Grade 9 Assessment of Mathematics

2012, Academic

Released Item-Specific Rubrics and Sample Student Responses with Annotations

What a Bargain

Code	Descriptor
B	Blank: nothing written or drawn in response to the question
I	- Illegible: cannot be read; completely crossed out/erased; not written in English; - Irrelevant content: does not attempt assigned question (e.g., comment on the task, drawings, "?", "!", "I don't know"); - Off topic: no relationship of written work to the question.
10	Application of knowledge and skills to use percents to determine the total cost of Susan's tennis racket shows limited effectiveness due to ● misunderstanding of concepts; ● incorrect selection or misuse of procedures.
20	Application of knowledge and skills to use percents to determine the total cost of Susan's tennis racket shows some effectiveness due to ● partial understanding of the concepts; ● errors and/or omissions in the application of the procedures.
30	Application of knowledge and skills to use percents to determine the total cost of Susan's tennis racket shows considerable effectiveness due to ● an understanding of most of the concepts; ● minor errors and/or omissions in the application of the procedures.
40	Application of knowledge and skills to use percents to determine the total cost of Susan's tennis racket shows a high degree of effectiveness due to ● a thorough understanding of the concepts; ● an accurate application of the procedures (any minor errors and/or omissions do not detract from the demonstration of a thorough understanding)

What a Bargain!

Susan buys a tennis racket from a store.

• The tennis racket's original price is $75.
• All tennis rackets are on sale for 25% off the original price.
• The tennis racket has a scratch, so she receives an additional 10% off the sale price.

How much does Susan pay for her tennis racket, including 13% tax?

Show your work.

$= \$75 - 25 = \$50$

$= \$50 + 13 = \$63$

∴ susan payed $63 for the tenis racket.

Annotation:
Response demonstrates a misunderstanding of concepts; shows percents treated as dollars with the first discount percent subtracted and the tax percent added, and the second discount percent not used.

What a Bargain!

Susan buys a tennis racket from a store.

- The tennis racket's original price is $75.
- All tennis rackets are on sale for 25% off the original price.
- The tennis racket has a scratch, so she receives an additional 10% off the sale price.

How much does Susan pay for her tennis racket, including 13% tax?

Show your work.

$$75 \times .25 = 18.75$$
$$75 - 18.75 = 56.25$$

Annotation:
Response demonstrates a partial understanding of the concepts; shows accurate calculations for the 25% discount and the first sale price, but the second sale price and the total price including tax are not calculated.

What a Bargain!

Susan buys a tennis racket from a store.

• The tennis racket's original price is $75.
• All tennis rackets are on sale for 25% off the original price.
• The tennis racket has a scratch, so she receives an additional 10% off the sale price.

How much does Susan pay for her tennis racket, including 13% tax?

Show your work.

$75   total sale = 35% off   (25+10).

$35\% = \frac{35}{100} = .35$

$75 \times .35 = 26.25$.   This means she will recieve a 26.25 dollar discount from the original price of $75.

$75 - 26.25 = \underline{48.75}$.

Now add 13%.

$13\% = \frac{13}{100} = .13$

$48.75 \times .13 = 6.33$ This means the tax on the tennis racket after 35% discount, is $6.33.

$48.75 + 6.33 = \$55.08$

Susan pays $55.08 for the tennis racket, after 35% discount, and 13% tax.

Annotation:
Response demonstrates an understanding of most of the concepts; shows incorrect totalling of the sale percents (10% is off first sale price not original price) but this discount is applied accurately to calculate the sale price as well as the tax on the sale price and the total price.

What a Bargain!

Susan buys a tennis racket from a store.

• The tennis racket's original price is $75.
• All tennis rackets are on sale for 25% off the original price.
• The tennis racket has a scratch, so she receives an additional 10% off the sale price.

How much does Susan pay for her tennis racket, including 13% tax?

Show your work.

$$
\begin{array}{r}
\$75 \\
\times \quad 0.75 \\
\hline
\$56.25
\end{array}
$$

$$
\begin{array}{r}
\$56.25 \\
\times 0.9 \\
\hline
\$50.625
\end{array}
$$

$$
\begin{array}{r}
\$50.625 \\
\times .13 \\
\hline
\$6.58125
\end{array}
$$

$$
\begin{array}{r}
\$50.625 \\
+ \ 6.58125 \\
\hline
\$57.20625 \\
\doteq \$57.21
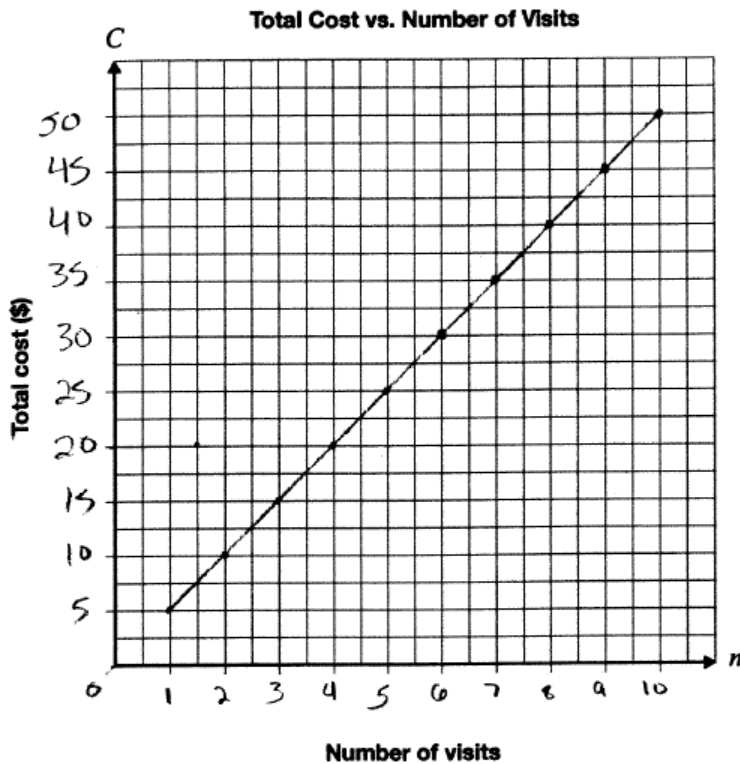\end{array}
$$

Susan pays $57.21 far her tennis racket.

Which is Which?

