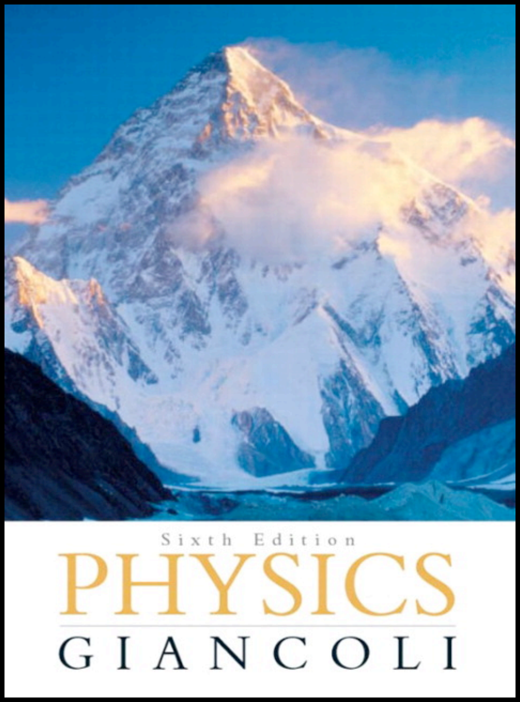

ConcepTest PowerPoints

Chapter 3

Physics: Principles with Applications, 6th edition

Giancoli

ConcepTest 3.1a Vectors I

If two vectors are given such that **A** + **B** = 0, what can you say about the magnitude and direction of vectors **A** and **B**?

1) same magnitude, but can be in any direction
2) same magnitude, but must be in the same direction
3) different magnitudes, but must be in the same direction
4) same magnitude, but must be in opposite directions
5) different magnitudes, but must be in opposite directions

ConcepTest 3.1a Vectors I

If two vectors are given such that **A** + **B** = 0, what can you say about the magnitude and direction of vectors **A** and **B**?

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4) same magnitude, but must be in opposite directions

5) different magnitudes, but must be in opposite directions

The magnitudes must be the same, but one vector must be pointing in the opposite direction of the other, in order for the sum to come out to zero. You can prove this with the tip-to-tail method.

ConcepTest 3.1b Vectors II

Given that **A** + **B** = **C**, and that $|A|^2 + |B|^2 = |C|^2$, how are vectors **A** and **B** oriented with respect to each other?

1) they are perpendicular to each other

2) they are parallel and in the same direction

3) they are parallel but in the opposite direction

4) they are at 45° to each other

5) they can be at any angle to each other

ConcepTest 3.1b Vectors II

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4) they are at 45° to each other
5) they can be at any angle to each other

Note that the magnitudes of the vectors satisfy the Pythagorean Theorem. This suggests that they form a right triangle, with vector **C** as the hypotenuse. Thus, **A** and **B** are the legs of the right triangle and are therefore perpendicular.

ConcepTest 3.1c Vectors III

Given that **A** + **B** = **C**, and that |**A**| + |**B**| = |**C**|, how are vectors **A** and **B** oriented with respect to each other?

1) they are perpendicular to each other
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Given that **A** + **B** = **C**, and that |A| + |B| = |C| , how are vectors **A** and **B** oriented with respect to each other?

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2) they are parallel and in the same direction
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4) they are at 45° to each other
5) they can be at any angle to each other

The only time vector magnitudes will simply add together is when the direction does not have to be taken into account (i.e., the direction is the same for both vectors). In that case, there is no angle between them to worry about, so vectors **A** and **B** must be pointing in the same direction.

ConcepTest 3.2a Vector Components I

If each component of a vector is doubled, what happens to the angle of that vector?

1) it doubles
2) it increases, but by less than double
3) it does not change
4) it is reduced by half
5) it decreases, but not as much as half

ConcepTest 3.2a Vector Components I

If each component of a vector is doubled, what happens to the angle of that vector?

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2) it increases, but by less than double
3) it does not change
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5) it decreases, but not as much as half

The magnitude of the vector clearly doubles if each of its components is doubled. But the angle of the vector is given by $\tan\theta = 2y/2x$, which is the same as $\tan\theta = y/x$ (the original angle).

Follow-up: If you double one component and not the other, how would the angle change?

ConcepTest 3.2b Vector Components II

A certain vector has *x* and *y* components that are equal in magnitude. Which of the following is a possible angle for this vector, in a standard *x*-*y* coordinate system?

