

# Mathematics Toolkit: Grade 6 Objective 1.B.2.b

Standard 1.0 Knowledge of Algebra, Patterns, and Functions

Topic B. Expressions, Equations, and Inequalities

Indicator 2. Identify, write, solve, and apply equations and inequalities

Objective b. Determine the unknown in a linear equation

Assessment Limits:

Use one operation (+, -, ×, ÷ with no remainders) and use positive whole number coefficients using decimals with no more than two decimal places (0 – 100)

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- Rubric - Brief Constructed Response

## Sample Item #1 Brief Constructed Response (BCR) Item with Annotated Student Responses

### Question

Look at the equation below.

$$x - 17.32 = 28.7$$

### Step A

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Solve the equation for  $x$ .

### Step B

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Explain why your value for  $x$  is correct. Use what you know about solving equations in your explanation. Use words, numbers, and/or symbols.

Step A is scored 0 (Incorrect) or 1 (Correct) and assesses 1.B.2.b.

Step B is scored with a 3 point (0, 1, 2) rubric and assesses Processes of Mathematics.

Note: Sixteen "Sample Student Responses" follow below. Each response appears on its own separate page and includes scoring information. The "Sample Student Responses" represent a range of score points.

### Correct Answer

Step A

$$x = 46.02$$

### Annotated Student Responses

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

11.25

**Step B**

Use what you know about solving equations to justify why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

I add up 17 to 28 and got 11 so  
 I new that was the whole number  
 than I thought what minus a #  
 = 7 and subtracted 32 from  
 25 and got 7 so the answer is  
 11.25

Score for Sample Student Response #1:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 0

Step B - Processes of Mathematics: 0

Annotation for Step B, Using the Rubric: This response is completely incorrect.

Look at the equation below.

$$x - 17.32 = 28.7$$

$$\begin{array}{r} - 28.7 \\ 17.32 \end{array}$$

**Step A**

Solve the equation for  $x$ .

$$\underline{46.02}$$

**Step B**

Use what you know about solving equations to justify why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

I subtracted 28.7 and 17.32  
and got my answer of 46.02

Score for Sample Student Response #2:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 1

Step B - Processes of Mathematics: 0

Annotation for Step B, Using the Rubric: This response is completely incorrect. The justification given does not support the answer for Step A.

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

$$\underline{11.42}$$

$$\begin{array}{r} 28.7 \\ 17.32 \\ \hline 11.42 \\ + 17.32 \\ \hline 28.7 \end{array}$$

**Step B**

Use what you know about solving equations to justify why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

First, I wrote down  $28.7 - 17.32$ . Then, I made sure the numbers were in a straight line and the decimals were lined up.

After that I subtracted and got 11.42. To make sure my answer was correct I subtracted  $11.42 - 17.32$  and I got 28.7.

Score for Sample Student Response #3:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 0

Step B - Processes of Mathematics: 1

Annotation for Step B, Using the Rubric: This response demonstrates a minimal understanding and analysis of the problem. A partial application of a strategy to justify the incorrect solution of  $x=11.42$  is indicated; however, the justification is logically flawed as the sum of 11.42 and 17.32 is 28.74, not 28.7 as indicated in the response.

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

$$\underline{11.38}$$

**Step B**

Use what you know about solving equations to justify why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

I added 11.38 to 17.32 in order to get 28.7, so I knew 11.38 was correct.

$$\begin{array}{r} 11.38 \\ +17.32 \\ \hline 28.7 \end{array}$$

Score for Sample Student Response #4:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 0

Step B - Processes of Mathematics: 1

Annotation for Step B, Using the Rubric: This response demonstrates a minimal understanding and analysis of the problem. A partial application of a strategy to justify the incorrect solution of  $x=11.38$  is indicated. The justification reveals a logical flaw in that 17.32 should have been added to 28.7, not subtracted from it.

Look at the equation below.

$$x - 17.32 = 28.7$$

$$\begin{array}{r} 28.70 \\ + 17.32 \\ \hline 46.02 \end{array}$$

**Step A**

Solve the equation for  $x$ .

$$\underline{46.02}$$

**Step B**

Use what you know about solving equations to justify why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

I think my value for  $x$  is correct because I  
know that if your doing subtraction and the  
answer and one of the numbers in the problem is  
shown all you have to do is add  $28.70 + 17.32$   
which is  $46.02$ , the value of  $x$ .

