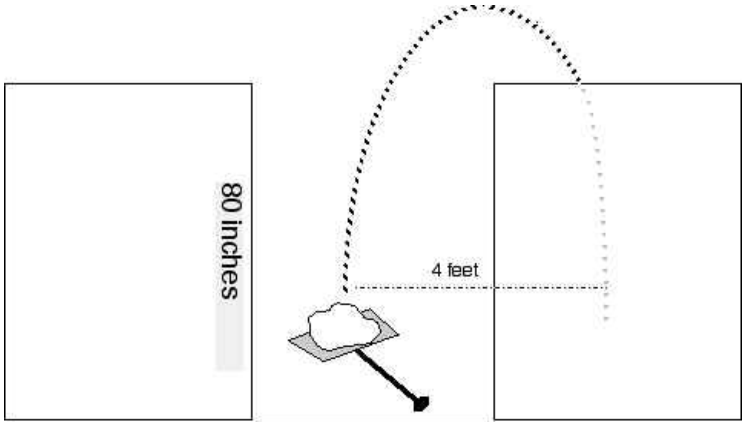
Throwing Up

On the east cost this year we've gotten very little snow. But in Alaska and Colorado there has been a lot. A man uses his snowplow to clear my driveway. I imagine the same activity is happening in Colorado. The plow piles the snow up to almost twice its previous height. So when I go out to shovel my sidewalk and clear away the edges of my driveway, I have to throw the snow up really high to make it over the plow piles. I have to throw up … you thought this was going to be a paper about a digestive situation … but no, it's about how tired I get throwing snow up.

How high do I have to throw the snow?

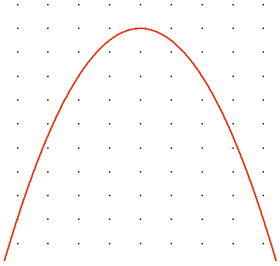
Sometimes I have to throw the snow practically straight up. But, straight up would make the snow land where I just shoveled it. So, I can't throw it straight up. I have to angle the shovel-full to the right or left a little. Let's underestimate the height of my snow walls and say that my walls are 80 inches high.




I can't have the snow land right at the edge of my 80-inch wall because then it will slide back onto my driveway and sidewalk. Ach!

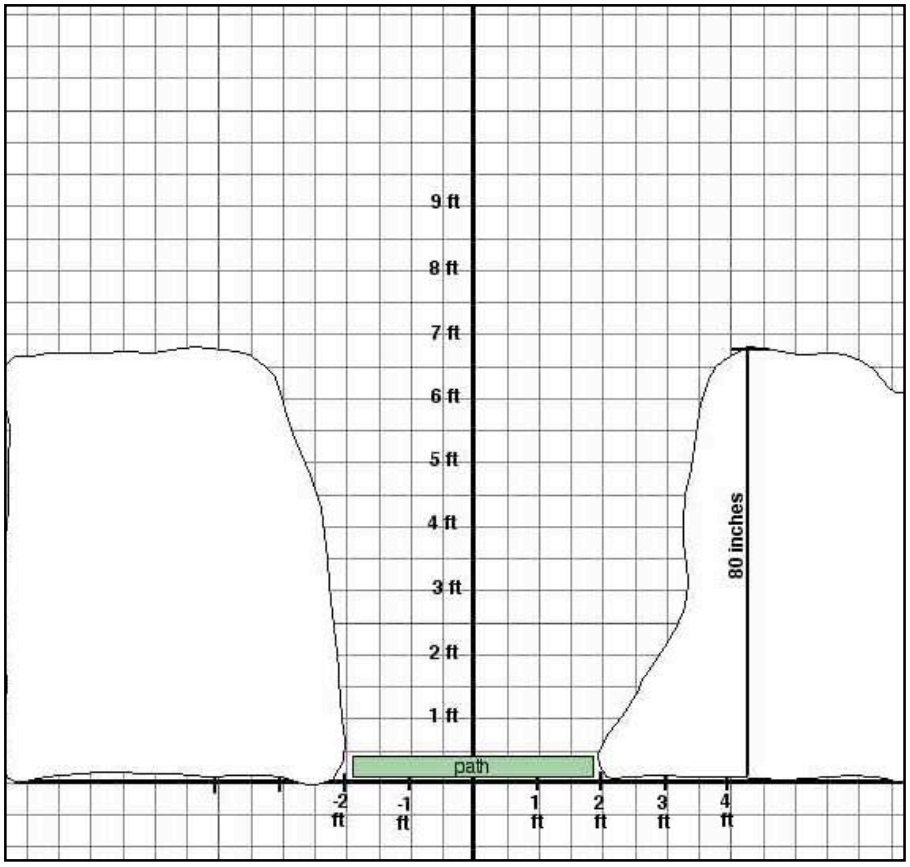
Let's figure this out. I want to move the snow 4 feet to the right and have it clear the height of 80 inches. There are formulas for the parabolic motion involved in throwing with a certain velocity and snow falling back according to gravity.

