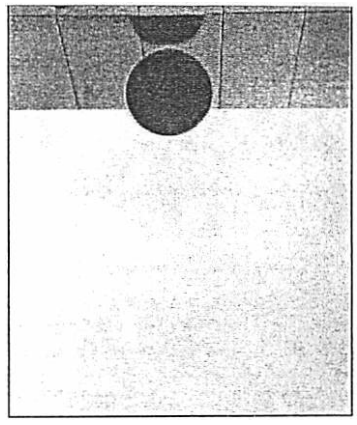
Mathematics Work Sample Assessment

Don't Hit the Ceiling

Use the information provided to solve the problem listed below. Be sure to show your work at all phases of problem solving. Refer to the **Mathematics Problem Solving Official Scoring Guide** to receive the highest score in each of the five process dimensions.

#B1



A group of friends have made up a game to play in the gym. Each person throws a ball toward the ceiling and the one who comes closest to the ceiling without touching it is the winner. After everyone has a turn, Hannah and Jake, with the two best tosses, go again.

The ceiling of the gym is 30 feet high. Hannah stands in the middle of the gym and throws the ball straight up. Jake stands near the gym door and throws the ball at an angle toward the ceiling.
Each equation represents the height of the ball (h), in feet, after *t* seconds.

Who wins?

a + b + c

Hannah: $h = -28t^2 + 56t + 4$

$t = \frac{56}{2(-28)}$

$t = \frac{56}{-56}$

$t = -1$

$H = -28(-1)^2 + 56(-1) + 4$

$H = -28 - 56 + 4$

$H = -80$

Jake: $h = -6t^2 + 24t + 5$

$t = \frac{24}{2(-6)}$

$t = \frac{24}{-12}$

$t = -2$

$H = -6(-2)^2 + 24(-2) + 5$

$H = -24 - 48 + 5$

$H = -67$

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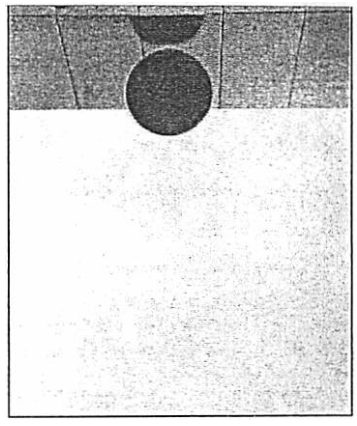
#B7



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Who wins?

Who wins?

equation #1

Hannah: $h = -28t^2 + 56t + 4$ (A B C)

$x = \frac{-b}{2a}$

Finding the Min/Max (vertex)

equation #2

Jake: $h = -6t^2 + 24t + 5$ (A B C)

Height = 1 ft

Seconds = 32 sec

$h = \frac{-56}{2(-28)}$

$h = 1$

$-28(1)^2 + 56(1) + 4$

$t = 32$

$h = \frac{-24}{2(-6)}$

$h = 2$

Height = 2 ft

Seconds = 29 sec

$-6(2)^2 + 24(2) + 5$

$t = 29$

In order for me to find the Maximum/minimum I need to find the vertex, Y. for me to find the vertex I need to use the equation $x = \frac{-b}{2a}$. In the equation for the height of the ball "$h = -28t^2 + 56t + 4$" label the number sections A, B, C and then fill out the vertex equation, Do that for both Jake and Hannah. When you find the height plug the number 1 back into Hannah's equation and solve for "t". Then do the same thing for Jake. You should come out with Jake being the winner.

Hannah	Jake
Height = 1 ft	Height = 2 ft
Seconds = 32	Seconds = 29

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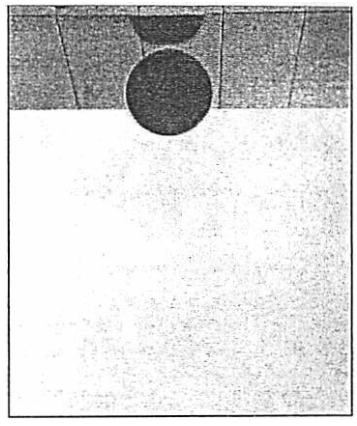
#B11



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Each equation represents the height of the ball (h), in feet, after *t* seconds.

Who wins?

Who wins? analyze, solve, answer, prove

Hannah: $h = -28t^2 + 56t + 4$

I need to find the maximums of both of the equations. Assuming the ball is really infenitesimally small, the size of a point, then at 30 feet or higher the ball has touched the ceiling. Using -b/2a will give me the x values of the vertices. Hannah's x value was 1, Jake's was 2.

I plug those values back into the original equations to find y values and the maximum values.

