ConcepTest 3.4a Firing Balls I

A small cart is rolling at constant velocity on a flat track. It fires a ball straight up into the air as it moves. After it is fired, what happens to the ball?

1) it depends on how fast the cart is moving
2) it falls behind the cart
3) it falls in front of the cart
4) it falls right back into the cart
5) it remains at rest

ConcepTest 3.4a Firing Balls I

A small cart is rolling at **constant** velocity on a flat track. It fires a ball straight up into the air as it moves. After it is fired, what happens to the ball?

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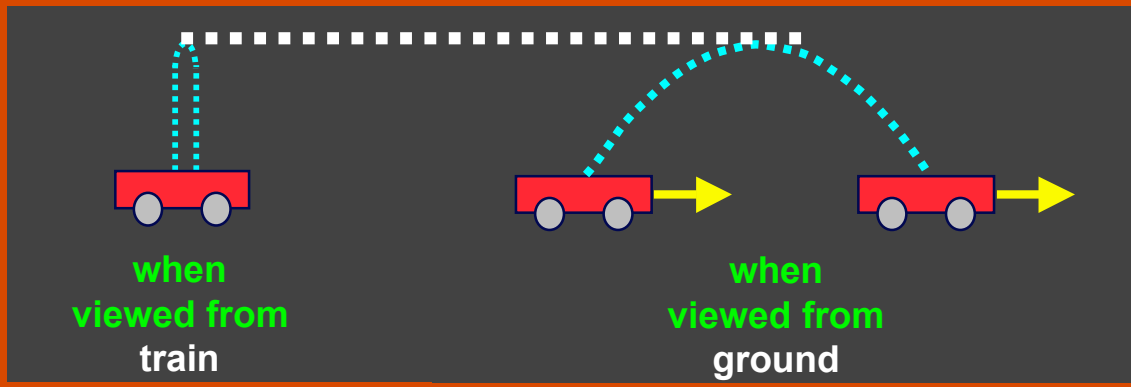
3) it falls in front of the cart
4) it falls right back into the cart
5) it remains at rest

In the frame of reference of the cart, the ball only has a **vertical** component of velocity. So it goes up and comes back down. To a ground observer, both the cart and the ball have the ***same horizontal velocity***, so the ball still returns into the cart.



ConcepTest 3.5 Dropping a Package

You drop a package from a plane flying at constant speed in a straight line. Without air resistance, the package will:

1) quickly lag behind the plane while falling

2) remain vertically under the plane while falling

3) move ahead of the plane while falling

4) not fall at all

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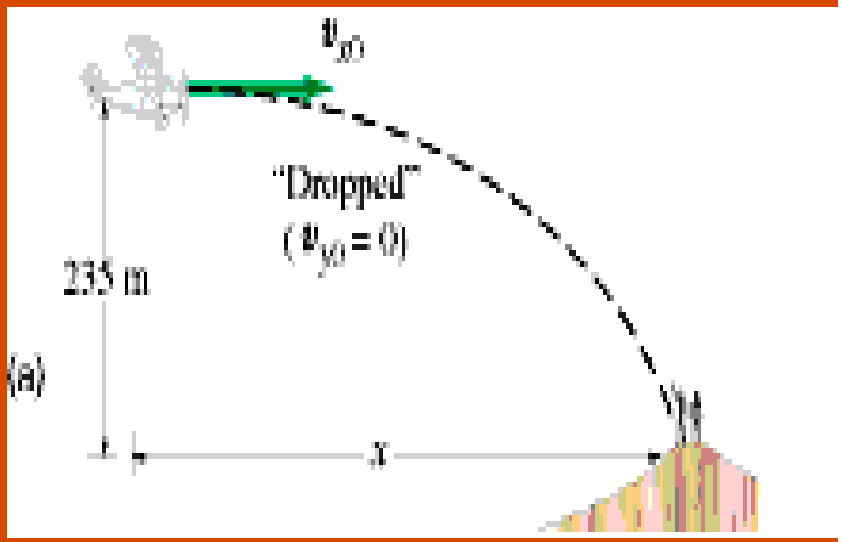
1) quickly lag behind the plane while falling
2) remain vertically under the plane while falling
3) move ahead of the plane while falling
4) not fall at all

Both the plane and the package have the ***same horizontal velocity*** at the moment of release. They will ***maintain*** this velocity in the ***x*-direction**, so they stay aligned.



Follow-up: What would happen if air resistance is present?

ConcepTest 3.6a Dropping the Ball I

From the *same* height (and at the *same* time), one ball is dropped and another ball is fired horizontally. Which one will hit the ground first?

(1) the "dropped" ball
(2) the "fired" ball
(3) they both hit at the same time
(4) it depends on how hard the ball was fired
(5) it depends on the initial height