1) 30°
2) 180°
3) 90°
4) 60°
5) 45°

ConcepTest 3.2b Vector Components II

A certain vector has *x* and *y* components that are equal in magnitude. Which of the following is a possible angle for this vector, in a standard *x*-*y* coordinate system?

1) 30°
2) 180°
3) 90°
4) 60°
5) 45°

The angle of the vector is given by $\tan\theta = y/x$. Thus, $\tan\theta = 1$ in this case if *x* and *y* are equal, which means that the angle must be 45°.

ConcepTest 3.3 Vector Addition

You are adding vectors of length 20 and 40 units. What is the only possible resultant magnitude that you can obtain out of the following choices?

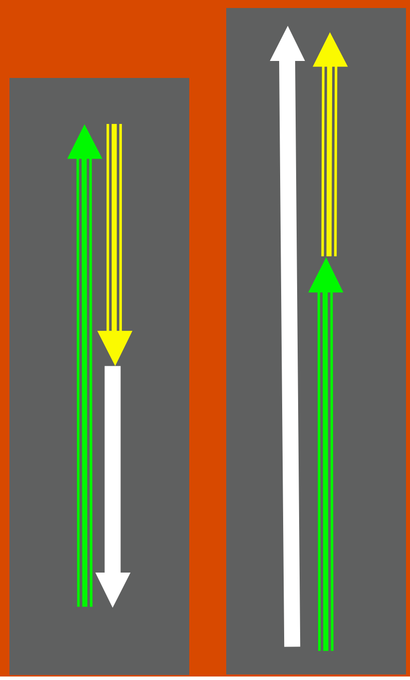
1) 0
2) 18
3) 37
4) 64
5) 100

ConcepTest 3.3 Vector Addition

You are adding vectors of length 20 and 40 units. What is the only possible resultant magnitude that you can obtain out of the following choices?

1) 0
2) 18
3) 37
4) 64
5) 100

The **minimum** resultant occurs when the vectors are **opposite**, giving **20 units**. The **maximum** resultant occurs when the vectors are **aligned**, giving **60 units**. Anything in between is also possible, for angles between 0° and 180°.



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

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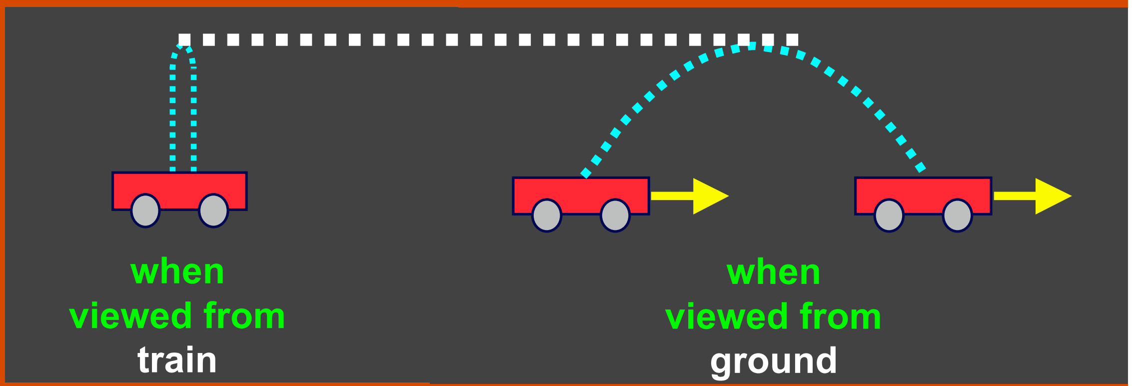
5) it remains at rest

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 3.4b Firing Balls II

Now the cart is being pulled along a horizontal track by an external force (a weight hanging over the table edge) and accelerating. It fires a ball straight out of the cannon as it moves. After it is fired, what happens to the ball?

1) it depends upon how much the track is tilted
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 3.4b Firing Balls II

Now the cart is being pulled along a horizontal track by an external force (a weight hanging over the table edge) and accelerating. It fires a ball straight out of the cannon as it moves. After it is fired, what happens to the ball?

1) it depends upon how much the track is tilted
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

Now the acceleration of the cart is completely unrelated to the ball. In fact, the ball does not have any horizontal acceleration at all (just like the first question), so it will lag behind the accelerating cart once it is shot out of the cannon.

