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

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 3.6b

Dropping the Ball II

From the *same* height (and at the *same* time), one ball is dropped and another ball is fired horizontally. Which ball has the greater velocity at ground level?

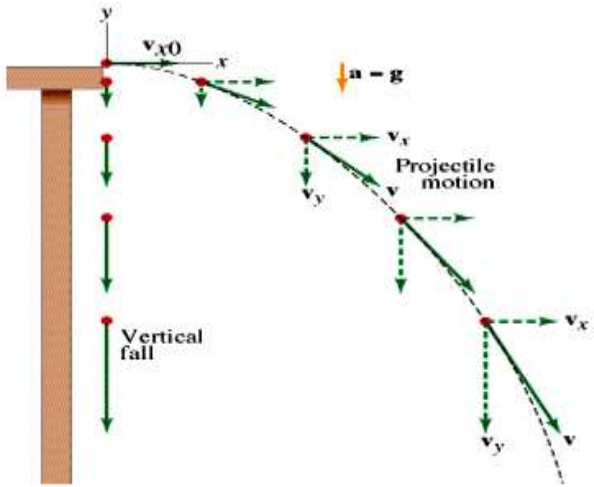
1) the "dropped" ball
2) the "fired" ball
3) neither – they both have the same velocity on impact
4) it depends on how hard the ball was thrown

ConcepTest 3.6b Dropping the Ball II

From the *same* height (and at the *same* time), one ball is dropped and another ball is fired horizontally. Which ball has the greater velocity at ground level?

1) the "dropped" ball
2) the "fired" ball
3) neither – they both have the same velocity on impact
4) it depends on how hard the ball was thrown

Both balls have the same *vertical* velocity when they hit the ground (since they are both acted on by gravity for the same time). However, the "fired" ball also has a *horizontal* velocity. When you add the two components vectorially, the "fired" ball has a larger net velocity when it hits the ground.



Follow-up: What would you have to do to have them both reach the same final velocity at ground level?

ConcepTest 3.6c

Dropping the Ball III

A projectile is launched from the ground at an angle of 30°. At what point in its trajectory does this projectile have the least speed?

1) just after it is launched
2) at the highest point in its flight
3) just before it hits the ground
4) halfway between the ground and the highest point
5) speed is always constant

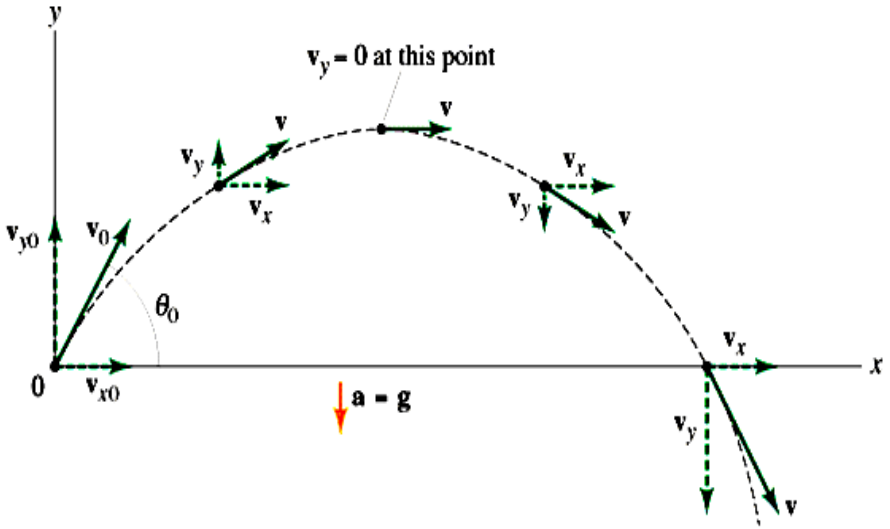
ConcepTest 3.6c

Dropping the Ball III

A projectile is launched from the ground at an angle of 30°. At what point in its trajectory does this projectile have the least speed?