ConcepTest 3.6a Dropping the Ball I

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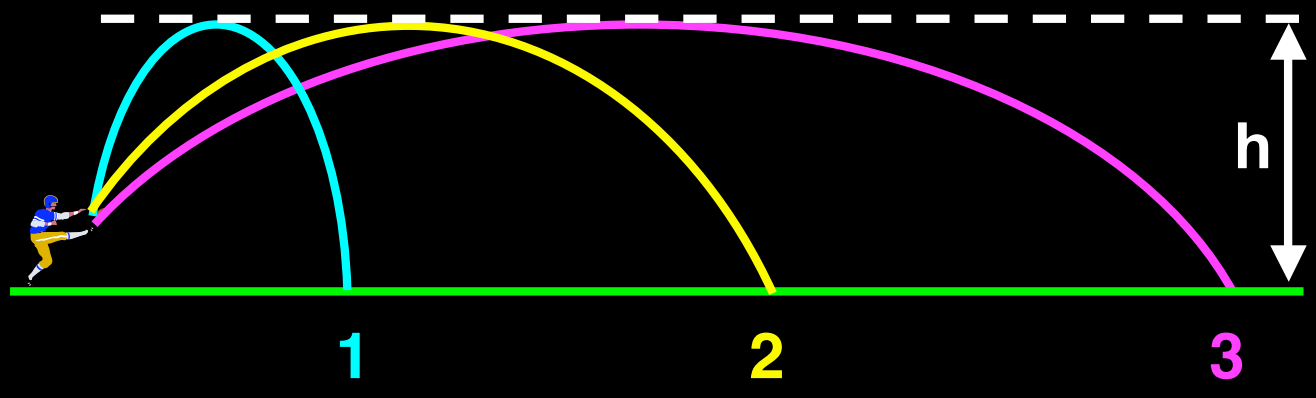
(3) they both hit at the same time
(4) it depends on how hard the ball was fired
(5) it depends on the initial height

Both of the balls are falling vertically under the influence of gravity. They both fall from the same height. Therefore, they will hit the ground at the same time. The fact that one is moving horizontally is irrelevant – remember that the *x* and *y* motions are completely independent !!

Follow-up: Is that also true if there is air resistance?

ConcepTest 3.7a Punts I

Which of the 3 punts has the longest hang time?



4) all have the same hang time

ConcepTest 3.7a Punts I

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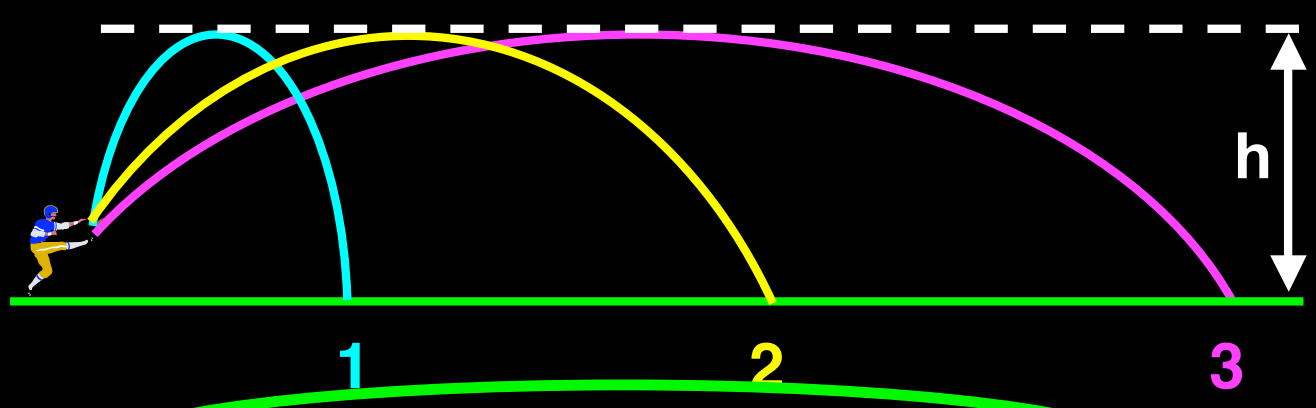

4) all have the same hang time

The time in the air is determined by the *vertical motion* !

Since all of the punts reach the same height, they all stay in the air for the same time.

Follow-up: Which one had the greater initial velocity?

ConcepTest 3.10a Shoot the Monkey I

You are trying to hit a friend with a water balloon. He is sitting in the window of his dorm room directly across the street. You aim straight at him and shoot. Just when you shoot, he falls out of the window! Does the water balloon hit him?

1) yes, it hits
2) maybe – it depends on the speed of the shot
3) no, it misses
4) the shot is impossible
5) not really sure

Assume that the shot does have enough speed to reach the dorm across the street.

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1) yes, it hits
2) maybe – it depends on the speed of the shot
3) no, it misses
4) the shot is impossible
5) not really sure

Your friend falls under the influence of gravity, just like the water balloon. Thus, they are both undergoing free fall in the *y*-direction. Since the slingshot was accurately aimed at the right height, the water balloon will fall exactly as your friend does, and it will hit him!!

Assume that the shot does have enough speed to reach the dorm across the street.

ConcepTest 4.1a Newton's First Law I

A book is lying at rest on a table. The book will remain there at rest because:

1) **there is a net force but the book has too much inertia**
2) **there are no forces acting on it at all**
3) **it does move, but too slowly to be seen**
4) **there is no net force on the book**
5) **there is a net force, but the book is too heavy to move**

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5) there is a net force, but the book is too heavy to move

There are forces acting on the book, but the only forces acting are in the *y*-direction. Gravity acts downward, but the table exerts an upward force that is equally strong, so the two forces cancel, leaving no net force.

ConcepTest 4.1c Newton's First Law III

You put your book on the bus seat next to you. When the bus stops suddenly, the book slides forward off the seat. Why?

1) a net force acted on it
2) no net force acted on it
3) it remained at rest
4) it did not move, but only seemed to
5) gravity briefly stopped acting on it

ConcepTest 4.1c Newton's First Law III

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1) a net force acted on it
2) no net force acted on it
3) it remained at rest
4) it did not move, but only seemed to
5) gravity briefly stopped acting on it

The book was initially moving forward (since it was on a moving bus). When the bus stopped, the book continued moving forward, which was its initial state of motion, and therefore it slid forward off the seat.

Follow-up: What is the force that usually keeps the book on the seat?