ConcepTest 3.4c Firing Balls III

The same small cart is now rolling down an inclined track and accelerating. It fires a ball straight out of the cannon as it moves. After it is fired, what happens to the ball?

1) it depends upon how much the track is tilted
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 3.4c Firing Balls III

The same small cart is now rolling down an inclined track and accelerating. It fires a ball straight out of the cannon as it moves. After it is fired, what happens to the ball?

1) it depends upon how much the track is tilted
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

Because the track is inclined, the cart accelerates. However, the ball has the *same component of acceleration* along the track as the cart does! This is essentially the component of *g* acting parallel to the inclined track. So the ball is effectively accelerating down the incline, just as the cart is, and it falls back 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:

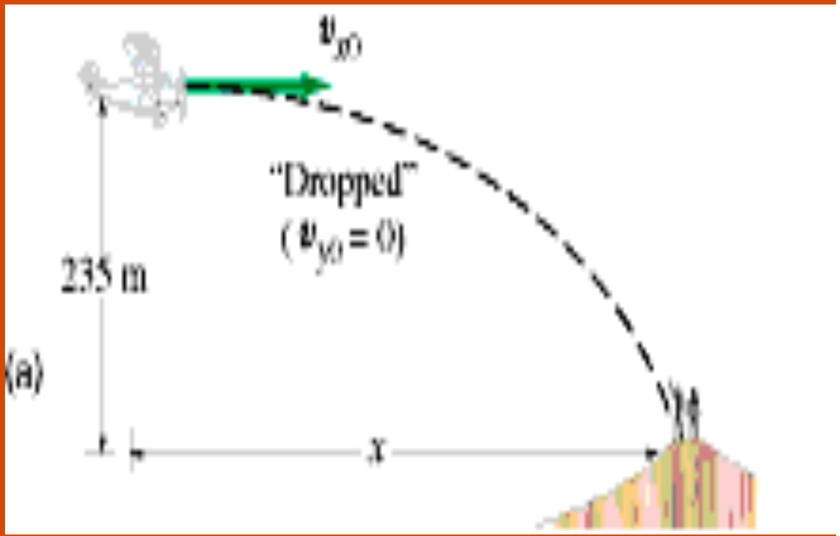
1) quickly lag behind the plane while falling
2) remain vertically under the plane while falling
3) move ahead of the plane while falling
4) not fall at all

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

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

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

In the previous problem, which ball has the greater velocity at ground level?

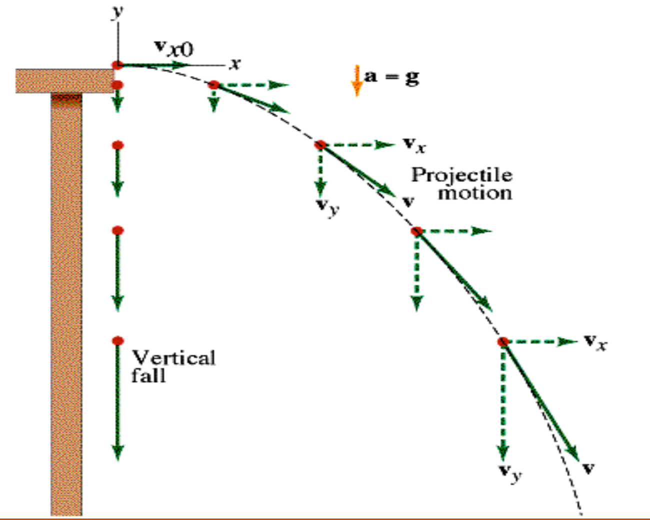
1) the "dropped" ball
2) the "fired" ball
3) neither – they both have the same velocity on impact
4) it depends on how hard the ball was thrown

ConcepTest 3.6b Dropping the Ball II

In the previous problem, 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?