Answer: Hannah's ball would hit the ceiling because the y value of her throw is higher than 30 ft. Jake's throw wins because he does not hit the ceiling.

Check: Graph the two functions on a calculator. Hannah's graph has a vertex at (1, 32) which exceeds the ceiling height. Jake's was at (2, 29) which does not exceed the ceiling height.

Jake: $h = -6t^2 + 24t + 5$

$-28t^2 + 56t + 4$

$\frac{-56}{2 \cdot (-28)} = 1 = x$

$-28 \cdot 1^2 + 56 \cdot 1 + 4$

$-28 \cdot 1 + 56 + 4$

$-28 + 60$

$32 = y$

$-6t^2 + 24t + 5$

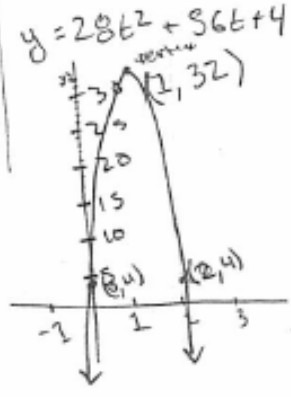
$\frac{-24}{2 \cdot (-6)} = \frac{-24}{-12} = 2 = x$

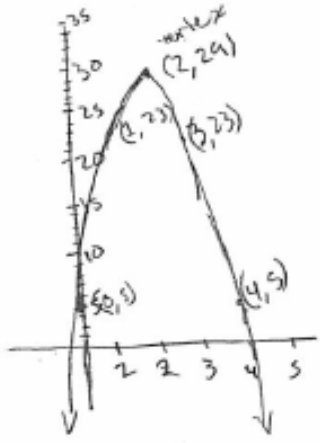
$-6 \cdot 2^2 + 24 \cdot 2 + 5$

$-6 \cdot 4 + 48 + 5$

$-24 + 53$

$29 = y$





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#B24

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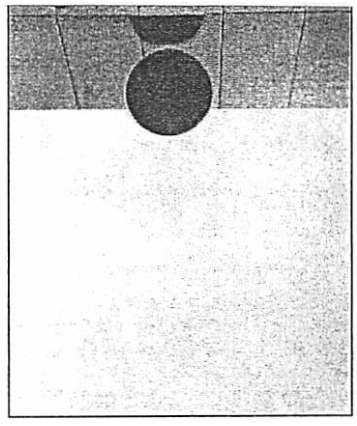

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Each equation represents the height of the ball (h), in feet, after *t* seconds.

Who wins?

A 2t B C
Hannah: $h = -28t^2 + 56t + 4$

Hannahs work
You will need to x using the foumala $x = \frac{-B}{a \times 2}$

$x = \frac{-56}{-28 \times 2} = \frac{-56}{-56} = 1$

56 will be a negative because B will always be the oppisite of a positive or negative of the equcuion. Also A will always be times by 2 because of its square root.
Second plug in x valucinto t in the original problem.

$H = -28(1)^2 + 56(1) + 4$

Find the square root first times all the numbers near a prendents. ( )

$H = -28(1) + 56(1) + 4$

$H = -28 + 56 + 4$
add or subract
$H = 60 - 28$
Tnen you will find Hannahs Height of kick $H = 32$

A B C
Jake: $h = -6t^2 + 24t + 5$

Jacks Height
Again you will neea to find the foumala by using $x = \frac{-B}{a}$

$x = \frac{-24}{-6 \times 2} = \frac{-24}{-12} = 2$

24 will be a negative because b will always be the oppisite of the original equation.
-6 will also be times by 2 because of its square root
Plug in x valve into it in the original equation

$H = -6(2^2) + 24(2) + 5$

Times all the numbers near prenteic $H = -6(4) + 24(2) + 5$

$H = 24 + 48 + 5$
$H = 24 + 48 + 5$
add 48 and 5's
53
Substact 24 from 53
Height = 29

Hannah Kick the highest

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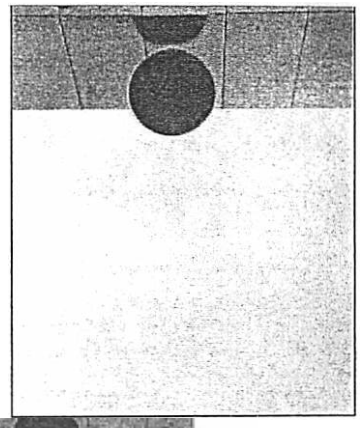
#B28



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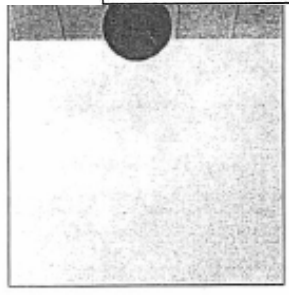
Who wins?



throws a ball toward the ceiling and the one who comes closest to the ceiling without touching it is the winner. After everyone has a turn, Hannah and Jake, with the two best tosses, go again.

