THE 2021 YOUNG MATHEMATICAL STORY AUTHOR (YMSA) COMPETITION

THE CINDY NEUSCHWANDER AWARD
(THE 12-15 YEARS OLD CATEGORY)

SHORTLISTED
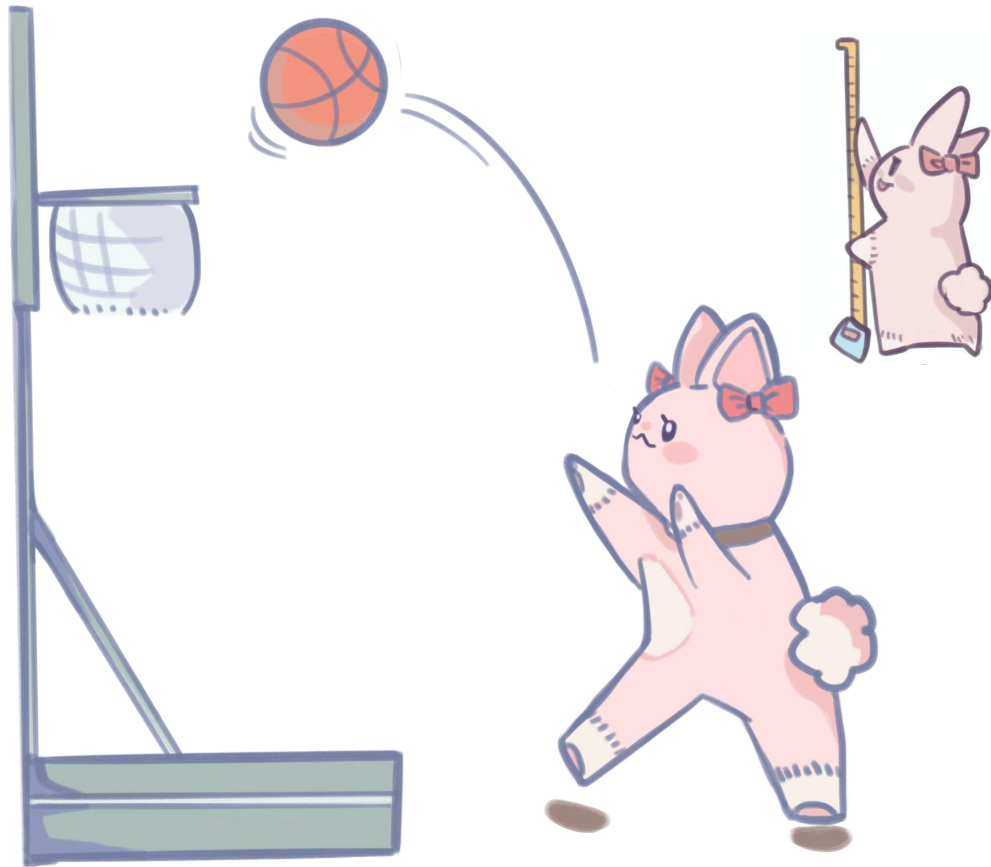
'Bunny Annie Shooting A Basketball' by Wendy Weng (14 years old)
at Ningbo Huamao International School (China)

You can read the author's inspiration for the story and the judges' comments on:

www.mathsthroughstories.org/ymsa2021
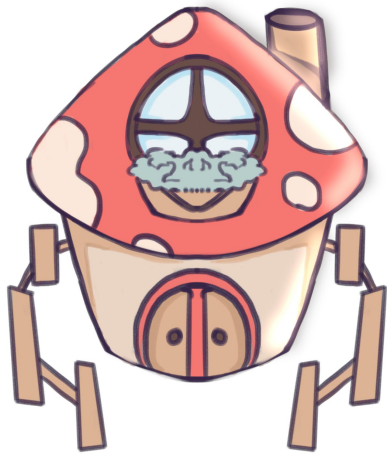
#YMSAMaths