Score for Sample Student Response #5:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 1

Step B - Processes of Mathematics: 1

Annotation for Step B, Using the Rubric: This response demonstrates a minimal understanding and analysis of the problem. An application of a reasonable strategy to solve for  $x$  is indicated. The explanation, " $28.70 + 17.32 = 46.02$ " is a partially developed justification for the mathematical process used to solve the problem.

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

$$\underline{x = 45.39}$$

**Step B**

Use what you know about solving equations to justify why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

First, in order to find my answer I had to find the sum of 17 and 28. That was 45.  
Then I found .39 as the sum of .32 and .7.  
Together I got 45.39. So to check my answer I subtracted 45.39 and 17.32 and got 28.7. That is why I know my answer is correct.

$$\textcircled{1} \begin{array}{r} 17 \\ + 28 \\ \hline 45 \end{array} \quad \textcircled{2} \begin{array}{r} .32 \\ + .7 \\ \hline .39 \end{array}$$

$$\textcircled{45.39}$$

$$\textcircled{3} \begin{array}{r} 45 \\ - 17 \\ \hline 28 \end{array} \quad \text{and} \quad \textcircled{4} \begin{array}{r} .39 \\ - .32 \\ \hline .07 \end{array}$$

$$\textcircled{28.7}$$

G6

Score for Sample Student Response #6:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 0

Step B - Processes of Mathematics: 2

Annotation for Step B, Using the Rubric: This response demonstrates a complete understanding and analysis of the problem. An application of a reasonable strategy for solving and justifying the equation is indicated. The justification for the solution is clear: "45-17=28 and .39-.32=.7." The error in computing with the decimals 0.32 and 0.7 is consistent throughout the problem. This error does not detract from the complete understanding of the mathematical process used to solve the problem.

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

$$x = \underline{46.02}$$

**Step B**

Use what you know about solving equations to explain why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

The student's work is written on lined paper and includes the following:

- A subtraction problem:  $45.102 - 17.32 = 28.70$ . Above the 45.102, the digits 3 and 15 are written. The result 28.70 is written below the line.
- A check:  $28.70 + 17.32 = 46.02$ . The result 46.02 is written below the line.
- A crossed-out subtraction problem:  $45.102 - 17.32 = 28.70$ . The entire calculation is heavily scribbled over with black ink.
- Handwritten annotations: "check (justification)" with an arrow pointing to the addition work, and "solve (work)" with an arrow pointing to the crossed-out subtraction work.

Score for Sample Student Response #7:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 1

Step B - Processes of Mathematics: 2

Annotation for Step B, Using the Rubric: This response demonstrates a complete understanding and analysis of the problem. An application of a reasonable strategy for solving and justifying the problem is indicated. The justification for the solution is clear, developed, and logical. Appropriate supportive numbers are provided as all work is shown.

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

$$\underline{46.02}$$

$$\begin{array}{r} 11 \\ 28.70 \\ + 17.32 \\ \hline 46.02 \\ - 17.32 \\ \hline 28.70 \end{array}$$

**Step B**

Use what you know about solving equations to justify why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

46.02 is equal to X. This is the correct answer because when I subtracted 17.32 from it the difference was 28.7.

Score for Sample Student Response #8:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 1

Step B - Processes of Mathematics: 2

Annotation for Step B, Using the Rubric: This response demonstrates a complete understanding and analysis of the problem. An application of a reasonable strategy for solving and justifying the problem is indicated. The justification for the problem is clear, developed, and logical: "I subtracted 17.32 from [46.02] the difference was 28.7." Appropriate numeric support is provided.

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

46.02

**Step B**

Use what you know about solving equations to justify why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

How I got my answer was adding 28.7 + 17.32,  
and I got 46.02. This is how I got  
my answer.

Score for Sample Student Response #9:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 1

Step B - Processes of Mathematics: 1

Annotation for Step B, Using the Rubric: This response demonstrates a minimal understanding and analysis of the problem. An application of a reasonable strategy to solve for  $x$  is indicated. The explanation, "I... was adding 28.7+17.32, and I got 46.02," is a partially developed justification for the mathematical process used to solve the problem. Compare to Sample Student Response #5.

