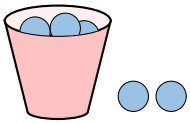
ALGEBRA

A DEFINITIONS

A.1 WRITING EXPRESSIONS

Ex 1:



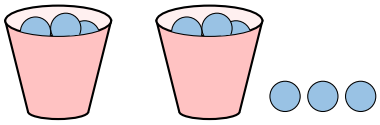
A cup contains x marbles. Next to the cup, there are 2 marbles outside. Write an algebraic expression for the total number of marbles.

$$\boxed{x+2}$$

Answer: There are x marbles inside the cup and 2 marbles outside, so the total number of marbles is:

$$x+2$$

Ex 2:



Each cup contains x marbles. Next to the cups, there are 3 marbles outside.Write an algebraic expression for the total number of marbles.

$$\boxed{x+x+3}$$

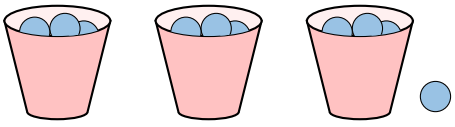
Answer: There are x marbles in each cup, and 3 marbles outside. The total number of marbles is:

$$x+x+3$$

which can be simplified to:

$$2x+3$$

Ex 3:



Each cup contains x marbles. Next to the cups, there is 1 marble outside.Write an algebraic expression for the total number of marbles.

$$\boxed{x+x+x+1}$$

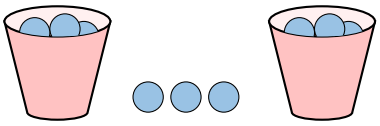
Answer: There are x marbles in each cup, and 1 marble outside. The total number of marbles is:

$$x+x+x+1$$

which can be simplified to:

$$3x+1$$

Ex 4:



Each cup contains x marbles. Next to the cups, there are 3 marbles outside.Write an algebraic expression for the total number of marbles.

$$\boxed{x+3+x}$$

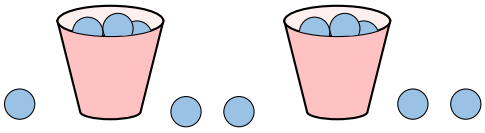
Answer: There are x marbles in each cup, and 3 marbles outside. The total number of marbles is:

$$x+3+x$$

which can be simplified to:

$$2x+3$$

Ex 5:



Each cup contains x marbles. Outside the cups, there are 1 marble, then 2 marbles, then another 2 marbles.Write an algebraic expression for the total number of marbles.

$$\boxed{1+x+2+x+2}$$

Answer: There are x marbles in each cup, and $1+2+2$ marbles outside. The total number of marbles is:

$$1+x+2+x+2$$

which can be simplified to:

$$2x+5$$

A.2 IDENTIFYING EQUATIONS OR EXPRESSIONS

MCQ 6: Is $2\pi r$ an equation?

☐ Yes

☒ No

Answer: No, $2\pi r$ is not an equation. It is an expression. An equation must have an equal sign separating two expressions.

MCQ 7: Is $x^2+y^2=r^2$ an equation?

☒ Yes

☐ No

Answer: Yes, $x^2+y^2=r^2$ is an equation. It has an equal sign separating two expressions.

MCQ 8: Is $a+b+c$ an equation?

☐ Yes

☒ No

Answer: No, $a + b + c$ is not an equation. It is an expression. An equation must have an equal sign separating two expressions.

MCQ 9: Is $5x = 20$ an equation?

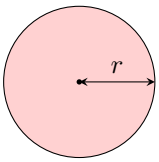
☒ Yes

☐ No

Answer: Yes, $5x = 20$ is an equation. It has an equal sign separating two expressions.

A.3 IDENTIFYING VARIABLES OR CONSTANTS

MCQ 10:



In the equation for the perimeter of the circle,

$$P = 2\pi r$$

find the variables.

☒ P

☐ 2

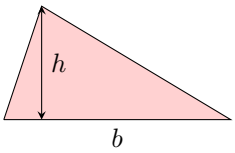
☐ π

☒ r

Answer:

- P and r are variables.
- 2 and π are constants.

MCQ 11:



In the equation for the area of a triangle,

$$A = \frac{1}{2}b \times h$$

find the variables.

☒ A

☐ $\frac{1}{2}$

☒ b

☒ h

Answer:

- A, b, and h are variables.
- $\frac{1}{2}$ is a constant.

MCQ 12: In the equation for Ohm's law,

$$V = IR$$

find the variables.

