Vectors and Motion in 2 Dimensions

Physics Clicker Quizzes

Vectors

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

A Same magnitude, but can be in any direction

B Same magnitude, but must be in the same direction

C Different magnitudes, but must be in the same direction

D Same magnitude, but must be in opposite directions

E Different magnitudes, but must be in opposite directions

D Same magnitude, 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.

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

A They are perpendicular to each other

B They are parallel and in the same direction

C They are parallel but in the opposite direction

D They are at 45° to each other

E They can be at any angle to each other

A They are perpendicular 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.

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

A It doubles

B It increases, but by less than double

C It does not change

D It is reduced by half

E It decreases, but not as much as half

C **It does not change**

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

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

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?

A 0

B 18

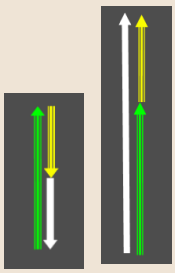
C 37

D 64

E 100

C **37**

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°.



Projectile Motion

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?

A It depends on how fast the cart is moving

B It falls behind the cart

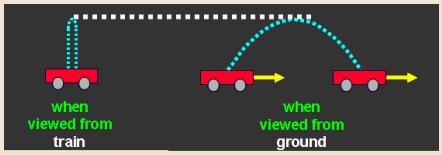
C It falls in front of the cart

D It falls right back into the cart

E It remains at rest

D **It falls right back into the cart**

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.



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?

A It depends on how fast the cart is moving
B It falls behind the cart
C It falls in front of the cart
D It falls right back into the cart
E It remains at rest

B **It falls behind the cart**

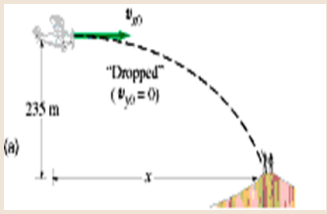
Now the acceleration of the cart is completely unrelated to the ball. In fact, the ball does not have any horizontal acceleration at all (just like the first question), so it will lag behind the accelerating cart once it is shot out of the cannon.

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

A Quickly lag behind the plane while falling
B Remain vertically under the plane while falling
C Move ahead of the plane while falling
D Not fall at all

B **Remain under the plane while falling**

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.



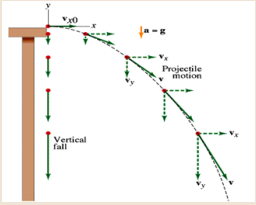
Follow-up:
What would happen if air resistance is present?

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?

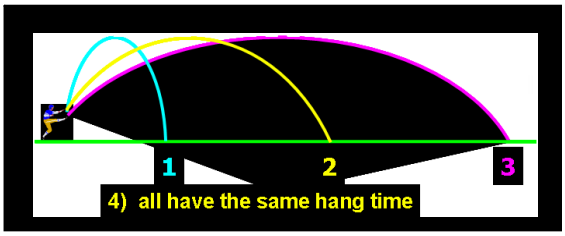
A The "dropped" ball
B The "fired" ball
C Neither – they both have the same velocity on impact
D It depends on how hard the ball was thrown

B **The fired ball**

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.



Which 3 punts has the longest hang time?



A 1
B 2
C 3
D They all have the same hang time

D **They 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?

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

A 15 degrees
B 30 degrees
C 45 degrees
D 60 degrees
E 75 degrees
F 90 degrees

C **45 degrees**

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.