right\rangle \Delta t$$



Example: Recoil

- When an object at rest emits a part of itself, in order to conserve momentum, it must go back in the opposite direction.
- What forces are responsible for this motion?



(object goes backwards)