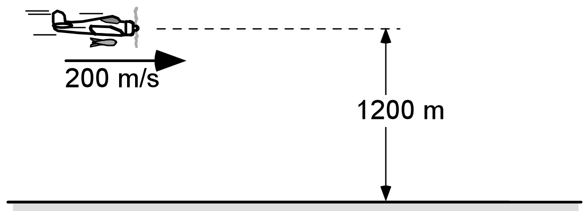
5. A military airplane is flying 1200 m above the ground at a speed of 200 m/s. It drops a practice bomb that hits the ground after traveling a horizontal distance of 3130 m. Ignore air resistance.



For each of the numbered changes below, use the lettered choices below to identify what will happen to the horizontal distance the bomb travels while falling compared to the situation above.

(a) The horizontal distance will be *greater than* 3130 m.
(b) The horizontal distance will be *less than* 3130 m but not to zero.
(c) The horizontal distance will be *equal to* 3130 m.
(d) The horizontal distance will be *zero,* i.e., the bomb will drop straight down.
(e) We *cannot determine* how this change will affect the horizontal distance.

For each of the following changes, only the feature(s) identified is(are) modified from the given situation above.

1) The plane's speed is tripled. ________

Explain.

A: The time it takes to hit the ground is the same, but the bomb has a greater horizontal velocity.

2) The plane is climbing straight up at the release point. ________

Explain.

D: Since there is no horizontal velocity it will come straight back down if it misses the plane.

3) The plane is flying in level flight at an altitude of 1100 m. ________

Explain.

B: It will take less time to reach the ground from a lower height, and the horizontal speed is the same.

4) The mass of the bomb is increased. ________

Explain.

C: The vertical acceleration is still g and is independent of the mass, so the path the bomb takes will

5) The bomb is thrown from the plane with a vertical downward velocity of 15 m/s. ________

Explain.

B: The acceleration of the bomb is the same, but with an initial downward vertical velocity it will

6) The plane is diving at a 20° angle and is at a height of 1200 m. ________

Explain.

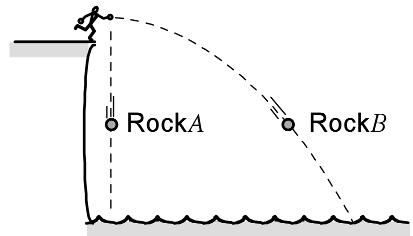
B: Thontal velocity is smaller since only a component of the 200 m/s is horizontal.

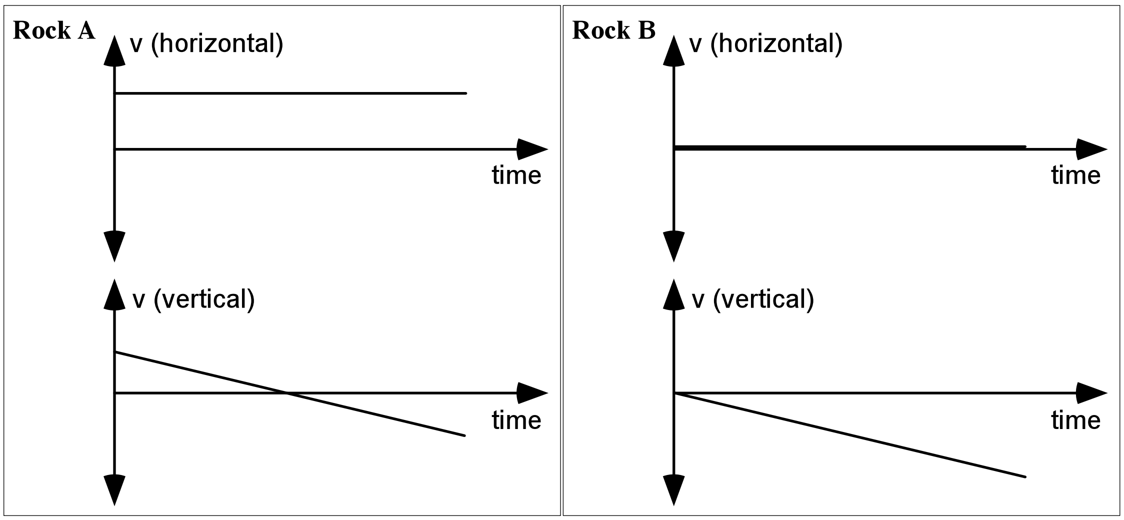
7) The plane's speed decreases, and it is flying at an altitude of 1800 m. ________

Explain.

