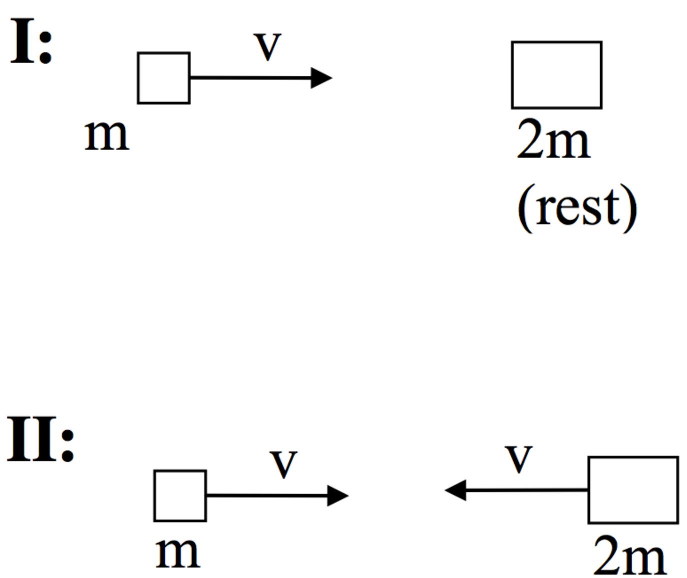
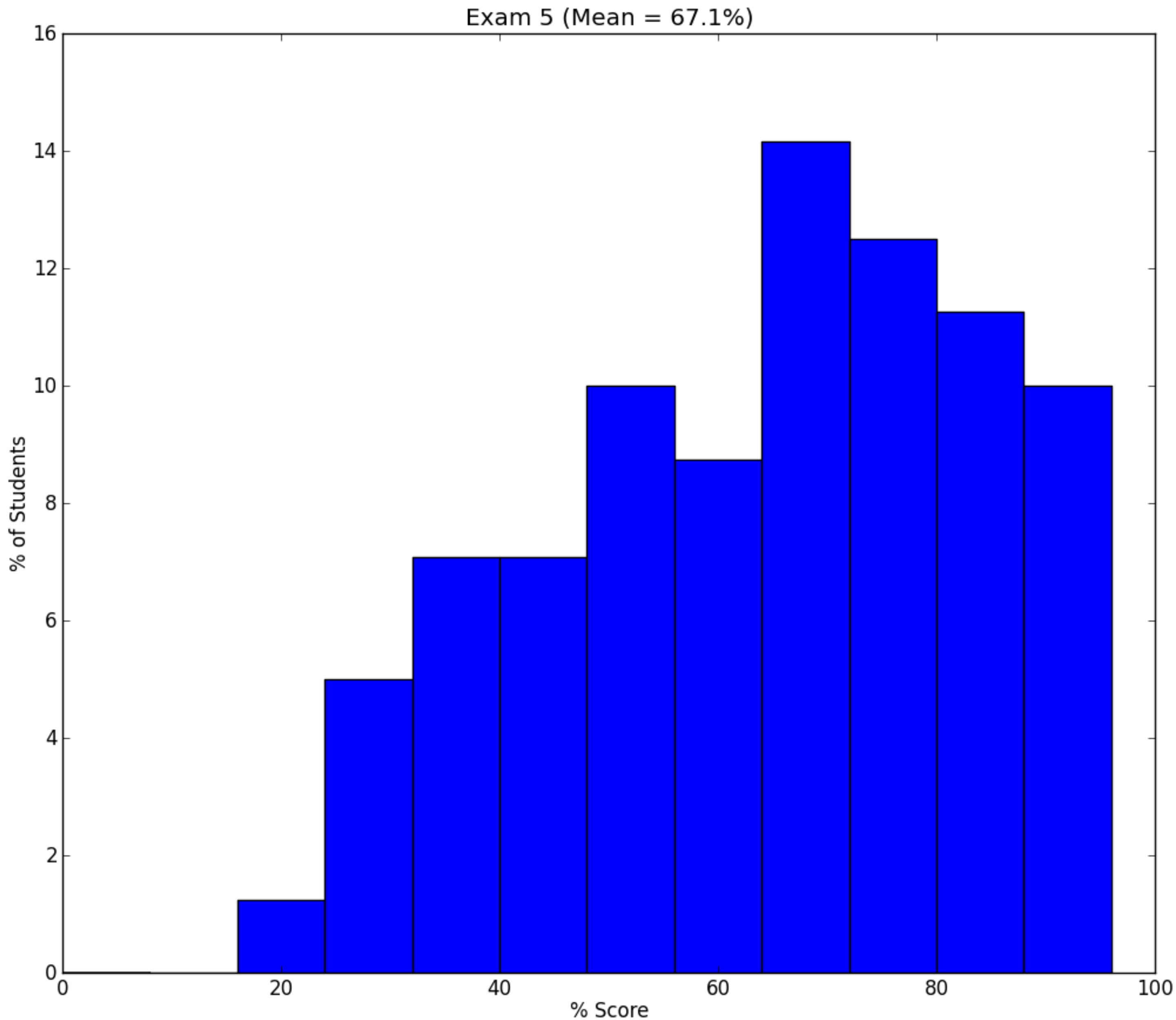
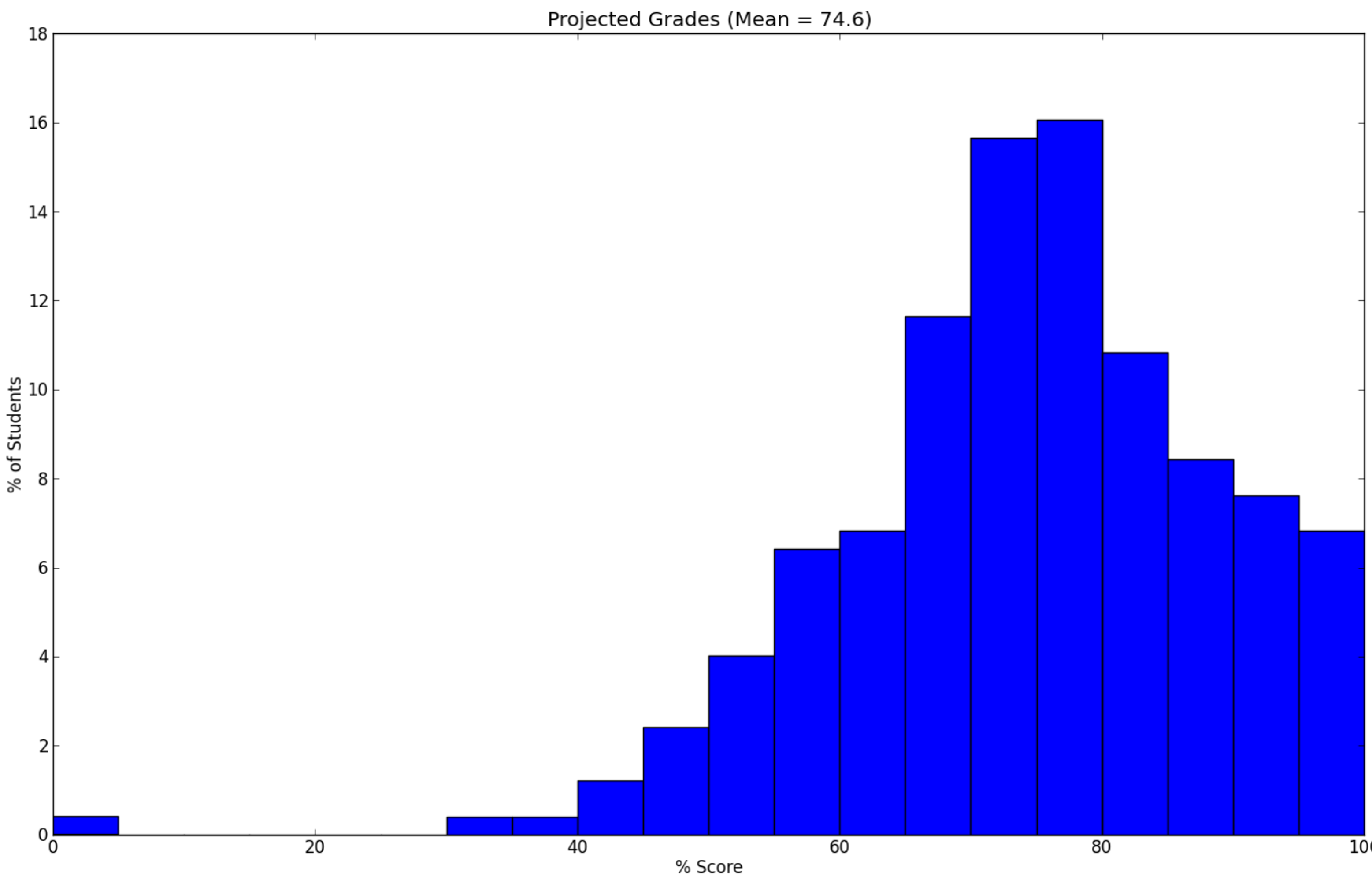
7-1) In which situation is the magnitude of the total momentum the largest?

