25 For \( n \) and \( p > 0 \), is the expression \( \left( p^{\frac{3}{2}} n^{\frac{1}{3}} \right)^{8} \sqrt[p]{p^{5} n^{4}} \) equivalent to \( p^{18} n^{6} \sqrt[p]{p} \)? Justify your answer.

\[
\left( p^{\frac{3}{2}} n^{\frac{1}{3}} \right)^{8} \sqrt[p]{p^{5} n^{4}} = p^{18} n^{6} \sqrt[p]{p}
\]

\[
\begin{align*}
    p^{\frac{3}{2} \cdot 8} n^{\frac{1}{3} \cdot 8} & = p^{12} n^{\frac{8}{3}} \\
    p^{12} n^{\frac{1}{2} \cdot 8} & = p^{12} n^{4} \\
    p^{\frac{3}{2} \cdot 6} n^{\frac{1}{3} \cdot 6} & = p^{9} n^{2}
\end{align*}
\]

Yes, they are equivalent.

Score 2: The student gave a complete and correct response.
Question 25

25 For \( n \) and \( p > 0 \), is the expression \( \left( p^{3/2} n^{1/2} \right)^8 \sqrt[p]{p^{5/4} n^{3/4}} \) equivalent to \( p^{18/6} n^{6/6} \sqrt[p]{p} \)? Justify your answer.

They are equivalent because when you simplify the left hand side you get \( p^{18/6} n^{6/6} \sqrt[p]{p} \).
25 For $n$ and $p > 0$, is the expression \( \left( p^{\frac{3}{2}} n^2 \right)^8 \sqrt[8]{p^5 n^4} \) equivalent to \( p^{18} n^6 \sqrt{p} \)? Justify your answer.

\[
\left( p^{\frac{3}{2}} n^2 \right)^8 \sqrt[8]{p^5 n^4} = p^{18} n^6 \sqrt{p} \\
\]

\[
p^{\frac{3}{2}} n^2 \sqrt[8]{p^5 n^4} = p^{18} n^6 \sqrt{p} \\
\]

\[
p^{18} n^6 \sqrt{p} \neq p^{18} n^6 \sqrt{p}
\]

**Score 1:** The student made a computational error in the last line.
For \( n \) and \( p > 0 \), is the expression \( \left( \frac{p^2 n^3}{3} \right)^8 \sqrt[8]{p^5 n^4} \) equivalent to \( p^{18} n^6 \sqrt{p} \)? Justify your answer.

\[ (n^4)(n^2) \]

\[ \frac{p^{16} n^4 \sqrt{p^5 n^4}}{\sqrt{p^5 n^2}} = p^{18} n^6 \sqrt{p} \]

\[ \frac{p^{16} n^6}{\sqrt{p^5 n^2}} = p^{18} n^6 \sqrt{p} \]

\[ \frac{p^{16} n^6}{\sqrt{p^5}} = p^{18} n^6 \sqrt{p} \]

**Score 1:** The student did not completely simplify the left side of the equation.
25 For \( n \) and \( p > 0 \), is the expression \( \left(p^3 n^2\right)^{\frac{1}{8}} \sqrt[8]{p^5 n^4} \) equivalent to \( p^{18} n^6 \sqrt[p]{p} \)? Justify your answer.

\[
\left(p^{10} n^{8.5}\right)\left(\sqrt[8]{p^5 n^4}\right)
\times \sqrt[p]{p^{15} n^{2.5}} = p^{18} n^6 \sqrt[p]{p}
\]

No, because \( \left(p^{10} n^{11.5}\right)^8 \sqrt[p]{p^{5} n^{4}} \) does not equal \( p^{18} n^6 \sqrt[p]{p} \) when reduced.

**Score 0:** The student made multiple errors.
Question 25

For \( n \) and \( p > 0 \), is the expression \( \left( p^3 \frac{1}{n^2} \right)^8 \sqrt[p^5 n^4]{p^5 n^4} \) equivalent to \( p^{18} n^6 \sqrt[p]{p} \)? Justify your answer.

\[
\begin{align*}
p &= 1 \\
n &= 2 \\
\left( (4)^2 \left( \frac{1}{2} \right)^2 \right)^8 \sqrt{4 \cdot 4} \sqrt[4]{4^2} \\
\left( 1 \cdot 1.4 \right)^2 \sqrt[4]{16} \\
16 \cdot 4 \\
&= 64
\end{align*}
\]

Score 0: The student did not indicate a positive response and did not provide a correct justification.
26 Show why \( x - 3 \) is a factor of \( m(x) = x^3 - x^2 - 5x - 3 \). Justify your answer.

\[
\begin{array}{c}
\frac{x^2+2x+1}{x-3} \\
\frac{x^3-x^2-5x-3}{+x^3+3x^2} \\
\frac{2x^2-5x}{+2x^2+6x} \\
\frac{x-3}{+x+3} \\
\end{array}
\]

\( x - 3 \) is a factor of \( x^3 - x^2 - 5x - 3 \) when it is multiplied by \( x^2 + 2x + 1 \).

**Score 2:** The student gave a complete and correct response.
Question 26

26 Show why \( x - 3 \) is a factor of \( m(x) = x^3 - x^2 - 5x - 3 \). Justify your answer.

\[
\begin{array}{c|ccc}
  & 1 & -1 & -5 \\
\hline
3 & 3 & 6 & 3 \\
\hline
1 & 2 & 1 & 0 \\
\end{array}
\]

\( x^2 + 2x + 1 \)

Score 2: The student gave a complete and correct response.
26 Show why \( x - 3 \) is a factor of \( m(x) = x^3 - x^2 - 5x - 3 \). Justify your answer.

\[
\begin{align*}
(3)^3 - (3)^2 - 5(3) - 3 \\
\downarrow \\
\text{0}
\end{align*}
\]

Since we plugged \( x - 3 \) in

\( \text{as } x = 3, \text{ the opposite} \) and

the remainder is 0, ;

\( x - 3 \) vs a factor.

Score 2: The student gave a complete and correct response.
26 Show why \( x - 3 \) is a factor of \( m(x) = x^3 - x^2 - 5x - 3 \). Justify your answer.

\[
\begin{align*}
x - 3 &= 0 \\
13 + 3 &= x = 3
\end{align*}
\]

\[
\begin{align*}
(3)^3 - (3)^2 - 5(3) - 3 &= 0 \\
27 - 9 - 15 &= 3 \\
18 - 12 &= 6
\end{align*}
\]

\textbf{Score 1: } The student received one credit for substituting 3 and setting the expression equal to zero.
26 Show why $x - 3$ is a factor of $m(x) = x^3 - x^2 - 5x - 3$. Justify your answer.

\[
\begin{array}{c}
\text{x - 3} \\
\hline
x^3 - x^2 - 5x - 3 \\
\text{x^3 - 3x^2} \\
\hline
2x^2 - 5x \\
2x^2 - 5x \\
\hline
0x - 3
\end{array}
\]

\[x^2 + 2x - \frac{3}{x-3}\]

\[x^2 + 2x - \frac{3}{x-3}\] is the quotient and $x - 3$ is a factor of $m(x) = x^3 - x^2 - 5x - 3$.

