Theme Music: Cannonball Adderly

Work Song

Cartoon: Bill Watterson

Calvin & Hobbes

Quiz 9

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Quiz 9 Average = 5.0
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 = $\vec{F} \cdot \Delta \vec{r}$ or $F_\parallel \Delta r$
  (part of force $\parallel$ to displacement)
- Work-energy theorem: $\Delta (\frac{1}{2}mv^2) = F_\parallel \Delta r$

Simplest example:
Consider the motion of two objects during a short time interval while they exert forces on each other.

Momentum change?
Impulse-momentum theorem!

$$\Delta \vec{p}_A = \vec{F}_{B \rightarrow A} \Delta t$$
$$\Delta \vec{p}_B = \vec{F}_{A \rightarrow B} \Delta t$$

Add and use N3!

$$\Delta \vec{p}_A + \Delta \vec{p}_B = \vec{F}_{B \rightarrow A} \Delta t + \vec{F}_{A \rightarrow B} \Delta t = (\vec{F}_{B \rightarrow A} + \vec{F}_{A \rightarrow B}) \Delta t = 0$$

Momentum Conservation!
Simplest example:
Consider the motion of two objects during a short time interval while they exert forces on each other.

KE change?
Work-energy theorem!

\[ \Delta KE_A = \vec{F}_{B \to A} \cdot \Delta \vec{r}_A \]
\[ \Delta KE_B = \vec{F}_{A \to B} \cdot \Delta \vec{r}_B \]

Add and use N3!

\[ \Delta KE_A + \Delta KE_B = \vec{F}_{B \to A} \cdot \Delta \vec{r}_A + \vec{F}_{A \to B} \cdot \Delta \vec{r}_B \]
\[ = \vec{F}_{B \to A} \cdot (\Delta \vec{r}_A - \Delta \vec{r}_B) \neq 0 \]

Foothold ideas:
Potential Energy

- For some forces between objects (gravity, electricity, springs) the work only depends on the change in relative position of the objects. Such forces are called conservative.

- For these forces the work done by them can be written

\[ \vec{F} \cdot \Delta \vec{r}_{rel} = -\Delta U \]

- \( U \) is called a potential energy and can be considered an energy of place belonging to the two objects that can be exchanged with KE.