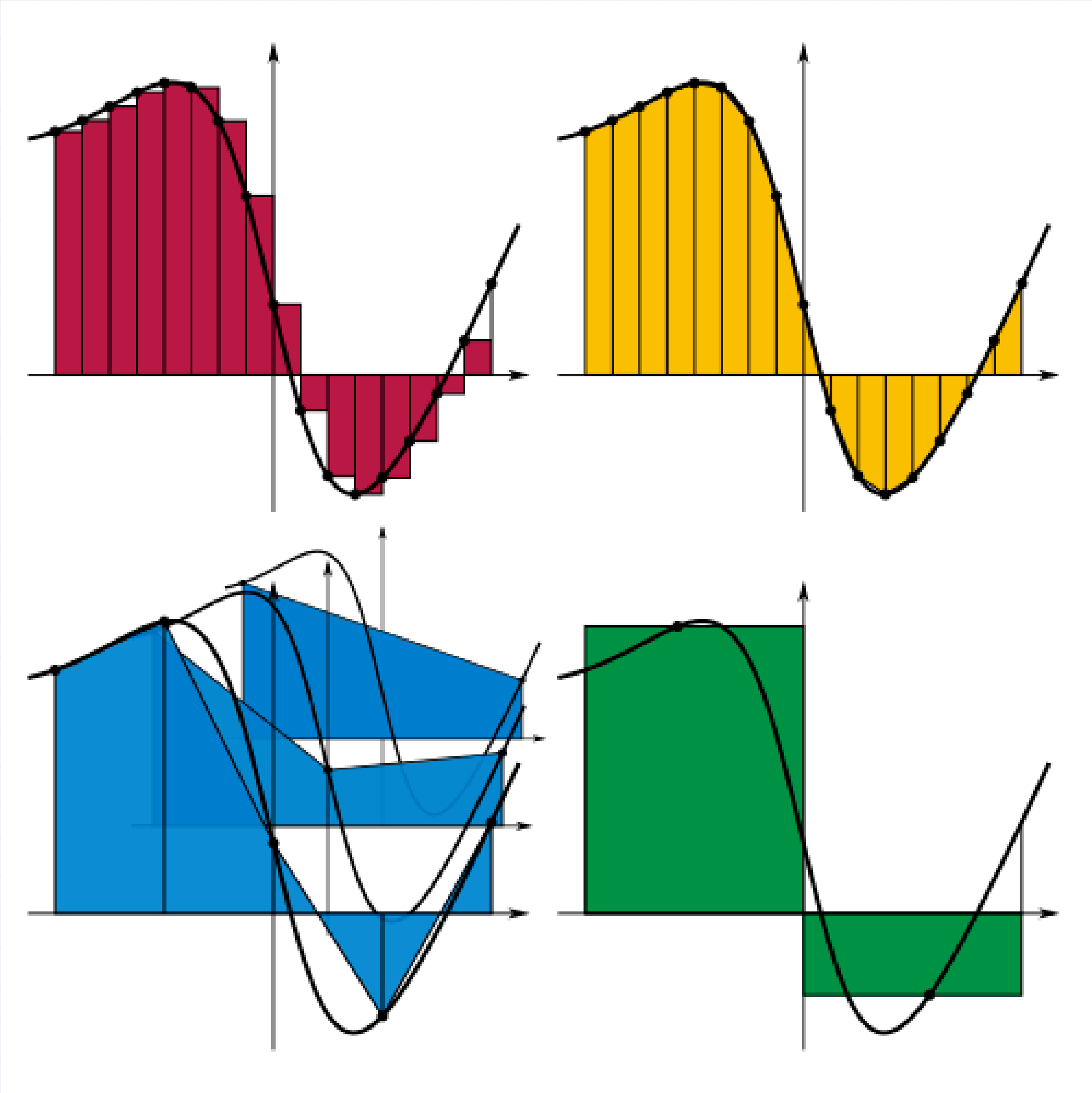
Day 10 - Integrating EOMs Numerically



Announcements

- **PERMANENT CHANGE:** OFFICE HOURS
  - DC Office hours 10:00-12:00 on Fridays (No Monday office hours)
- **CHANGES THIS WEEK** (DC has a conflict):
  - Office Hrs on Zoom today 16:00-17:00 https://msu.zoom.us/j/92295821308
  - 15:00-16:00 on Friday -> 14:00-15:00 on Friday

Seminars this week

Astronomy Seminar, Wednesday Feb 5th at 1:30pm in 1400 BPS

- Lia Corrales, Univ. of Michigan, *The cosmic journey of the elements, from dust to life*