Score 0: The student made multiple errors.
27 Describe the transformation applied to the graph of \( p(x) = 2^x \) that form the new function 
\[ q(x) = 2^{x-3} + 4. \]

\[ q(x) \] would be 4 spaces higher and would be shifted to the right by 3.

**Score 2:** The student gave a complete and correct response.
27 Describe the transformation applied to the graph of \( p(x) = 2^x \) that form the new function \( q(x) = 2^{x-3} + 4 \).

Score 2: The student gave a complete and correct response.
27 Describe the transformation applied to the graph of $p(x) = 2^x$ that form the new function $q(x) = 2^{x-3} + 4$.

Score 1: The student made one error in describing the vertical shift.
Question 27

27 Describe the transformation applied to the graph of \( p(x) = 2^x \) that form the new function \( q(x) = 2^{x-3} + 4 \).

left 4, up 3

Score 0: The student made multiple errors in the transformation.
Question 28

28 The parabola \( y = -\frac{1}{20}(x - 3)^2 + 6 \) has its focus at (3,1). Determine and state the equation of the directrix.

(The use of the grid below is optional.)

Score 2: The student gave a complete and correct response.
28 The parabola \( y = -\frac{1}{20}(x - 3)^2 + 6 \) has its focus at \((3,1)\). Determine and state the equation of the directrix.

(The use of the grid below is optional.)

\[ \text{plug in find vertex} \]

\[ v = (3,6) \]

\[ y = 11 \]

Score 2: The student gave a complete and correct response.
28 The parabola \( y = -\frac{1}{20}(x - 3)^2 + 6 \) has its focus at (3,1). Determine and state the equation of the directrix.

(The use of the grid below is optional.)

Score 1: The student stated the directrix as a coordinate.
28 The parabola \( y = -\frac{1}{20}(x - 3)^2 + 6 \) has its focus at (3,1). Determine and state the equation of the directrix.

(The use of the grid below is optional.)

Score 1: The student used an incorrect focus to find the value of \( p \).
28 The parabola \( y = -\frac{1}{20}(x - 3)^2 + 6 \) has its focus at (3,1). Determine and state the equation of the directrix.

(The use of the grid below is optional.)

\[
\text{directrix: } y = -4.
\]

\[
\text{max of parabola } y \quad \text{is } (3, b) \quad b-1 = \sqrt{5} \quad \downarrow \quad \text{p-value}
\]

**Score 1:** The student incorrectly placed the directrix below the focus.
The parabola \( y = -\frac{1}{20}(x - 3)^2 + 6 \) has its focus at (3,1). Determine and state the equation of the directrix.

(The use of the grid below is optional.)

Score 0: The student made multiple errors.
29 Given the geometric series $300 + 360 + 432 + 518.4 + \ldots$, write a geometric series formula, $S_n$, for the sum of the first $n$ terms. Use the formula to find the sum of the first 10 terms, to the nearest tenth.

\[
S_n = \frac{300 - 300(1.2)^n}{1 - 1.2}
\]

\[
S_{10} = \frac{300 - 300(1.2)^{10}}{1 - 1.2}
\]

\[
S_{10} = 7787.6
\]

Score 2: The student gave a complete and correct response.
Question 29

29 Given the geometric series $300 + 360 + 432 + 518.4 + \ldots$, write a geometric series formula, $S_n$, for the sum of the first $n$ terms. Use the formula to find the sum of the first 10 terms, to the nearest tenth.

$$S_n = \sum_{i=1}^{n} 300 (1.2)^{i-1}$$

$$S_{10} = \sum_{i=1}^{10} 300 (1.2)^{i-1} = 7787.6$$

Score 2: The student gave a complete and correct response.
Question 29

29 Given the geometric series $300 + 360 + 432 + 518.4 + ...$, write a geometric series formula, $S_n$, for the sum of the first $n$ terms. Use the formula to find the sum of the first 10 terms, to the nearest tenth.

\[ S_n = \frac{a_1 - a_1 r^n}{1 - r} \]

\[ S_n = \frac{300 - 300 \left(\frac{3}{5}\right)^n}{1 - \frac{3}{5}} \]

\[ S_{10} = \frac{300 - 300 \left(\frac{3}{5}\right)^{10}}{1 - \frac{3}{5}} \]

\[ S_{10} = 1857.5209 \approx -2 \]

\[ S_{10} = 9287.604634 \]

\[ 9.3 \]

Score 1: The student made one computational error.
29 Given the geometric series $300 + 360 + 432 + 518.4 + \ldots$, write a geometric series formula, $S_n$, for the sum of the first $n$ terms. Use the formula to find the sum of the first 10 terms, to the nearest tenth.

\[
S_n = \frac{a_1(1 - r^n)}{1 - r}
\]

\[
S_{10} = 300 \cdot \frac{1 - (1.2)^{10}}{1 - 1.2}
\]

\[
S_{10} = 300 \cdot \frac{1 - 6.191736422}{-0.2}
\]

\[
S_{10} = 300 \cdot 1857.5
\]

\[
S_{10} = -1857.5
\]

\[
S_{10} = 7787.5
\]

**Score 1:** The student made a rounding error.
Given the geometric series $300 + 360 + 432 + 518.4 + \ldots$, write a geometric series formula, $S_n$, for the sum of the first $n$ terms. Use the formula to find the sum of the first 10 terms, to the nearest tenth.

$$a_1 = 300$$

$$S_n = 300 \cdot (n \cdot 1.2)$$

$$300, 360, 432, 518.4, 622.08, 746.496, 895.7952, 1074.79524, 1289.493088, 15.47.43406$$

$$7787.6046$$

$$\approx 7787$$

**Score 0:** The student wrote an incorrect geometric series formula and made a rounding error.
Given the geometric series \(300 + 360 + 432 + 518.4 + \ldots\), write a geometric series formula, \(S_n\), for the sum of the first \(n\) terms. Use the formula to find the sum of the first 10 terms, to the nearest tenth.

\[
S_n = \frac{a_1 - a_1 r^n}{1 - r}
\]

\[
\frac{518.4 - 12.92 \cdot \ldots^{10}}{1 - \frac{4}{4}} = \ ?
\]

Score 0: The student did not show enough correct work to receive any credit.
Visible light can be represented by sinusoidal waves. Three visible light waves are shown in the graph below. The midline of each wave is labeled $\ell$.