☒ V

☒ I

☒ R

Answer:

- V, I, and R are variables.

MCQ 13: In the equation of a line

$$y = 2x + 1$$

find the variables.

☒ y

☐ 2

☒ x

☐ 1

Answer:

- y and x are variables.
- 2 and 1 are constants.

B NOTATIONS

B.1 SIMPLIFYING REPEATED ADDITION

Ex 14: Simplify:

$$x + x + x = \boxed{3x}$$

Answer: Repeated addition: $x + x + x = 3x$

Ex 15: Simplify:

$$n + n + n + n + n = \boxed{5n}$$

Answer: Repeated addition: $n + n + n + n + n = 5n$

Ex 16: Simplify:

$$x + x + 2 + 2 + 2 = \boxed{2x + 6}$$

Answer: $x + x + 2 + 2 + 2 = 2x + 6$

Ex 17: Simplify:

$$x + x + x + 2 \times 3 = \boxed{3x + 6}$$

Answer: $x + x + x + 2 \times 3 = 3x + 6$

B.2 SIMPLIFYING REPEATED MULTIPLICATION

Ex 18: Simplify:

$$x \times x \times x = \boxed{x^3}$$

Answer: Repeated multiplication: $x \times x \times x = x^3$

Ex 19: Simplify:

$$n \times n = \boxed{n^2}$$

Answer: Repeated multiplication: $n \times n = n^2$

Ex 20: Simplify:

$$x \times x \times x \times x = \boxed{x^4}$$

Answer: Repeated multiplication: $x \times x \times x \times x = x^4$

Ex 21: Simplify:

$$x \times x + 2 + 3 = \boxed{x^2 + 5}$$

Answer: $x \times x + 2 + 3 = x^2 + 5$

Ex 22: Simplify:

$$x \times x \times x - x \times x = \boxed{x^3 - x^2}$$

Answer: $x \times x \times x - x \times x = x^3 - x^2$

B.3 COMBINING LIKE TERMS

Ex 23: Simplify:

$$3x + 2x = \boxed{5x}$$

Answer:

$$\begin{aligned} 3x + 2x &= x + x + x + x + x \\ &= 5x \end{aligned}$$

Ex 24: Simplify:

$$2n + 4n = \boxed{6n}$$

Answer:

$$\begin{aligned} 2n + 4n &= n + n + n + n + n + n \\ &= 6n \end{aligned}$$

Ex 25: Simplify:

$$2x - x = \boxed{x}$$

Answer:

$$\begin{aligned} 2x - x &= x + x - x \\ &= x \end{aligned}$$

Ex 26: Simplify:

$$5x - 2x = \boxed{3x}$$

Answer:

$$\begin{aligned} 5x - 2x &= x + x + x + x + x - x - x \\ &= 3x \end{aligned}$$

Ex 27: Simplify:

$$3n - 2n = \boxed{n}$$

Answer:

$$\begin{aligned} 3n - 2n &= n + n + n - n - n \\ &= n \end{aligned}$$

B.4 COMBINING LIKE TERMS

Ex 28: Simplify:

$$10x + 5x = \boxed{15x}$$

Answer:

$$\begin{aligned} 10x + 5x &= (10 + 5)x \\ &= 15x \end{aligned}$$

Ex 29: Simplify:

$$x - 8x = \boxed{-7x}$$

Answer:

$$\begin{aligned} x - 8x &= (1 - 8)x \\ &= -7x \end{aligned}$$

Ex 30: Simplify:

$$2x - 4x - 3x = \boxed{-5x}$$

Answer:

$$\begin{aligned} 2x - 4x - 3x &= (2 - 4 - 3)x \\ &= (-2 - 3)x \\ &= -5x \end{aligned}$$

Ex 31: Simplify:

$$x - 2x + 5x = \boxed{4x}$$

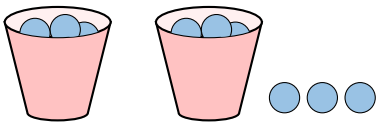
Answer:

$$\begin{aligned} x - 2x + 5x &= (1 - 2 + 5)x \\ &= (-1 + 5)x \\ &= 4x \end{aligned}$$

C IDENTITY

C.1 WRITING ALGEBRAIC EXPRESSIONS IN SIMPLIFIED FORM

Ex 32:



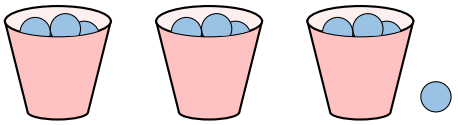
Each cup contains x marbles. Next to the cups, there are 3 marbles outside.Write an algebraic expression for the total number of marbles.**Express your answer in simplified form.**

$$\boxed{2x + 3}$$

Answer: There are x marbles in each cup, and 3 marbles outside. The total number of marbles is:

$$x + x + 3 = 2x + 3$$

Ex 33:



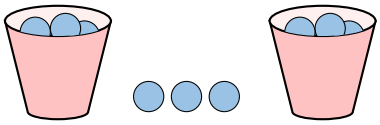
Each cup contains x marbles. Next to the cups, there is 1 marble outside.Write an algebraic expression for the total number of marbles.**Express your answer in simplified form.**

$$\boxed{3x+1}$$

Answer: There are x marbles in each cup, and 1 marble outside. The total number of marbles is:

$$x+x+x+1=3x+1$$

Ex 34:



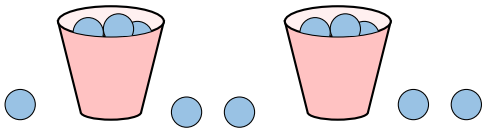
Each cup contains x marbles. Next to the cups, there are 3 marbles outside.Write an algebraic expression for the total number of marbles.**Express your answer in simplified form.**

$$\boxed{2x+3}$$

Answer: There are x marbles in each cup, and 3 marbles outside. The total number of marbles is:

$$x+3+x=2x+3$$

Ex 35:



Each cup contains x marbles. Outside the cups, there are 1 marble, then 2 marbles, then another 2 marbles.Write an algebraic expression for the total number of marbles.**Express your answer in simplified form.**

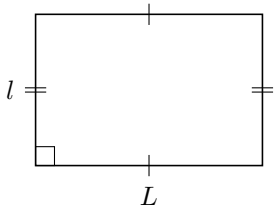
$$\boxed{2x+5}$$

Answer: There are x marbles in each cup, and $1+2+2=5$ marbles outside. The total number of marbles is:

$$1+x+2+x+2=2x+5$$

C.2 WRITING FORMULAS FOR PERIMETER AND AREA

Ex 36:

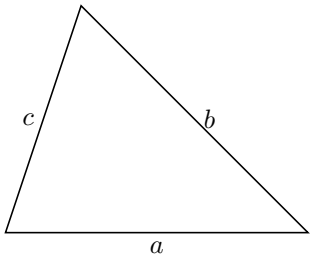


Write a formula for the perimeter of the rectangle using the variables P (perimeter), l (length), and L (width).

Answer: The possible correct formulas for the perimeter are:

- $P=2(l+L)$
- $P=l+L+l+L$
- $P=2l+2L$

Ex 37:

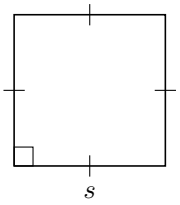


Write a formula for the perimeter of the triangle using the variables P (perimeter), a, b, and c (side lengths).

Answer: A correct formula for the perimeter is:

$$P=a+b+c$$

Ex 38:

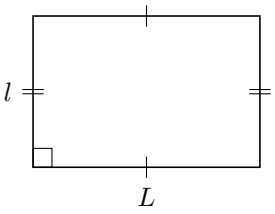


Write a formula for the area of the square using the variable A (area) and s (side length).

Answer: The possible correct formulas for the area are:

- $A=s^2$
- $A=s\times s$

Ex 39:



Write a formula for the area of the rectangle using the variables A (area), l (length), and L (width).

Answer: The possible correct formulas for the area are:

- $A=l\times L=lL$
- $A=L\times l=Ll$

C.3 SIMPLIFYING EXPRESSIONS

Ex 40: Simplify the expression:

$$2x+4+x-2=\boxed{3x+2}$$

Answer:

$$\begin{aligned} 2x+4+x-2 &= 2x+4+x-2 && \text{(identifying)}\\ &= (2+1)x+4-2 && \text{(combining)}\\ &= 3x+2 && \text{(symplifying)} \end{aligned}$$

Ex 41: Simplify the expression:

$$3x + 5 - x - 3 = \boxed{2x + 2}$$

Answer:

$$\begin{aligned} 3x + 5 - x - 3 &= 3x+5-x-3 && \text{(identifying)} \\ &= (3-1)x + 5 - 3 && \text{(combining)} \\ &= 2x + 2 && \text{(simplifying)} \end{aligned}$$