E: Without knowing how much the speed decreased (and doing a calculation) we cannot tell how these changes will affect the horizontal distance. Decreasing the speed acts to decrease the horizontal distance, while increasing the height acts to increase it. But we cannot tell which change will be most important.

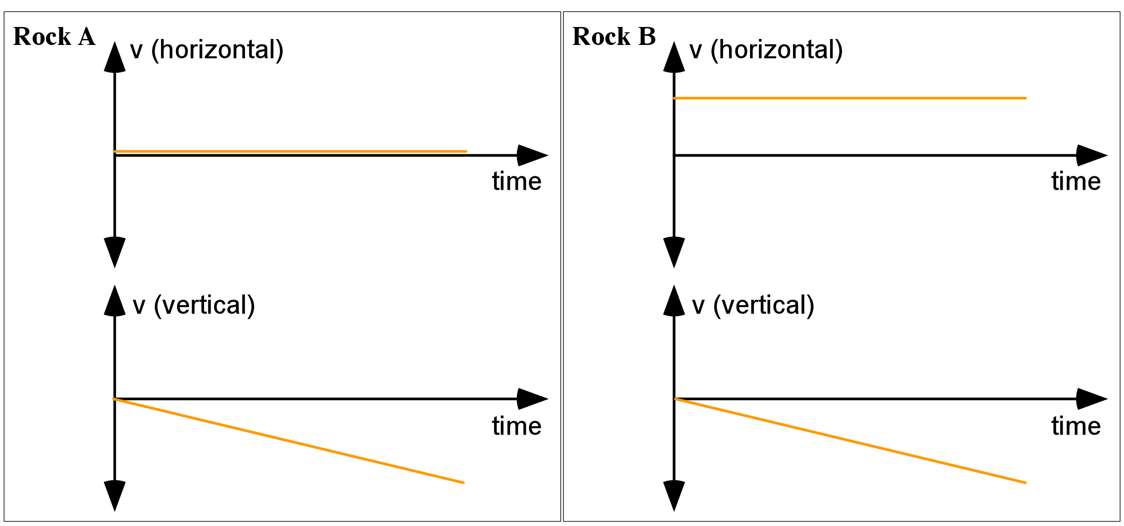
2. Rock *A* is dropped from the top of a cliff at the same instant that Rock *B* is thrown horizontally away from the cliff. The rocks are identical. A student draws the following graphs to describe part of the motion of the rocks. He uses a coordinate system in which up is the positive vertical direction, and the positive horizontal direction is away from the cliff, with the origin at the point the rocks were released.



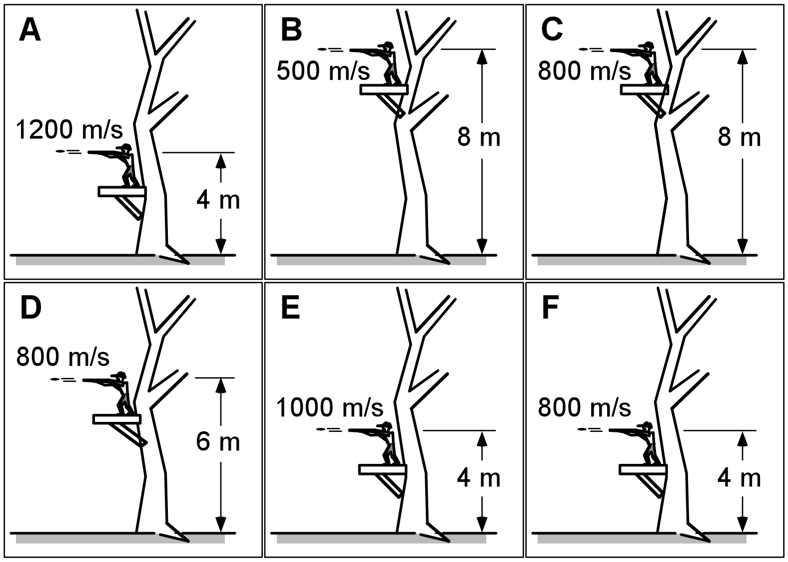


What, if anything, is wrong with these graphs for the motions of the two rocks? If something is wrong, identify it and explain how to correct it. If the graphs are correct, explain why.

