Momentum

Physics 211
Syracuse University, Physics 211 Spring 2022
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April 5, 2022

Announcements

- A reminder: The final exam is on May 11. You cannot take it early by University rules.
- Group Exam 3 on Friday; Exam 3 next Tuesday
- Review notes posted on the website
- Extra homework help hours today: 9:45-10:45, 2:30-3:30 PM, 5-7 PM (Physics Clinic – combination of me and others)
- HW7 due Friday

Recitation or homework questions?

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A request: “the one with the penguin” from last week

Sample problems: an excited dog

A person of mass m is sitting in a tire swing with a string of length L when their dog (mass M) runs and jumps horizontally into their lap.

If they swing up to an angle θ above the horizontal, how fast was their dog running?

Sample problems: “springs and momentum”

This was on 2020’s practice exam (on a separate PDF)...

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The Newton's cradle

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- **All** collisions conserve momentum
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Let's look at some examples from 2020's practice exam on this. For each one, tell me:

- A: Conserves momentum, but loses energy (inelastic collision)
- B: Conserves momentum and conserves energy (elastic collision)
- C: Conserves momentum, but gains energy (not possible)
- D: Does not conserve momentum or energy (not possible)
- E: Does not conserve momentum, but does conserve energy (not possible)

An application: neutron moderators

The only truly elastic collisions in nature are between particles. If we want *totally* elastic collisions, we should look to nuclear physics!

A note: this calculation we are going to do here demonstrates two things:

- How elastic collisions work
- ... and how *the art of approximation* is used in physics and engineering!

Recall how a nuclear reactor works:

- ^{235}U fissions when struck by neutrons with low energy (600 times more likely at low energy, less than 0.1 eV)
- When ^{235}U fissions, it produces neutrons with 2 MeV of kinetic energy ($v \approx 20$ million m/s)

How do we make these neutrons go from 2 million eV to 0.1 eV of kinetic energy so they can produce more fissions?

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How much kinetic energy is lost?

The fraction of kinetic energy lost is

$$4\frac{m}{M}.$$

So what atoms can we use as moderators?

They have to scatter neutrons more readily than they absorb them (hydrogen so-so, oxygen/carbon/heavy hydrogen great)

They have to be lightweight (that's what we just found)

They have to not be chemically grouchy (no hydrogen or oxygen by themselves!)

- H_2O (light water: most of the world, not the best moderator)
- D_2O (heavy water: Canadians)
- CO_2 (carbon dioxide: British)
- Pure carbon (Graphite: Soviets)