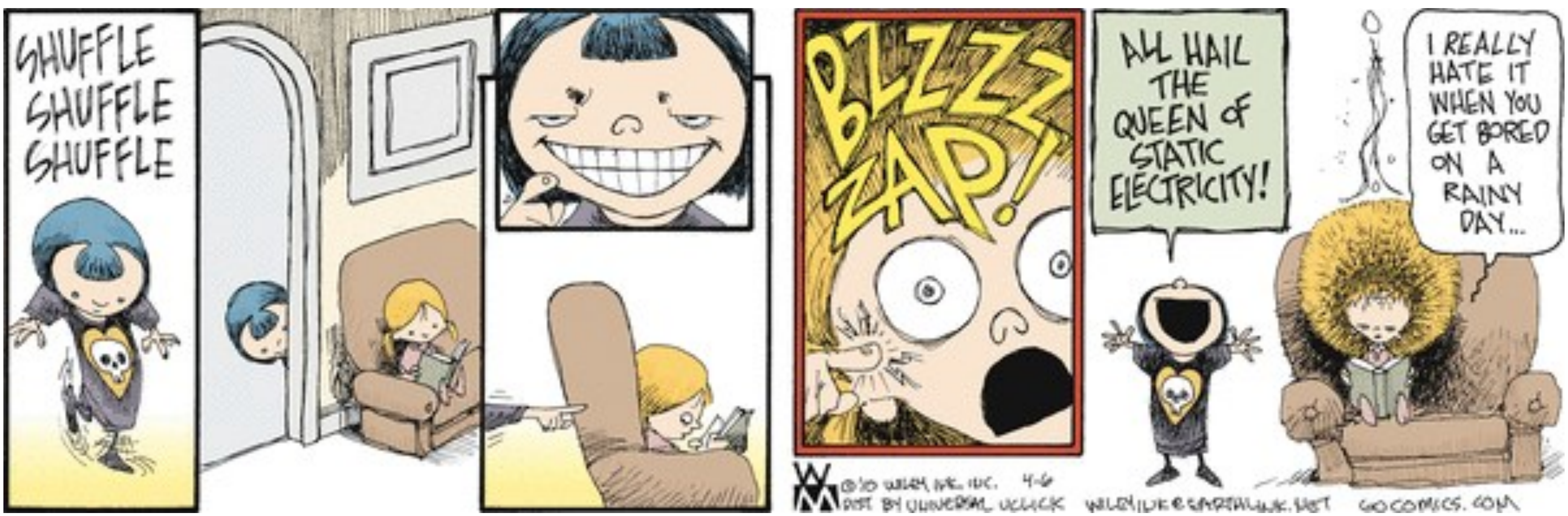
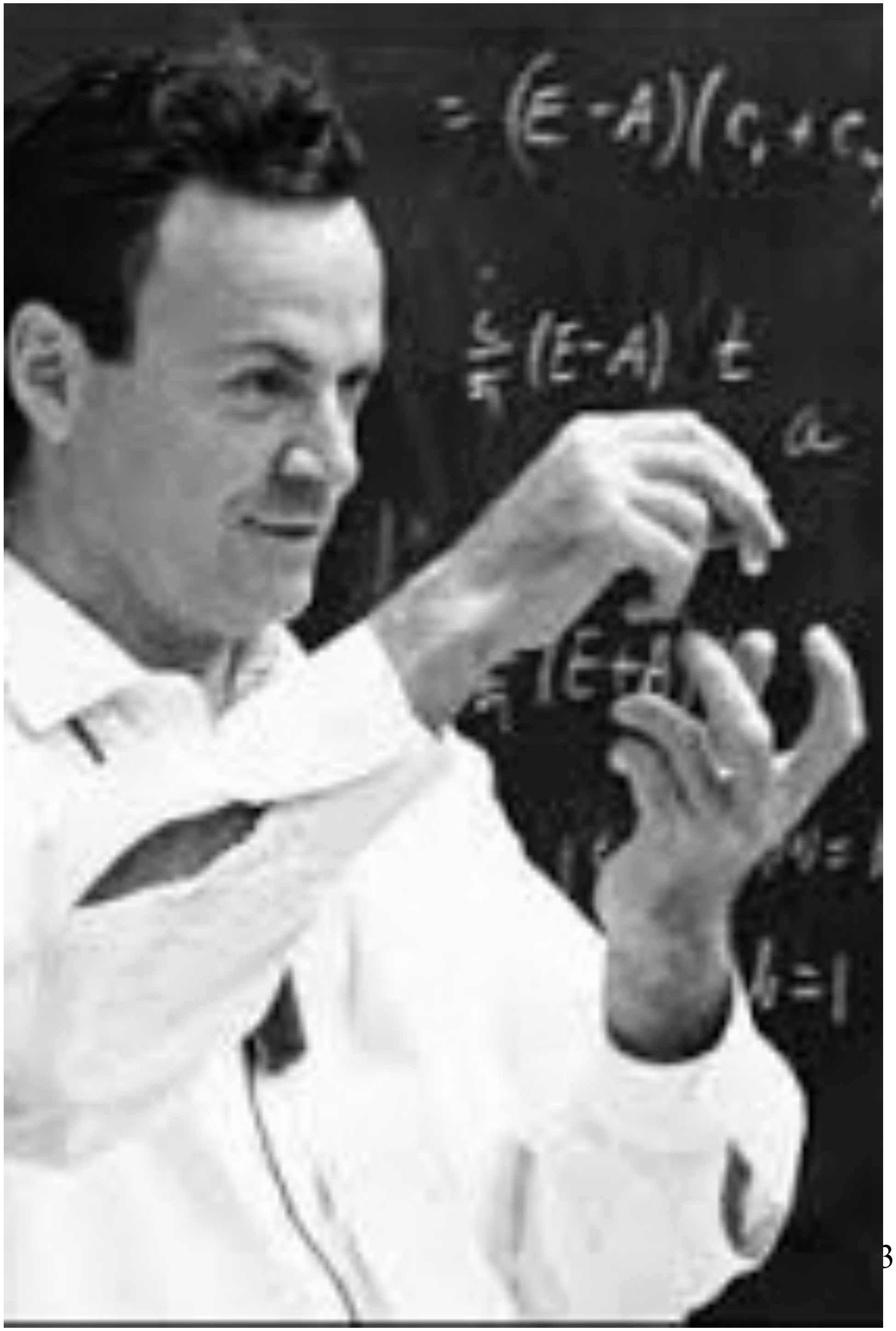
November 20, 2015 Physics 131 Prof. E. F. Redish

