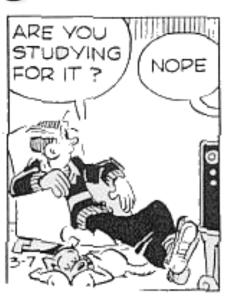# ■ Theme Music: Take the A Train
Duke Ellington

■ Cartoon: Blondie
Chick Young

Equations

- We only have a small number of basic equations.

- You need not only to learn (memorize) each one but you also need to learn how to use them and what they tell you conceptually.

- In these notes, each equation is boxed in the middle of an otherwise blank page. Use these to attach lots of "bubbles" to the equation with interpretations and extra info you will need to use it. (e.g. – what Δ means, how the equation relates to graphs, etc., etc., etc.)

Meaning of symbols?
Construct connections to graphs!

$$\langle v \rangle = \frac{\Delta x}{\Delta t}$$

$$\langle a \rangle = \frac{\Delta v}{\Delta t}$$

Physical meaning?
Coordinate representation
Adding and subtracting

$$\vec{r} = x\hat{i} + y\hat{j}$$

Summary of Newton's Laws

- **Newton 0:**
  - Objects only feel forces when something touches them. An object responds to the forces it feels when it feels them – plus the non-touching force of gravity.

- **Newton 1:**
  - An object that feels no unbalanced force keeps moving with the same velocity (which may = 0).

- **Newton 2:**
  - An object that is acted upon by other objects changes its velocity so that the acceleration is proportional to the net force and inversely proportional to the object's mass.

- **Newton 3:**
  - When two objects interact the forces they exert on each other are equal and opposite. $\vec{F}_{A \to B} = -\vec{F}_{B \to A}$

Physical meaning?
Which forces?
N2 for multiple objects

$$\vec{a}_A = \frac{\vec{F}_A^{net}}{m_A}$$

Classification of Forces

- Physical forces are what two objects do to each other that tends to change each other's velocity.
- Every force is an interaction that involves two objects.
- Touching forces
  - perpendicular to the surface and pressing in (NORMAL – N)
  - hooked to the surface and pulling out (TENSION – T)
  - parallel to the touching surfaces and opposing the relative motion of the surfaces (FRICTION – f)
- Non-touching forces
  - the earth pulling an object down (GRAVITY – W)

$$\vec{F}_{A \to B} \quad \text{where } F \text{ is either } N, T, f, \text{ or } W$$

Spring forces
Physical meaning?

$$T = ks$$

Physical meaning?
Implications?
Free fall?

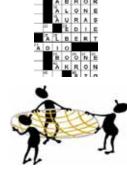$$\vec{W}_{E \to A} = m_A \vec{g}$$

Kinds of problems
(fill this in from your experience with HW and quizzes)

"How we think" Icons
(see lecture notes for detail on each one)

- Cat television
- Measurement
- Consistency
- Making sense
- Multiple representations
- Shopping for ideas
- Foothold ideas
- The implications game

Estimation:
Some numbers I will expect you to know

- Numbers

– number of UG students at UMd	~ 25,000	2.5×10^4
– number of people in MD	~ 4-5 million	4.5×10^6
– number of people in USA	~ 300 million	3.0×10^8
– number of people in world	~ 6 billion	6×10^9

- Distances (fill them in yourself!)
  - distance across DC
  - distance across USA
  - distance around the world
  - radius of the earth

- Measurements (fill them in yourself!)
  - your height
  - your weight
  - length of first digit of your thumb
  - length of your forearm

- And!
  - size of a foot, meter, mile
  - conversion between inches and cm
  - working with units and dimensions
  - sig. figs.!