Flipping the classroom and never looking back
Flipping the classroom and never looking back

@eric__mazur

iOnTheFuture4 Conference
Sydney, Australia, 20 August 2016
thermal expansion
All of them
Consider a rectangular metal plate with a circular hole in it.
Consider a rectangular metal plate with a circular hole in it.

When the plate is uniformly heated, the diameter of the hole

1. increases.
2. stays the same.
3. decreases.
Consider a rectangular metal plate with a circular hole in it.

When the plate is uniformly heated, the diameter of the hole

1. increases.
2. stays the same.
3. decreases.

you got all fired up!
Before I tell you the answer, let’s analyze what happened.
Before I tell you the answer, let’s analyze what happened.

You…
Before I tell you the answer, let’s analyze what happened.

You...

1. made a commitment
Before I tell you the answer, let’s analyze what happened.

You...

1. made a commitment
2. externalized your answer
Before I tell you the answer, let’s analyze what happened.

You…

1. made a commitment
2. externalized your answer
3. moved from the answer/fact to reasoning
Before I tell you the answer, let’s analyze what happened.

You…

1. made a commitment
2. externalized your answer
3. moved from the answer/fact to reasoning
4. became emotionally invested in the learning process
Consider a rectangular metal plate with a circular hole in it.

When the plate is uniformly heated, the diameter of the hole

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1. increases. ✓
2. stays the same.
3. decreases.
consider atoms at rim of hole
consider atoms at rim of hole
consider atoms at rim of hole
consider atoms at rim of hole
consider atoms at rim of hole

you won’t forget this
1st exposure deeper understanding
how to effectively transfer information outside classroom?
but...
• transfer pace set by video
• viewer passive
• viewing/attention tanks as time passes
• isolated/individual experience
we’re simply moving this outside classroom!
• transfer pace set by reader
• viewer active
but...
isolated/individual experience &
no real accountability
want:
every student prepared for every class
want:
every student prepared for every class
(without additional instructor effort)
Solution
turn out-of-class component also into a social interaction!
Perusall every student prepared for every class
CHAPTER 4  MOMENTUM

In the preceding two chapters, we developed a mathematical framework for describing motion along a straight line. In this chapter, we continue our study of motion by investigating inertia, a property of objects that affects their motion. The experiments we carry out in studying inertia lead us to discover one of the most fundamental laws in physics—conservation of momentum.

4.1 Friction

Picture a block of wood sliding on a wooden surface. If the block is released from a height, it travels a certain distance but eventually comes to rest. Depending on the smoothness of the block and the smoothness of the wooden surface, this stopping may happen sooner or it may happen later. If the two surfaces in contact are very smooth and slippery, the block slides for a longer time interval than if the surfaces are rough or sticky. This you know from everyday experience: A hockey puck slides easily on ice but not on a rough road.

Figure 4.1 shows how the velocity of a wooden block decreases on three different surfaces. The slowing down is due to friction—the resistance to motion that one surface or object encounters when moving over another. Notice that, during the interval covered by the velocity-versus-time graph, the velocity decreases as the block slides over ice is hardly observable. The block slides easily over ice because there is very little friction between the two surfaces. The effect of friction is to bring two objects to rest with respect to each other—in this case the wooden block and the surface it is sliding on. The less friction there is, the longer it takes for the block to come to rest.

![Figure 4.2](image.png)

Figure 4.2 Low-friction track and carts used in the experiments described in this chapter.

In the absence of friction, objects moving along a horizontal track keep moving without slowing down.
log in through social network
CHAPTER 4 MOMENTUM

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You may wonder whether it is possible to make surfaces that have no friction at all, such that an object, once given a shove, continues to glide forever. There is no totally frictionless surface over which objects slide forever, but there are ways to minimize friction. You can, for instance, float an object on a cushion of air. This is most easily accomplished with a low-friction track—a track whose surface is dotted with little holes through which pressurized air blows. The air serves as a cushion on which a conveniently shaped object can float, with friction between the object and the track all but eliminated. Alternatively, one can use wheeled carts with low-friction bearings on an ordinary track. Figure 4.2 shows low-friction carts you may have encountered in your lab or class. Although there is still some friction both for low-friction tracks and for the track shown in Figure 4.2, this friction is so small that it can be ignored during an experiment. For example, if the track in Figure 4.2 is horizontal, carts move along its length without slowing down appreciably. In other words:

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see who is online
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Figure 4.1 shows how the velocity of a wooden block decreases on three different surfaces. The slowing down is due to friction—the resistance to motion that one surface or object encounters when moving over another. Notice that, during the interval covered by the velocity-versus-time graph, the velocity decrease as the block slides over ice is hardly observable. The block slides easily over ice because there is very little friction between the two surfaces. The effect of friction is to bring two objects to rest with respect to each other—in this case the wooden block and the surface it is sliding on. The less friction there is, the longer it takes for the block to come to rest.