Ex 42: Simplify the expression:

$$x + 4x + 3 - 2 = \boxed{5x + 1}$$

Answer:

$$\begin{aligned} x + 4x + 3 - 2 &= x+4x+3-2 && \text{(identifying)} \\ &= (1+4)x + 3 - 2 && \text{(combining)} \\ &= 5x + 1 && \text{(simplifying)} \end{aligned}$$

Ex 43: Simplify the expression:

$$3 + 2x - x + 5 = \boxed{x + 8}$$

Answer:

$$\begin{aligned} 3 + 2x - x + 5 &= 3+2x-x+5 && \text{(identifying)} \\ &= (2-1)x + 3 + 5 && \text{(combining)} \\ &= x + 8 && \text{(simplifying)} \end{aligned}$$

Ex 44: Simplify the expression:

$$x^2 + x + 3x^2 = \boxed{4x^2 + x}$$

Answer:

$$\begin{aligned} x^2 + x + 3x^2 &= x^2+3x^2+x && \text{(identifying)} \\ &= (1+3)x^2 + x && \text{(combining)} \\ &= 4x^2 + x && \text{(simplifying)} \end{aligned}$$

Ex 45: Simplify the expression:

$$2 + 4x - x^2 - 3x + 3x^2 = \boxed{2x^2 + x + 2}$$

Answer:

$$\begin{aligned} 2 + 4x - x^2 - 3x + 3x^2 &= 2+4x-x^2-3x+3x^2 && \text{(identifying)} \\ &= (-1+3)x^2 + (4-3)x + 2 && \text{(combining)} \\ &= 2x^2 + x + 2 && \text{(simplifying)} \end{aligned}$$

Ex 46: Simplify the expression:

$$x^2 + x + 3x^2 - 2x + 6 = \boxed{4x^2 - x + 6}$$

Answer:

$$\begin{aligned} x^2 + x + 3x^2 - 2x + 6 &= x^2+3x^2+x-2x+6 && \text{(identifying)} \\ &= (1+3)x^2 + (1-2)x + 6 && \text{(combining)} \\ &= 4x^2-x + 6 && \text{(simplifying)} \end{aligned}$$

Ex 47: Simplify the expression:

$$3x^2 + 2x - 3 - 2x^2 + 3x - 4 = \boxed{x^2 + 5x - 7}$$

Answer:

$$\begin{aligned} 3x^2 + 2x - 3 - 2x^2 + 3x - 4 &= 3x^2+2x-3-2x^2+3x-4 && \text{(identifying)} \\ &= (3-2)x^2 + (2+3)x + (-3-4) && \text{(combining)} \\ &= x^2 + 5x-7 && \text{(simplifying)} \end{aligned}$$

C.4 SIMPLIFYING USING COMMUTATIVITY AND ASSOCIATIVITY

Ex 48: Simplify:

$$2 \times 3x = \boxed{6x}$$

Answer:

$$\begin{aligned} 2 \times 3x &= (2 \times 3) \times x && \text{(associativity)} \\ &= 6x \end{aligned}$$

Ex 49: Simplify:

$$x \times 3x = \boxed{3x^2}$$

Answer:

$$\begin{aligned} x \times 3x &= 3 \times (x \times x) && \text{(commutativity and associativity)} \\ &= 3x^2 \end{aligned}$$

Ex 50: Simplify:

$$4 \times 2x = \boxed{8x}$$

Answer:

$$\begin{aligned} 4 \times 2x &= (4 \times 2) \times x && \text{(associativity)} \\ &= 8x \end{aligned}$$

Ex 51: Simplify:

$$5x \times 2 = \boxed{10x}$$

Answer:

$$\begin{aligned} 5x \times 2 &= (5 \times 2) \times x && \text{(associativity)} \\ &= 10x \end{aligned}$$

Ex 52: Simplify:

$$2x \times 4x = \boxed{8x^2}$$

Answer:

$$\begin{aligned} 2x \times 4x &= (2 \times 4) \times (x \times x) && \text{(associativity and commutativity)} \\ &= 8x^2 \end{aligned}$$