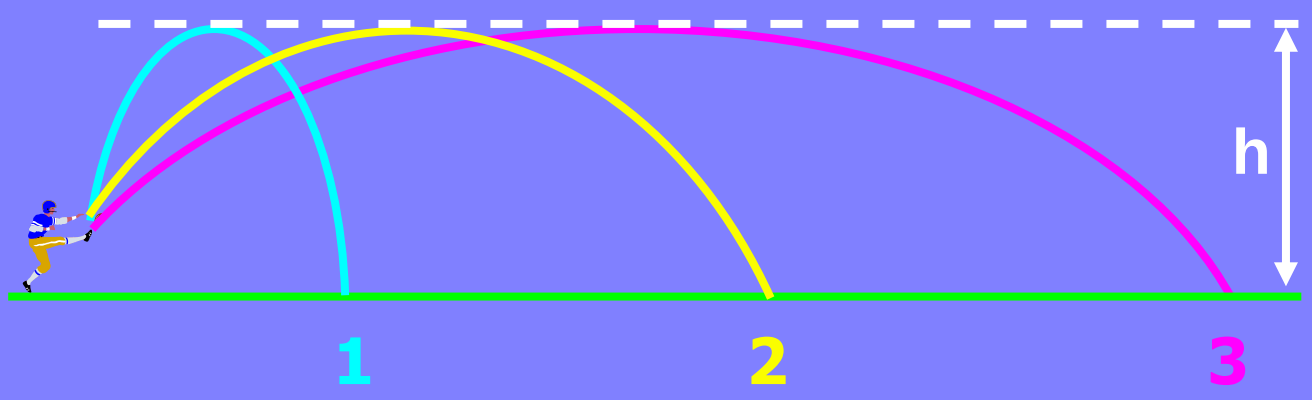
1) just after it is launched
2) at the highest point in its flight
3) just before it hits the ground
4) halfway between the ground and the highest point
5) speed is always constant

The speed is smallest at the highest point of its flight path because the *y*-component of the velocity is zero.



ConcepTest 3.7a Punts I

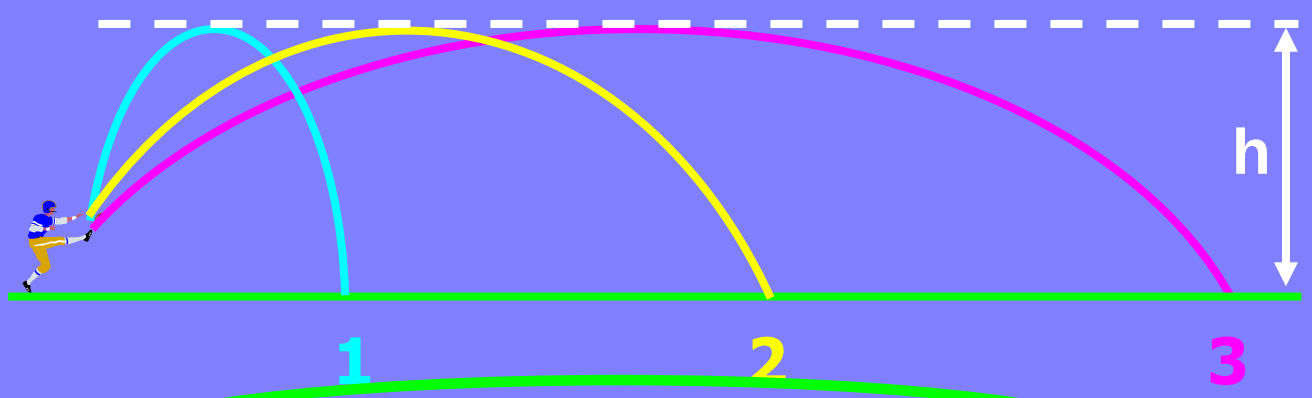
Which of the 3 punts has the longest hang time?