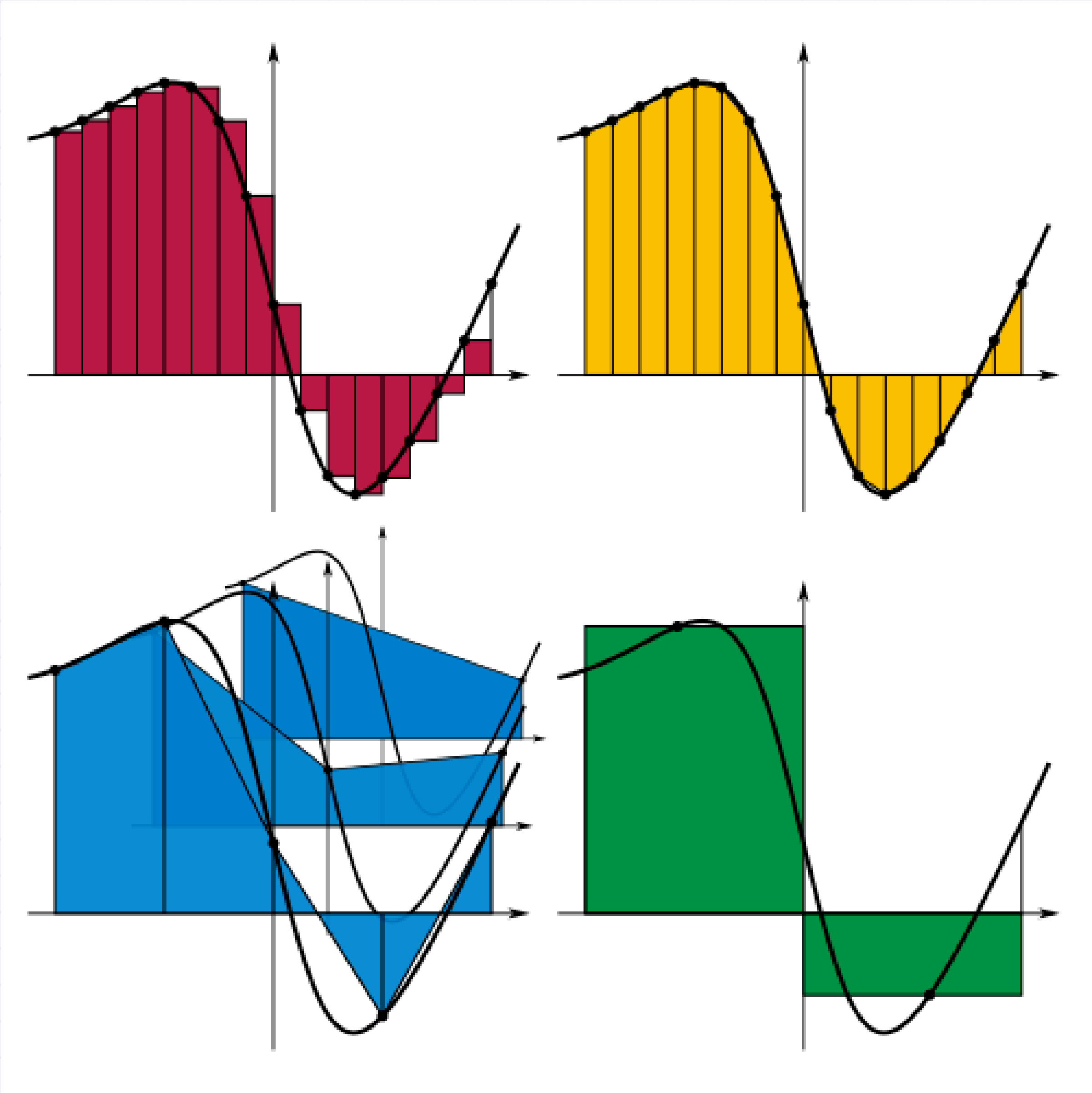
Physics & Astronomy Colloquium, Thursday Feb 6th at 3:30pm in 1415 BPS

- Andreas Jung, Purdue University, *Entangled Titans: unraveling the mysteries of Quantum Mechanics with top quarks*

Reminder: email me your extra credit seminar write-ups

Goals for this week

- Establish a model for drag forces
- Develop an understanding of the process for modeling forces
- Produce equations of motion that can be investigated
- Start probing the behavior of these systems with math and computing



Model-to-EOM Pipeline for Classical Mechanics

1. ✅ Develop conceptual description of the system; make justifiable assumptions
2. ✅ Using a framework of physics (i.e., Newton's Laws, Lagrangian Dynamics), develop a mathematical model of the system
3. ✅ Produce the equations of motion (EOM) by following the framework (i.e., ordinary differential equations)
4. 😵 **Solve for trajectories of the system** (e.g., $x(t)$, $v(t)$, $v(x)$)

Most EOMs are nonlinear

We need approximate methods to produce trajectories

Clicker Question 6-5

For the system of **Quadratic Drag in 1D**, we found a solution for the velocity as a function of time, with $v = 0$ at $t = 0$.

$$v(t) = v_{term} \tanh(gt/v_{term})$$

where $v_{term} = \sqrt{mg/c}$. What happens when $t \to \infty$?

1. The object stops moving.
2. The object travels at a constant velocity.
3. The object travels at an increasing velocity.
4. The object travels at a decreasing velocity.
5. I'm not sure.

Clicker Question 6-6

For the gravitational interaction, I want to compute the force acting on body B, located at $\vec{r}_B$, by body A, located at $\vec{r}_A$.

The gravitational force is given by:

$$\vec{F} = -G\frac{m_1 m_2}{r^2}\hat{r}$$

What is the appropriate form of $\vec{r}$?

1. $\vec{r} = \vec{r}_A - \vec{r}_B$
2. $\vec{r} = \vec{r}_B - \vec{r}_A$
3. Either is ok

Clicker Question 6-7

We found that the equation of motion for the spring-mass system was:

$$\ddot{x} = -\frac{k}{m}x = -\omega^2 x$$

Your friends have proposed the following **general solutions**:

1. $x(t) = A\cos(\omega t)$
2. $x(t) = B\sin(\omega t)$
3. $x(t) = A\cos(\omega t) + B\sin(\omega t)$
4. $x(t) = A\cos(\omega t + \phi)$
5. $x(t) = B\sin(\omega t + \phi)$
6. $x(t) = A\cos(\omega t + \phi) + B\sin(\omega t + \phi)$

How many of them are correct?

(1) Only one (2) Two (3) Three

(4) Four (5) All of them