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

$$\underline{46.02}$$

**Step B**

Use what you know about solving equations to explain why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

Handwritten student work for Step B showing a justification for the solution  $x = 46.02$ . The student shows two addition problems:

$$\begin{array}{r} 17.32 \\ + 28.7 \\ \hline 46.02 \end{array}$$

$$\begin{array}{r} 46.02 \\ - 28.7 \\ \hline 17.32 \end{array}$$

An arrow points from the 17.32 in the second equation to the 17.32 in the first equation. The number 46.02 is circled and labeled "answer".

Score for Sample Student Response #10:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 1

Step B - Processes of Mathematics: 2

Annotation for Step B, Using the Rubric: This response demonstrates a complete understanding and analysis of the problem. An application of a reasonable strategy for solving and justifying the problem is indicated. The justification for the solution is clear, developed, and logical. Appropriate supportive numbers are provided as all work is shown. Compare to Sample Student Response #7.

Look at the equation below.

$$x - 17.32 = 28.7$$

Step A

Solve the equation for  $x$ .

$$\underline{20.19}$$

Step B

Use what you know about solving equations to explain why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

The way I got my equation was to add 1732 with 287 and I got 2019 then when I got it I subtracted it with 1732 and got 287.

$$\begin{array}{r} 11 \\ 1732 \\ + 287 \\ \hline 2019 \\ 9 \\ 2019 \\ - 1732 \\ \hline 287 \end{array}$$

Score for Sample Student Response #11:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 0

Step B - Processes of Mathematics: 1

Annotation for Step B, Using the Rubric: This response demonstrates a minimal understanding and analysis of the problem. A partial application of a strategy to justify the incorrect solution of  $x=20.19$  is indicated. However, the justification is logically flawed as no decimals are used in the process of solving the problem. Compare to Sample Student Response #3.

Look at the equation below.

$$x - 17.32 = 28.7$$

Step A

Solve the equation for  $x$ .

$$\underline{1.67}$$

$$\begin{array}{r} \phantom{17.32} \overline{) 28.7} \\ 17.32 \phantom{0} \\ \hline 11.38 \\ 10.64 \\ \hline 0.74 \end{array}$$

~~$$x - 17.32 = 28.7$$~~

Step B

Use what you know about solving equations to justify why your value for  $x$  is correct.  
Use words, numbers, and/or symbols in your justification.

I divided 28.7 by 17.32 = 1.67 3  
that's why now I solved the problem

Score for Sample Student Response #12:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 0

Step B - Processes of Mathematics: 0

Annotation for Step B, Using the Rubric: This response is completely incorrect. Compare to Sample Student Response #1.

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

$$\underline{x = 45.39}$$

$$\begin{array}{r} 3 \\ \cancel{4}5 \\ - 17 \\ \hline 28 \end{array} \quad \begin{array}{r} -45.39 \\ - 17.32 \\ \hline 28.7 \end{array} \quad \begin{array}{r} .39 \\ - .32 \\ \hline .7 \end{array}$$

**Step B**

Use what you know about solving equations to explain why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

I got  $x = 45.39$ . This is correct because  
if you do  $45.39 - 17.32$  you will get  
 $28.7$ . I figured this out by using subtract-  
ion.

Score for Sample Student Response #13:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 0

Step B - Processes of Mathematics: 2

Annotation for Step B, Using the Rubric: This response demonstrates a complete understanding and analysis of the problem. An application of a reasonable strategy for solving and justifying the equation is indicated. The justification for the solution is clear: "If you do  $45.39 - 17.32$  you will get  $28.7$ ." The error in subtracting, " $0.39 - 0.32 = .7$ " is consistent throughout the problem. This error does not detract from the complete understanding of the mathematical process used to solve the problem. Compare to Sample Student Response #6.

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

46.02

**Step B**

Use what you know about solving equations to justify why your value for  $x$  is correct. Use words, numbers, and/or symbols in your justification.

I know this because in the fifth grade this is all we did in math.