A) Situation I has the larger total momentum
B) Situation II
C) Same magnitude total momentum in both situations



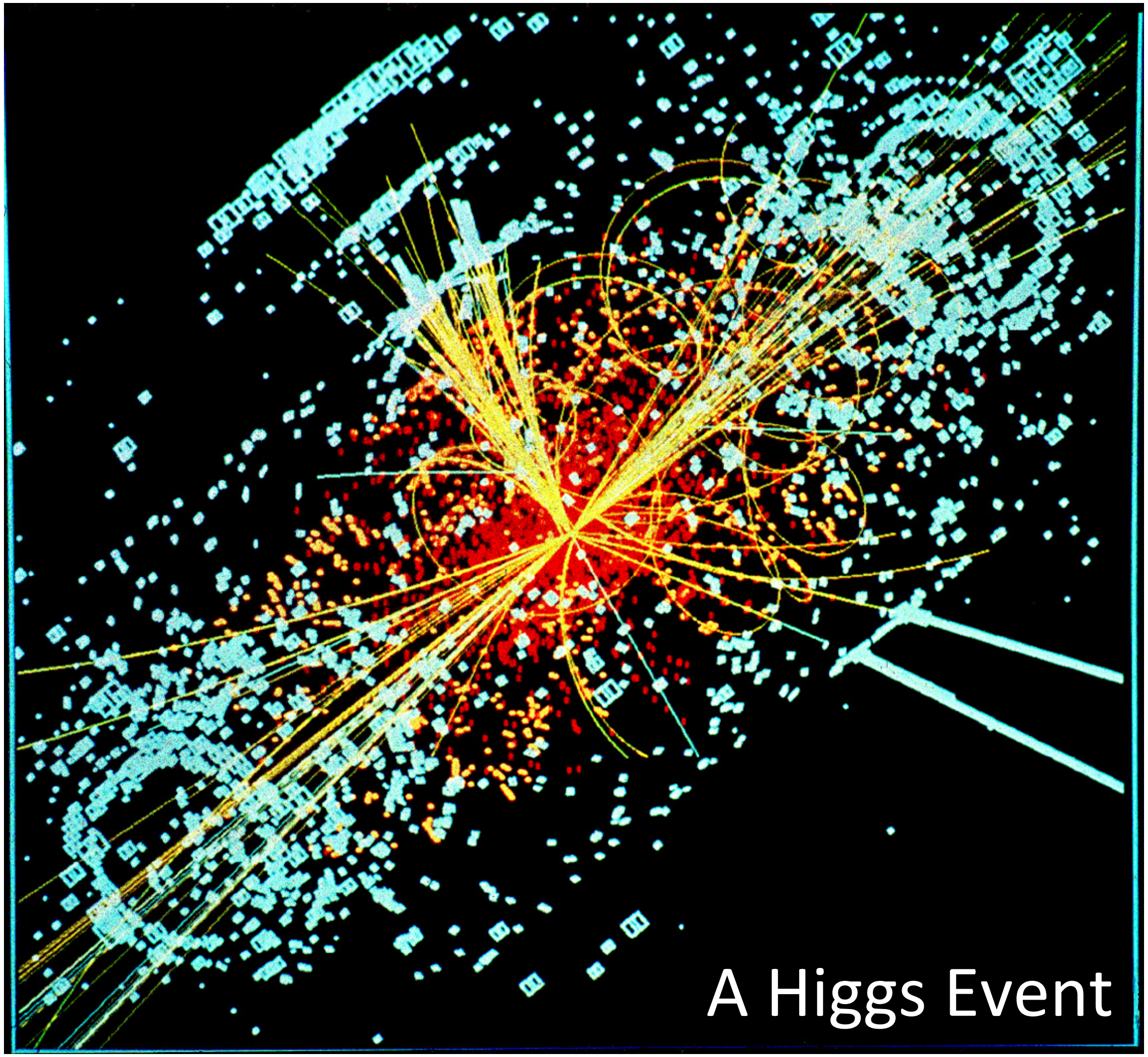


Exam 5 (Mean = 67.1%)
% of Students
% Score
0
2
4
6
8
10
12
14
16
0
20
40
60
80
100

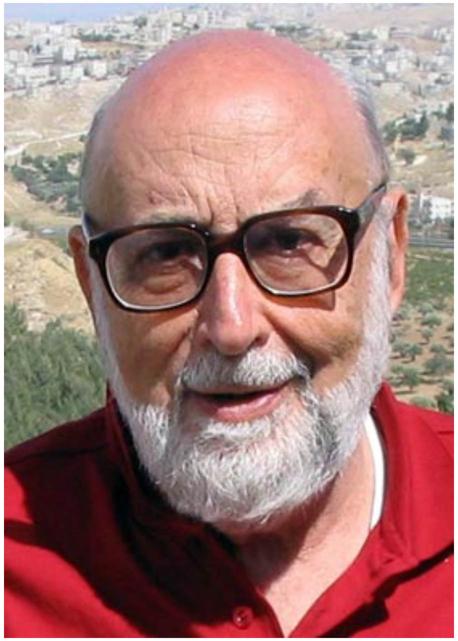


Projected Grades (Mean = 74.6)
% of Students
% Score
0
2
4
6
8
10
12
14
16
18
0
20
40
60
80
100

