

Chapter C8: Force and Energy

Physics I

College of the Atlantic

This chapter is about *relationships*...

C8.1: Momentum and Kinetic Energy

Kinetic energy is related to momentum:

$$K = \frac{p^2}{2m} . \quad (1)$$

Not all momentum transfers lead to a change in kinetic energy. Consider a small momentum transfer $d\vec{p}$. Suppose an object is moving at velocity \vec{v} . Only the “portion” of $d\vec{p}$ that is in the same direction as \vec{v} will lead to a change in kinetic energy.

$$dK = v dp \cos \theta = \vec{v} \cdot d\vec{p} , \quad (2)$$

where v is the speed of the object, dp the magnitude of the momentum transfer, and θ is the angle between \vec{v} and $d\vec{p}$.

C8.2: The Dot Product

The dot product between \vec{u} and \vec{v} is the magnitude of \vec{u} times that portion of $\text{mag}(\vec{v})$ that’s in \vec{u} ’s direction.

Two important formulas:

$$\vec{u} \cdot \vec{v} \equiv uv \cos \theta , \quad (3)$$

where $\theta \equiv$ the angle between \vec{u} and \vec{v} . Also,

$$\vec{u} \cdot \vec{w} = u_x w_x + u_y w_y + u_z w_z . \quad (4)$$

Note that:

- $\vec{u} \cdot \vec{w}$ is a scalar.
- $\vec{u} \cdot \vec{w}$ can be positive or negative.
- $\vec{u} \cdot \vec{u} = u^2$.

C8.3 An Interaction's Contribution to dK

An interaction gives rise to a force on an object. The amount by which this interaction changes the object's kinetic energy is given by:

$$[dK] \equiv \vec{F} \cdot d\vec{r} \quad (5)$$

Recall that Force and impulse $[d\vec{p}]$ are related by:

$$\vec{F} \equiv \frac{[d\vec{p}]}{dt}. \quad (6)$$

C8.4 The Meaning of k-Work

When there's a kinetic energy transfer $[dK]$, the energy comes from some sort of potential energy—it does not come from another interaction. Remember that potential energy is a property of an interaction, not a property of a particular object.

C8.5 The Earth's Kinetic Energy

Yet again, we note that the earth is way bigger than us.

C8.6 Force Laws

Don't worry about this section. The main point is that one can go from a potential energy function to a force and vice-versa.

C8.7 Contact Interactions

The normal (perpendicular) part of a contact interaction contributes no k-work.