Score for Sample Student Response #14:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 1

Step B - Processes of Mathematics: 0

Annotation for Step B, Using the Rubric: This response is completely irrelevant to the answer given in Step A. Compare to Sample Student Response #2.

Look at the equation below.

$$x - 17.32 = 28.7$$

$$\begin{array}{r} 1 \phantom{1} \\ 28.7 \\ + 17.32 \\ \hline 46.02 \end{array}$$

$$\begin{array}{r} \checkmark \text{check } 3 \phantom{15} \phantom{10} \\ 46.02 \\ - 17.32 \\ \hline 28.70 \end{array}$$

Step A

Solve the equation for x.

$$\underline{28.7 + 17.32 = 46.02} \quad x = 46.02$$

Step B

Use what you know about solving equations to explain why your value for x is correct. Use words, numbers, and/or symbols in your justification.

Since -(subtraction) is the opposite of +(addition)

I reversed the equation and did addition.

$28.7 + 17.32 = 46.02$ .  $x = 46.02$ . To check

your answer and put 46.02 for x.  $46.02 - 17.32$

and if equals 28.7 your answer is correct

$$- \begin{array}{r} 3 \phantom{15} \phantom{10} \\ 46.02 \\ - 17.32 \\ \hline 28.70 \end{array} = 28.7 \text{ so it is correct}$$

Score for Sample Student Response #15:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 1

Step B - Processes of Mathematics: 2

Annotation for Step B, Using the Rubric: This response demonstrates a complete understanding and analysis of the problem. An application of a reasonable strategy for solving and justifying the problem is indicated. The justification for the problem is clear, developed, and logical: "To check you answer put 46.02 for x... and if it equals 28.7 your answer is correct." Appropriate numeric support is provided. Compare to Sample Student Response #8.

Look at the equation below.

$$x - 17.32 = 28.7$$

**Step A**

Solve the equation for  $x$ .

46.2

**Step B**

Use what you know about solving equations to explain why your value for  $x$  is correct.  
Use words, numbers, and/or symbols in your justification.

I know my value for  $x$  is correct because  
I added the two decimals together.

Score for Sample Student Response #16:

Step A - Content (Knowledge of Algebra, Patterns, and Functions): 0

Step B - Processes of Mathematics: 1

Annotation for Step B, Using the Rubric: This response demonstrates a minimal understanding and analysis of the problem. A strategy for solving the equation for  $x$  is indicated. The explanation for the process used to solve the problem is overly general: "I added the decimals together." This provides a partial justification for the process used to solve the problem. Supportive information and/or numbers are not provided to justify the solution in Step A. Compare to Sample Student Response #4.

## Rubric - Brief Constructed Response (BCR)

### Score 2

The response demonstrates a complete understanding and analysis of a problem.

- Application of a reasonable strategy in the context of the problem is indicated.
- Explanation<sup>1</sup> of and/or justification<sup>2</sup> for the mathematical process(es) used to solve a problem is clear, developed, and logical.
- Connections and/or extensions made within mathematics or outside of mathematics are clear.
- Supportive information and/or numbers are provided as appropriate.<sup>3</sup>

### Score 1

The response demonstrates a minimal understanding and analysis of a problem.

- Partial application of a strategy in the context of the problem is indicated.
- Explanation<sup>1</sup> of and/or justification<sup>2</sup> for the mathematical process(es) used to solve a problem is partially developed, logically flawed, or missing.
- Connections and/or extensions made within mathematics or outside of mathematics are partial or overly general, or flawed.
- Supportive information and/or numbers may or may not be provided as appropriate.<sup>3</sup>

### Score 0

The response is completely incorrect, irrelevant to the problem, or missing.<sup>4</sup>

### Notes:

- <sup>1</sup> Explanation refers to students' ability to communicate how they arrived at the solution for an item using the language of mathematics.
- <sup>2</sup> Justification refers to students' ability to support the reasoning used to solve a problem, or to demonstrate why the solution is correct using mathematical concepts and principles.
- <sup>3</sup> Students need to complete rubric criteria for explanation, justification, connections and/or extensions as cued for in a given problem.
- <sup>4</sup> Merely an exact copy or paraphrase of the problem will receive a score of "0".

Rubric Document Date: August 2003