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10	Application of knowledge and skills involving drawing a graph, determining an equation and explaining the properties of a partial variation shows limited effectiveness due to • misunderstanding of concepts; • incorrect selection or misuse of procedures.
20	Application of knowledge and skills involving drawing a graph, determining an equation and explaining the properties of a partial variation shows some effectiveness due to • partial understanding of the concepts; • errors and/or omissions in the application of the procedures.
30	Application of knowledge and skills involving drawing a graph, determining an equation and explaining the properties of a partial variation shows considerable effectiveness due to • an understanding of most of the concepts; • minor errors and/or omissions in the application of the procedures.
40	Application of knowledge and skills involving drawing a graph, determining an equation and explaining the properties of a partial variation shows a high degree of effectiveness due to • a thorough understanding of the concepts; • an accurate application of the procedures (any minor errors and/or omissions do not detract from the demonstration of a thorough understanding)

Which Is Which?

A relationship between the total cost to use a gym for a month, *C*, and the number of visits, *n*, is a partial variation. The total cost for 10 visits during one month is $50.

Draw a graph that could represent this relationship. Label each axis with an appropriate scale.

Total Cost vs. Number of Visits

Determine the equation for your graph.

$C = $ *50n +10*

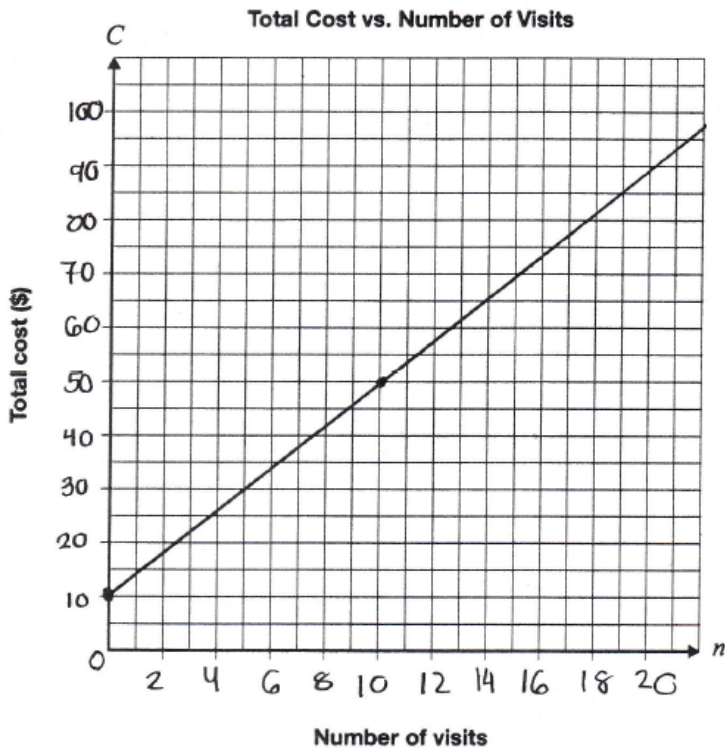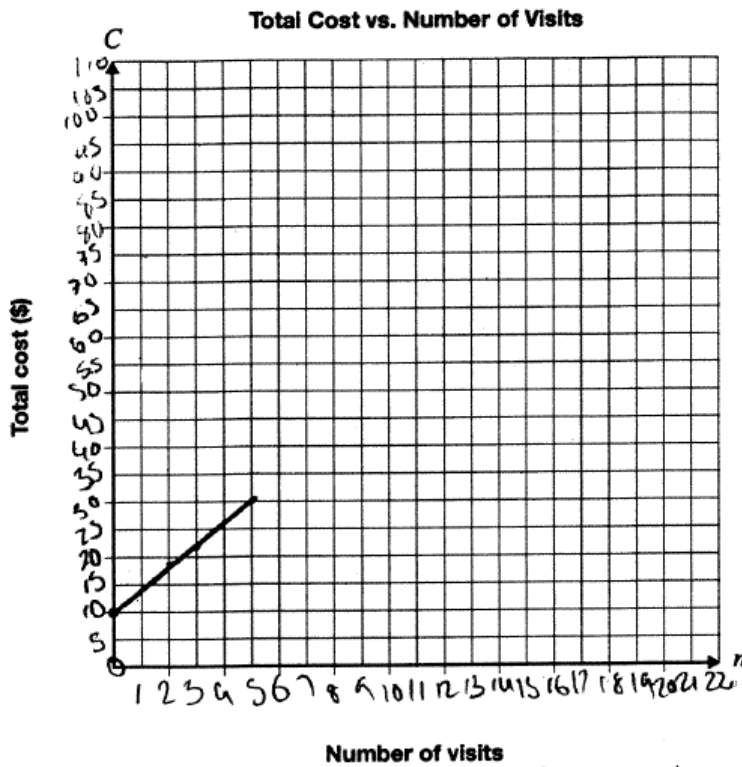Explain how you know your equation represents a partial variation.

I know my equation represents a partial variation because to total cost per month for 10 visits is $50.

Which Is Which?

A relationship between the total cost to use a gym for a month, C, and the number of visits, n, is a partial variation. The total cost for 10 visits during one month is $50.

Draw a graph that could represent this relationship. Label each axis with an appropriate scale.

Total Cost vs. Number of Visits
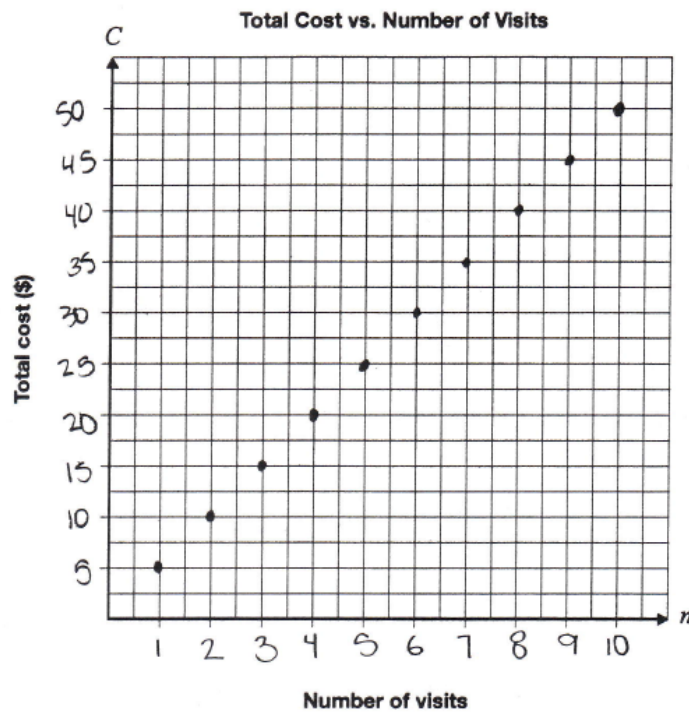
Determine the equation for your graph.