4) all have the same hang time

ConcepTest 3.7a Punts I

Which of the 3 punts has the longest hang time?



4) all have the same hang time

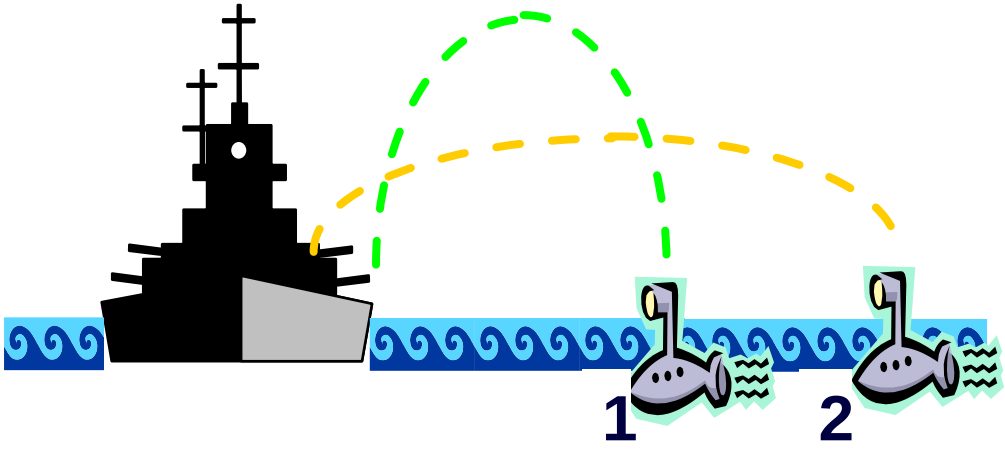
The time in the air is determined by the *vertical motion* !

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 3.7b Punts II

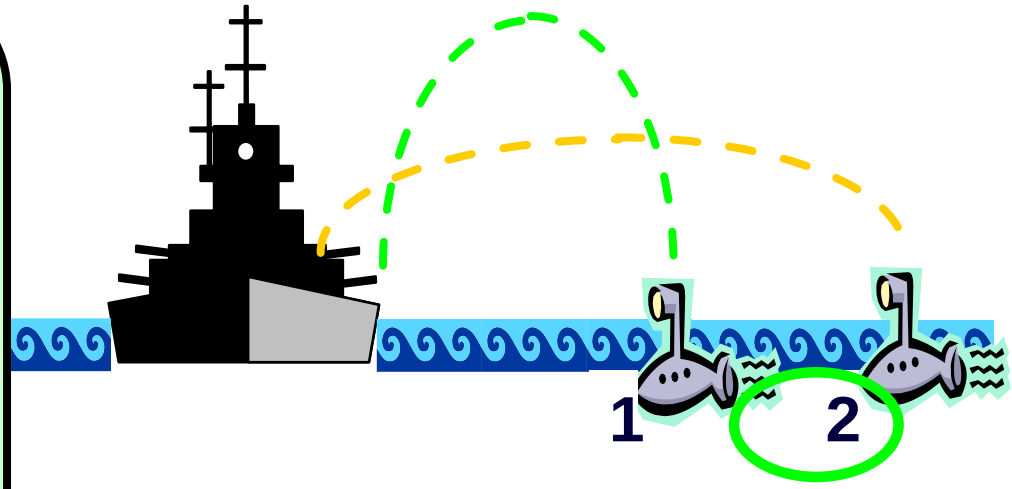
A battleship simultaneously fires two shells at two enemy submarines. The shells are launched with the same initial velocity. If the shells follow the trajectories shown, which submarine gets hit first ?



3) both at the same time

ConcepTest 3.7b Punts II

A battleship simultaneously fires two shells at two enemy submarines. The shells are launched with the same initial velocity. If the shells follow the trajectories shown, which submarine gets hit first ?



