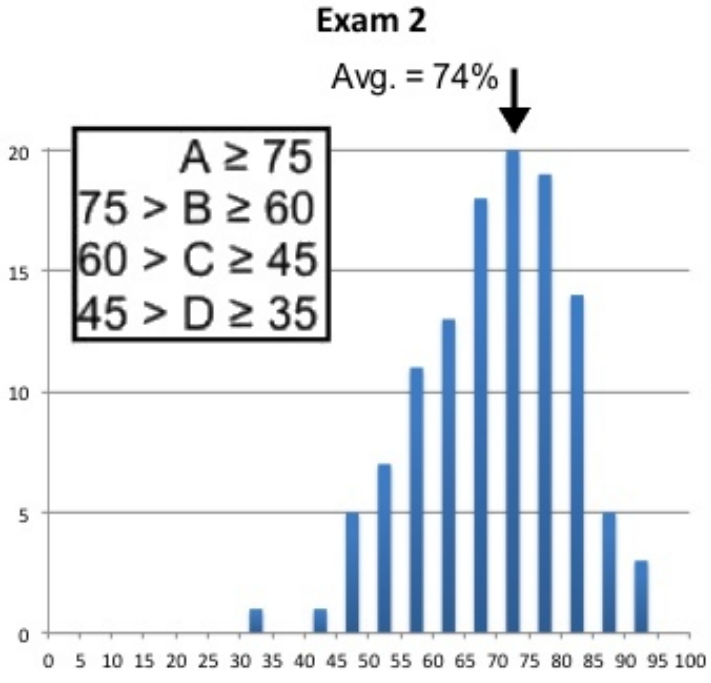
November 12, 2012 Physics 131 Prof. E. F. Redish

- **Theme Music:**
  Benny Goodman
  Runnin' Wild

- **Cartoon:**
  John McPherson
  Close to Home



2

Success on individual problems

	#1	#2	#3	#4	#5
Pct Correct	69%	84%	59%	72%	79%

Results on Problem #1

	1.1		1.2		1.3	1.4
A	0%	0	6%	A	8%	8%
B	16%	1	0%	B	6%	58%
C	83%	2	88%	C	10%	0%
		3	2%	D	75%	17%
		4	0%	E		16%
		5	0%			
		6	3%			

Principles for #1

- Each individual particle wanders randomly as a results of collisions with the ambient fluid.
- As a result of concentration differences, an initially localized distribution will spread out, getting wider and wider. This phenomenon is called *diffusion*.
- The width of the distribution grows like (and similarly for y and z)

$$\left\langle (\Delta x)^2 \right\rangle = 2Dt$$

Principles for #2

- Coulomb's law (as a vector)

$$\vec{F}_{A\to B} = \frac{k_c Q_A Q_B}{r_{AB}^2}\hat{r}_{A\to B}$$

- Geometry – Pythagorean theorem
- Forces add as vectors
  - Being able to take components.

Principles for #3

- Size of a mammalian cell
- Estimation of area
- Dividing by area of a single cell
- Doubling growth: solving for n given N

$$N = 2^n$$
$$\log N = n \log 2$$
$$n = \log N / \log 2$$

For #4

- Identify the number of questions that were in problem #4 and write them on your whiteboard.
- How many of these did you actually answer in your response?

Sample essay

A model can be thought of as a way to understand how something works given certain circumstances. A fundamental principle can be seen as a fact about something that is [almost] always true and never fails. The main difference lies in the fact that one always works in every situation (the fundamental principle), the other only works within some situations (the model). We can consider Hooke's law to be a model because it fails when the spring is stretched too much and when the spring is compressed to the point where all of its coils are touching. (At this point it takes a lot more force to compress it further). Newton's second law is different because it always holds true in every known situation. Since it never fails, we can consider Newton's second law to be a fundamental principle of our universe.

Sample essay

A fundamental principle is something deep rooted holds true almost all of the time. It can be a characteristic of a group of things that will hold for every member of that group. For example, a fundamental principle of biology would be that organisms are made up of cells....By this definition Hooke's law and N2 are not fundamental principles but rather are models. A model is an idealized representation of something. ...For example, DNA is not an idealized spring so HL cannot always hold true, although there are sections of the molecule in which we can use the law to describe it. Aditionally, N2 is helpful for making general predictions about objects' motion, but sometimes there are so many forces acting on the object it can be impossible to give us exact information about the objects' motion. However, it can still be used as a helpful guideline.

Principles for #5

- Momentum defined by $\vec{p} = m\vec{v}$
- If two objects interact with each other in such a way that the external forces on the pair cancel, then momentum is conserved.

$$\Delta\left(m_A\vec{v}_A + m_B\vec{v}_B\right) = 0$$

$$m_A\vec{v}_A^{\,i} + m_B\vec{v}_B^{\,i} = m_A\vec{v}_A^{\,f} + m_B\vec{v}_B^{\,f}$$