$C = $ _Sn_____

Explain how you know your equation represents a partial variation.

because it increases by $5
each time causing a partial
variation.

Annotation:
Response demonstrates partial understanding of the concepts; shows a graph that represents a direct variation and equation matches the graph, but explanation does not support direct variation.

Which Is Which?

A relationship between the total cost to use a gym for a month, C, and the number of visits, n, is a partial variation. The total cost for 10 visits during one month is $50.

Draw a graph that could represent this relationship. Label each axis with an appropriate scale.

Total Cost vs. Number of Visits

$n = 10$

$C = 50$

Determine the equation for your graph.

$C = \underline{10n + 10}$

Explain how you know your equation represents a partial variation.

It represents a partial variation because it doesn't start at the origin.

Which Is Which?

A relationship between the total cost to use a gym for a month, C, and the number of visits, n, is a partial variation. The total cost for 10 visits during one month is $50.

Draw a graph that could represent this relationship. Label each axis with an appropriate scale.

Total Cost vs. Number of Visits

$60 = n +$

Determine the equation for your graph.

$C = \underline{4n + 10}$

Explain how you know your equation represents a partial variation.

I know the equation represents a partion variation because it has a 'y' intercept, $10.

Annotation:
Response demonstrates an accurate application of the procedures; shows a graph that represents a partial variation which would go through (10,50) if the graph was extended, equation matches the graph and explanation supports partial variation (has a *y*-intercept).

Counting Pennies

Code	Descriptor
B	Blank: nothing written or drawn in response to the question
I	- Illegible: cannot be read; completely crossed out/erased; not written in English; - Irrelevant content: does not attempt assigned question (e.g., comment on the task, drawings, "?", "!", "I don't know"); - Off topic: no relationship of written work to the question.
10	Problem-solving process to determine the number of pennies in the container when the total mass is 185 g shows limited effectiveness due to • minimal evidence of a solution process; • limited identification of important elements of the problem; • too much emphasis on unimportant elements of the problem; • no conclusions presented or conclusion presented without supporting evidence.
20	Problem-solving process to determine the number of pennies in the container when the total mass is 185 g shows some effectiveness due to • an incomplete solution process; • identification of some of the important elements of the problem; • some understanding of the relationships between important elements of the problem; • simple conclusions with little supporting evidence.
30	Problem-solving process to determine the number of pennies in the container when the total mass is 185 g shows considerable effectiveness due to • a solution process that is nearly complete; • identification of most of the important elements of the problem; • a considerable understanding of the relationships between important elements of the problem; • appropriate conclusions with supporting evidence.
40	Problem-solving process to determine the number of pennies in the container when the total mass is 185 g shows a high degree of effectiveness due to • a complete solution process; • identification of all important elements of the problem; • a thorough understanding of the relationships between all of the important elements of the problem; • appropriate conclusions with thorough and insightful supporting evidence.

Counting Pennies

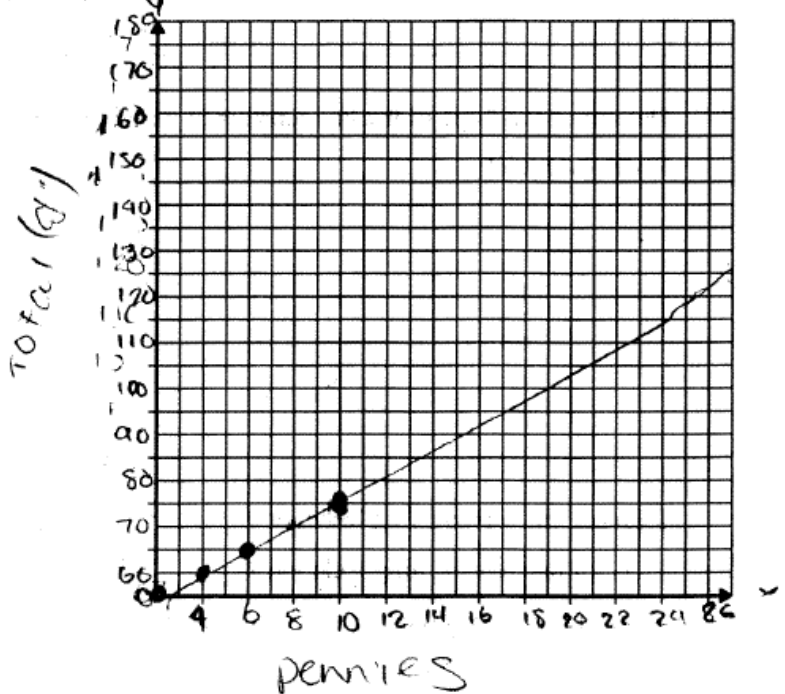Identical pennies are placed in a container and the total mass is recorded.

The table below gives information about the total mass of different numbers of pennies in the container.

Number of pennies	Total mass (g)
4	60
6	65
10	75

Use the data to determine the number of pennies in the container when the total mass is 185 g.
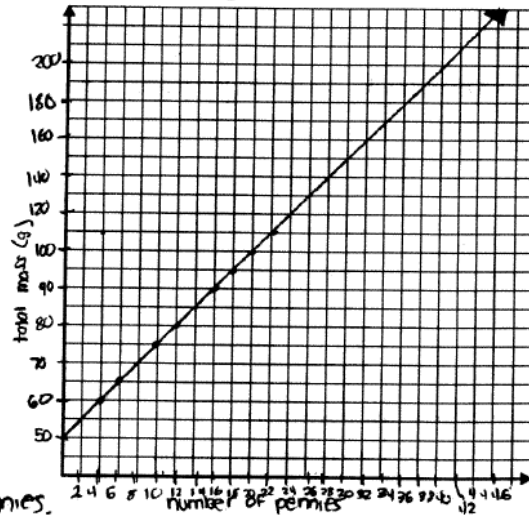
Justify your answer. You may use the grid if you wish.