Bunny Annie
shooting a basketball

By Wendy Weng Ningbo Huamao International School (China)

It's summer now and the warm sun shines on a huge mushroom house. Inside the mushroom house, there is a hedgehog teacher with glasses standing at a podium speaking to a lot of little animals sitting below. And this is where bunny Annie studies.
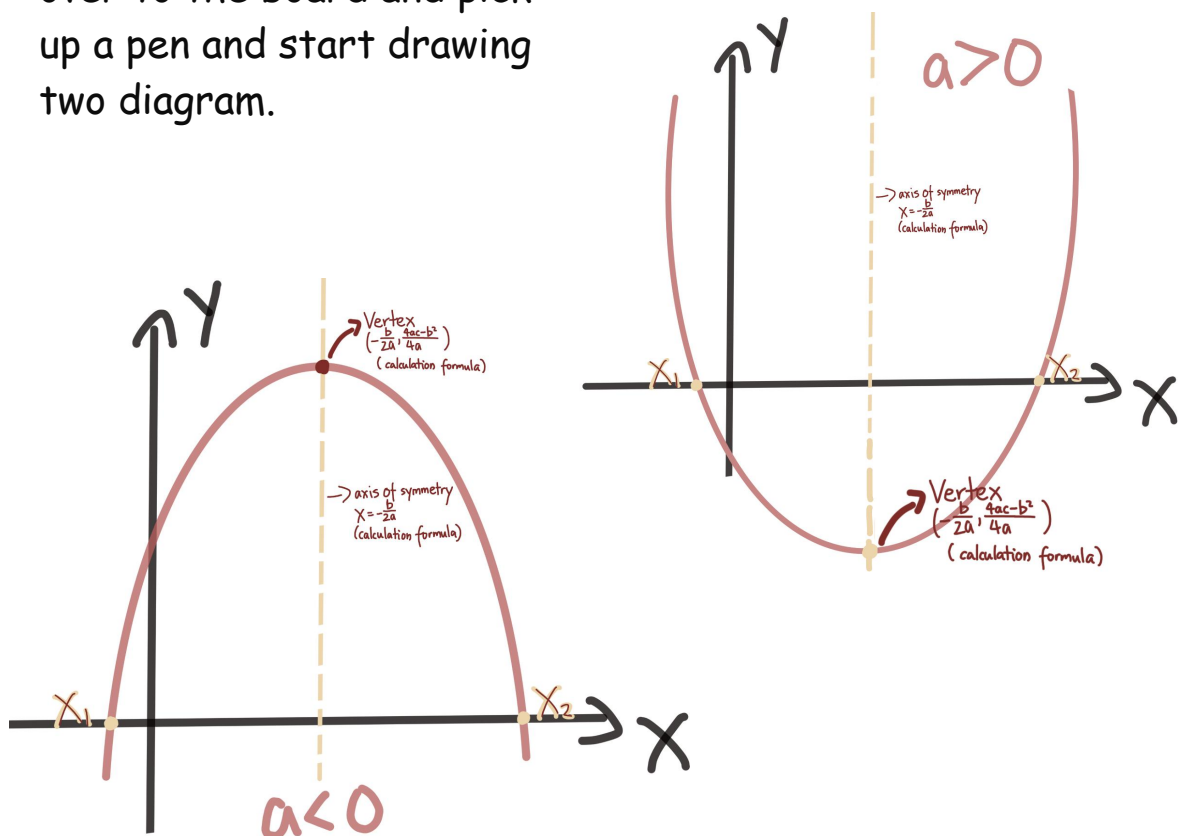
Bunny Annie is a lovely little pink rabbit with two red bows beside her ears and a necklace around her neck. Annie is a little rabbit who likes math very much. Her favorite math subject is quadratic function.

This is the day before the summer holidays were due to arrive, Mr. Hedgehog gave the forest class an assignment. "Before I assign homework, does anyone else remember what we've been learning about quadratic function in math class this term?" Mr. Hedgehog asked.