Based on the graph, which light wave has the longest period? Justify your answer.

Light C because it's the only wave that does not go through a full period on the graph, meaning it's longer and can't fit on the graph.

Score 2: The student gave a complete and correct response.
Visible light can be represented by sinusoidal waves. Three visible light waves are shown in the graph below. The midline of each wave is labeled $\ell$.

Based on the graph, which light wave has the longest period? Justify your answer.

Line C because it has the greatest distance between its minimum and maximum 320 nm

Line B 220 nm

Line A 280 nm

Score 2: The student gave a complete and correct response.
Visible light can be represented by sinusoidal waves. Three visible light waves are shown in the graph below. The midline of each wave is labeled $\ell$.

Based on the graph, which light wave has the longest period? Justify your answer.

Light wave C has the longest period because one period is about 330 nanometers while light waves A and B have shorter periods.

Score 1: The student received no credit for the justification.
30 Visible light can be represented by sinusoidal waves. Three visible light waves are shown in the graph below. The midline of each wave is labeled \( \ell \).

![Graph showing three sinusoidal waves labeled A, B, and C.](image)

Based on the graph, which light wave has the longest period? Justify your answer.

A because it's period takes up the most nanometers.

Score 0: The student did not show any correct work.
31 Biologists are studying a new bacterium. They create a culture with 100 of the bacteria and anticipate that the number of bacteria will double every 30 hours. Write an equation for the number of bacteria, $B$, in terms of the number of hours, $t$, since the experiment began.

\[ B(t) = 100 \left(2^{\frac{t}{30}}\right) \]

Score 2: The student gave a complete and correct response.
31 Biologists are studying a new bacterium. They create a culture with 100 of the bacteria and anticipate that the number of bacteria will double every 30 hours. Write an equation for the number of bacteria, \( B \), in terms of the number of hours, \( t \), since the experiment began.

\[
\begin{align*}
200 &= 100e^{\frac{\ln 2}{30}t} \\
\ln 2 &= \ln e^{\frac{\ln 2}{30}t} \\
\frac{\ln 2}{30} &= \frac{\ln 2}{\ln e} \\
B(t) &= 100e^{\left(\frac{\ln 2}{30}\right)t}
\end{align*}
\]

**Score 2:** The student gave a complete and correct response.
Biologists are studying a new bacterium. They create a culture with 100 of the bacteria and anticipate that the number of bacteria will double every 30 hours. Write an equation for the number of bacteria, $B$, in terms of the number of hours, $t$, since the experiment began.

$$B = 100(2)^{\frac{t}{30}}$$

**Score 1:** The student applied the doubling time incorrectly.
Question 31

31 Biologists are studying a new bacterium. They create a culture with 100 of the bacteria and anticipate that the number of bacteria will double every 30 hours. Write an equation for the number of bacteria, $B$, in terms of the number of hours, $t$, since the experiment began.

\[
100 \left(2^{\frac{t}{30}}\right) = 
\]

**Score 1:** The student made a notation error by writing an expression, not an equation.
Question 31

31 Biologists are studying a new bacterium. They create a culture with 100 of the bacteria and anticipate that the number of bacteria will double every 30 hours. Write an equation for the number of bacteria, $B$, in terms of the number of hours, $t$, since the experiment began.

\[ y = 100 \left(2^{\frac{t}{30}}\right) \]

Score 0: The student made multiple errors.
32 Graph \( y = x^3 - 4x^2 + 2x + 7 \) on the set of axes below.

Score 2: The student gave a complete and correct response.
32 Graph \( y = x^3 - 4x^2 + 2x + 7 \) on the set of axes below.

Score 2: The student gave a complete and correct response.
32 Graph $y = x^3 - 4x^2 + 2x + 7$ on the set of axes below.

**Score 1:** The student made one graphing error at the relative minimum.
32 Graph \( y = x^3 - 4x^2 + 2x + 7 \) on the set of axes below.

**Score 0:** The student made multiple graphing errors.
Sonja is cutting wire to construct a mobile. She cuts 100 inches for the first piece, 80 inches for the second piece, and 64 inches for the third piece. Assuming this pattern continues, write an explicit equation for \( a_n \), the length in inches of the \( n \)th piece.

\[
a_n = 100 \left( \frac{2}{3} \right)^{n-1}
\]

Sonja only has 40 feet of wire to use for the project and wants to cut 20 pieces total for the mobile using her pattern. Will she have enough wire? Justify your answer.

\[
S_n = \frac{100 \left( \frac{2}{3} \right)^n}{1 - \frac{2}{3}}
\]

\[
S_n = 149.4 \text{ inches}
\]

\[40 \times 12 = 480\]

She will not have enough wire because for 20 pieces she needs about 494.29 inches but she only has 480 inches of wire.

**Score 4:** The student gave a complete and correct response.
33 Sonja is cutting wire to construct a mobile. She cuts 100 inches for the first piece, 80 inches for the second piece, and 64 inches for the third piece. Assuming this pattern continues, write an explicit equation for \( a_n \), the length in inches of the \( n \)th piece.

\[
\frac{100}{a_1} = \frac{80}{a_2} = \frac{64}{a_3} \quad a_n = 100 (0.8)^{n-1}
\]

\[
r = 0.8
\]

Sonja only has 40 feet of wire to use for the project and wants to cut 20 pieces total for the mobile using her pattern. Will she have enough wire? Justify your answer.

\[
\text{40ft} \rightarrow 480\text{in}
\]

Geometric Series

\[
\begin{align*}
\text{Geometric Series} & = \frac{100 - 100(0.8)^n}{1 - 0.8} \\
& = \frac{100 - 100(0.8)^{20}}{0.2} \\
& = 494.2333925
\end{align*}
\]

She will not have enough, she needs 444 inches of wire and she only has 480 in.