$P =$
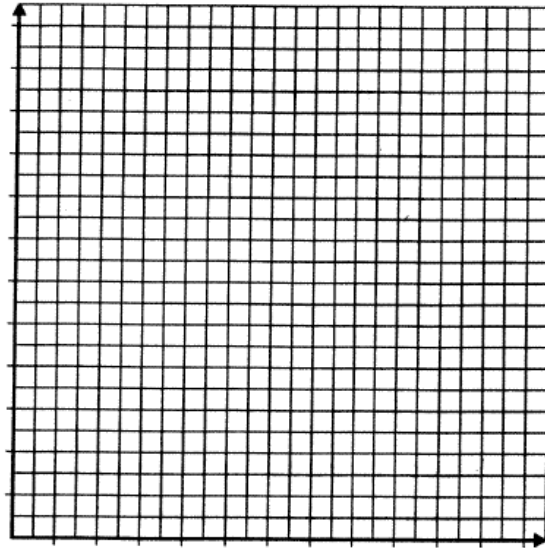
Counting Pennies

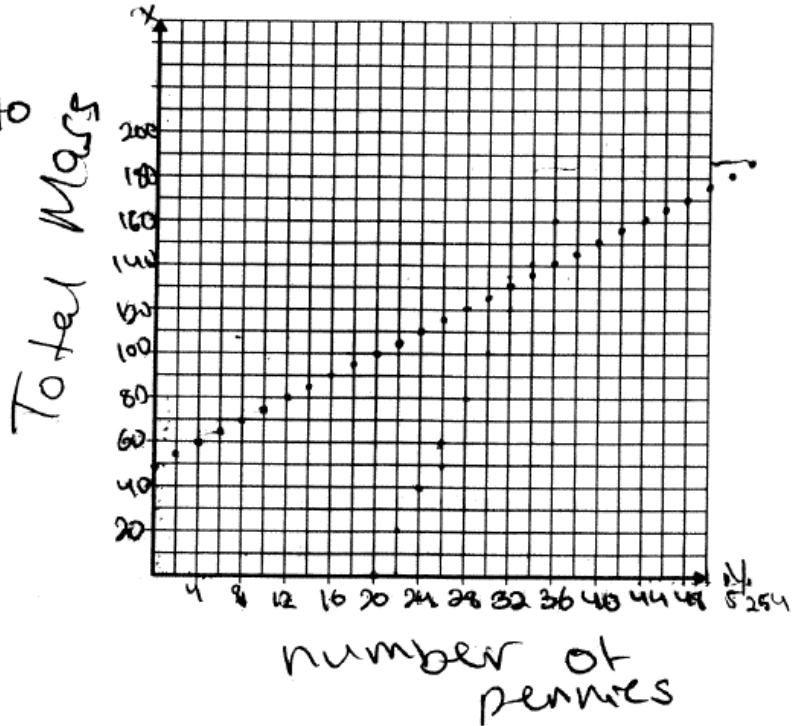Identical pennies are placed in a container and the total mass is recorded.

The table below gives information about the total mass of different numbers of pennies in the container.

Number of pennies	Total mass (g)
4	60
6	65
10	75

Use the data to determine the number of pennies in the container when the total mass is 185 g.

Justify your answer. You may use the grid if you wish.

Annotation:
Response demonstrates an incomplete solution process; shows the rate of change used to extend the table beyond 10 pennies but the number of pennies for 185 g is not determined.

Counting Pennies

Identical pennies are placed in a container and the total mass is recorded.

The table below gives information about the total mass of different numbers of pennies in the container.

Number of pennies	Total mass (g)
4	60
6	65
10	75

$+5$

$+10$ $8 = 70$

Use the data to determine the number of pennies in the container when the total mass is 185 g.

Justify your answer. You may use the grid if you wish.

Counting Pennies

by looking at the table, I see that every 2 penny added is 5g. so every penny is 2.5g.

also since 60g = 4 pennies, I know that the starting mass is 50g with no pennies (subtracting 4(0.25) from 60)

so that is my constant ↔ 50g. (initial mass)

then each penny I add is 2.5g.

n = number of pennies.

$$y = 50 + 2.5n$$

$$y = 50 + 2.5(185)$$
$$= 50 + 462.5$$
$$y = 512.5g \text{ when } 185 \text{ pennies}$$

Counting Pennies

Identical pennies are placed in a container and the total mass is recorded.

The table below gives information about the total mass of different numbers of pennies in the container.

Number of pennies	Total mass (g)
4	60
6	65
10	75

Use the data to determine the number of pennies in the container when the total mass is 185 g.

Justify your answer. You may use the grid if you wish.

∴ 185g equals to 54 pennies.

Total Mass

number of pennies

Know Your Lines

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10	Application of knowledge and skills to compare Line A and Line B using the properties of slopes of lines shows limited effectiveness due to ● misunderstanding of concepts; ● incorrect selection or misuse of procedures.
20	Application of knowledge and skills to compare Line A and Line B using the properties of slopes of lines shows some effectiveness due to ● partial understanding of the concepts; ● errors and/or omissions in the application of the procedures.
30	Application of knowledge and skills to compare Line A and Line B using the properties of slopes of lines shows considerable effectiveness due to ● an understanding of most of the concepts; ● minor errors and/or omissions in the application of the procedures.
40	Application of knowledge and skills to compare Line A and Line B using the properties of slopes of lines shows a high degree of effectiveness due to ● a thorough understanding of the concepts; ● an accurate application of the procedures (any minor errors and/or omissions do not detract from the demonstration of a thorough understanding)

Know Your Lines
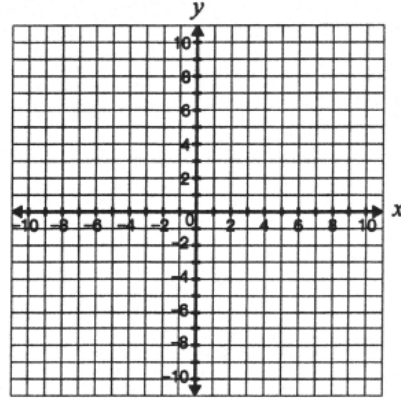
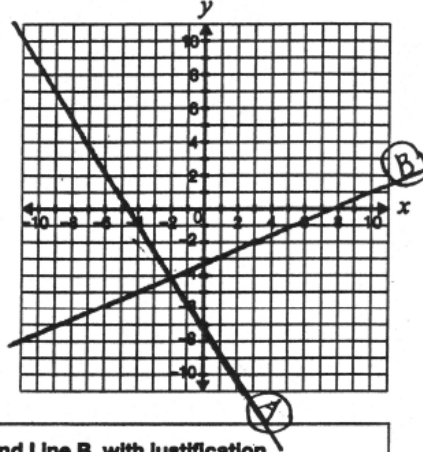Consider the equations of the two lines below.