"I know, I know! " Annie raise up her hands excitedly because it is her favorite subject, "Quadratic functions are a common type of function. The image of a quadratic function is a parabola, but a parabola is not necessarily a quadratic function. A parabola that opens upwards or downwards is a quadratic function. The basic representation of the quadratic function is y = ax² + bx + c (a ≠ 0). The image of a quadratic function is a curve line upward or downward, because it depend on a>0 or a<0. And there must be an axis of symmetry in the middle. Oh! There is also a vertex, and the intersection of the x-axis and the y-axis, or without x-intercept, but y-intercept is a must." And then Annie Walk over to the board and pick up a pen and start drawing two diagram.

$a > 0$

axis of symmetry
$X = -\frac{b}{2a}$
(calculation formula)

X_1 X_2

Vertex
$(-\frac{b}{2a}, \frac{4ac-b^2}{4a})$
(calculation formula)

Vertex
$(-\frac{b}{2a}, \frac{4ac-b^2}{4a})$
(calculation formula)

axis of symmetry
$X = -\frac{b}{2a}$
(calculation formula)

X_1 X_2

$a < 0$

"Haha, well done Annie. That was a very detailed explanation" laughed Mr. Hedgehog, "What I was also able to add is that there are two other expressions for quadratic functions, the vertex form y=a(x-h)^2+k (a≠0), this kind of formula can help us find the vertex faster, because "h" is the "x" of vertex coordinates and "k" is the "y" of vertex coordinates. Also the intercept form y=a(x- x1)(x-x2) (a≠0), which "x1" and "x2" means two x-intercept."

"Okay, such a long conversation between us, now I'm going to announce our task for summer vacation. The task are to discover the 'quadratic functions' that will appear in our lives during the summer holidays and to solve them", the Mr. Hedgehog said.

"What does it mean to find 'quadratic functions' that will occur in our life and solve them? What should we do?" Annie raised her hand and asked. "It is to find things about quadratic functions that occur in our own lives and then do the calculations and write an equation of it," answered by hedgehog teacher. "Okay, I understand, thank you Mr. Hedgehog," Annie replied.
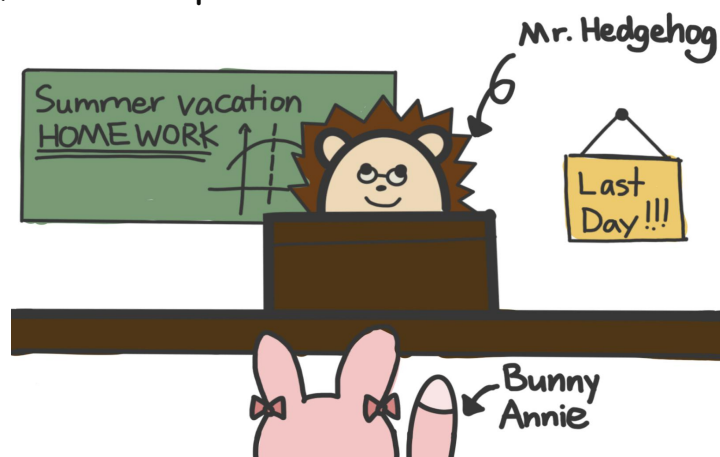
"Finally, I would like to emphasize one thing: the student with the best homework can get a special gift! But everyones equation should be different," said Mr. Hedgehog. All the students were thrilled to hear this, some wondering what the prize was and some wanting it, including Annie.

After walking out of the mushroom hut, everyone was discussing how to go about completing it.

Kitten thought, "I can go to the bridge at the bend of the creek to work out the parabola and get the formula."

Puppy thought, "I can get a formula by playing Angry Birds and using the parabola of the bird hitting the pig as it flies out to do the calculation."