The horizontal velocity graphs need to be switched, because Rock A has no horizontal velocity, and Rock B has a constant horizontal velocity. The vertical graph for Rock B is correct for both rocks.



1. Rifles are fired horizontally from platforms at various heights. The bullets fired from these rifles are identical, but they leave the rifle barrels at different speeds as shown in the diagrams. All of the bullets miss their targets and hit the ground. Ignore air resistance in this task.



Students who are asked to rank these situations on the basis of how long it takes the bullets to hit the ground respond as follows:

Anja: "I think the ranking should be C > B > D > A> E > F, because if two bullets are shot from the same height at different speeds, their y-acceleration is the same, meaning the one shot faster would have to cover more of the horizontal distance before hitting the ground, thereby making the time longer. So we rank first by height then by velocity."

Brina: "The higher the platform, the longer it will take, but the faster the bullet the smaller the time to hit the ground. So using rate times time equals distance we get time = height/velocity, which gives us the ranking B > C > D > F > E> A."

Charlie: "I think the ranking should be A > E > C > D > F > B. I agree that the height of the platform matters as does the velocity. The faster a bullet is moving, the longer it takes to hit the ground and the higher the longer too. So we rank first by velocity, then by the height if the velocities are the same."

Deepa: "I get B = C > D > A = E = F. The time that each bullet is in the air depends on the initial vertical velocity and the height. Since the initial vertical velocity is zero we only need to worry about the height, with the larger height giving a longer time. The horizontal velocity does not matter."

Ellie: "I think the ranking is A > E > C = D = F > B, since the time to reach the ground is directly related to the horizontal velocity."

Which, if any, of these students do you agree with?

Anja ___ *Brina* ___ *Charlie* ___ *Deepa* ___ *Ellie*___ None of them___

Explain.

Answer: Deepa's explanation is correct; B = C > D > A = E = F.

1.

(~15m/s)

2.

a) $u_x = u \cos 50°$
$u_y = u \sin 50°$

b) Taking upwards and rightwards as positive, consider the ball at its highest point of its trajectory

$v_y^2 – u_y^2 + 2a_ys_y$

$0 = (u \sin 50°)^2 + 2(-9.81)(8.0)$

$u = 16.355$

$u = 16 \text{ m s}^{-1}$

c)

$v_y^2 – u_y^2 + 2a_ys_y$

$v_y^2 = (16.355 \times \sin 50°)^2 + 2(-9.81)(-2.0)$

$v_y^2 = 196.2$

$v_y = -14.007$

$v_y = -14 \text{ m s}^{-1}$

d) $v^2 = v_x^2 + v_y^2$

$v^2 = (16.355 \cos 50°) + (-14.007)^2$

$v = 17.513$

$v = 17 \text{ m s}^{-1}$

$\tan θ = (v_y / v_x)$

$\tan θ = (14.007 / 16.355 \cos 50°)$

$θ = 53.111°$

$θ = 53°$

The velocity of the ball is 17 m s^{-1} at an angle of 53° below the horizontal.

e) $v_y = u_y + a_yt$

$-14.007 = (16.335 \times \sin 50°) + (-9.81)$

$t = 2.7049$

$t = 2.7 \text{ s}$

3. a) Vx= 54cos(35)

(Time to go 172m) = 172m/Vx = 3.89s

b) Max height of fence = Y-position at time to go 172 m = ½ (-9.8)t^2 + Voy*t+Yo = 47.35m

c) Vyfinal = a*t+Voy = a negative number