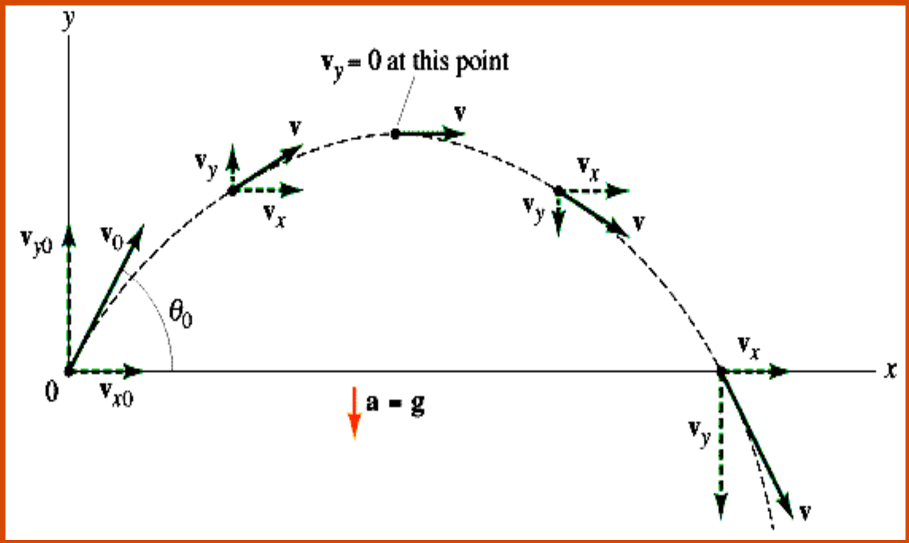
1) just after it is launched
2) at the highest point in its flight
3) just before it hits the ground
4) halfway between the ground and the highest point
5) speed is always constant

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?

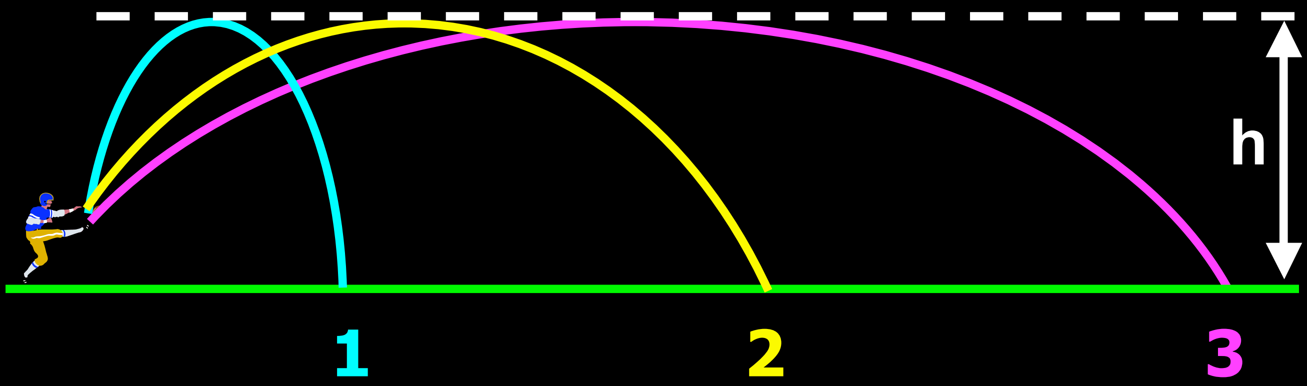
1) just after it is launched
2) at the highest point in its flight
3) just before it hits the ground
4) halfway between the ground and the highest point
5) speed is always constant

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

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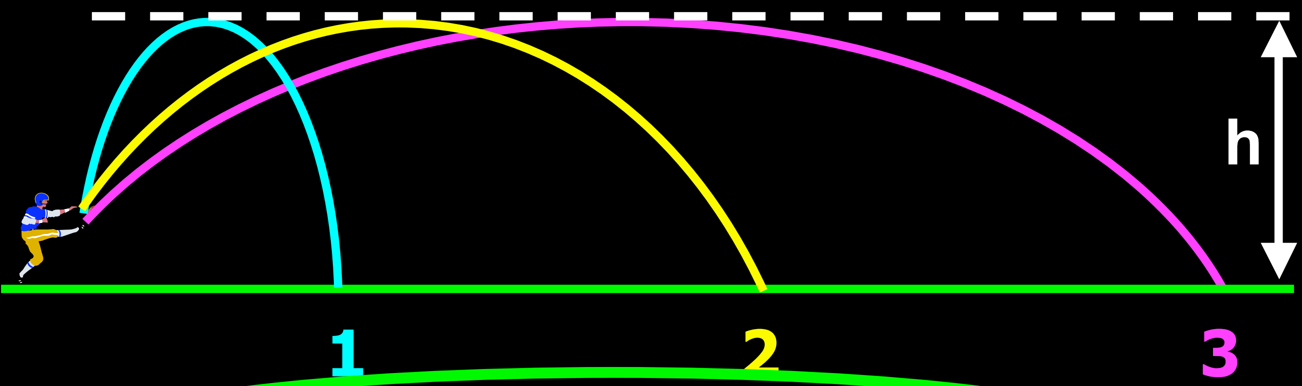