C.5 SIMPLIFYING USING THE ZERO IDENTITY

Ex 53: Simplify:

$$0(2x - x^2 + 2)^2 \boxed{0}$$

Answer: Any number multiplied by 0 is 0:

$$0(2x - x^2 + 2)^2 = 0$$

Ex 54: Simplify:

$$2x + 0(x^2 - 2) = \boxed{2x}$$

Answer:

$$\begin{aligned} 2x + 0(x^2 - 2) &= 2x + 0 \\ &= 2x \end{aligned}$$

Ex 55: Simplify:

$$2x + 6x - 8x = \boxed{0}$$

Answer:

$$\begin{aligned} 2x + 6x - 8x &= (2 + 6 - 8)x \\ &= 0x \\ &= 0 \end{aligned}$$

Ex 56: Simplify:

$$(2x - 2x)^2 + 3 = \boxed{3}$$

Answer:

$$\begin{aligned} (2x - 2x)^2 + 3 &= (0)^2 + 3 \\ &= 0 + 3 \\ &= 3 \end{aligned}$$

D SUBSTITUTING

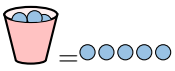
D.1 EVALUATING EXPRESSIONS

Ex 57:

Each cup contains x marbles. The expression for the total number of marbles is:

$$2x + 4$$

Evaluate this expression when $x = 5$ (that is, 5 marbles in each cup):



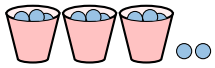
$\boxed{14}$ marbles in total.

Answer:

$$\begin{aligned} 2x + 4 &= 2 \times (5) + 4 \quad \text{(substituting } x = 5\text{)} \\ &= 10 + 4 \\ &= 14 \end{aligned}$$

There are 14 marbles in total.

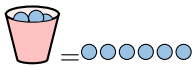
Ex 58:



Each cup contains x marbles. The expression for the total number of marbles is:

$$3x + 2$$

Evaluate this expression when $x = 6$ (that is, 6 marbles in each cup):



$\boxed{20}$ marbles in total.

Answer:

$$\begin{aligned} 3x + 2 &= 3 \times (6) + 2 \quad \text{(substituting } x = 6\text{)} \\ &= 18 + 2 \\ &= 20 \end{aligned}$$

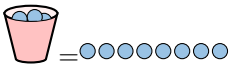
There are 20 marbles in total.

Ex 59:

Each cup contains x marbles. The expression for the total number of marbles is:

$$4x + 3$$

Evaluate this expression when $x = 8$ (that is, 8 marbles in each cup):



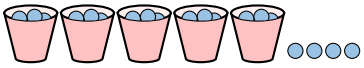
$\boxed{35}$ marbles in total.

Answer:

$$\begin{aligned} 4x + 3 &= 4 \times (8) + 3 \quad \text{(substituting } x = 8\text{)} \\ &= 32 + 3 \\ &= 35 \end{aligned}$$

There are 35 marbles in total.

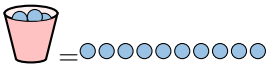
Ex 60:



Each cup contains x marbles. The expression for the total number of marbles is:

$$5x + 4$$

Evaluate this expression when $x = 10$ (that is, 10 marbles in each cup):



$\boxed{54}$ marbles in total.

Answer:

$$\begin{aligned} 5x + 4 &= 5 \times (10) + 4 \quad \text{(substituting } x = 10\text{)} \\ &= 50 + 4 \\ &= 54 \end{aligned}$$

There are 54 marbles in total.

D.2 EVALUATING EXPRESSIONS: LEVEL 1

Ex 61: When $x = 2$, evaluate:

$$3x - 4 = \boxed{2}$$

Answer:

$$\begin{aligned} 3x - 4 &= 3 \times (2) - 4 \quad \text{(substituting } x = 2\text{)} \\ &= 6 - 4 \\ &= 2 \end{aligned}$$

Ex 62: When $x = 4$, evaluate:

$$5 - 2x = \boxed{-3}$$

Answer:

$$\begin{aligned} 5 - 2x &= 5 - 2 \times (4) \quad \text{(substituting } x = 4\text{)} \\ &= 5 - 8 \\ &= -3 \end{aligned}$$

Ex 63: When $x = 3$, evaluate:

$$x^2 - 2 = \boxed{7}$$

Answer:

$$\begin{aligned} x^2 - 2 &= (3)^2 - 2 \quad \text{(substituting } x = 3\text{)} \\ &= 9 - 2 \\ &= 7 \end{aligned}$$

D.3 EVALUATING EXPRESSIONS: LEVEL 2

Ex 64: When $x = -2$, evaluate:

$$x^2 + 4 = \boxed{8}$$

Answer:

$$\begin{aligned} x^2 + 4 &= (-2)^2 + 4 \quad \text{(substituting } x = -2\text{)} \\ &= 4 + 4 \\ &= 8 \end{aligned}$$