**Score 4:** The student gave a complete and correct response.
33 Sonja is cutting wire to construct a mobile. She cuts 100 inches for the first piece, 80 inches for the second piece, and 64 inches for the third piece. Assuming this pattern continues, write an explicit equation for $a_n$, the length in inches of the $n$th piece.

\[ a_n = 100(0.8)^{n-1} \]

Sonja only has 40 feet of wire to use for the project and wants to cut 20 pieces total for the mobile using her pattern. Will she have enough wire? Justify your answer.

\[
\begin{align*}
a_1 &= 100(0.8)^0 = 100 \\
a_2 &= 100(0.8)^1 = 80 \\
a_3 &= 100(0.8)^2 = 64 \\
a_4 &= 100(0.8)^3 = 51.2 \\
&= 51.2 \\
a_5 &= 41 \\
a_6 &= 33 \\
a_7 &= 26 \\
a_8 &= 21 \\
a_9 &= 17 \\
a_{10} &= 13 \\
a_{11} &= 11 \\
a_{12} &= 9 \\
a_{13} &= 7 \
\end{align*}
\]

**Score 4:** The student gave a complete and correct response.
Sonja is cutting wire to construct a mobile. She cuts 100 inches for the first piece, 80 inches for the second piece, and 64 inches for the third piece. Assuming this pattern continues, write an explicit equation for \(a_n\), the length in inches of the \(n\)th piece.

\[
\frac{80}{100} = 0.8
\]

\[
100 \cdot (0.8)^{n-1}
\]

Sonja only has 40 feet of wire to use for the project and wants to cut 20 pieces total for the mobile using her pattern. Will she have enough wire? Justify your answer.

\[
\begin{align*}
S_n &= a_1 - a_1 r^n \\
S_n &= \frac{100 - 100(0.8)^{20}}{1 - 0.8} \\
S_n &= \frac{100 - 1,152.921505}{0.2} \\
S_n &= 494.2353905
\end{align*}
\]

She will not have enough wire.

**Score 3:** The student made a notation error by writing an expression, not an equation.
Sonja is cutting wire to construct a mobile. She cuts 100 inches for the first piece, 80 inches for the second piece, and 64 inches for the third piece. Assuming this pattern continues, write an explicit equation for $a_n$, the length in inches of the $n$th piece.

\[
\begin{align*}
a_1 &= 100 \\
a_n &= a_{n-1} \cdot \left(\frac{4}{5}\right)
\end{align*}
\]

Sonja only has 40 feet of wire to use for the project and wants to cut 20 pieces total for the mobile using her pattern. Will she have enough wire? Justify your answer.

\[
a_n = a_1 - a_1 \cdot r^n \\
\frac{100 - 100 \left(\frac{4}{5}\right)^n}{1 - \frac{4}{5}}
\]

No, she does not have enough wire to cut 20 pieces because it comes out to be more than 40 feet.

1 ft = 12 in

\[
\frac{494.2353925}{12} = 41.18628271
\]

**Score 3:** The student wrote a recursive formula in the first part.
Sonja is cutting wire to construct a mobile. She cuts 100 inches for the first piece, 80 inches for the second piece, and 64 inches for the third piece. Assuming this pattern continues, write an explicit equation for $a_n$, the length in inches of the $n$th piece.

\[ a_n = 100 \cdot (0.8)^{n-1} \]

Sonja only has 40 feet of wire to use for the project and wants to cut 20 pieces total for the mobile using her pattern. Will she have enough wire? Justify your answer.

\[ a_n = 100 \cdot (0.8)^{19} \]

Score 2: The student answered the first part correctly.
33 Sonja is cutting wire to construct a mobile. She cuts 100 inches for the first piece, 80 inches for the second piece, and 64 inches for the third piece. Assuming this pattern continues, write an explicit equation for $a_n$, the length in inches of the $n$th piece.

$$a_n = a_{n-1} \times 0.8$$

Sonja only has 40 feet of wire to use for the project and wants to cut 20 pieces total for the mobile using her pattern. Will she have enough wire? Justify your answer.

$$S_n = \sum_{k=1}^{n} a_k = \frac{a_1 - a_1 r^n}{1-r}$$

$$S_{20} = \frac{100 - 100 \times 0.8^{20}}{1-0.8}$$

$$= 494.2$$

**Score 1:** The student earned credit for correctly finding the amount of wire needed.
Question 33

33 Sonja is cutting wire to construct a mobile. She cuts 100 inches for the first piece, 80 inches for the second piece, and 64 inches for the third piece. Assuming this pattern continues, write an explicit equation for \( a_n \), the length in inches of the \( n \)th piece.

\[
\begin{align*}
\alpha_0 &= 100 \\
\alpha_1 &= 80 \\
\alpha_2 &= 64 \\
\alpha_n &= \, ?
\end{align*}
\]

\[
\begin{align*}
\Delta_1 &= 80 - 100 = -20 \\
\alpha_n &= \alpha_1 + (n-1) \Delta_1 \\
\alpha_n &= 100 + (n-1) (-20)
\end{align*}
\]

Sonja only has 40 feet of wire to use for the project and wants to cut 20 pieces total for the mobile using her pattern. Will she have enough wire? Justify your answer.

No because according to the geometric sequence formula it won't be enough.

Score 0: The student did not do enough correct work to receive any credit.
34 Graph the following function on the axes below.

\[ f(x) = \log_3(2 - x) \]

State the domain of \( f \).

Domain: \(( -\infty, 2)\)

State the equation of the asymptote.

asymptote \( x = 2 \)

Score 4: The student gave a complete and correct response.
34 Graph the following function on the axes below.

\[ f(x) = \log_3(2 - x) \]

State the domain of \( f \).

The domain is all real numbers less than 2.

State the equation of the asymptote.

The equation of the asymptote is \( x = 2 \).

Score 4: The student gave a complete and correct response.
Question 34

34 Graph the following function on the axes below.

\[ f(x) = \log_3(2 - x) \]

State the domain of \( f \).

\[ \text{Domain: } x < 2. \]

State the equation of the asymptote.

\[ \text{Equation of the asymptote: } y = \lim_{x \to -\infty} \log_3(2 - x). \]

Score 3: The student did not state the correct equation of the asymptote.
34 Graph the following function on the axes below.

\[ f(x) = \log_3(2 - x) \]

State the domain of \( f \).

\[ \text{domain of } f: \quad x < 2 \]

State the equation of the asymptote.

\[ \text{asymptote } = x = 2 \]

**Score 3:** The student made one graphing error.
34 Graph the following function on the axes below.

\[ f(x) = \log_3(2 - x) \]

State the domain of \( f \).

\[ (-\infty, 1] \]

State the equation of the asymptote.

\[ x = 2 \]

Score 2: The student made one graphing error and stated an incorrect domain.
Question 34

34 Graph the following function on the axes below.

\[ f(x) = \log_3(2 - x) \]

State the domain of \( f \).

\[ -\infty \leq x \leq 2 \]

State the equation of the asymptote.

Score 1: The student received one credit for the graph.
34 Graph the following function on the axes below.

\[ f(x) = \log_3(2 - x) \]

State the domain of \( f \).

\((-\infty, \infty)\)

State the equation of the asymptote.