Conservation of Momentum

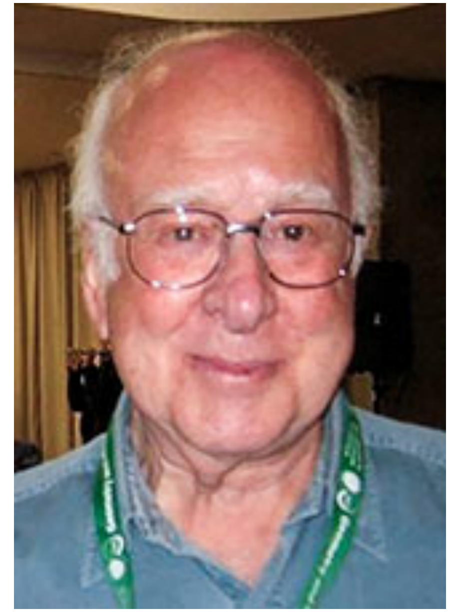


2013 Nobel Prize in Physics



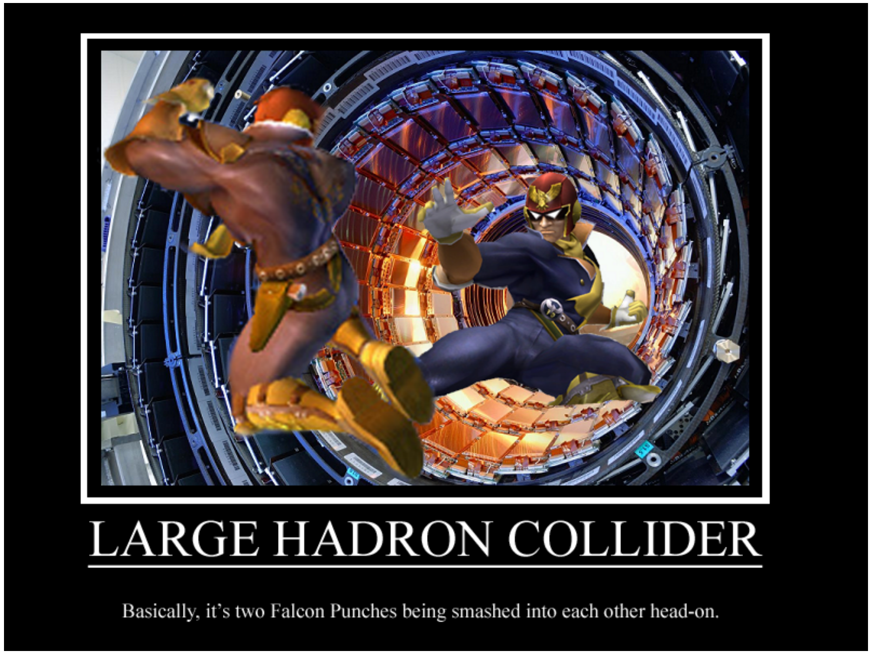
Francois Englert (Belgium)

"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider"



Peter W. Higgs (UK)

Large Hadron Collider (CERN)



- $9 Billon to construct
- 17 mile circumference
- Spans two countries
- 10,000 scientists and engineers work on project

http://hasthelargehadroncolliderdestroyedtheworldyet.com/

7-1) In which situation is the magnitude of the total momentum the largest?

A) Situation I has the larger total momentum