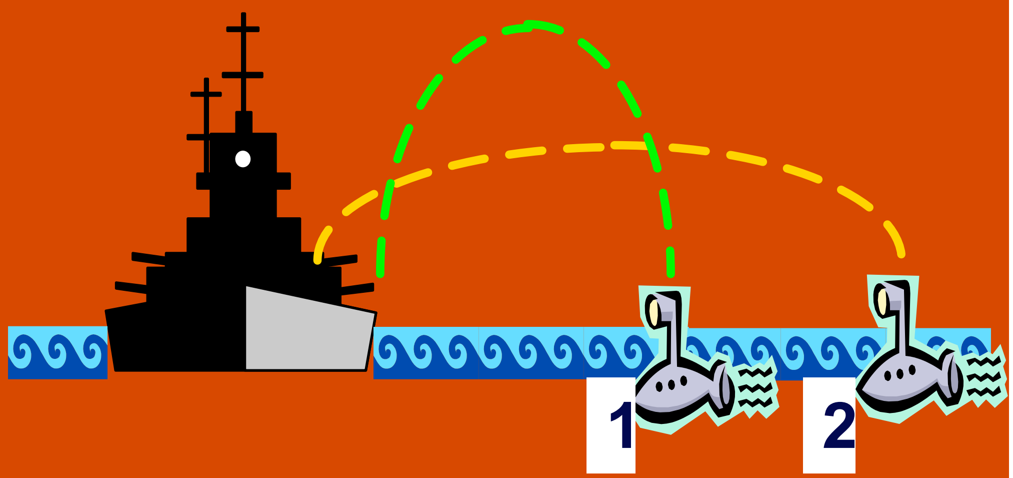
4) all have the same hang time

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 3.7b 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 ?

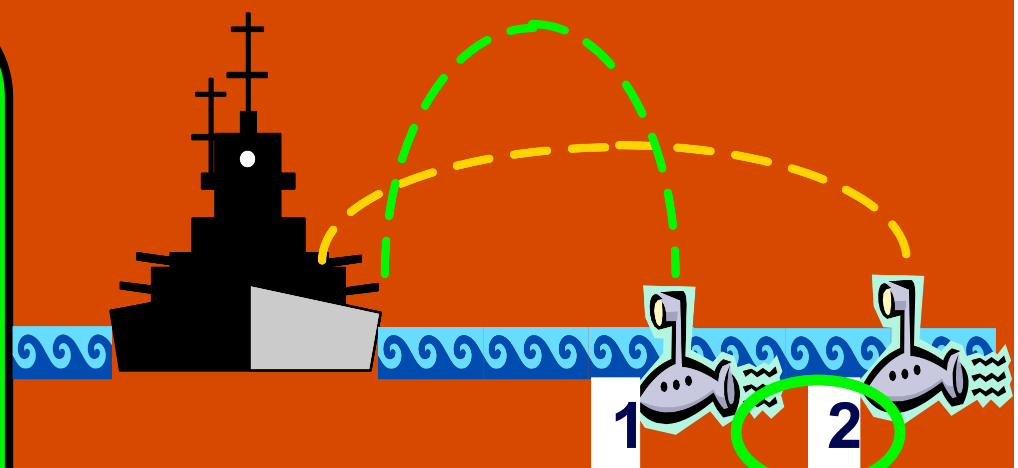


3) both at the same time

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** ?

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 ship #2 goes *less high*, therefore it stays in flight for *less time* than the other shell. Thus, ship #2 is hit first.

