



### Problem 1 – Punkin' Chunkin' Team 1

The objective of a Punkin' Chunkin' contest is to shoot an 8-10 pound pumpkin as far as possible. A trebuchet is a medieval tool often used to accomplish this goal. It uses gravitational potential energy and converts it to kinetic energy to launch the pumpkin. Various types of cannons are also used to launch pumpkins.

In a recent contest, a college engineering student team launched a pumpkin using a trebuchet. Its motion may be modeled by the equation  $f(x) = -0.00057x^2 + 0.32426x + 4$ .

To view the path of this magnificent pumpkin, enter the equation into the  $y=$  screen. Then press  $\boxed{\text{window}}$  and match the window settings to the right. Press  $\boxed{\text{graph}}$ .

```
NORMAL FLOAT AUTO REAL Radian MP
DISTANCE BETWEEN TICK MARKS ON AXIS
WINDOW
Xmin=-10
Xmax=600
Xscl=50
Ymin=-20
Ymax=70
Yscl=5
Xres=1
ΔX=2.3106060606061
TraceStep=4.6212121212122
```

Calculate points of interest.

- Zeros: Press  $\boxed{2\text{nd}}\boxed{[\text{calc}]}$ , select **zero**, and follow the on-screen directions.
- Maximum: Press  $\boxed{2\text{nd}}\boxed{[\text{calc}]}$ , select **maximum**, and follow the on-screen directions.
- Minimum: Press  $\boxed{2\text{nd}}\boxed{[\text{calc}]}$ , select **minimum**, and follow the on-screen directions.
- y-intercept: Press  $\boxed{\text{trace}}$  and enter  $\boxed{0}$ .

```
NORMAL FLOAT AUTO REAL Radian MP
CALCULATE
1:value
2:zero
3:minimum
4:maximum
5:intersect
6:dy/dx
7:∫f(x)dx
```



Using these points of interest answer the following questions:

1. What are the maximum height reached and the total horizontal distance traveled for the pumpkin?  
Round to the nearest foot.
2. At what distance above the ground was the pumpkin launched?
3. If a 10-foot high chain-linked fence is in the path of the pumpkin at a distance of 500 feet from where the pumpkin is released, will it pass over the fence? How high is the pumpkin when it reaches the fence? (Hint: Use the `trace` key and type `500`.)

### Problem 2 – Punkin' Chunkin' Team 2

While the first team did have a highly successful launch, they did not win the contest. The winning engineering student team launched a pumpkin whose path can be modeled by the equation

$$f(x) = -0.00012x^2 + 0.18238x + 5.$$

Repeat the same procedures as in Problem 1 to find the points of interest for this new equation.

**Note:** In the **Window Settings**, you will need to set **Xmax** = 1700, **Xscl** = 100 and **Ymax** = 80. All other settings may remain the same.

Use what you have learned in Problem 1 to answer the questions about Team 2's launch.

4. What are the maximum height reached and the total horizontal distance traveled for the pumpkin?  
Round to the nearest foot.
5. At what distance above the ground was the winning pumpkin launched?
6. Overall, how did the trajectory of Team 1's pumpkin compare to Team 2's pumpkin? Why do you think Team 2's pumpkin went farther?



### Problem 3 – Cost of Kayaks

A small kayak design company has determined that when  $x$  hundred kayaks of a certain design are built, the average cost per kayak is given by  $C(x) = 0.57x^2 - 0.75x + 1.86$ , where  $C(x)$  is in hundreds of dollars.

Repeat the same procedures as in Problem 1 to find the points of interest for this new equation.

**Note:** Press  $\boxed{\text{zoom}}$  and select **ZStandard** to set the window up correctly for this problem.

7. How many kayaks should the shop build to minimize the average cost per kayak?

8. What is the cost per kayak in the minimized cost situation?

### Problem 4 – Espresso Yourself

Espresso Yourself sells one size of espresso and it charges  $x$  dollars per cup. The weekly profit for this espresso stand is modeled by the equation  $P(x) = -2900x^2 + 7250x - 2900$ .

Repeat the same procedures as in problem 1 to find the points of interest for this new equation.

**Note:** In the **Window Settings**, set **Xmin** = -1, **Xmax** = 3, **Xscl** = 0.25, **Ymin** = -500, **Ymax** = 2000, **Yscl** = 100.

9. What are the maximum profit and the approximate price per cup of espresso that yields this maximum profit?

10. According to the given model, at what price per cup will sales be so low that the stand will not obtain any profit?