Midterm is canceled. There will be a “Homework #3.5” instead. Homework #3 stops after problem 18. Problems 19–28 will move to Homework #3
to Homework #3\textsuperscript{1}\textsubscript{2}.
Gradebook data (only your own!) is now online

You can now check your entries in my grade book with the “my info” button on the online feedback page.

This is still a bit of a work in progress.
Comments on course policies

So much weight on homework is unusual in a physics course.

- many other courses make grades nearly 100% exam-based
- instructors worry that students will copy answers
- I want to give you incentive to put your best effort into HW
- you learn much more from HW than from studying for exams

Handing out solutions so promptly is also unusual

- I hand them out when you’re most likely to learn from them
- I want you to take deadlines seriously, not to fall behind

Both of these decisions require me to trust you

- right balance between collaboration and thinking for yourself
- using good judgement about deadlines and excuses
- taking seriously Penn’s very high standards for academic integrity and honesty in your work
Comments on course policies

In a class of 46 busy college students, some crises will happen

- if I’m unfairly harsh with you, it hurts your motivation
- if I’m too lenient, it hurts everyone else’s motivation to work
- so I think I need to have a clear policy:

  I will always accept late work, but the maximum credit will be 50%, unless there is a legitimate emergency that requires us to negotiate an extension.

  If you have an emergency that requires turning in HW late, you need to contact me early enough that you actually get a response from me before the deadline. Otherwise, just accept responsibility for your own actions and take the 50% late penalty.

  If you ask me more than once in the term for an extension, I will use the Course Problem Notice mechanism to ensure that you discuss with your academic advisor whatever may be causing difficulty in your life. Sometimes people have real crises, and advisors can be very helpful in offering their wisdom.

I see grading as a way to motivate you to learn

- not to select who is born to be “better at physics,” etc.
- I want you to learn as much as you reasonably can this year
- If you keep up and do all of the work, you’ll be happy with your grade. I want to help you to succeed!
Chapter 6 — (pre-Einsteinian) relativity

Sources of confusion:
  ▶ whole chapter!
  ▶ especially the notation!!

Sigh . . . and after such an artful first sentence: “Did you ever, sitting in a car at a red light and looking at the car next to you, slam on the brakes because you thought you were starting to roll, but it turned out that your car never moved?”
Key ideas from Chapter 6

- velocities add
- when you add the same offset to every velocity (e.g. by observing it from the perspective of a moving train) an expression like $\vec{v}_1 - \vec{v}_2$ doesn’t change
Key ideas from Chapter 6

▶ velocities add
▶ when you add the same offset to every velocity (e.g. by observing it from the perspective of a moving train) an expression like $\vec{v}_1 - \vec{v}_2$ doesn't change
▶ but be careful: something like $\frac{1}{2}m_1 v_1^2 + \frac{1}{2}m_2 v_2^2$ does change
Key ideas from Chapter 6

- velocities add
- when you add the same offset to every velocity (e.g. by observing it from the perspective of a moving train) an expression like $\vec{v}_1 - \vec{v}_2$ doesn’t change
- but be careful: something like $\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$ does change
- Imagine a car accident, as witnessed by a stationary pedestrian and also by a passing motorist. The physics of what happened to the two colliding cars does not depend on the motion of the observer. But the two observers might write down different math corresponding to what they see.
Key ideas from Chapter 6

▶ velocities add
▶ when you add the same offset to every velocity (e.g. by observing it from the perspective of a moving train) an expression like $\vec{v}_1 - \vec{v}_2$ doesn’t change
▶ but be careful: something like $\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$ does change
▶ Imagine a car accident, as witnessed by a stationary pedestrian and also by a passing motorist. The physics of what happened to the two colliding cars does not depend on the motion of the observer. But the two observers might write down different math corresponding to what they see.
▶ In many cases, the math is greatly simplified if you analyze the problem from the reference frame in which the center of mass is not moving. I’ll work out an example.
Key ideas from Chapter 6

► velocities add
► when you add the same offset to every velocity (e.g. by observing it from the perspective of a moving train) an expression like $\vec{v}_1 - \vec{v}_2$ doesn’t change
► but be careful: something like $\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$ does change
► Imagine a car accident, as witnessed by a stationary pedestrian and also by a passing motorist. The physics of what happened to the two colliding cars does not depend on the motion of the observer. But the two observers might write down different math corresponding to what they see.
► In many cases, the math is greatly simplified if you analyze the problem from the reference frame in which the center of mass is not moving. I’ll work out an example.
► If you close your eyes (and there is no wind, etc.), there is no way for you to “feel” the difference between being at rest and moving at a constant velocity.
Imagine that you are in a jet airplane that has just landed and is in the midst of screeching to a stop on the runway. Is the frame of reference in which your body is at rest an inertial frame?