Figure 4.1 Velocity-versus-time graph for a wooden block sliding on three different surfaces. The rougher the surface, the more quickly the velocity decreases.

You may wonder whether it is possible to make surfaces that have no friction at all, such that an object, once given a shove, continues to glide forever. There is no totally frictionless surface over which objects slide forever, but there are ways to minimize friction. You can, for instance, float an object on a cushion of air. This is most easily accomplished with a low-friction track—a track whose surface is dotted with little holes through which pressurized air blows. The air serves as a cushion on which a conveniently shaped object can float, with friction between the object and the track all but eliminated. Alternatively, one can use wheeled carts with low-friction bearings on an ordinary track. Figure 4.2 shows low-friction carts you may have encountered in your lab or class. Although there is still some friction both for low-friction tracks and for the track shown in Figure 4.2, this friction is so small that it can be ignored during an experiment. For example, if the track in Figure 4.2 is horizontal, carts move along its length without slowing down appreciably. In other words:

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Another advantage of using such carts is that the track constrains the motion to being along a straight line. We can then use a high-speed camera to record the cart's position at various instants, and from that information determine its speed and acceleration.

4.1 (a) Are the accelerations of the motions shown in Figure 4.1 constant? (b) For which surface is the acceleration largest in magnitude?
In the preceding two chapters, we developed a mathematical framework for describing motion along a straight line. In this chapter, we continue our study of motion by investigating inertia, a property of objects that affects their motion. The experiments we carry out in studying inertia lead us to discover one of the most fundamental laws in physics—conservation of momentum.

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Figure 4.1 shows how the velocity of a wooden block decreases on ice due to friction. During the graph, the velocity decreases as the block slides over ice is hardly observable. The block slides easily over ice because there is very little friction between the two surfaces. The effect of friction is to bring two objects to rest with respect to each other—in this case the wooden block and the surface it is sliding on. The less friction there is, the longer it takes for the block to come to rest.

Figure 4.1: Velocity-versus-time graph for a wooden block sliding on three different surfaces. The smoother the surface, the more quickly the velocity decreases.

You may wonder whether it is possible to make surfaces that have no friction at all, such that an object, once given a shove, continues to glide forever. There is no totally frictionless surface over which objects slide forever, but there are ways to minimize friction. You can, for instance, float an object on a cushion of air. This is most easily accomplished with a low-friction track—a track whose surface is dotted with little holes through which pressurized air blows. The air serves as a cushion on which a conveniently shaped object can float, with friction between the object and the track all but eliminated. Alternatively, one can use wheeled carts

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Figure 4.1 shows how the speed of an object decreases over time due to friction—the resistance to motion that one surface or object encounters when moving over another. Notice that, during the interval covered by the velocity-versus-time graph, the velocity decrease as the block slides. For ice is hardly observable. The block slides easily because there is very little friction between the two surfaces. The effect of friction is to bring two objects into rest with respect to each other—in this case the wooden block and the surface it is sliding on. The less friction there is, the longer it takes for the block to come to rest.

**Figure 4.1** Velocity-versus-time graph for a wooden block sliding on three different surfaces. The smoother the surface, the more quickly the velocity decreases.

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This chat window is now open...
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Figure 4.1 shows how the velocity of a wooden block decreases on three different surfaces. The slowing down is due to friction—the resistance to motion that one surface or object encounters when moving over another. Notice that, during the interval covered by the velocity-versus-time graph, the velocity decreases as the block slides over ice is hardly observable. The block slides easily over ice because there is very little friction between the two surfaces. The effect of friction is to bring two objects to rest with respect to each other—in this case the wooden block and the surface it is sliding on. The less friction there is, the longer it takes for the block to come to rest.

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The lever arm distances must now be determined relative to the left end of the rod. The lever arm distance of force $F_1$ to this point is zero, and so the torque caused by that force about the left end of the rod is zero. If I choose counterclockwise as the positive direction of rotation, $F_1$ causes a negative torque about the left end of the rod; the force $F_1^r$, exerted by the pivot, causes a positive torque about the left end of the rod. The lever arm distance of $F_2$ about the left end of the rod is $r_1 + r_2$ that of $F_2^r$ is $r_1$. Because the rod is at rest, the magnitude of the force exerted by the pivot is equal to the sum of the forces $F_1$ and $F_2$. Taking into account the signs of the torques, we find that the sum of the torques about the left end of the rod is $r_1(F_1 + F_2) - (r_1 + r_2)F_2 = r_1F_1 - r_2F_2$. This is the same result we obtained for the torques about the pivot, and so the sum of the torques about the left end is zero. 