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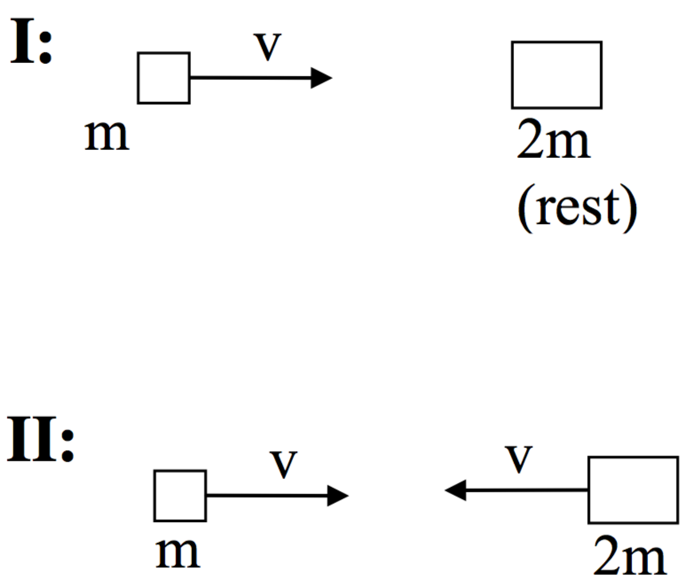
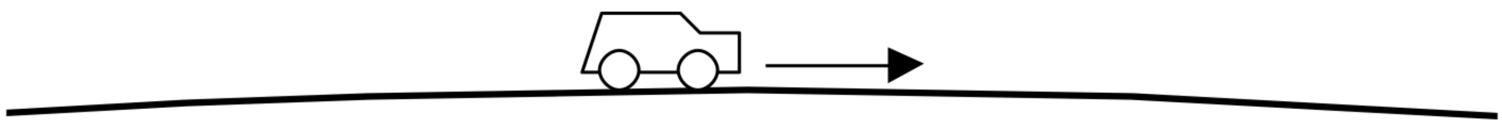


Example: Colliding Students

Two students are running down the hall to make it to Prof. Caballero’s class. They turn a corner and collide; coming to a complete stop. What force did they exert on each other?

(Claim: The collision force is really big!)

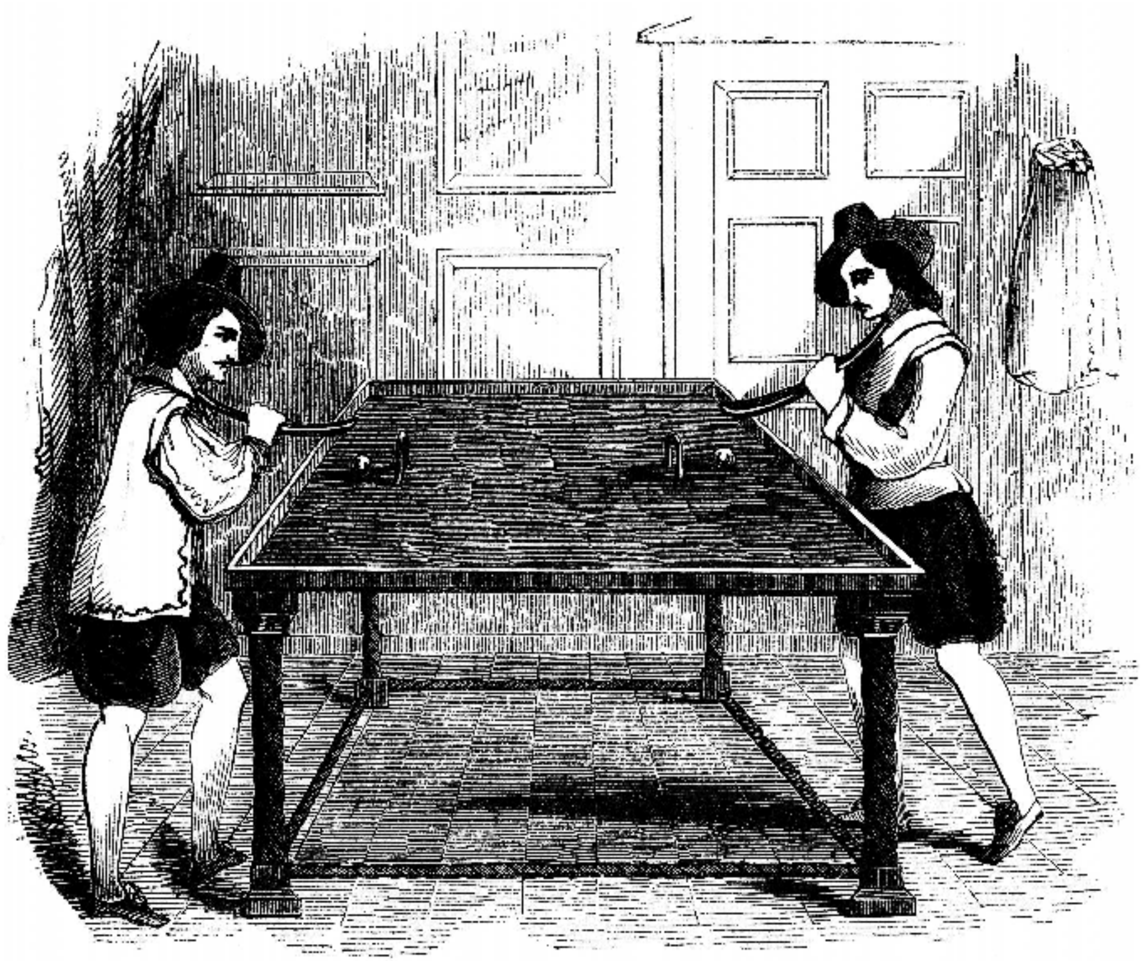
7-2) A car is sitting on the surface of the Earth and both the car and the Earth are at rest. (Pretend the Earth is not rotating or revolving around the Sun.) The car accelerates to a final velocity.



