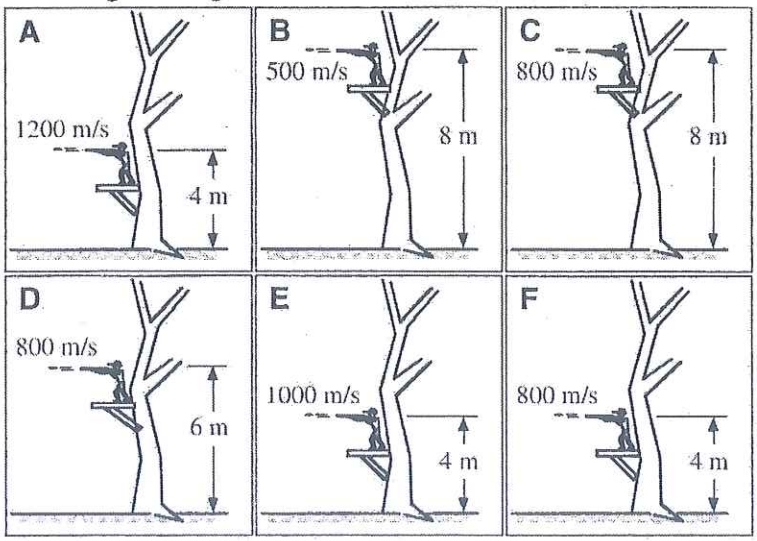
NT4E-CCT15: RIFLE SHOTS—TIME TO HIT GROUND

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.

Velocity doesn't matter because they're all accel. at 9.8 m/s² towards the ground.

2.86 sec 2.47 sec 2.02 sec

$\therefore B = C > D > A = E = F$

$A = E = F$ $B = C$

④ A

$V_{ix} = 1200$ m/s

20 m

$\Delta t = \sqrt{\frac{2(20)}{9.8}}$

$\Delta t = 2.02$ s

$\Delta X = V_{ix} \cdot \Delta t$

$= 1200 \times 2.02$

$= 2424$ m

② C

800 m/s

40 m

$\Delta t = \sqrt{\frac{2(40)}{9.8}}$

$= 2.86$

$\Delta X = V_x \cdot T$

$= 800 \cdot 2.86$

$= 2288$ m

E

$V = 1000$ m/s

20 m

$\Delta t = \sqrt{\frac{2120}{9.8}}$

$= 2.02$ s

$\Delta X = V_{ix} \cdot \Delta t$

$= 1000 \times 2.02$

$= 2020$ m (5)

① B $V = 500$ m/s

40 m

$\Delta t = \sqrt{\frac{2(40)}{9.8}}$

$= 2.86$ s

$\Delta X = 500 \times 2.86$

$= 1430$ m

⑤ D

800 m/s

30 m

$\Delta T = \sqrt{\frac{2(30)}{9.8}}$

$= 2.475$

$\Delta X = V_x \cdot T$

$= 800 \cdot 2.47$

$= 1976$ m

F

$V = 800$ m/s

20 m

$\Delta T = \sqrt{\frac{2(20)}{9.8}}$

$= 2.02$ s

$\Delta X = V_x \cdot T$

$= 800 \cdot 2.02$

$= 1616$ m

(6)