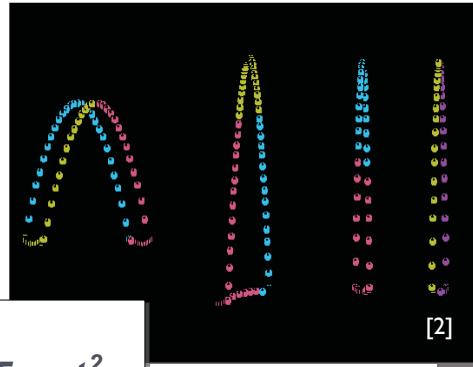


Juggling: as easy as...

$$(F+D)H=(V+D)N \quad [1]$$

F = time ball's in the air
 D = time ball's in a hand
 V = time a hand is vacant
 N = # balls
 H = # hands.



$$x(t) = x(0) + v_x(0) \cdot t$$

$$y(t) = y(0) + v_y(0) \cdot t - 0.5 \cdot g \cdot t^2$$

[1] Scientific Aspects of Juggling. In *Claude Elwood Shannon: Collected Papers*. Edited by N.J.A. Sloane and A. D. Wyner. IEEE Press, 1993.

[2] The Science of Juggling, by Peter J. Beek and Arthur Lewbel, *Scientific American*, November, 1995, Volume 273, Number 5, pages 92-97.

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Bloom's 2-Sigma Paper

This figure has been removed due to copyright restrictions. Please see:

Bloom, B. "The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring." *Educational Researcher* 13, no. 6 (June 1984): 4-16.



< 1 minute “active learning”

Give students enough time to actually formulate a question

- ▶ What questions do you have? 



A word about (these) clickers...

- Make sure your clicker is turned on 
- You should see:
 - a “Q:”
- When answering:
 - make a selection
 - press “enter” = 

you can change your response after entering



It's important to be thoughtful about what questions you ask, and why

Who is the sixteenth president of the United States?

- a. James Madison
- b. Woodrow Wilson
- c. Abraham Lincoln
- d. John Hancock

What level of Bloom's taxonomy is this question?

Level 1 - Remember

It's important to be thoughtful about what questions you ask, and why

If living cells similar to those found on earth were found on another planet where there was no molecular oxygen, which cell part would most likely be absent?

- a. Cell membrane
- b. Nucleus
- c. Mitochondria
- d. Ribosome
- e. Chromosomes

What level of Bloom's taxonomy is this question?

Level 2 - Understand

It's important to be thoughtful about what questions you ask, and why

The statement below is written from which of the following perspectives?

The Appalachian Development Highway Program (ADHP) is a road building program that is intended to break Appalachia's regional isolation and encourage Appalachian economic development.

- a. pro-environment
- b. pro-development
- c. pro-consumer

What level of Bloom's taxonomy is this question?

Level 4 - Analyze



Clickers can help engage students

1. *Based on research at NASA, what was the approximate net global change in temperature between 1880 and 1975?**

- a) + 2 °C
- b) + 0.4 °C
- c) + 0.08 °C
- d) - 0.08 °C
- e) - 0.4 °C
- f) - 2 °C

*Hansen J et al. PNAS 2006;103:14288-14293



5 - 20 minute exercise: Ask for student predictions **BEFORE** a conclusion is drawn. Students who are vested in the outcome will be more engaged.*

When tapped, do you think the thicker block will display a tone that is:

- higher than
- lower than
- the same as

the thinner block?

- Vote
- Discuss with partner
- Vote again

*Polya, 1965

clicker question #3

Open-ended, small group Brainstorm (5-20 minutes)

You have been called by the manufacturer of this hammer to determine:

- 1) why their hammers keep breaking like this;
- 2) what they can do to prevent this.

What information, tests, etc. do you need to make your recs?



Large-group, participatory demos (5-20 minutes)

- *Vacancy diffusion*
Students are the atoms on a 2-d lattice. Apply “jump” rules.
- *Tensile test*
Students are the atoms in a test specimen.



Desert Island Questions

- ▶ You're stuck on a desert island and you need to...
 - ...get a value for the coefficient of thermal expansion of Si
 - ...find out how long it will take your tea to cool down
 - ...find the 5th root of 900
 - ...etc.



5-20 minute activity: Designing a Carrot Peeler

- ▶ In groups of ~3 write down a list of qualities & attributes you think are important for carrot peelers. Be prepared to discuss this with the larger group.
 - ▶ Iterations
-

“Pair”-Share: Active Learning Strategies for your class

With a 1 or 2 others from similar disciplines:

- ▶ Consider the Learning Outcomes that you developed for your course (syllabus assignment).
 - ▶ Consider the various time-scales for active learning methods.
 - ▶ Develop active learning activities that will help students meet learning outcomes.
 - ▶ Consider problems/obstacles in implementation.
 - ▶ Be prepared to report to the larger group.
-

Bloom's Taxonomy of Cognitive Abilities

<http://web.mit.edu/tll/teaching-materials/learning-objectives/taxonomies.html>



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