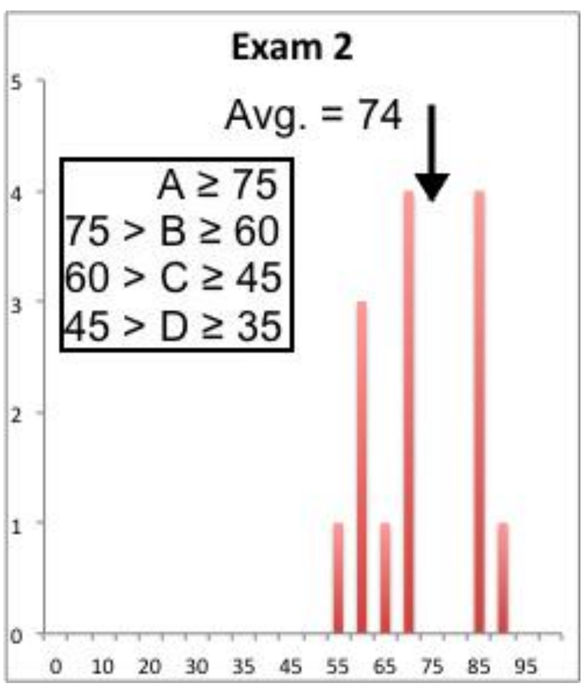
November 12, 2012 Physics 131 Prof. E. F. Redish

- **Theme Music:**
  Billy Joel
  Second Wind

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

A diabolical new testing technique: math essay questions.

11/12/12 Physics 131 **1**



11/12/12 **2**

Results on Problem #1

	1.1	1.2	1.3		1.4	1.5
L	14%	21%	14%	>	7%	21%
R	**86%**	**79%**	**79%**	=	7%	14%
0	0%	0%	7%	<	**86%**	**64%**
U	0%	0%	0%		0%	0%
D	0%	0%	0%		0%	0%

11/12/12 Physics 131 **3**

Success on individual problems

	#1	#2	#3	#4	#5
Pct Correct	79%	85%	54%	81%	84%

11/12/12 Physics 131 **4**

Principles for #1

- 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.

11/12/12 Physics 131 **5**

Principles for #2

- As a result of random motion, an initially localized distribution will spread out, getting wider and wider. This phenomenon is called *diffusion*
- The width of the distribution will grow like

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

11/12/12 Physics 131 **6**

Principles for #3

- Force due to pressure $\vec{F} = p\vec{A}$
- Estimation of size (of feet) and weight (of gecko) from experience and known measurements.
- Balance of forces and N2.

11/12/12 Physics 131 7

Sample essay

"Kenny and Jesse both bring up good points, but seem to be missing what they are fully trying to say. Kenny is missing the fact that in random motion Newton's laws do apply, but it is impossible to calculate or describe every molecule's motion individually with Newton's laws. I like to describe this issue as Newton's laws applying but not being applicable. In other words, they are subject to Newton's laws, but we personlyl cannot describe them directly and individually with Newton's laws.

Jesse also brings up a good point, that Newton's laws still apply, but the difference between random and directed motion is not necessarily how closely you look. For example, water can have a directed and random motion. As Kenny says, they are separate from each other. Each molecule of water will have movement in the direction the entire water body is moving, but it also has its random motion.

To reconcile both Kenny and Jesse, we would introduce them to emergent properties such as pressure, where we have used Newton's laws to describe the properties that many molecules are having, and that we can observe. Random motion is still present, and it is this random motion that can lead to observable behaviors such as forces, pressure, diffusion, momentum, etc."

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.

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

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

11/12/12 Physics 131 **9**