Exercise 12.1 shows that the sum of the torques about the left end of the rod is zero, just like the sum of the torques about the pivot. You can repeat the calculation for the torques about the right end of the rod or any other point, and each time you will find that the sum of the torques is zero. The reason is that the rod is not rotating about any point, and so the sum of the torques must be zero about any point. In general we can say:

For a stationary object, the sum of the torques is zero.

For a stationary object we can choose any reference point we like to calculate torques. It pays to choose a reference point that simplifies the calculation. As you have seen, we do not need to consider any force that is exerted at the reference point. So, by putting the reference point at the point of application of a force, we can eliminate that force from the calculation.
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12.2 In the situation depicted in Figure 12.2a, you must
I don’t understand how this combination of factors tells you anything about direction? Aren’t magnitude and lever arm distance both scalar quantities? It seems like we would need to know some sort of direction to calculate torque.

Oct 20 12:09 am

I think you may be able to think about the
direction separately. So, after multiplying this magnitude and
distance, you can attach a sign to the torque based on the defined
parameters of the system. In the following paragraph, they start to
explain how to choose this direction.

Oct 20 12:38 am

This is a great question. To further elaborate on
this, we can think of this in terms of the Torque equation. The
equation for torque is $\tau = r \times F$, with $r$ being the level arm distance
and $F$ being force. We know that force is a vector vector from previous
chapters, and in regards to "$r" it can also be thought of as the radial
vector. What this means is that this distance from the pivot points from
the axis of rotation to the point where the force acts. In as previously
mentioned, there is a general convention (the right-hand rule) that is used
to determine the direction which happens to be perpendicular to both the
radius from the axis and to the force.

Oct 22 8:48 pm
how to get students to participate?
use combination of intrinsic and extrinsic motivation drivers
rubric-based assessment

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rubric-based assessment

- quality (thoughtful reading & interpretation)
rubric-based assessment

- **quality** (thoughtful reading & interpretation)
- **quantity** (minimum 10)
rubric-based assessment

• quality (thoughtful reading & interpretation)

• quantity (minimum 10)

• timeliness (before class)
rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
- timeliness (before class)
- distribution (not clustered)
rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
- timeliness (before class)
- distribution (not clustered)

over 20,000 annotations!
rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
- timeliness (before class)
- distribution (not clustered)

how do you process all of that??
rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
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- distribution (not clustered)

how do you process all of that??

fully automated assessment
fully automated assessment

- specialized machine learning algorithm
- assesses intellectual content
- exceeds intercoder reliability
connect pre-class and in-class activities
Confusion report for Chapter 24

**right hand rule (11 questions)**

- **JB**: Can someone in simpler terms explain the right-hand rule?
- **WJ**: Is there another way, besides the right hand rule, to find the direction of the magnetic field with a current?
- **SB**: Using the right hand rule, I believe the answer is D. Is that correct?

**direction magnetic field (8 questions)**

- **CP**: Why is it that the magnet field points away from the north pole and towards the south pole? When on the previous page it stated that the direction of the magnetic field is the direction that the north pole of a compass needle points.
- **AB**: How can you determine which direction the magnetic field will point towards?
- **KH**: So whichever way the north pole faces is the direction of the magnetic field but that doesn't always mean its pointing true north?

**earth magnetic field (6 questions)**

- **CP**: Does that mean that the compass will be distracted from the Earth's magnetic field and use the magnetic field that the current of the wire gives off?
motivating factors

Intrinsic:

• social interaction
motivating factors

Intrinsic:

• social interaction
• tie-in to in-class activity
motivating factors

Intrinsic:
- social interaction
- tie-in to in-class activity

Extrinsic:
- assessment (fully automated)
close to 95%!
every student prepared for every class
Benefits

- virtually 100% completion of assignments
- improved use of class time
Benefits

- virtually 100% completion of assignments
- improved use of class time

all at no cost & without additional instructor effort!
Education is not just about:

• transferring information

• getting students to do what we do
Education is not just about:

- transferring information

- getting students to do what we do

active participation/social interaction a must!
for a copy of this presentation

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