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Who wins?

Hannah: $h = -28t^2 + 56t + 4$

X	Y
-2	-220
-1	-80
0	4
1	32
2	4
3	-80

I made a chart and 32 was the number that made the graph off which means it equals 32ft.

Jake: $h = -6t^2 + 24t + 5$

I made a graph plotting these numbers but first I made a chart and the number Jake got was 29.

X	Y
0	5
1	23
2	29
3	23
4	5

Hannah won because she got 3 more feet than Jake.

Scores and Commentary: Don't Hit the Ceiling, Paper #B-1

Making Sense of the Task (MS)	Representing and Solving the Task (RS)	Communicating Reasoning (CR)	Accuracy (AC)	Reflecting and Evaluating (RE)
2	3	3	2	1

MS 2: The student inappropriately uses b/2a to find the t coordinate of the vertex instead of –b/2a. The student does not address the computation of negative heights in the context of the problem.

RS 3: A correct formula would have generated a strategy that would be effective. As it is, the strategy is only partially effective.

CR 3: The student work is easy to follow and the computations shown are complete and done correctly, but the student never addresses the question asked.

AC 2: The solution is incorrect and incomplete.

RE 1: The solution is not stated within the context of the problem and no reflection is evident.

Scores and Commentary: Don't Hit the Ceiling, Paper #B-7

Making Sense of the Task (MS)	Representing and Solving the Task (RS)	Communicating Reasoning (CR)	Accuracy (AC)	Reflecting and Evaluating (RE)
3	4	4	2	2

MS 3: The translation into mathematics is partially developed. The student never gains an awareness of transposing height and time.

RS 4: The strategy is effective and would lead to a correct solution had the student not transposed height and time.

CR 4: The communication is clear and coherent and leads to a clearly identified solution.

AC 2: The solution is incorrect. The ceiling is 30 feet high and the identified solution has Jake throwing the ball 2 feet above the ground.

RE 2: The student restates the vertices found earlier making the reflection minimal.

Scores and Commentary: Don't Hit the Ceiling, Paper #B-11

Making Sense of the Task (MS)	Representing and Solving the Task (RS)	Communicating Reasoning (CR)	Accuracy (AC)	Reflecting and Evaluating (RE)
5	4	5	4	5

MS 5: The interpretation is enhanced by the student recognizing that the mathematical model is the center of the ball's path. To eliminate the effect of the radius one must consider the ball to have an infinitesimally small radius.

RS 4: The strategy is effective and will lead to a correct solution.

CR 5: The communication of the reasoning is clear, insightful and leads to a clearly identified solution.

AC 4: The given solution is correct and supported by the work.

RE 5: The student solves the problem explicitly and graphically. The graphical solution would have been stronger had the student graphed y = 30 to represent the ceiling. This is an example of a weak 5.

Scores and Commentary: Don't Hit the Ceiling, Paper #B-24

Making Sense of the Task (MS)	Representing and Solving the Task (RS)	Communicating Reasoning (CR)	Accuracy (AC)	Reflecting and Evaluating (RE)
3	4	4	3	2

MS 3: The interpretation of the task is only partially developed. The student does not address the 30 foot ceiling height.

RS 4: The strategy selected is both effective and complete. The strategy would have led to a correct solution had the results been interpreted correctly.

CR 4: The student work follows a clear path throughout. The reasoning is questionable with the statement "times by 2 because of the square root". This flaw is minor compared to the rest of the work.

AC 3: The solution is partially correct. All work leading to the final answer is correct, but the results are misinterpreted in the end.

RE 2: There is some justification evident in the commentary, but it only addresses part of the strategy and does not review concepts, calculations or reasonableness.

Scores and Commentary: Don't Hit the Ceiling, Paper #B-28

Making Sense of the Task (MS)	Representing and Solving the Task (RS)	Communicating Reasoning (CR)	Accuracy (AC)	Reflecting and Evaluating (RE)
3	3	3	3	1

MS 3: The interpretation of the task is partially developed. The student creates a table of values from the given equations but then incorrectly graphs Hannah's equation. The ceiling constraint is misrepresented by the student.

RS 3: The strategy is partially effective. The graph representing Hannah's throw is incorrect and does not match the table.

CR 3: The communication of the reasoning contains gaps. No computations are shown and the graph of Hannah's throw is not helpful, nor is it connected to the solution.

AC 3: The solution is partially correct. The student correctly computes both the y coordinates of the vertices, but states that Hannah won with a height of 32 feet.

RE 1: The reflection is not evident.