After the car reaches its final velocity, the magnitude of the Earth's momentum is ___________ the magnitude of the car's momentum.

A) more than   B) the same as   C) less than

D) Cannot answer the question because the answer depends on the interaction between the Earth and the car.

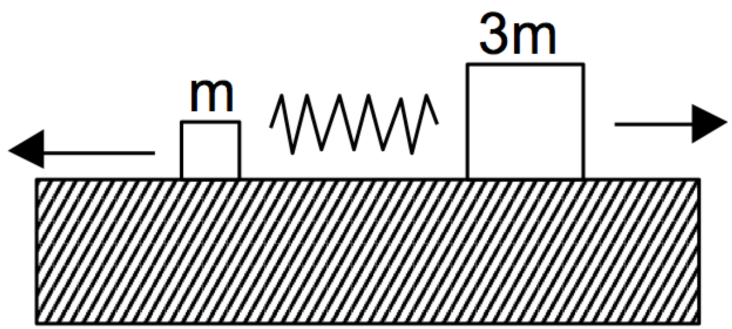


"We perceive from the engraving of the Billiards of the seventeenth century, that the game was altogether different from what it is now."
- Wikipedia

7-4a) Two masses m_1 and m_2 are approaching each other on a frictionless table and collide. Is it possible that, as a result of the collision, all of the kinetic energy of both masses is converted to heat?

A) Yes, all KE can disappear B) No, impossible

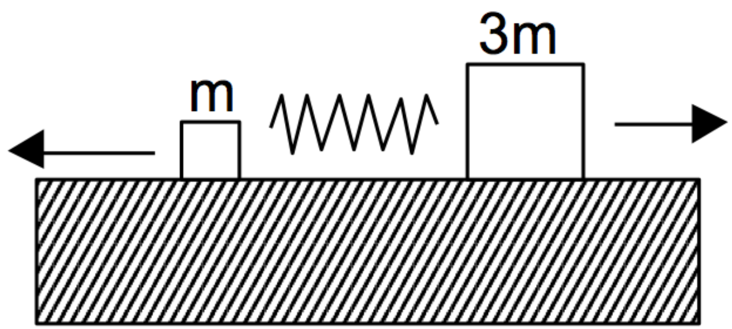
7-5a) Two masses, of size m and 3m, are at rest on a frictionless surface. A compressed, massless spring between the masses is suddenly allowed to uncompress, pushing the masses apart.



After the masses are apart, the speed of m is _____ the speed of 3m.

A) the same as B) twice C) three times
D) 4 times E) none of these

7-5b) Two masses, of size m and 3m, are at rest on a frictionless surface. A compressed, massless spring between the masses is suddenly allowed to uncompress, pushing the masses apart.



The kinetic energy of m is ___________ the kinetic energy of 3m.