Score 0: The student did not show enough correct work to receive any credit.
35 Algebraically solve the following system of equations.

\[
\begin{align*}
(x - 2)^2 + (y - 3)^2 &= 16 \\
x + y - 1 &= 0
\end{align*}
\]

\[
\begin{align*}
y &= x + 1 \\
(x-2)^2 + (-x-2)^2 &= 16 \\
x^2 - 4x + 4 + x^2 + 4x + 4 &= 16 \\
\frac{2x^2 + 8}{2} &= 16 \\
x^2 + 4 &= 8 \\
x^2 &= 4 \\
x &= \pm 2
\end{align*}
\]

\[
\begin{align*}
2 + y - 1 &= 0 \\
y + 1 &= 0 \\
y &= -1 \\
-2 + y - 1 &= 0 \\
y &= 3
\end{align*}
\]

\[
(2, -1) \quad \text{or} \quad (-2, 3)
\]

Score 4: The student gave a complete and correct response.
35 Algebraically solve the following system of equations.

\[(x - 2)^2 + (y - 3)^2 = 16\]
\[x + y - 1 = 0\]

\[x = -y + 1\]

\[(x - 2)^2 + (y - 3)^2 = 16\]
\[(-y + 1 - 2)^2 + (y - 3)^2 = 16\]
\[(-y - 1)^2 + (y - 3)^2 = 16\]

\[y^2 + 2y + 1 + y^2 - 6y + 9 = 16\]
\[2y^2 - 4y + 10 = 16\]
\[y^2 - 2y + 5 = 8\]
\[y^2 - 2y - 3 = 0\]
\[(y - 3)(y + 1) = 0\]

\[y = 3, y = -1\]

\[x = -y + 1\]
\[x = -(3) + 1\]
\[x = -2\]

\[(-2, 3)\]

\[x = -y + 1\]
\[x = -(-1) + 1\]
\[x = 2\]

\[(2, -1)\]

**Score 4:** The student gave a complete and correct response.
35 Algebraically solve the following system of equations.

\[(x - 2)^2 + (y - 3)^2 = 16\]
\[x + y - 1 = 0\]

\[
\begin{align*}
(x-2)^2 + (y-3)^2 &= 16 \\
y &= -x+1 \\
(x-2)^2 + (-x+1-3)^2 &= 16 \\
(x-3)(x-2) + (-x-2)(-x-2) &= 16 \\
x^2 - 4x + 4 + x^2 + 4x + 4 &= 16 \\
2x^2 + 8 &= 16 \\
2x^2 &= 8 \\
x^2 &= 4 \\
2(x^2 - 4) &= 0 \\
2(x - 2)(x + 2) &= 0 \\
x - 2 &= 0 \quad \text{or} \quad x + 2 &= 0 \\
x &= 2 \quad \text{or} \quad x &= -2
\end{align*}
\]

\[y = -1\]
\[y = 3\]

**Score 3:** The student did not show solutions that are paired.
Question 35

Algebraically solve the following system of equations.

\begin{align*}
(x - 2)^2 + (y - 3)^2 &= 16 \\
x + y - 1 &= 0 \\
x + y &= 1 \Rightarrow y = -x + 1
\end{align*}

\[
\begin{align*}
(x - 2)^2 + (-x - 1 - 3)^2 &= 16 \\
2x^2 + 4x + 20 &= 16 \\
2x^2 + 4x + 4 &= 0 \\
x^2 + 2x + 2 &= 0 \\
(x + 2)(x + 1) &= 0 \\
x &= -2 \\
y &= (-2) + 1 \\
y &= 3 \\
(-2, 3)
\end{align*}
\]

Score 2: The student made a transcription error and a factoring error.
Algebraically solve the following system of equations.

\[(x - 2)^2 + (y - 3)^2 = 16\]
\[x + y - 1 = 0 \quad y = -x + 1\]

\[\begin{align*}
(x - 2)^2 + (y - 3)^2 &= 16 \\
(x - 2)^2 + (-x + 1 - 3)^2 &= 16 \\
(x^2 - 2y + 4) + (x^2 + 4x + 4) &= 16 \\
2x^2 + 8 &= 16 \\
2x^2 - 16 &= 0 \\
2x^2 &= 16 \\
(x^2 - 8) &= 0 \\
\sqrt{x^2 - 8} &= \pm 8 \\
x &= \pm 2 \\
\end{align*}\]

\[x = 2\]

\[\begin{align*}
x^2 - 8 &= 0 \\
+8 &= 8 \\
\sqrt{x^2 - 8} &= \pm 8 \\
\sqrt{x^2 - 8} &= 0 \\
\end{align*}\]

\[x = \pm 2\]

\[x = 2\sqrt{2}\]

**Score 1:** The student wrote a correct quadratic equation in one variable.
35 Algebraically solve the following system of equations.

\[(x - 2)^2 + (y - 3)^2 = 16\]
\[x + y - 1 = 0\]

\[x^2 - 4x + y^2 - 6y + 4 = 16\]
\[x^2 + y^2 - 9 = 20\]
\[x^2 + y^2 = 29\]

**Score 0:** The student did not show any relevant correct work.
35 Algebraically solve the following system of equations.

\[(x - 2)^2 + (y - 3)^2 = 16\]
\[x + y - 1 = 0\]

\[
x - 2 = y - 3
\]
\[
x^2 - 4x + 4
\]
\[
y^2 - 6y + 9
\]
\[
x = -2
\]
\[
y = 3
\]

**Score 0:** The student obtained one correct solution by an obviously incorrect procedure.
### Question 36

36 The table below gives air pressures in kPa at selected altitudes above sea level measured in kilometers.

<table>
<thead>
<tr>
<th>x</th>
<th>Altitude (km)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>Air Pressure  (kPa)</td>
<td>101</td>
<td>90</td>
<td>79</td>
<td>70</td>
<td>62</td>
<td>54</td>
</tr>
</tbody>
</table>

Write an exponential regression equation that models these data rounding all values to the **nearest thousandth**.

\[ y = 101.523 \times 0.883^x \]

Use this equation to algebraically determine the altitude, to the **nearest hundredth** of a kilometer, when the air pressure is 29 kPa.