Seeing that everyone had their own ideas, Annie felt frustrated because everyones equation should be different, and she didn't have any ideas to complete her homework.
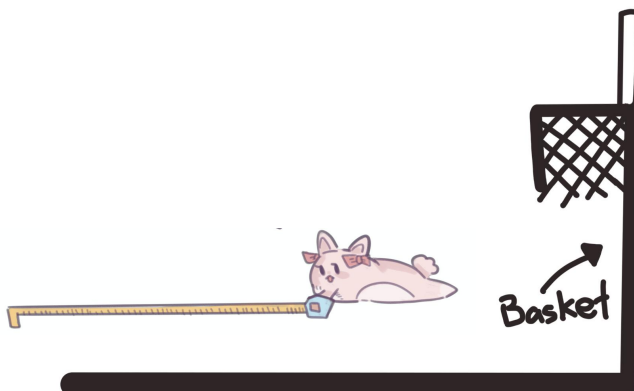
A sad Annie walks off alone and on her way back to home, she finds a basketball and basket. So she decided to play basketball for a while to relieve her sadness. As she played, she suddenly thought of a problem.

Annie starts thinking about what she needs to prepare to calculate the parabola to throw basketball to the basket at home the next day. So she decided to take a 4 meter tape measure and a basketball to the basketball court again
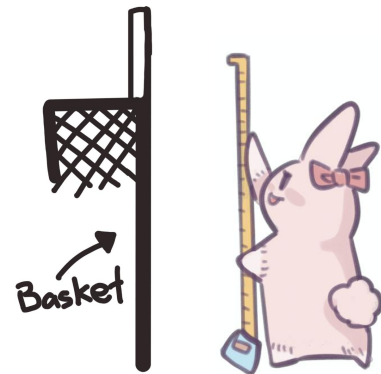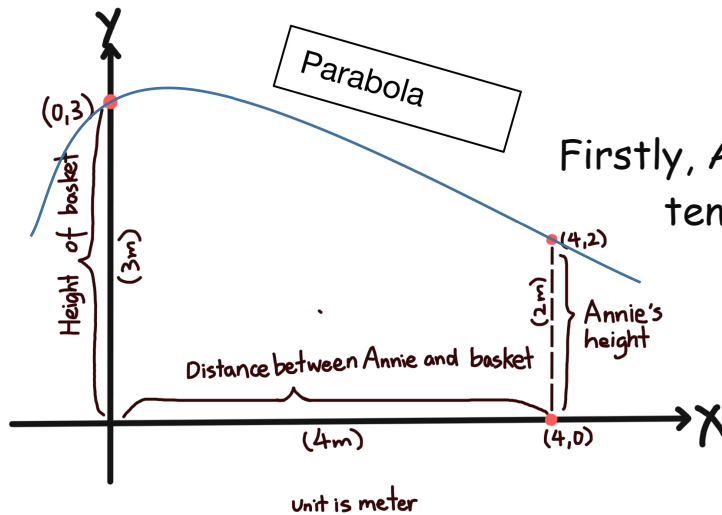
After arriving at the basketball court, first she decided to measure the height of the basket, which was three meters high.

Basket

Next was where she stood she measure where she was standing, from where Annie was standing to the basketball hoop was four meters away and Annie herself was two meters high. So say Annie now gets a graph like this by drawing on a piece of paper.

Basket

Parabola

(0,3)

Height of basket

(3m)

(4,2)

(2m) } Annie's height

Distance between Annie and basket

(4m)

(4,0)

Unit is meter

Firstly, Annie is a weak and tender bunny, so the highest point of the parabola is the position of the basket.

Next, she then needs to work out the formula for the parabola formed by the basketball thrown from her position and height.

Formula used: vertex form

⭐ $Y = a(x-h)^2 + k$

Vertex is (0,3)
Substituting vertex form

$Y = a(x-0)^2 + 3$

$Y = a(x-0)^2 + 3$ ← plug in (4,2)

$2 = a(4-0)^2 + 3$

$a(4-0)^2 = 2-3$

$a(4-0)^2 = -1$

$16a = -1$

$a = -\frac{1}{16}$

Now Annie has got a formula, but she has found a problem that 'a' is still unknown. "So how to calculate the 'a' in the formula," Annie thought.