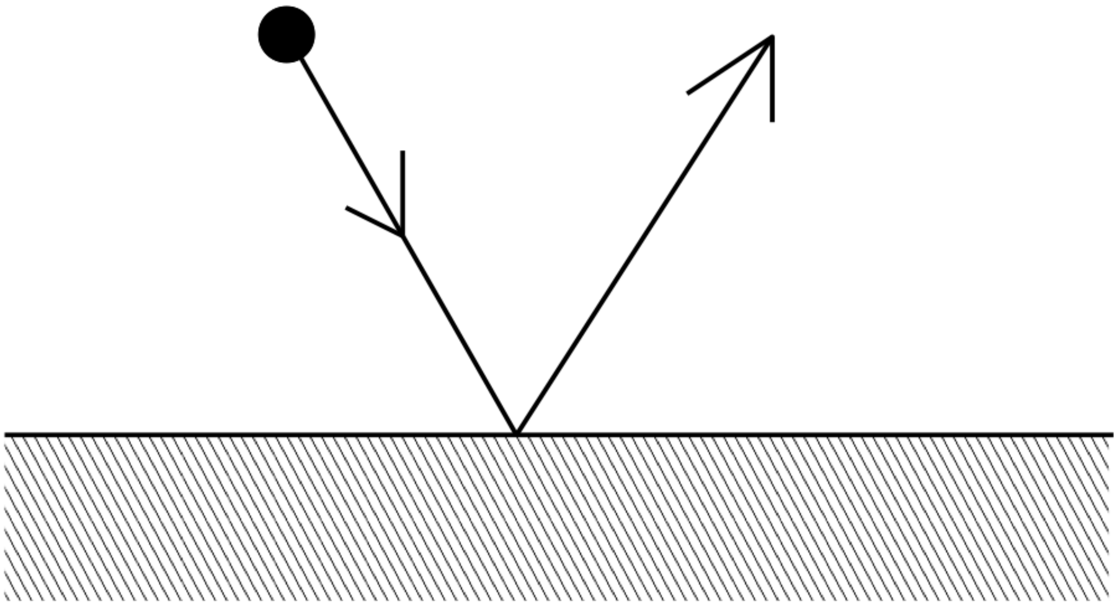
(Hint: If $P_{tot} = 0$, then $m_A|v_A| = m_B|v_B|$.)

A) the same as B) greater than C) less than

Bullets hitting bullets. What?!

http://www.youtube.com/watch?v=QfDoQwIAaXg

7-6) A ball bounces off the floor elastically as shown. The direction of the impulse of the ball is…



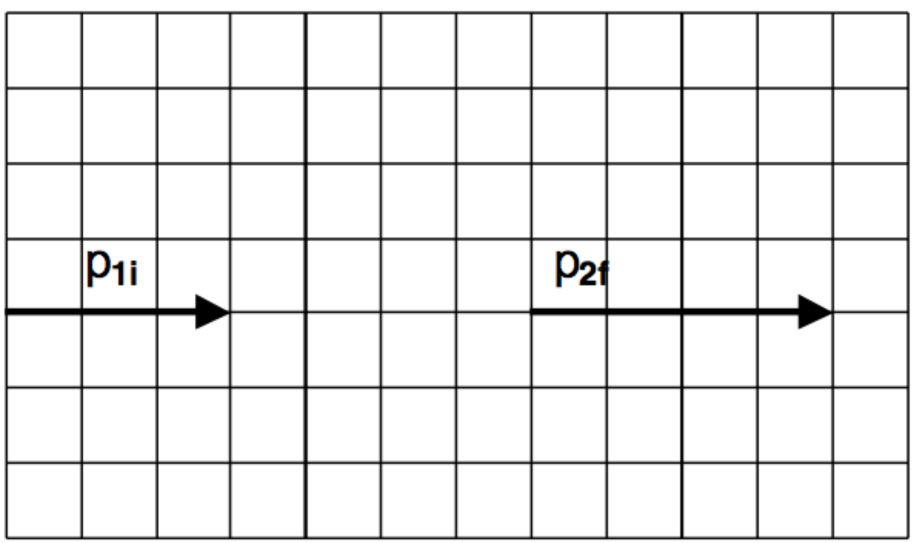
A) Straight up
B) Straight down
C) To the right
D) To the left

7-8) Suppose a tennis ball and a bowling ball are rolling toward you. Both have the same momentum, and you exert the same force to stop each. How do the time intervals to stop them compare?

A) It takes less time to stop the tennis ball.
B) Both take the same time.
C) It takes more time to stop the tennis ball.

7-11) Ball 1 strikes **stationary** Ball 2 in 1D elastic collision. The initial momentum of Ball 1, $\mathbf{p}_{1i}$, and the final momentum of Ball 2, $\mathbf{p}_{2f}$, are shown on the graph. In units shown on the graph, what is the $\mathbf{p}_{1f}$?
(To the right is positive.)

A) 0 B) +1 C) -2 D) -1 E) None of these



Example: Deer Hunting

When I was 13, I went deer hunting with my grandfather. I decided that I didn't like the "kick" of the gun, so I pressed myself against a tree before firing a 12-gauge (3.5 kg) loaded with a deer slug (0.22kg). Was this?

A) A good idea

B) A big mistake

C) Doesn't matter

Example: Deer Hunting

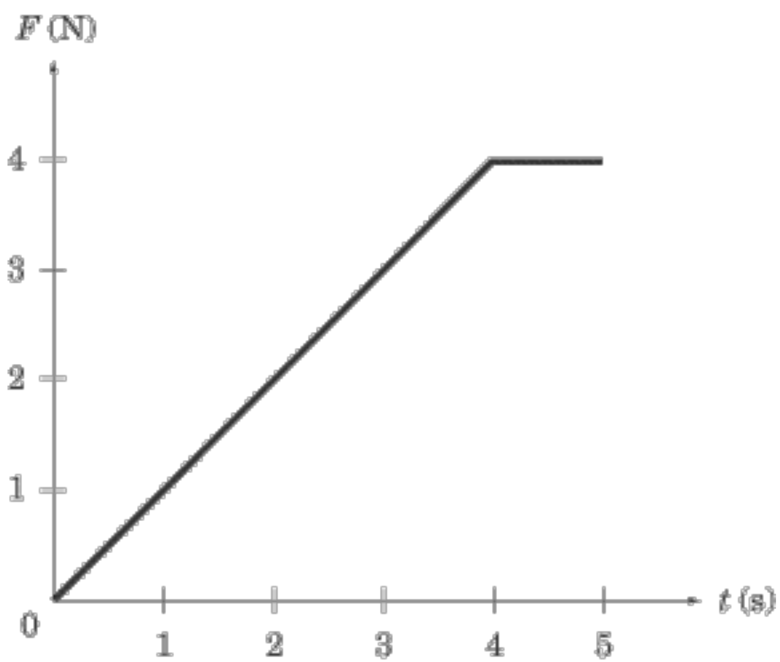
When I was 13, I went deer hunting with my grandfather. I decided that I didn't like the "kick" of the gun, so I pressed myself against a tree before firing a 12-gauge (3.5 kg) loaded with a deer slug (0.22kg). how much force would be exerted on my shoulder after firing the gun if the slug leaves the barrel at 500 m/s?