Line A: $y = -\frac{3}{2}x - 7$

Line B: $y = \frac{2}{3}x - 4$

Compare Line A and Line B. You may use the grid if you wish.

Justify your answers.

Complete the table below.

Characteristic	Comparison of Line A and Line B, with justification
Direction from left to right	the line A is Positive and the line B is negative
Steepness	The line A have the more steepness becau
Parallel, perpendicular or neither	They are neither of them.

Annotation:
Response demonstrates a misunderstanding of the concepts; no comparison is made of directions, Line A is identified as steeper with no justification and the lines are not identified as perpendicular.

Know Your Lines

Consider the equations of the two lines below.

Line A: $y = -\frac{3}{2}x - 7$

Line B: $y = \frac{2}{3}x - 4$

Compare Line A and Line B. You may use the grid if you wish.

Justify your answers.

Complete the table below.
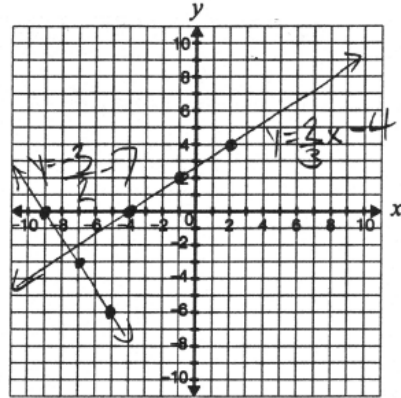
Characteristic	Comparison of Line A and Line B, with justification	
Direction from left to right	line A -rises to the left	line b -rises to the right
Steepness	line A slope is $\frac{-3}{2}$	line b Slope is $\frac{2}{3}$
Parallel, perpendicular or neither	line A perpendicular to line B	line B perpendicular to line A

Annotation:
Response demonstrates a partial understanding of the concepts; directions compared correctly but the graphed lines have errors, no comparison is made of their steepness and the lines are identified as perpendicular with no justification.

Anchor Code 30

Know Your Lines

Consider the equations of the two lines below.

Line A: $y = -\frac{3}{2}x - 7$

Line B: $y = \frac{2}{3}x - 4$

Compare Line A and Line B. You may use the grid if you wish.

Justify your answers.

Complete the table below.

Characteristic	Comparison of Line A and Line B, with justification
Direction from left to right	A: slopes downward from left to right. B: slopes upward from left to right. Line A is negative ↘ $y = -\frac{3}{2}x - 7$ negative slope Line B is positive ↗ $y = \frac{2}{3}x - 4$ positive slope
Steepness	A: very steep B: Less steep than "Line A." Line A is steeper → $\frac{3}{2}$ → higher rise than run. Line B is less steep → $\frac{-2}{3}$ → lower rise than run.
Parallel, perpendicular or neither	Lines "A" • "B" are perpendicular Slope of: → Line A: $\frac{-3}{2}$ ↰ → Line B: $\frac{2}{3}$ ↲ } negative reciprocals. •They intersect!

Reduce, Reuse and Recycle

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B	Blank: nothing written or drawn in response to the question
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10	Problem-solving process to determine all the possible values of n and C shows limited effectiveness due to ● minimal evidence of a solution process; ● limited identification of important elements of the problem; ● too much emphasis on unimportant elements of the problem; ● no conclusions presented or conclusion presented without supporting evidence.
20	Problem-solving process to determine all the possible values of n and C shows some effectiveness due to ● an incomplete solution process; ● identification of some of the important elements of the problem; ● some understanding of the relationships between important elements of the problem; ● simple conclusions with little supporting evidence.
30	Problem-solving process to determine all the possible values of n and C shows considerable effectiveness due to ● a solution process that is nearly complete; ● identification of most of the important elements of the problem; ● a considerable understanding of the relationships between important elements of the problem; ● appropriate conclusions with supporting evidence.
40	Problem-solving process to determine all the possible values of n and C shows a high degree of effectiveness due to ● a complete solution process; ● identification of all important elements of the problem; ● a thorough understanding of the relationships between all of the important elements of the problem; ● appropriate conclusions with thorough and insightful supporting evidence.

Reduce, Reuse and Recycle

A high school is starting a recycling program.

The relationship between the total cost of the program, C, and the number of recycling bins, n, is represented by the equation $C = 48n + 75$.

The school must install a minimum of 12 recycling bins and has a maximum of $1000 to spend on the program.

What are the possible values of C and n in this situation?

Justify your answer.

multiply 75 by the # of bins needed (12) and the answer was 900. they have enough money, because the max dollars spent was supposed to be $1000.00

The possible values of n are ___12___.

The possible values of C are ___900___.

Reduce, Reuse and Recycle

A high school is starting a recycling program.

The relationship between the total cost of the program, C, and the number of recycling bins, n, is represented by the equation $C = 48n + 75$.

The school must install a minimum of 12 recycling bins and has a maximum of $1000 to spend on the program.

What are the possible values of C and n in this situation?

Justify your answer.

$$n = 19$$

$$1000 = 48(n) + 75$$
$$1000 - 75 = 48(n)$$
$$925 = 48(n)$$
$$\frac{925}{48} = \frac{48}{48}(n)$$

The possible values of n are ___19___.

$$C = 48(12) + 75$$
$$C = 576 + 75$$
$$C = 651$$

The possible values of C are ___$651___.

Reduce, Reuse and Recycle

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The relationship between the total cost of the program, C, and the number of recycling bins, n, is represented by the equation $C = 48n + 75$.

The school must install a minimum of 12 recycling bins and has a maximum of $1000 to spend on the program.

What are the possible values of C and n in this situation?

Justify your answer.

$C = 48n + 75$
$C = 48(12) + 75$
$C = 651$ ✓

$C = 48n + 75$
$C = 48(15) + 75$
$C = 795$ ✓

The possible values of n are 12, 15, 19 .

$C = 48n + 75$
$C = 48(20) + 75$
$C = 1035$ ✗

The possible values of C are $651, $795, $987 .

$C = 48n + 75$
$C = 48(19) + 75$
$C = 987$ ✓

∴ the school can buy at maximum 19 recycling bins because the total cost will come to $987. Any higher and it would be $1035. Theres no need to go less because you will have money left over for more.

Reduce, Reuse and Recycle

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The relationship between the total cost of the program, C, and the number of recycling bins, n, is represented by the equation $C = 48n + 75$.

The school must install a minimum of 12 recycling bins and has a maximum of $1000 to spend on the program.

What are the possible values of C and n in this situation?