When air pressure is 29 kPa, altitude is \(10.07 \text{ (km)}\).

\[
29 = \frac{101.523 \times 0.883^x}{101.523}
\]

\[
0.28565 = 0.883^x
\]

\[
\log(0.28565) = x \log(0.883)
\]

\[
\frac{\log(0.28565)}{\log(0.883)} = x
\]

\[
x = 10.07
\]

**Score 4:** The student gave a complete and correct response.
Question 36

36 The table below gives air pressures in kPa at selected altitudes above sea level measured in kilometers.

<table>
<thead>
<tr>
<th>x</th>
<th>Altitude (km)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>Air Pressure (kPa)</td>
<td>101</td>
<td>90</td>
<td>79</td>
<td>70</td>
<td>62</td>
<td>54</td>
</tr>
</tbody>
</table>

Write an exponential regression equation that models these data rounding all values to the nearest thousandth.

\[ y = 101.523(0.883)^x \]

Use this equation to algebraically determine the altitude, to the nearest hundredth of a kilometer, when the air pressure is 29 kPa.

\[
\frac{29}{101.523} = (0.883)^x
\]

\[
0.28516 \ldots = 0.883^x
\]

\[
x = \log 0.883 \cdot 0.28516
\]

\[
x = 10.07 \text{ km}
\]

Score 4: The student gave a complete and correct response.
36 The table below gives air pressures in kPa at selected altitudes above sea level measured in kilometers.

<table>
<thead>
<tr>
<th>x</th>
<th>Altitude (km)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>Air Pressure (kPa)</td>
<td>101</td>
<td>90</td>
<td>79</td>
<td>70</td>
<td>62</td>
<td>54</td>
</tr>
</tbody>
</table>

Write an exponential regression equation that models these data rounding all values to the nearest thousandth.

\[ 101.523 (0.883)^x \]

Use this equation to algebraically determine the altitude, to the nearest hundredth of a kilometer, when the air pressure is 29 kPa.

\[ 29 = 101.523 (0.883)^x \]

\[ \log_{10} 0.296 = \log_{10} 0.883 x \]

\[ x \approx 10.07 \]

**Score 3:** The student made a notation error by writing an expression, not an equation.
Question 36

The table below gives air pressures in kPa at selected altitudes above sea level measured in kilometers.

<table>
<thead>
<tr>
<th>$x$</th>
<th>Altitude (km)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>Air Pressure (kPa)</td>
<td>101</td>
<td>90</td>
<td>79</td>
<td>70</td>
<td>62</td>
<td>54</td>
</tr>
</tbody>
</table>

Write an exponential regression equation that models these data rounding all values to the nearest thousandth.

$$y = 101.523 \times (0.883)^{x}$$

Use this equation to algebraically determine the altitude, to the nearest hundredth of a kilometer, when the air pressure is 29 kPa.

$$29 = \frac{101.523 \times (0.883)^{x}}{101.523}$$

$$28.56 = (0.883)^{x}$$

$$\log_{10} 28.56 = x \times \log_{10} 0.883$$

Score 3: The student made a rounding error.
Question 36

36 The table below gives air pressures in kPa at selected altitudes above sea level measured in kilometers.

<table>
<thead>
<tr>
<th>x</th>
<th>Altitude (km)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tr>
<td>y</td>
<td>Air Pressure (kPa)</td>
<td>101</td>
<td>90</td>
<td>79</td>
<td>70</td>
<td>62</td>
<td>54</td>
</tr>
</tbody>
</table>

Write an exponential regression equation that models these data rounding all values to the nearest thousandth.

\[ y = ab^x \]
\[ a = 101.523 \]
\[ b = 0.883 \]

\[ y = 101.523(0.883)^x \]

Use this equation to algebraically determine the altitude, to the nearest hundredth of a kilometer, when the air pressure is 29 kPa.

\[ 29 = 101.523(0.883)^x \]
\[ \frac{29}{101.523} = (0.883)^x \]
\[ 0.286 = (0.883)^x \]
\[ \ln 0.286 = \ln (0.883)^x \]
\[ \ln 0.286 = x \ln 0.883 \]
\[ x = \frac{\ln 0.286}{\ln 0.883} \]
\[ x = \frac{10.06}{10.06} \text{ km} \]

Score 2: The student made one rounding error and one notation error writing the logarithm.
The table below gives air pressures in kPa at selected altitudes above sea level measured in kilometers.

<table>
<thead>
<tr>
<th>x</th>
<th>Altitude (km)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>y</td>
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<td>90</td>
<td>79</td>
<td>70</td>
<td>62</td>
<td>54</td>
</tr>
</tbody>
</table>

Write an exponential regression equation that models these data rounding all values to the nearest thousandth.

\[ y = a(b^x) \]
\[ y = 101.523(883)^x \]

Use this equation to algebraically determine the altitude, to the nearest hundredth of a kilometer, when the air pressure is 29 kPa.

\[ \frac{29}{101.523} = \frac{101.523(883)^x}{101.523} \]
\[ 0.286 = (883)^x \]

Score 2: The student earned credit for the correct exponential regression equation.
Question 36

36 The table below gives air pressures in kPa at selected altitudes above sea level measured in kilometers.

<table>
<thead>
<tr>
<th>x</th>
<th>Altitude (km)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>Air Pressure (kPa)</td>
<td>101</td>
<td>90</td>
<td>79</td>
<td>70</td>
<td>62</td>
<td>54</td>
</tr>
</tbody>
</table>

Write an exponential regression equation that models these data rounding all values to the nearest thousandth.

\[ y = a(b^x) \]

\[ y = 101.438(0.883)^x \]

Use this equation to algebraically determine the altitude, to the nearest hundredth of a kilometer, when the air pressure is 29 kPa.

\[ y = 101.438(0.883)^{29} \]

\[ 2.75 \text{ km} \]

Score 1: The student made a computation error in the first part and earned no credit for the second part.
36 The table below gives air pressures in kPa at selected altitudes above sea level measured in kilometers.

<table>
<thead>
<tr>
<th>x</th>
<th>Altitude (km)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>Air Pressure (kPa)</td>
<td>101</td>
<td>90</td>
<td>79</td>
<td>70</td>
<td>62</td>
<td>54</td>
</tr>
</tbody>
</table>

Write an exponential regression equation that models these data rounding all values to the nearest thousandth.

\[ y = -9.37 \cdot e^{x} + 99.43 \]

Use this equation to algebraically determine the altitude, to the nearest hundredth of a kilometer, when the air pressure is 29 kPa.

\[ y = -9.37 \cdot (29) + 99.43 \]

\[ y = -172.3 \]

**Score 0:** The student did not show enough correct relevant work to receive any credit.
Sarah is fighting a sinus infection. Her doctor prescribed a nasal spray and an antibiotic to fight the infection. The active ingredients, in milligrams, remaining in the bloodstream from the nasal spray, \( n(t) \), and the antibiotic, \( a(t) \), are modeled in the functions below, where \( t \) is the time in hours since the medications were taken.

\[
\begin{align*}
n(t) &= \frac{t + 1}{t + 5} + \frac{18}{t^2 + 8t + 15} \\
a(t) &= \frac{9}{t + 3}
\end{align*}
\]

Determine which drug is made with a greater initial amount of active ingredient. Justify your answer.

\[
\begin{align*}
n(0) &= \frac{0 + 1}{0 + 5} + \frac{18}{0 + 15} = \frac{1}{5} + \frac{18}{15} = \frac{1 + 18}{15} = \frac{19}{15} \\
a(0) &= \frac{9}{0 + 3} = 3
\end{align*}
\]

The antibiotic is made with more active ingredient because \( a(t) = 3 \) at \( t = 0 \), which is greater than \( n(t) = \frac{19}{15} \).