7-16) If we choose the system to be the gun and the slug, which of the following correct describes the velocity of the gun?

A) $v_G = (m_S/M_G)v_S$
B) $v_G = -(m_S/M_G)v_S$
C) $v_G = (M_G/m_S)v_S$
D) $v_G = -(M_G/m_S)v_S$
E) None of these

7-17) Ideas: We need a collision time.
How can we estimate it?

7-15) A 5kg ball is moving with a velocity in the x-direction of 2 m/s experiences the impulse shown in the graph below. How fast is the ball moving after 5 seconds?



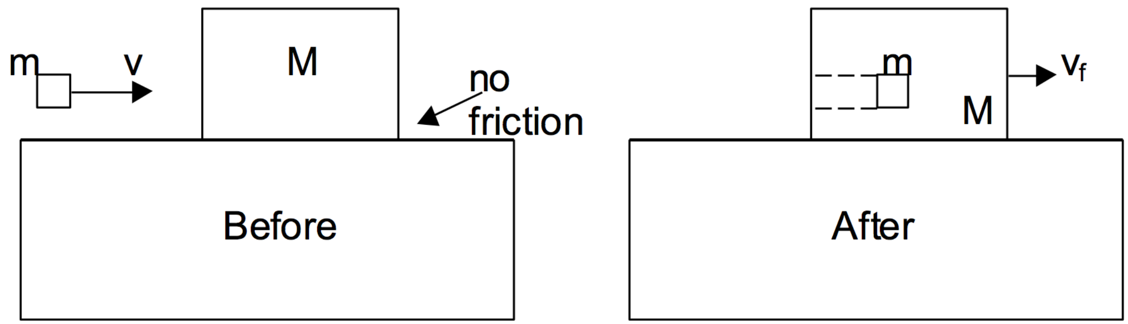
A) 2.4 m/s
B) 4.4 m/s
C) 10 m/s
D) 22 m/s
E) None of these

Imagine you are an 18th century engineer, which basically means you make bridges or guns. You make guns. You are tasked with determining the 'firing power' of guns and designing ones with more power.

Because, why not? We did very silly things in the 1700s, but we also invented some awesome things like the fire extinguisher, the steam engine, and freedom.

Ok, how do you determine the speed at which a projectile leaves the barrel?

7-14) A bullet of mass m and velocity v is fired into a wood block of mass M initially at rest on a frictionless surface. The bullet buries itself in the wood block and then the wood block is seen to have a final velocity v_f.



Was this an elastic collision? A) Yes B) No

True (A) or False (B): $mv = Mv_f$

True (A) or False (B): $(1/2)mv^2 = (1/2)(M+m)\,v_f^2$

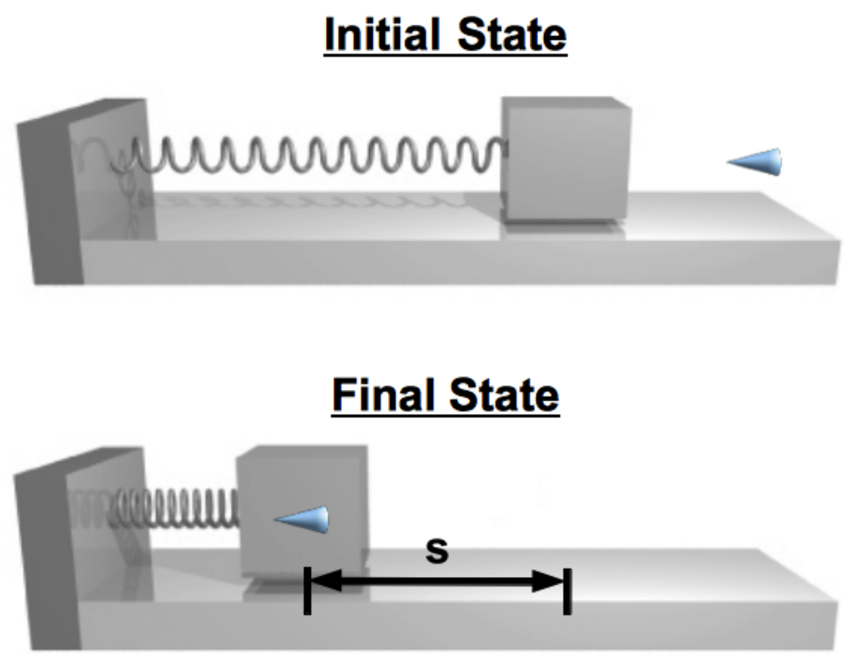
7-18) A bullet of mass **m** is traveling to the left with speed **v** when it embeds itself in a block of mass **M**. The block sits on a frictionless surface and is connected to a spring of stiffness **k**. What is the compression **s** of the spring when the bullet and block come to rest?