Justify your answer.

$C =$ the amount spent (max $1000)
$n =$ number of recycling bins (min 12)

The possible values of n are ___12 − 19,_____ .

$$C = 48(12) + 75$$
$$= \$651$$

$$C = 48(19) + 75$$
$$= \$987$$

The possible values of C are ___$651 − $987_____ .

Annotation:
Response demonstrates identification of all important elements of the problem; shows correct ranges for both n and C with corresponding upper and lower bounds and justification includes calculations.

All the Right Stuff

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10	Application of knowledge and skills to determine the value of x by using the Pythagorean theorem shows limited effectiveness due to ● misunderstanding of concepts; ● incorrect selection or misuse of procedures.
20	Application of knowledge and skills to determine the value of x by using the Pythagorean theorem shows some effectiveness due to ● partial understanding of the concepts; ● errors and/or omissions in the application of the procedures.
30	Application of knowledge and skills to determine the value of x by using the Pythagorean theorem shows considerable effectiveness due to ● an understanding of most of the concepts; ● minor errors and/or omissions in the application of the procedures.
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All the Right Stuff

The diagram below shows a small right triangle inside a large right triangle.
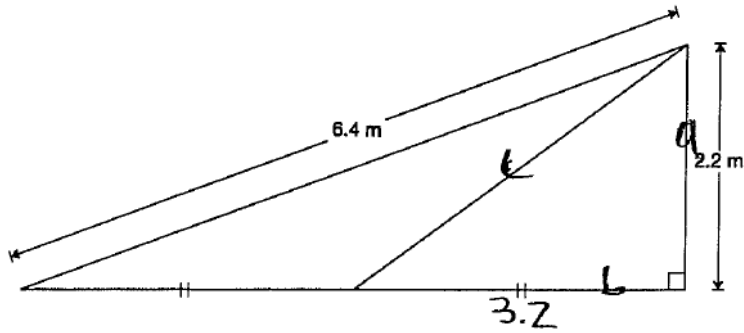
6.4 m

x

2.2 m

Determine the value of x.

Show your work.

$a^2 + b^2 = c^2$

$2.2^2 + 3.2^2 = c^2$

$4.84 + 10.24 = c^2$

$15.08 = c^2$

All the Right Stuff

The diagram below shows a small right triangle inside a large right triangle.

6.4 m

2.2 m

3.2

$\dfrac{6.4}{2} = 3.2$

Determine the value of x.

Show your work.

$$a^2 + b^2 = c^2$$
$$2.2^2 + 3.2^2 = c^2$$
$$4.84 + 10.24 = c^2$$
$$15.08 = c^2$$
$$\sqrt{15.08} = c$$
$$3.88 = c$$

$\therefore$ The value of x is 3.88 m.

Annotation:
Response demonstrates errors and omissions in the application of the procedures; shows 6.4 used as the length of the base, base is divided by 2 and the Pythagorean theorem is applied correctly to determine x using this value of 3.2.

All the Right Stuff

The diagram below shows a small right triangle inside a large right triangle.

A
6.4 m

x

2.2 m

B

3.39

3.39

90°

C
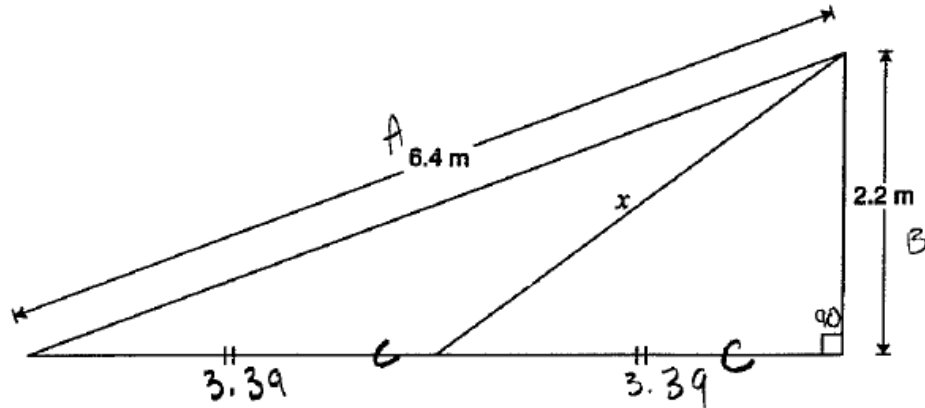
Determine the value of x.

Show your work.   – find C

$a^2 + b^2 = c^2$

$6.4^2 + 2.2^2 = c^2$

$40.96 + 4.84 = c^2$

$45.8 = c^2$

$C = \sqrt{45.8}$

$C = 6.77$

find x

$a^2 + b^2 = c^2$

$2.2 + 3.39 = c^2$

$4.84 + 11.49 = c^2$

$16.33 = c^2$

$\sqrt{16.33} = c^2$
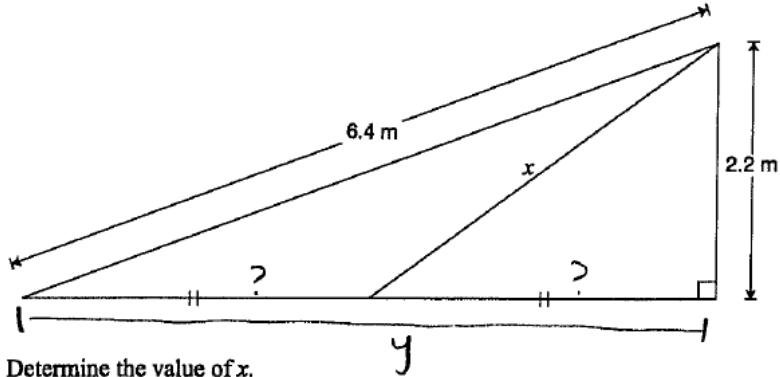
$\boxed{4.04 = C}$

∴ x is 4.04 m long.

Annotation:
Response demonstrates an understanding of most of the concepts; shows the Pythagorean theorem applied incorrectly to determine base (addition instead of subtraction), base is divided by 2 and the Pythagorean theorem is applied a second time to determine x correctly, based on error.

All the Right Stuff

The diagram below shows a small right triangle inside a large right triangle.

Determine the value of x.