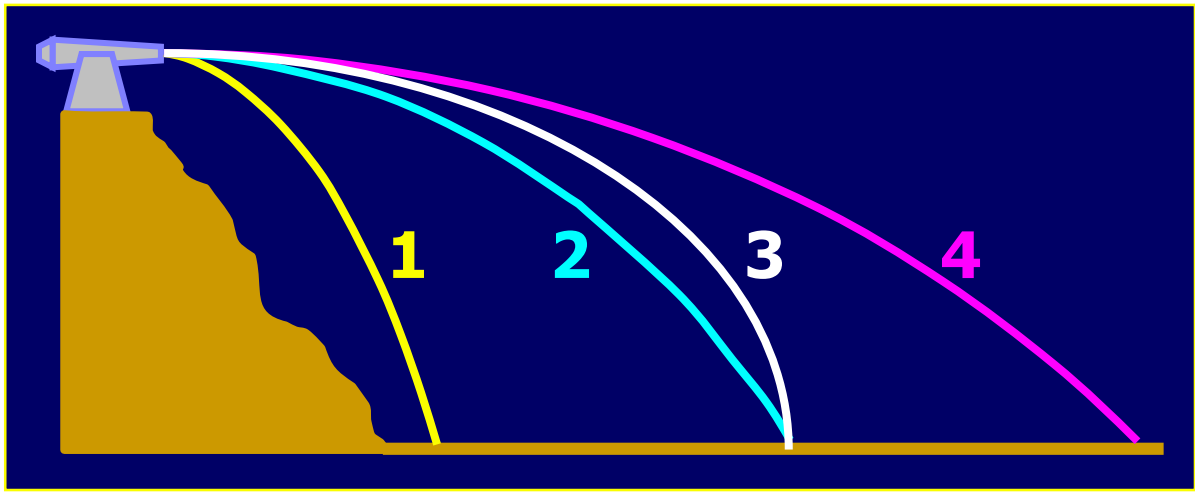
3) both at the same time

The flight time is fixed by the motion in the *y*-direction. The *higher* an object goes, the *longer* it stays in flight. The shell hitting submarine #2 goes *less high*, therefore it stays in flight for *less time* than the other shell. Thus, submarine #2 is hit first.

Follow-up: Which one traveled the greater distance?

ConcepTest 3.8 Cannon on the Moon

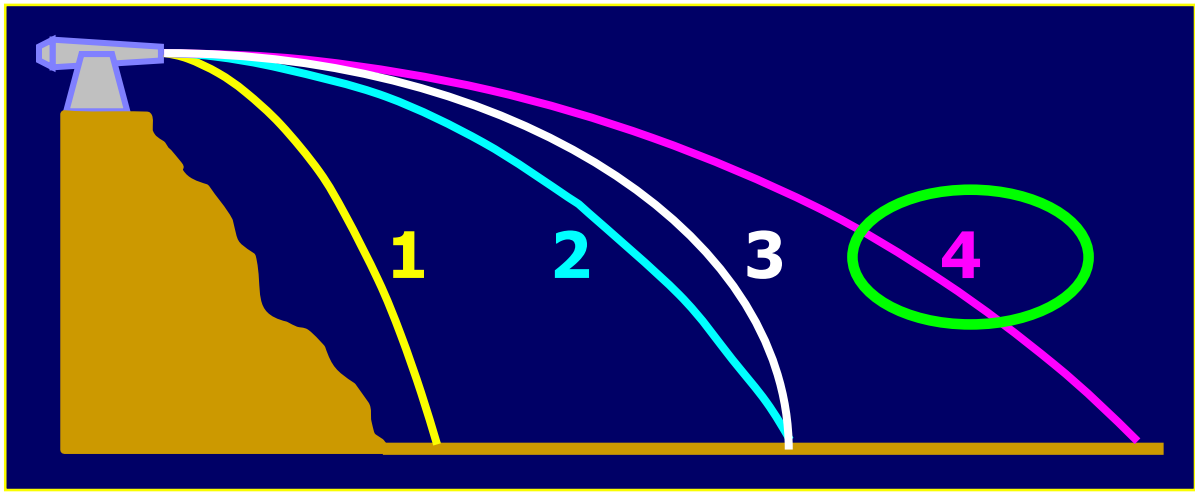
For a cannon on Earth, the cannonball would follow path 2. Instead, if the same cannon were on the Moon, where $g = 1.6$ m/s^2, which path would the cannonball take in the same situation?