Question 37 is continued on the next page.

**Score 6:** The student gave a complete and correct response.
Question 37 continued.

Sarah’s doctor told her to take both drugs at the same time. Determine algebraically the number of hours after taking the medications when both medications will have the same amount of active ingredient remaining in her bloodstream.

\[
\frac{t+1}{t+5} + \frac{18}{t^2 + 8t + 15} = \frac{9}{t+3}
\]

\[
(t+3)(t+5) \times \frac{t+1}{t+5} + \frac{18}{(t+3)(t+5)} = \frac{9}{t+3}
\]

\[
(t+1)(t+3) + 18 = 9(t+5)
\]

\[
t^2 + 4t + 3 + 18 = 9t + 45
\]

\[
t^2 - 5t - 42 = 0
\]

\[
(t-8)(t+3)
\]

Can’t have (negative time)

\[
t = 8 \quad t = -3
\]

After 8 hours, the 2 drugs will have the same amount of active ingredient in the blood.
37 Sarah is fighting a sinus infection. Her doctor prescribed a nasal spray and an antibiotic to fight the infection. The active ingredients, in milligrams, remaining in the bloodstream from the nasal spray, \( n(t) \), and the antibiotic, \( a(t) \), are modeled in the functions below, where \( t \) is the time in hours since the medications were taken.

\[
 n(t) = \frac{t+1}{t+5} + \frac{18}{t^2+8t+15} \\
 a(t) = \frac{9}{t+3}
\]

Determine which drug is made with a greater initial amount of active ingredient. Justify your answer.

**Score 5:** The student gave an incomplete justification for “antibiotic”.

Question 37 is continued on the next page.
Sarah’s doctor told her to take both drugs at the same time. Determine algebraically the number of hours after taking the medications when both medications will have the same amount of active ingredient remaining in her bloodstream.

\[
\frac{t + 1}{t + 5} + \frac{18}{t^2 + 8t + 15} = \frac{9}{t + 3}
\]

\[
(t + 1)(t + 3) + 18 = 9(t + 5)
\]

\[
t^2 + 4t + 3 + 18 = 9t + 45
\]

\[
t^2 + 4t + 21 = 9t + 45
\]

\[
t^2 - 5t - 24 = 0
\]

\[
(t - 8)(t + 3) = 0
\]

\[
t = 8, \quad t = -3
\]

After 8 hours

\[
t = 8 \, \text{hours}
\]
Sarah is fighting a sinus infection. Her doctor prescribed a nasal spray and an antibiotic to fight the infection. The active ingredients, in milligrams, remaining in the bloodstream from the nasal spray, \( n(t) \), and the antibiotic, \( a(t) \), are modeled in the functions below, where \( t \) is the time in hours since the medications were taken.

\[
\begin{align*}
    n(t) &= \frac{t + 1}{t + 5} + \frac{18}{t^2 + 8t + 15} \\
    a(t) &= \frac{9}{t + 3}
\end{align*}
\]

Determine which drug is made with a greater initial amount of active ingredient. Justify your answer.

\[
\begin{align*}
    t = 1 & \quad \frac{1 + 1}{1 + 5} + \frac{18}{1^2 + 8(1) + 15} = \frac{13}{12} \\
    \frac{9}{1 + 3} &= \frac{9 \times \frac{3}{4}}{3} = \frac{27}{12}
\end{align*}
\]

If you plug in \( 1 \) for both equation you see that equation \( a(t) \) has a higher fraction hence \( a(t) \) is greater made with a greater amount.

Question 37 is continued on the next page.

**Score 4:** The student mistakenly substituted 1 for the initial time and did not reject \( t = -3 \).
Sarah’s doctor told her to take both drugs at the same time. Determine algebraically the number of hours after taking the medications when both medications will have the same amount of active ingredient remaining in her bloodstream.

\[
\frac{t+3}{t+1} = \frac{t^2 + 4t + 3}{t^2 + 8t + 15}
\]

\[
\frac{(t+3)(t+1)}{9(t+5)(t+3)} + \frac{18}{6(t^2 + 8t + 15)} = \frac{(9)(t+5)}{(t+3)(t+5)}
\]

\[
(t+3)(t+1) + 18 = 9(t+5)
\]

\[
(t^2 + 4t + 3) + 18 = 9t + 45
\]

\[
t^2 + 4t + 3 + 18 = 9t + 45
\]

\[
t^2 + 4t + 3 - 9t - 45 = 0
\]

\[
t^2 - 5t - 24 = 0
\]

\[
(t+8)(t-3) = 0
\]

\[
t = -3 \text{ or } 8
\]
Sarah is fighting a sinus infection. Her doctor prescribed a nasal spray and an antibiotic to fight the infection. The active ingredients, in milligrams, remaining in the bloodstream from the nasal spray, \( n(t) \), and the antibiotic, \( a(t) \), are modeled in the functions below, where \( t \) is the time in hours since the medications were taken.

\[
\begin{align*}
n(t) &= \frac{t + 1}{t + 5} + \frac{18}{t^2 + 8t + 15} \\
a(t) &= \frac{9}{t + 3}
\end{align*}
\]

Determine which drug is made with a greater initial amount of active ingredient. Justify your answer.

Question 37 is continued on the next page.