Show your work.

$$y = \sqrt{6.4^2 - 2.2^2}$$
$$y = \sqrt{40.96 - 4.84}$$
$$y = \sqrt{36.12}$$
$$y = 6\,m$$

$$? = 6 \div 2$$
$$? = 3$$

Ans. The value of x is
3.72 m.

$$x = \sqrt{2.2^2 + 3^2}$$
$$x = \sqrt{4.84 + 9}$$
$$x = \sqrt{13.84}$$
$$x = 3.72\,m.$$

Annotation:
Response demonstrates a thorough understanding of the concepts; shows the Pythagorean theorem applied correctly to determine missing base, base is divided by 2 and the Pythagorean theorem is applied correctly a second time to determine x.

Tricky Triangle

Code	Descriptor
B	Blank: nothing written or drawn in response to the question
I	- Illegible: cannot be read; completely crossed out/erased; not written in English; - Irrelevant content: does not attempt assigned question (e.g., comment on the task, drawings, "?", "!", "I don't know"); - Off topic: no relationship of written work to the question.
10	Problem-solving process to determine the value of h using Pythagorean theorem or properties of polygons shows limited effectiveness due to ● minimal evidence of a solution process; ● limited identification of important elements of the problem; ● too much emphasis on unimportant elements of the problem; ● no conclusions presented or conclusion presented without supporting evidence.
20	Problem-solving process to determine the value of h using Pythagorean theorem or properties of polygons shows some effectiveness due to ● an incomplete solution process; ● identification of some of the important elements of the problem; ● some understanding of the relationships between important elements of the problem; ● simple conclusions with little supporting evidence.
30	Problem-solving process to determine the value of h using Pythagorean theorem or properties of polygons shows considerable effectiveness due to ● a solution process that is nearly complete; ● identification of most of the important elements of the problem; ● a considerable understanding of the relationships between important elements of the problem; ● appropriate conclusions with supporting evidence.
40	Problem-solving process to determine the value of h using Pythagorean theorem or properties of polygons shows a high degree of effectiveness due to ● a complete solution process; ● identification of all important elements of the problem; ● a thorough understanding of the relationships between all of the important elements of the problem; ● appropriate conclusions with thorough and insightful supporting evidence.

Tricky Triangle

Line segment **AB** joins the midpoints of two sides of the triangle below. The length of **AB** is half the length of the base of the triangle.
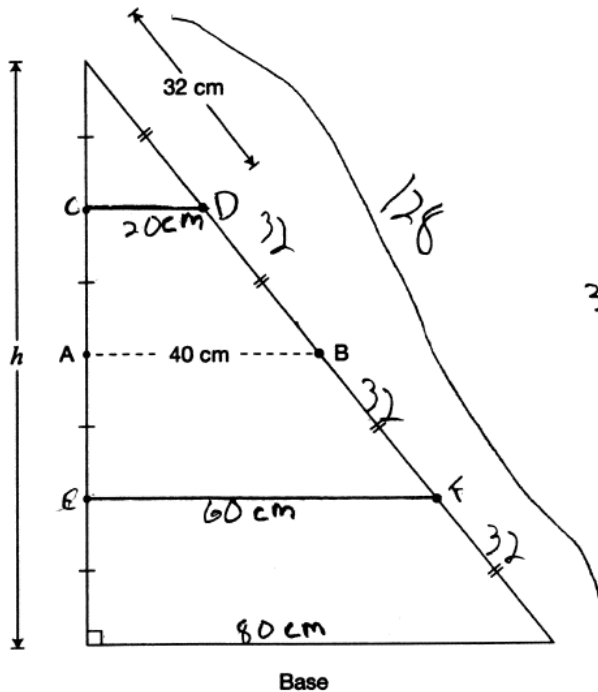
Determine the **value of h** in the diagram.

Show your work.

$\overline{EF}$ is $\frac{3}{4}$ of the base
$\overline{CD}$ is $\frac{1}{4}$ the base

$20 + 40 + 60 + 80$
$= 60 + 60 + 80$
$= 120 + 80$
$= 200$

the value of $h = 200$ cm

Annotation:
Response demonstrates limited identification of important elements of the problem; shows proportions used to determine the lengths of the base and hypotenuse of the small and large triangles, but no evidence of using the Pythagorean theorem to determine h.

Tricky Triangle

Line segment AB joins the midpoints of two sides of the triangle below. The length of AB is half the length of the base of the triangle.

$h^2 = 40^2 + 32^2$

$h^2 = 1600 + 1024$
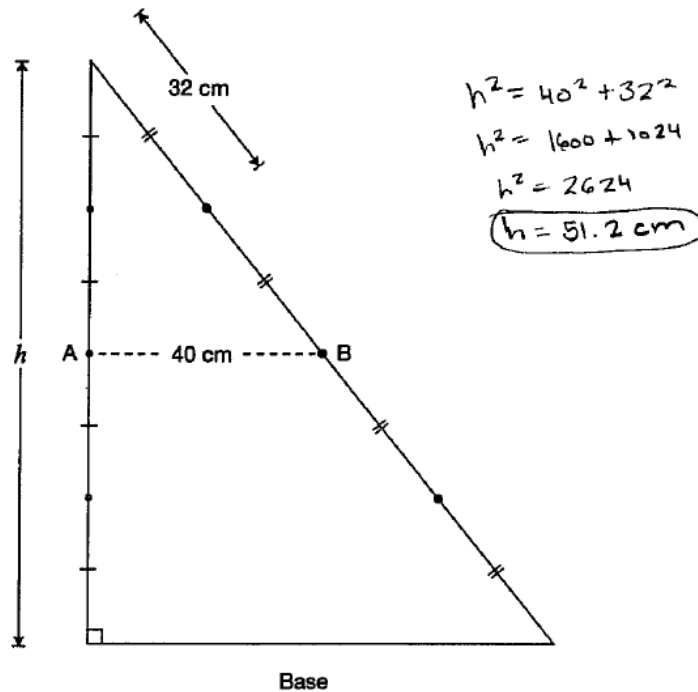
$h^2 = 2624$

$\boxed{h = 51.2\ cm}$

Determine the value of h in the diagram.

Show your work.