A) $s = v\sqrt{M/k}$

B) $s = v\sqrt{m/k}$

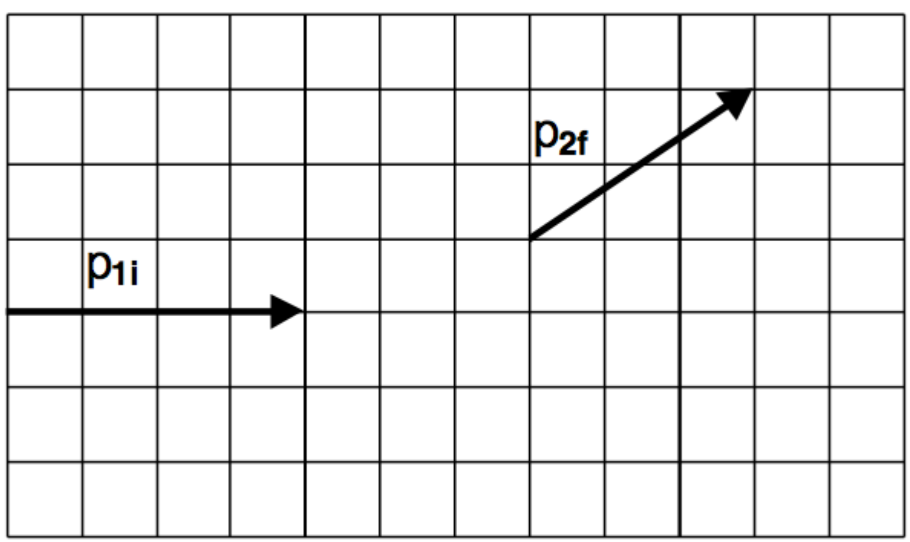
C) $s = v\sqrt{m/kM}$

D) $s = mv\sqrt{1/(k(m+M))}$



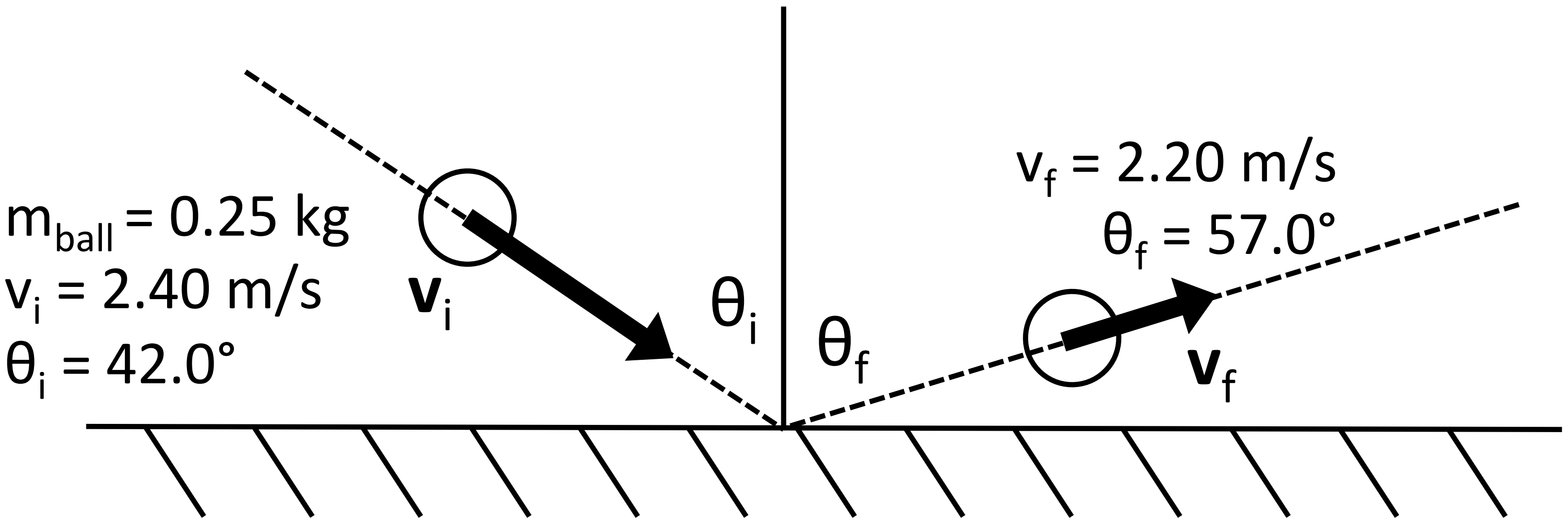
7-12) Ball 1 strikes **stationary** Ball 2 in 2D collision. The initial momentum of Ball 1, $\mathbf{p}_{1i}$, and the final momentum of Ball 2, $\mathbf{p}_{2f}$, are shown on the graph. In units shown on the graph, what is the x-component of $\mathbf{p}_{1f}$?

A) 0 B) +1 C) +2 D) +3 E) None of these



Example: 2D Collision

A billiard ball strikes a cushion and bounces off as shown below. What is the magnitude of the change in momentum of the billiard ball?



Ok, we just completed a really long example of 2D collisions. What's wrong with it? Or more precisely, what's wrong with the model for the collision? What are we leaving out?

Take a few minutes with your neighbors and discuss all the things you think we left out.