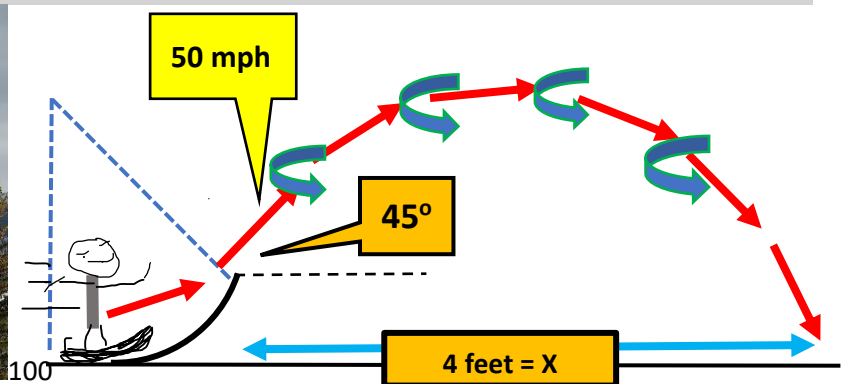


CENTRIPETAL FORCE & PROJECTILES

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Snowboarders Resist Making Big Air All About the Latest Trick



Mark McMorris of Canada hit a backside triple cork 1440(4 X 360) in the men's snowboard slopestyle event at the 2016 Winter X Games last January in Aspen, Colo.

It was a shot across the bow, and the snowboarder Billy Morgan played the part of cannonball, wearing all black while tucking and **somersaulting through the air more than 100 feet from a specially constructed jump made of snow** at a resort in Livigno, Italy. This was in April 2015, when Morgan, of Britain, landed a backside quadruple cork 1800, a marvel of physics and rotational forces consisting **of four off-axis back flips and six spins compressed into about three seconds of hang time.**



Danny Davis took a practice run on Wednesday for the Winter X Games superpipe in Aspen.

KEY CONCEPTS FOR PROJECTILE MOTION:

- *Horizontal velocity = constant,
- *Vertical velocity acts like freely falling object,
- * horizontal time = vertical time

INTRODUCTION: Goal is to find arc radius (R) of jump ramp(see graphic) & confirm four back flips are done in under 3 seconds?

QUESTIONS: (a) Convert 50 mph to ft./s.?, (b) As stated in article the centripetal acceleration is 4 g while moving at 50 mph. Find radius of arc on ramp?, (c) Find maximum height (H_{MAX}) reached by Snowboarder?,(d) Find his time (t) in air?

HINTS: $g = 32 \text{ ft./s.}^2$, $a_{CENTRIPETAL} = V^2/R$, $X = V_{HORIZONTAL} t$
 $V^2 = V_o^2 + 2 a X$, $Y = V_{OV} t + \frac{1}{2} a t^2$, when doing projectile solutions it is best to break solution into horizontal and vertical working equations. $\sin.\theta / \cos.\theta = \tan.\theta$, 60 mph = 88 ft./s.

ANSWERS: (a) 73.33 ft./s. , (b) $R = \sim 42 \text{ ft.}$, (c) $H_{MAX} = \sim 42 \text{ ft.}$, (d) $t = \sim 2.5 \text{ s.}$, just under three seconds as stated for hang time.

Stassel competes in big air and slopestyle disciplines, and has never landed a quad cork. He said that he and other competitors have focused on difficult moves they can land more smoothly and easily, like triple corks and 1620s — four-and-a-half spins — and judges have tended to reward them. For now, no one has landed a quad in competition. All that could change this week at the Winter X Games in Aspen when the men's snowboard big air finals are held on **a straight jump that will launch riders 100 feet** from Buttermilk Mountain on Friday night. In **a segment for ESPN's "Sport Science,"** the host, John Brenkus, **demonstrated how Parrot's quad flip required approaching a jump at more than 50 miles an hour, and generated four g's of centripetal acceleration while spinning — equivalent to the most extreme amusement park rides — and resulted in a half-ton of force upon landing.** "A bigger spin, say, an 1800, you have to throw it so hard, and get the grab and hold, that you don't have as much time to put your style, or personal stamp, on the trick," Mike Jankowski, the head coach of the United States snowboarding team, said. "The best riders will stand out having that unique personal stamp on the trick."