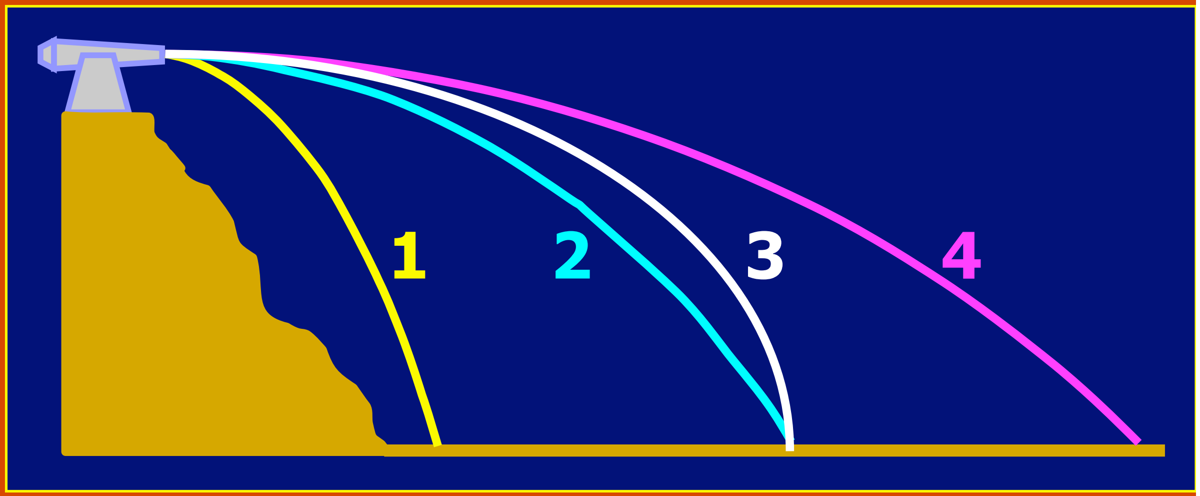


3) both at the same time

Follow-up: Which one traveled the greater distance?

ConcepTest 3.8 Cannon on the Moon

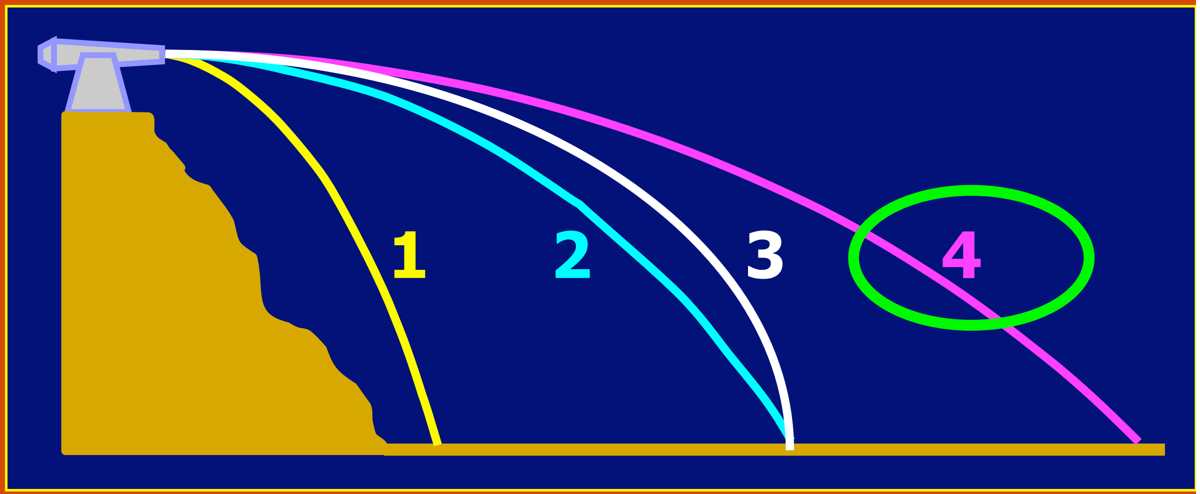
For a cannon on **Earth**, the cannonball would follow **path 2**. Instead, if the same cannon were on the **Moon**, where $g = 1.6\ m/s^2$, which path would the cannonball take in the same situation?



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 the air 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°

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1) 15°
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.

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.

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?

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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 3.10b Shoot the Monkey II

You’re on the street, trying to hit a friend with a water balloon. He sits in his dorm room window above your position. 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
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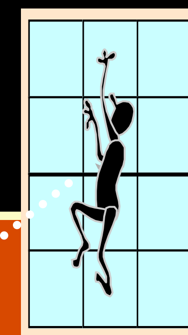
4) no, it misses
5) not really sure



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

ConcepTest 3.10b Shoot the Monkey II

You're on the street, trying to hit a friend with a water balloon. He sits in his dorm room window above your position. You aim straight at him and shoot. Just when you shoot, he falls out of the window! Does the water balloon hit him??