When you throw something up into the air, it follows a parabolic path because gravity slows the rise of what you've tossed and finally brings the object back to the ground.



Typically, one would estimate the velocity that you throw your shovel-full into the air and calculate its horizontal and vertical motion. I want my snow to move 4 feet to the right and rise high enough to go over an 80-inch pile of snow. But, I have no clue what my initial throwing velocity is … nor do I care. So I won't be doing this with initial velocity and gravity calculations.

The general equation of a parabola that looks like this is $Y = -X^2$. Let's just try to figure how high I have to throw my pile of snow to get it over the snow bank and not near the edge of the wall.

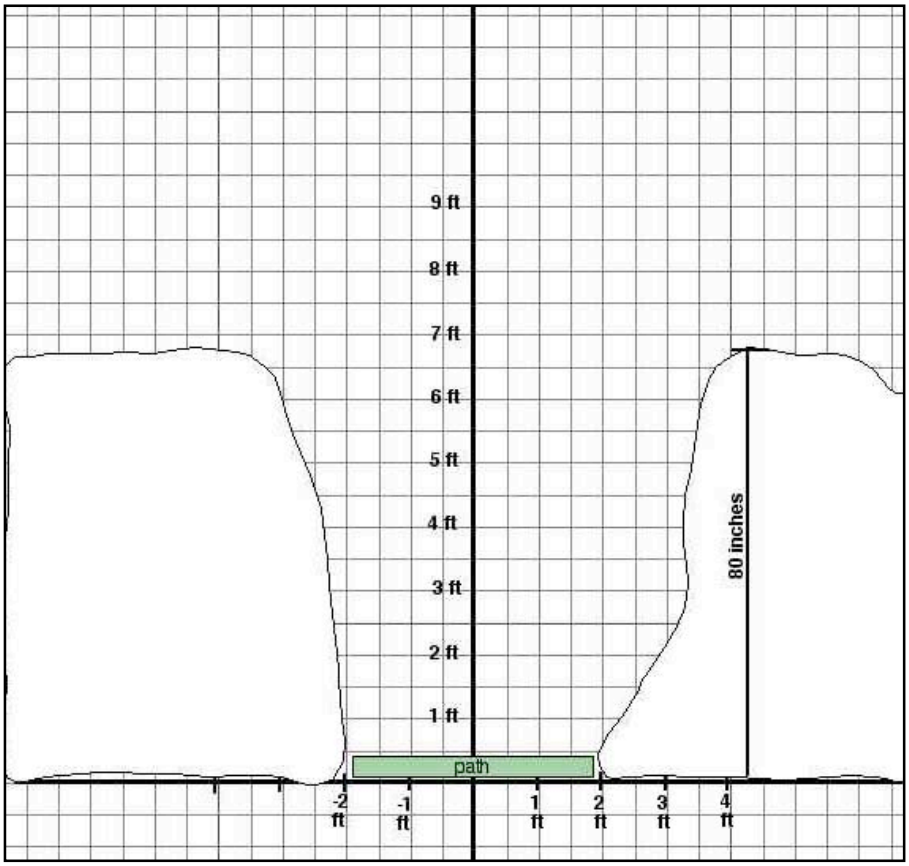



First we should experiment.

