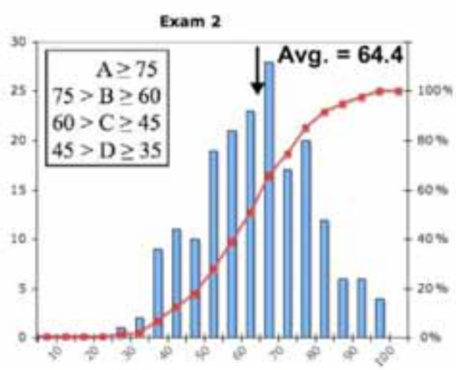
November 15, 2010 Physics 121 Prof. E. F. Redish

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

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

11/15/10 Physics 121 1



11/15/10 Physics 121 2

Success on individual problems

	#1	#2	#3	#4	#5
Pct Correct	63%	57%	83%	52%	68%

11/15/10 Physics 121 4

Principles for #1

- Reading of variables from "movie frames".
- Definition of angular velocity $\langle\omega\rangle = \frac{\Delta\theta}{\Delta t}$
- Pattern of vector directions of $\vec{r}, \vec{v}, \vec{a}$ in circular motion
- Components of vectors give sine and cosine
- What sin(θ), cos(θ) curves look like

11/15/10 Physics 121 5

Principles for #2

- N0: An object responds to the forces it feels at the instant it feels them (types: *T, N, f, W*)
- N1: When all forces are balanced, an object keeps a constant velocity.
- Work-energy theorem $\Delta\left(\frac{1}{2}mv^2\right) = W = \vec{F}^{net} \cdot \Delta\vec{r}$
- Velocity definition $\langle v\rangle = \frac{\Delta x}{\Delta t}$
- Friction rule $f = \mu N$
- Impulse definition $\mathcal{I} = F\,\Delta t$

11/15/10 Physics 121 6

Principles for #4

- Mech. Energy is conserved when all forces on the objects being considered are conservative (gravity, spring)
- Forms of energy (½ mv^2, ½ kx^2, mgh)

11/15/10 Physics 121 7

Sample answer for #4

- Lucy is right in this scenario. She should explain it to the other two by first validating their thoughts. Perhaps Fred is thinking that since the mass is the same in the dart and it's the same gun it should go the same distance. Maybe Ethel is thinking that since the spring is condensed half as much the dart will go half as far. Both are incorrect however! We need to think about energy conservation … We know that PE of a spring is $\frac{1}{2}kx^2$, and this must equal mgh because the PE at the top is only gravity: $\frac{1}{2}kx^2 = mgh$. We know that the spring coefficient, the mass, and gravity stay constant so we can essentially remove the from the equation. Therefore h really only depends on x. If x is halved, x^2 is ¼ of the original. Therefore, h would be ¼ x 24 or 6m.

11/15/10 Physics 121 **8**

Sample answer for #4

Lucy is correct. She should explain to her friends that this situation is one of conservation of mechanical energy. In the situation, given all of the forces are conservative, so the law is applicable. At $t = 0$s, all of the mechanical energy is in spring PE because it is at $h = 0$ (no grav PE) and the dart is not moving (no KE). At the time at maximum height, all of the mechanical energy is in gravitational PE because the spring in not touching the dart (spring PE = 0) and the velocity at that instant is 0 m/s. Therefore

$$ME_f = ME_i$$

$$\text{grav PE} = mgh = \tfrac{1}{2}kx^2 = \text{spring PE}$$

When the factor of x is ½, the effect of this change on h is x^2 or $(\frac{1}{2})^2$ equals ¼ .

11/15/10 Physics 121 **9**

Principles for #5

- Forms of energy ($\frac{1}{2}mv^2$, mgh)
- Energy conservation
- Translation of a situation into graphical representations through energies.

11/15/10 Physics 121 **10**