Pythagorean theorem for h
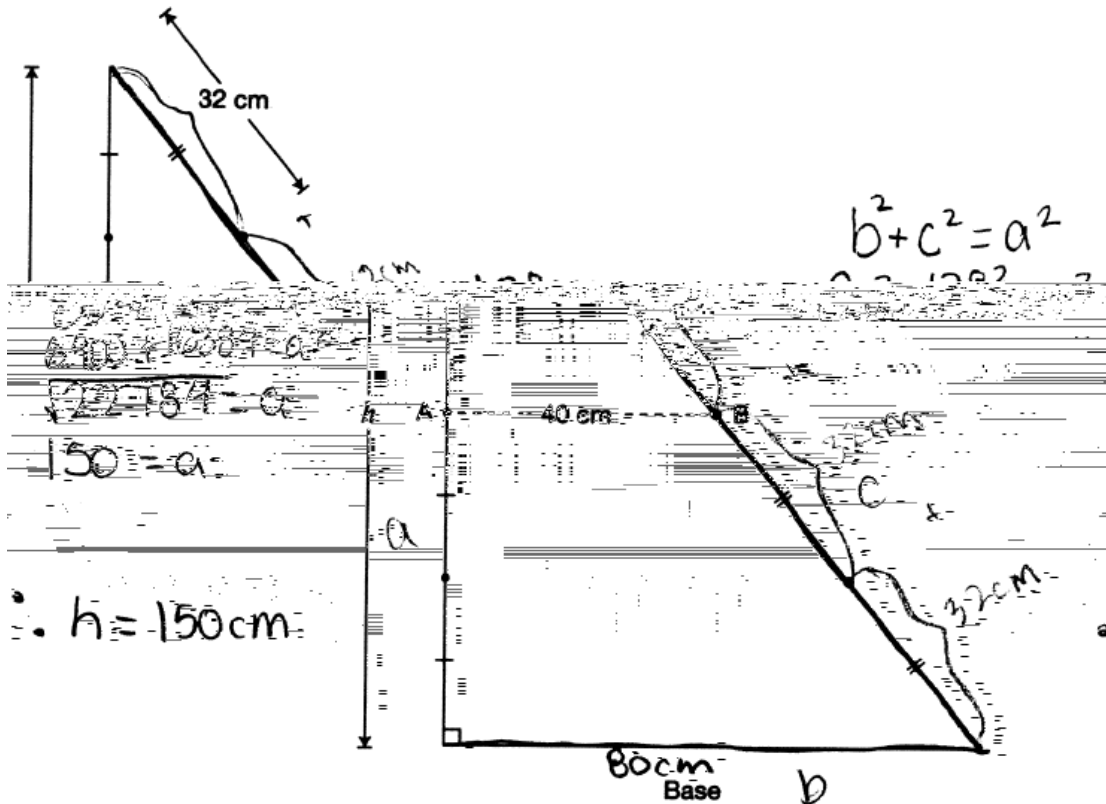
$h^2 = 40^2 + 32^2$

$h^2 = 1600 + 1024$

$h^2 = 2624$

$h = 51.2\ cm$

Annotation:
Response demonstrates some understanding of the relationships between important elements of the problem; corresponding hypotenuse is not used when the Pythagorean theorem is applied to determine the height of the mid-size triangle and there is an error in the application of the Pythagorean theorem (addition instead of subtraction).

Tricky Triangle

Line segment AB joins the midpoints of two sides of the triangle below. The length of AB is half the length of the base of the triangle.

32 cm

$b^2 + c^2 = a^2$

40 cm

$\therefore h = 150 \, cm$

80 cm
Base b

Determine the value of h in the diagram.

Show your work.

Tricky Triangle

Line segment AB joins the midpoints of two sides of the triangle below. The length of AB is half the length of the base of the triangle.

32 cm

50cm

h A ----- 40 cm ------ B

$c^2 = a^2 + b^2$

$64^2 = a^2 + 40^2$

$4096 = a^2 + 1600$

$4096 - 1600 = c^2$

$\sqrt{2496} = a$

$a = \sqrt{2496}$

$a \doteq 50$

$50 + 50 = 100$

$\therefore h = 100 \, cm$

Base
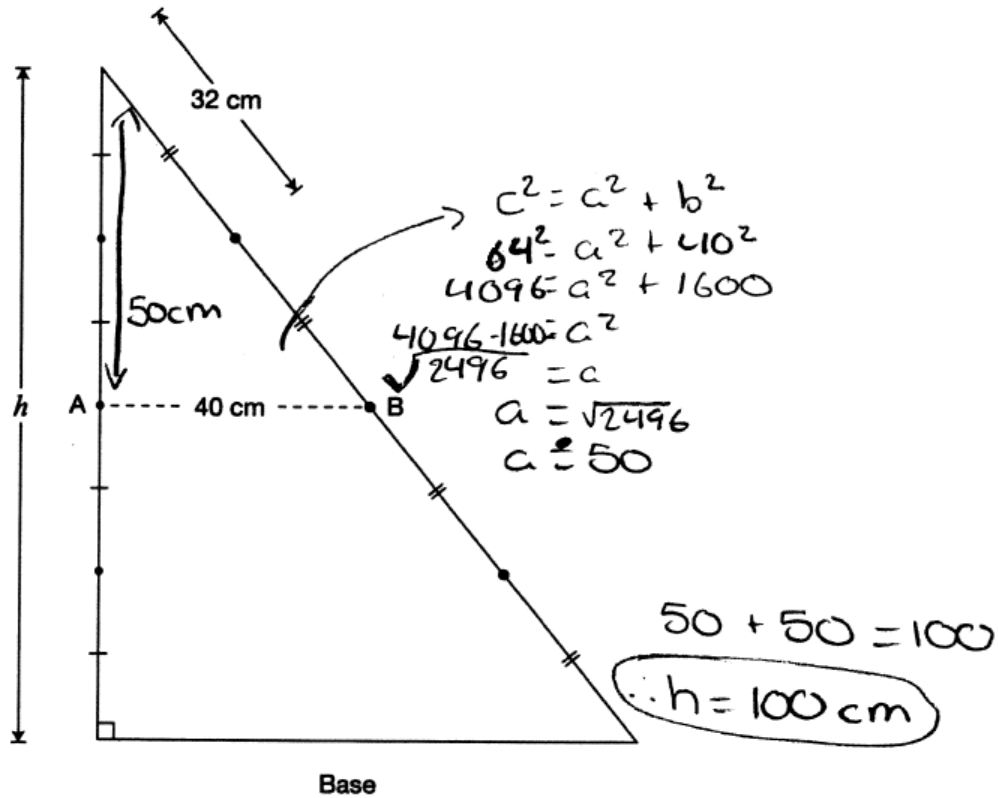
Determine the value of h in the diagram.

Show your work.

Annotation:
Response demonstrates a thorough understanding of the relationships between all of the important elements of the problem; proportions used to determine the length of the hypotenuse of the mid-size triangle. The corresponding base is used with this when the Pythagorean theorem is applied accurately to determine the missing side, and this value is doubled to determine h.