1. In pencil, sketch the graph of $y = -x^2 + 8$ feet by plugging in some values for X and calculating the height (Y-value) where our trajectory would land snow. (I added 8 feet to the original formula to get the snow to reach 8 feet before it fell back to the snow bank.)

| X | Y |
|---|---|
| -1 | |
| -1/2 | |
| 0 | |
| -1/2 | |
| 1 | |
| 2 | |
| 3 | |

2. Was that a good path for my snow? Why?

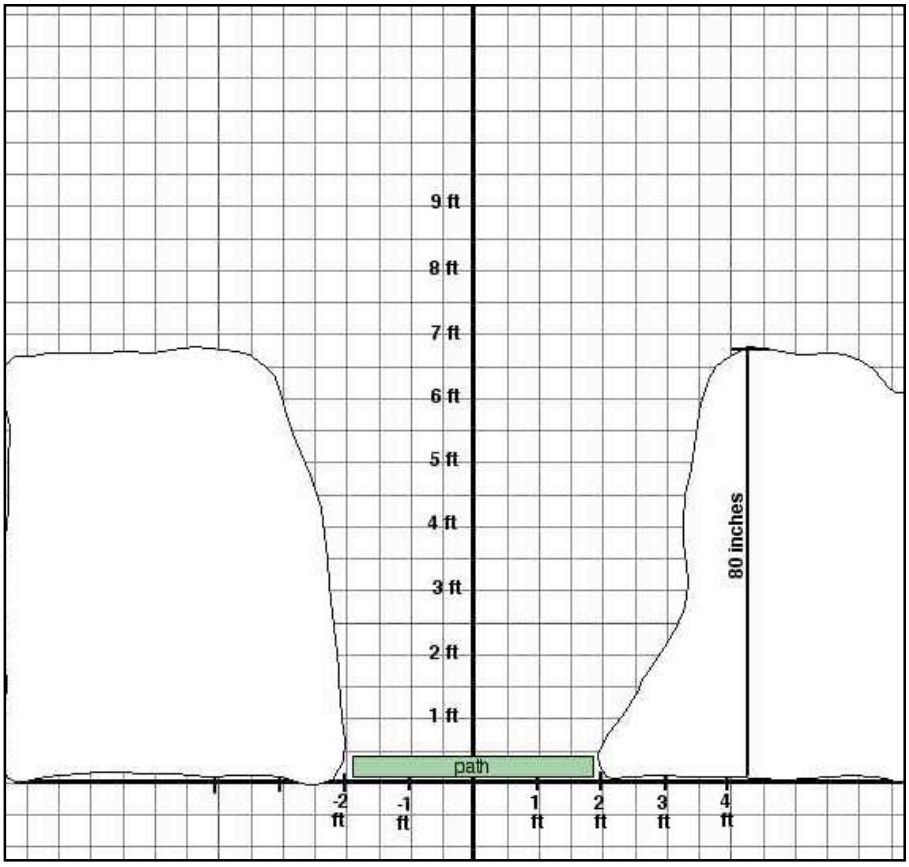



We can alter our parabola in several ways. If I want the arc to move to the right, I can surround my x with parenthesis and subtract a number.

For instance, $y = -(x-2)^2 + 8$ should make our parabola shift 2 feet to the right.

3. Graph $y = -(x-2)^2 + 8$. How do you want to adjust what was subtracted from the x? Change your equation to make that adjustment.

4. Do you want your throw to go higher before it starts to fall back to the snow bank?




Change your equation to do that.

Or we could make our parabola skinnier or fatter by adding a coefficient in front of the $x^2$. For instance, $y = -2x^2 + 8$ would make our parabola skinnier and $y = -\frac{1}{2}x^2 + 8$ would make our parabola fatter.

5. Choose a new equation for your parabola and plot it here to see how your snow-throwing arc is starting to look.

Good work. Now let's make your parabola perfect.

6. Did your snow-throw clear the wall before it started to fall back into the snow bank? If not, fix your equation.

7. Did your snow-throw get far enough horizontally into the snow pile when it landed? If not fix your equation.

8. How far did you throw up?