**Score 4:** The student earned credit for correctly solving for \( t = 8 \).
Question 37 continued.

Sarah’s doctor told her to take both drugs at the same time. Determine algebraically the number of hours after taking the medications when both medications will have the same amount of active ingredient remaining in her bloodstream.

\[
\frac{(t+5)}{(t+3)} + \frac{18}{(t+5)}(t+3) = \frac{9}{(t+3)}(t+3)
\]

\[
(t+1)(t+3) + 18 = 9(t+5)
\]

\[
t^2 + 4t + 3 + 18 = 9t + 45
\]

\[
t^2 - 5t - 24 = 0
\]

\[
(t - 8)(t + 3) = 0
\]

\[
t = -3, 8
\]

\[
t = 8
\]

---

\[\therefore\] after 8 hours, they will have the same amount of active ingredient.
37 Sarah is fighting a sinus infection. Her doctor prescribed a nasal spray and an antibiotic to fight the infection. The active ingredients, in milligrams, remaining in the bloodstream from the nasal spray, \( n(t) \), and the antibiotic, \( a(t) \), are modeled in the functions below, where \( t \) is the time in hours since the medications were taken.

\[
\begin{align*}
n(t) &= \frac{t + 1}{t + 5} + \frac{18}{t^2 + 8t + 15} \\
a(t) &= \frac{9}{t + 3}
\end{align*}
\]

Determine which drug is made with a greater initial amount of active ingredient. Justify your answer.

\[
\begin{align*}
n(t) &= \frac{t + 1}{t + 5} + \frac{18}{t^2 + 8t + 15} \\
a(t) &= \frac{9}{t + 3}
\end{align*}
\]

Question 37 is continued on the next page.

Score 3: The student did not earn any credit in the first part and did not reject \( t = -3 \) in the second part.
Sarah’s doctor told her to take both drugs at the same time. Determine algebraically the number of hours after taking the medications when both medications will have the same amount of active ingredient remaining in her bloodstream.

\[
\frac{\frac{t+1}{t+5} + \frac{18}{t^2+8t+15}}{t+3} = \frac{9}{t+5}
\]

\[
\frac{(t+1)(t+3)}{(t+5)(t+3)} + \frac{18}{(t+5)(t+3)} = \frac{9(t+5)}{(t+5)(t+3)}
\]

\[
\frac{t^2+3t+t+3}{(t+1)(t+3)+18 - 9(t+5)} = \frac{8}{3}
\]

\[
\frac{t^2+4t+3 + 18 - 9t - 45}{t^2 - 5t - 24 = 0}
\]

\[
(t-8)(t+3)
\]
37 Sarah is fighting a sinus infection. Her doctor prescribed a nasal spray and an antibiotic to fight the infection. The active ingredients, in milligrams, remaining in the bloodstream from the nasal spray, \( n(t) \), and the antibiotic, \( a(t) \), are modeled in the functions below, where \( t \) is the time in hours since the medications were taken.

\[
\begin{align*}
    n(t) & = \frac{t+1}{t+5} + \frac{18}{t^2+8t+15} \\
    a(t) & = \frac{9}{t+3}
\end{align*}
\]

Determine which drug is made with a greater initial amount of active ingredient. Justify your answer.

\( a(t) \) has a greater amount of active ingredient because when both equations are plugged into the calculator at \( t = 0 \), \( n(t) \) has 7.5 milligrams of active ingredient and \( a(t) \) has 3 milligrams.

Question 37 is continued on the next page.

Score 3: The student did not provide enough work to justify \( t = 8 \).
Sarah’s doctor told her to take both drugs at the same time. Determine algebraically the number of hours after taking the medications when both medications will have the same amount of active ingredient remaining in her bloodstream.

\[
\frac{(t+3)\, \frac{t-1}{t+5} + \frac{18(t)}{t^{2}+8t+15}}{(t+3)(t+5)} = \frac{9}{t+3}
\]

\[t = 8\]
Sarah is fighting a sinus infection. Her doctor prescribed a nasal spray and an antibiotic to fight the infection. The active ingredients, in milligrams, remaining in the bloodstream from the nasal spray, $n(t)$, and the antibiotic, $a(t)$, are modeled in the functions below, where $t$ is the time in hours since the medications were taken.

$$n(t) = \frac{t+1}{t+5} + \frac{18}{t^2 + 8t + 15}$$

$$a(t) = \frac{9}{t+3}$$

Determine which drug is made with a greater initial amount of active ingredient. Justify your answer.

**The antibiotic is made with a greater amount of the active ingredient because it has a greater $y$-intercept, $(0,3)$ compared to the nasal spray's $(0,1.4)$**

**Score 2:** The student only earned credit for the first part.
Question 37 continued.

Sarah’s doctor told her to take both drugs at the same time. Determine algebraically the number of hours after taking the medications when both medications will have the same amount of active ingredient remaining in her bloodstream.

\[ \frac{t + 1}{t + 5} + \frac{1618}{t^2 + 8t + 17} = \frac{9}{t + 3} \]
Question 37

Sarah is fighting a sinus infection. Her doctor prescribed a nasal spray and an antibiotic to fight the infection. The active ingredients, in milligrams, remaining in the bloodstream from the nasal spray, \( n(t) \), and the antibiotic, \( a(t) \), are modeled in the functions below, where \( t \) is the time in hours since the medications were taken.

\[
n(t) = \frac{t+1}{t+5} + \frac{18}{t^2 + 8t + 15} \\
\]

\[
a(t) = \frac{9}{t+3} \\
\]

Determine which drug is made with a greater initial amount of active ingredient. Justify your answer.

Question 37 is continued on the next page.
Sarah’s doctor told her to take both drugs at the same time. Determine algebraically the number of hours after taking the medications when both medications will have the same amount of active ingredient remaining in her bloodstream.

8 hours
37 Sarah is fighting a sinus infection. Her doctor prescribed a nasal spray and an antibiotic to fight the infection. The active ingredients, in milligrams, remaining in the bloodstream from the nasal spray, \( n(t) \), and the antibiotic, \( a(t) \), are modeled in the functions below, where \( t \) is the time in hours since the medications were taken.

\[
\begin{align*}
n(t) &= \frac{t+1}{t+5} + \frac{18}{t^2 + 8t + 15} \\
a(t) &= \frac{9}{t+3}
\end{align*}
\]

Determine which drug is made with a greater initial amount of active ingredient. Justify your answer.

\[ n(T) \text{ is the one that has the greater amount of active ingredient because when you solve for } T \text{ you end up getting a higher number than } a(T) \]

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**Score 0:** The student did not provide enough correct work to earn any credit.
Question 37 continued.

Sarah’s doctor told her to take both drugs at the same time. Determine algebraically the number of hours after taking the medications when both medications will have the same amount of active ingredient remaining in her bloodstream.

\[
\begin{align*}
  n(T) &= \frac{T+1}{T+5} + \frac{18}{10T+81+15} \\
  a(T) &= \frac{9}{T+3}
\end{align*}
\]

\[
\begin{align*}
  \frac{9}{T+3} &= \frac{T+1}{T+5} + \frac{18}{10T+81+15} \\
  \frac{9}{T+3} &= \frac{T+1}{T+5} + \frac{18}{5T+1+15} \\
  9 &= T+1 + 18 \\
  9 &= T + 19 \\
  T &= 10
\end{align*}
\]