Annie remembered! As long as any other coordinate of the figure is substituted in the formula, the 'a' can be calculated. Annie then chooses to substitute (4,2) on the graph.

After that, Annie substituted a into the vertex formula she just used.

Final vertex equation:
$$y=-\frac{1}{16}(x-0)^2+3$$

"So how can I verify that I've done the math right myself?" Annie said to herself, "Right! Mr. Hedgehog said that if the parabola is down, then it will be a<0." "My 'a' is negative and the parabola is also down!" Annie was delighted.

At this point Annie decided that one vertex formula was not enough for her task, so she think about that she could write out the other two expressions standard form and intercept form.

Finally, with Annie's different calculations, three different equations for the basketball parabola were obtained.

Standard form:
ex. ax^2+bx+c $(a\neq0)$

Calculate:
$-\frac{1}{16}(x-0)^2+3$
$=-\frac{1}{16}(x^2)+3$
$=-\frac{1}{16}x^2+3$

Final standard form

Intercept form:
ex. $y=a(x-x_1)(x-x_2)$ $(a\neq0)$

Calculate:
$y=a(x-4\sqrt{3})(x+4\sqrt{3})$
$3=ax-4\sqrt{3}\times4\sqrt{3}$
$3=ax-48$
$a=-\frac{1}{16}$
$y=-\frac{1}{16}(x-4\sqrt{3})(x+4\sqrt{3})$
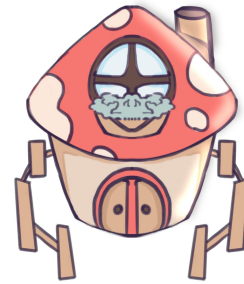
Final intercept form

Final three equation

standard form
$y=-\frac{1}{16}x^2+3$

Vertex form
$y=-\frac{1}{16}(x-0)^2+3$

Intercept form
$y=-\frac{1}{16}(x-4\sqrt{3})(x+4\sqrt{3})$

Annie wrote all three formulas on her homework

Finally, on the day school started, everyone returned to that mushroom house, where Mr. Hedgehog stood at the classroom podium waiting for each student, and their homework.

After Mr. Hedgehog had read all the students homework, he smiled and said, "Everyone has found good with quadratic functions from life and to work with it. For example, the arc of a bridge bending over by a stream versus the arc of an angry bird throw, but I think the one who did her homework most completely was Annie. Annie worked out the formula for the quadratic function by throwing the arc of a basketball and she wrote out all three forms of the formula. So I decided to give Annie the special gift I had prepared! "

Annie happily accepted the gift, "Thank you Mr. Hedgehog!" she said. When Annie opened the special gift, she found a cool pair of glasses!
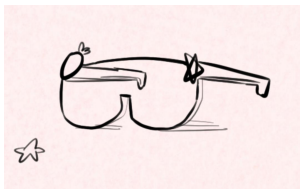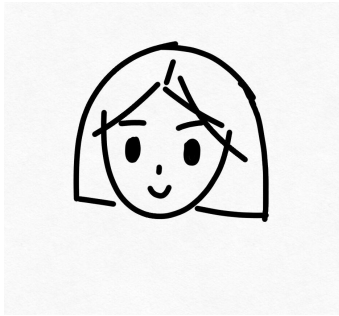
She happily put them on, "The glass is so cool!" Annie said and put on the glasses.

-THE END-

A little maths story about a bunny called Annie uses a basketball to complete a quadratic function task.

From **Ningbo Huamao International School MYP grade 9.**

Wendy Weng

Inspiration: Because our maths teacher Ms. Yarina was teaching us quadratic functions and I thought they were very interesting. So I came up with the idea of a quadratic problem and use a rabbit as my main character of this story.

In conclusion, I think YMSA is a very meaningful competition. Completing a novel through mathematical knowledge can be a good exercise for us.

THANK YOU FOR WATCHING!