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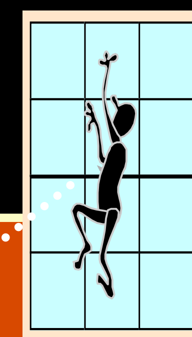


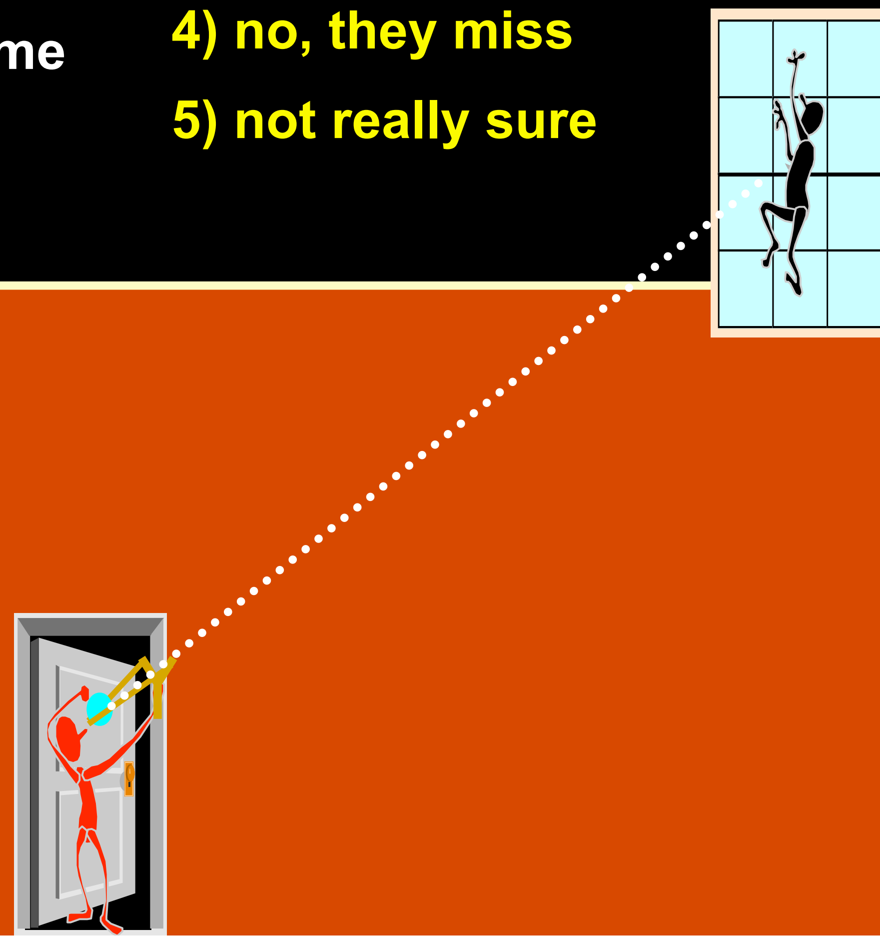
This is really the same situation as before!! The only change is that the initial velocity of the water balloon now has a *y*-component as well. But both your friend and the water balloon still fall with the same acceleration -- *g* !!

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

ConcepTest 3.10c Shoot the Monkey III

You're on the street, trying to hit a friend with a water balloon. He sits in his dorm room window above your position and is aiming at you with HIS water balloon! You aim straight at him and shoot and he does the same in the same instant. **Do the water balloons hit each other?**

1) yes, they hit
2) maybe – it depends on the speeds of the shots
3) the shots are impossible
4) no, they miss
5) not really sure



ConcepTest 3.10c Shoot the Monkey III

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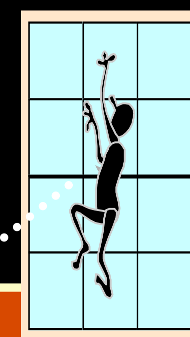
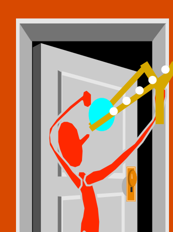


This is still the same situation!! Both water balloons are aimed straight at each other and both still fall with the same acceleration -- *g* !!



Follow-up: When would they NOT hit each other?