(a) Yes
(b) No
Suppose I’m a passenger on a train that is speeding toward NYC at 40 m/s. In search of coffee, I walk toward the back of the train at 2 m/s, just as the train whizzes past Princeton Junction. To a passenger watching me from the train platform, my speed is

(a) 2 m/s
(b) 38 m/s
(c) 40 m/s
(d) 42 m/s
I’m driving east at 50 mph. A little kid looks out the window of a westbound car that is going 40 mph. From the kid’s point of view, how fast am I moving?

(a) 10 mph
(b) 40 mph
(c) 50 mph
(d) 90 mph
I’m driving east at 50 mph. A truck driving east at 60 mph overtakes me. As I look out my window, how fast does the truck appear to be moving?

(a) 10 mph
(b) 50 mph
(c) 60 mph
(d) 110 mph
Suppose you are sitting in a soundproof, windowless room aboard Air Force One, which is flying at cruising altitude in smooth air. Which of the following can you detect from inside the room?

(a) how fast the airplane is moving with respect to the ground
(b) whether or not the airplane is speeding up
(c) whether or not the airplane is slowing down
(d) whether or not the airplane is changing direction
(e) all of the above
(f) (b) and (c)
(g) (b), (c), and (d)
Suppose that I bolt a set of weights securely onto the two ends of a metal bar, forming a kind of dumbbell, and I determine that when the bar is at rest, the center of mass is 10 cm away from the heavier end of the bar. I tie a piece of string to mark the center of mass. (Draw this on board?)

Now I throw the dumbbell across the room. The center of mass of the flying dumbbell

(a) is at rest in the earth’s reference frame
(b) depends on whether the dumbbell is isolated
(c) is different from the location of the string
(d) is still indicated by the location of the string
If I observe a system from its zero-momentum reference frame, what can I say about its center-of-mass velocity?

(a) The center-of-mass velocity (as seen from the ZM frame) is the same as the velocity of the ZM reference frame (as seen from the earth frame).

(b) The center-of-mass velocity (as seen from the ZM frame) is zero.

(c) When observing from earth’s frame of reference, a system’s center-of-mass velocity will be the same as the velocity of the ZM reference frame.

(d) (a) and (c)

(e) (a), (b), and (c)

(f) (b) and (c) [oops, I had left this one out]
For which of the following totally inelastic collisions can all of the initial kinetic energy be converted into deforming the car (or somehow be converted into something other than kinetic energy)?

(a) $m_1 = 1000 \text{ kg}$, $|v_1| = 10 \text{ m/s}$, $m_2 = 1000 \text{ kg}$, $|v_2| = 10 \text{ m/s}$
(b) $m_1 = 1000 \text{ kg}$, $|v_1| = 20 \text{ m/s}$, $m_2 = 1000 \text{ kg}$, $|v_2| = 10 \text{ m/s}$
(c) $m_1 = 1000 \text{ kg}$, $|v_1| = 20 \text{ m/s}$, $m_2 = 2000 \text{ kg}$, $|v_2| = 10 \text{ m/s}$
(d) $m_1 = 1000 \text{ kg}$, $|v_1| = 10 \text{ m/s}$, $m_2 = 2000 \text{ kg}$, $|v_2| = 20 \text{ m/s}$
(e) (a) and (c)
(f) (a), (b), and (c)
(g) (a), (b), (c), and (d)
When a small ball collides elastically with a more massive ball that is initially at rest, the massive ball tends to remain (approximately) at rest, whereas the small ball bounces back at almost its original speed. Now consider a massive ball of inertia $M$ moving at speed $v$ and striking a small ball of inertia $m$ initially at rest. The change in the small ball’s momentum is

(a) $Mv$
(b) $2Mv$
(c) $mv$
(d) $2mv$
(e) none of the above
A small rubber ball is put on top of a basketball, and the combination is dropped from a certain height. Compared to the speed that it has just before the basketball hits the ground, the speed with which the rubber ball rebounds is

(a) the same
(b) twice as large
(c) three times as large
(d) four times as large
(e) none of the above
The 200 g head of a golf club is moving at 45 m/s when it strikes a stationary 50 g golf ball. Let’s look at it both from the “earth” frame and from the “zero momentum” frame. Many questions we could ask, but let’s start with figuring out how fast the golf ball moves after the collision.