ConcepTest 3.8 Cannon on the Moon

For a cannon on Earth, the cannonball would follow path 2. Instead, if the same cannon were on the Moon, where $g = 1.6$ m/s^2, which path would the cannonball take in the same situation?

The ball will spend more time in flight because $g_{Moon} < g_{Earth}$. With more time, it can travel farther in the horizontal direction.



Follow-up: Which path would it take in outer space?

ConcepTest 3.9 Spring-Loaded Gun

The spring-loaded gun can launch projectiles at different angles with the same launch speed. At what angle should the projectile be launched in order to travel the greatest distance before landing?

1) 15°
2) 30°
3) 45°
4) 60°
5) 75°

ConcepTest 3.9 Spring-Loaded Gun

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2) 30°
3) 45°
4) 60°
5) 75°

A steeper angle lets the projectile stay in the air longer, but it does not travel so far because it has a small *x*-component of velocity. On the other hand, a shallow angle gives a large *x*-velocity, but the projectile is not in the air for very long. The compromise comes at 45°, although this result is best seen in a calculation of the "range formula" as shown in the textbook.

A 100 g ball rolls off a table and lands 2 m from the base of the table. A 200 g ball rolls off the same table with the same speed. It lands at distance

A. <1 m.
B. 1 m.
C. between 1m and 2 m.
D. 2 m.
E. > 2 m.

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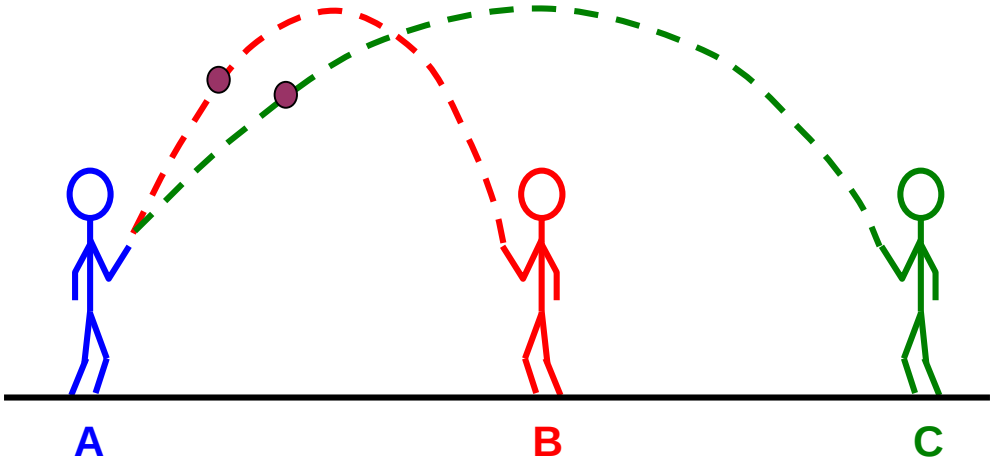
A. <1 m.
B. 1 m.
C. between 1m and 2 m.
✔ **D. 2 m.**
E. > 2 m.

Boy A throws two balls to two other boys, B & C, at the same instant. Both balls reach the same height in the air. Which boy catches a thrown ball first?



A. Boy B does.

B. Boy C does.

✔ C. Both B and C catch a ball at the same instant.

D. Not told enough to answer the question.