- **<u>Theme Music:</u> Information Society**
  Pure Energy
- **<u>Cartoon:</u> Wiley Miller**
  Non Sequitur





The Equation of the Day

Potential energy

$$\Delta U^{gravity} = \Delta\left(mgh\right)$$

$$\Delta U^{spring} = \Delta\left(\tfrac{1}{2}kx^2\right)$$

$$\Delta U^{spring} = \Delta\left(\frac{k_C qQ}{r}\right)$$

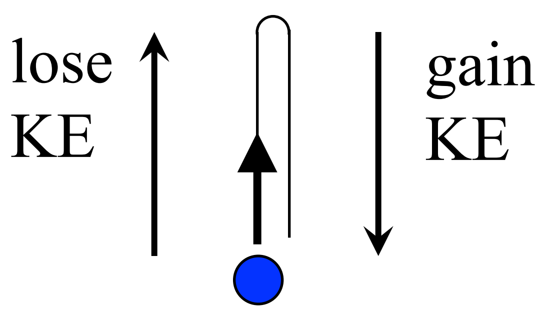
Physics 131

Foothold ideas: Kinetic Energy and Work

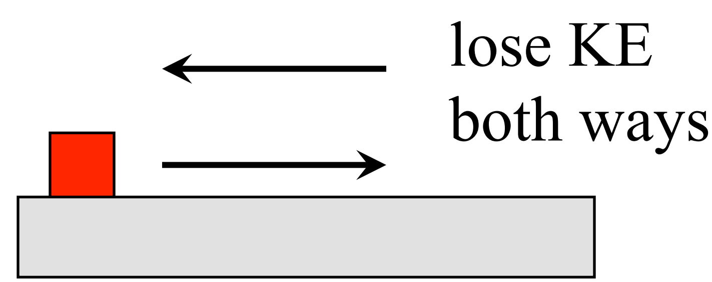
- Newton's laws tell us how velocity changes. The Work-Energy theorem tells us how speed (independent of direction) changes.
- Kinetic energy = $\frac{1}{2}mv^2$
- Work done by a force = $F_x \Delta x$ or $F_{||}\Delta r$ (part of force || to displacement)
- Work-energy theorem: $\Delta(\frac{1}{2}mv^2) = \vec{F}^{net} \cdot \Delta\vec{r}$

Conservative forces

- Forces (like gravity or springs) are conservative if when the force takes KE away, you can get it back when you go back to where you started.
- If the kinetic energy that a force takes away <u>can't</u> be restored by going back to where you started it is called non-conservative.
- Compare gravity and friction:



Gravity: Conservative



Friction: Non-Conservative

Foothold ideas: Potential Energy

- For some forces work only depends on the change in position. Then the work done can be written

$$\vec{F} \cdot \Delta\vec{r} = -\Delta U$$

U is called a *potential energy*.

- For gravity, $U_{gravity} = mgh$

For a spring, $U_{spring} = \frac{1}{2} kx^2$

For electric force, $U_{electric} = k_C Q_1 Q_2 / r_{12}$

Foothold ideas: Conservation of Mechanical Energy

- Mechanical energy
  - The mechanical energy of a system of objects is conserved if resistive forces can be ignored.

$$\Delta(KE + PE) = 0$$

$$KE_{initial} + PE_{initial} = KE_{final} + PE_{final}$$

This is why we define the PE with a negative sign.

- Thermal energy
  - Resistive forces transform coherent energy of motion (energy associated with a net momentum) into *thermal energy* (energy associated with internal chaotic motions and no net momentum)