Ex 65: When $x = 3$, evaluate:

$$x^2 + 2x = \boxed{15}$$

Answer:

$$\begin{aligned} x^2 + 2x &= (3)^2 + 2 \times (3) \quad \text{(substituting } x = 3\text{)} \\ &= 9 + 6 \\ &= 15 \end{aligned}$$

Ex 66: When $x = 3$, evaluate:

$$2x^2 - 2x + 1 = \boxed{13}$$

Answer:

$$\begin{aligned} 2x^2 - 2x + 1 &= 2 \times (3)^2 - 2 \times (3) + 1 \quad \text{(substituting } x = 3\text{)} \\ &= 2 \times 9 - 2 \times 3 + 1 \\ &= 18 - 6 + 1 \\ &= 13 \end{aligned}$$

Ex 67: When $x = 2$, evaluate:

$$x(5 - x) = \boxed{6}$$

Answer:

$$\begin{aligned} x(5 - x) &= (2)(5 - (2)) \quad \text{(substituting } x = 2\text{)} \\ &= 2(5 - 2) \\ &= 2 \times 3 \\ &= 6 \end{aligned}$$

D.4 EVALUATING IN EQUATIONS

Ex 68: For the equation $y = 2x - 1$, when $x = 2$, find y.

$$y = \boxed{3}$$

Answer:

$$\begin{aligned} y &= 2x - 1 \\ &= 2 \times (2) - 1 \quad \text{(substituting } x = 2\text{)} \\ &= 4 - 1 \\ &= 3 \end{aligned}$$

Ex 69: For the equation $y = 1 - x$, when $x = 2$, find y.

$$y = \boxed{-1}$$

Answer:

$$\begin{aligned} y &= 1 - x \\ y &= 1 - (2) \quad \text{(substituting } x = 2\text{)} \\ y &= -1 \end{aligned}$$

Ex 70: For the equation $y = x^2 + 1$, when $x = 3$, find y.

$$y = \boxed{10}$$

Answer:

$$\begin{aligned} y &= x^2 + 1 \\ &= (3)^2 + 1 \quad \text{(substituting } x = 3\text{)} \\ &= 9 + 1 \\ &= 10 \end{aligned}$$

Ex 71: For the equation $y = x^2 + 1$, when $x = -1$, find y.

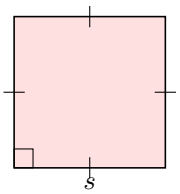
$$y = \boxed{2}$$

Answer:

$$\begin{aligned} y &= x^2 + 1 \\ &= (-1)^2 + 1 \quad \text{(substituting } x = -1\text{)} \\ &= 1 + 1 \\ &= 2 \end{aligned}$$

D.5 EVALUATING IN FORMULAE

Ex 72:



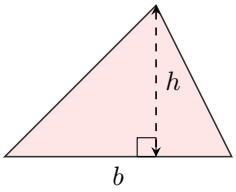
The area formula is $A = s^2$. Calculate the area of a square given $s = 2$ cm.

$$A = \boxed{4} \text{ cm}^2$$

Answer:

$$\begin{aligned} A &= c^2 \\ &= (2)^2 \quad \text{(substituting } c = 2\text{)} \\ &= 4 \text{ cm}^2 \end{aligned}$$

Ex 73:



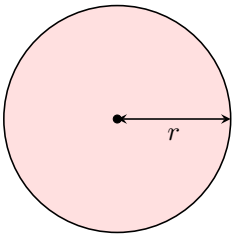
The area formula is $A = \frac{b \times h}{2}$. Calculate the area of a triangle given $b = 4$ cm and $h = 3$ cm.

$$A = \boxed{6} \text{ cm}^2$$

Answer:

$$\begin{aligned} A &= \frac{b \times h}{2} \\ &= \frac{4 \times 3}{2} \quad \text{(substituting } b = 4, h = 3\text{)} \\ &= \frac{12}{2} \\ &= 6 \text{ cm}^2 \end{aligned}$$

Ex 74:



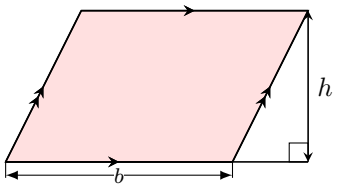
The area formula is $A = \pi r^2$. Find the area of a circle with $r = 2$ cm (round to 1 decimal place).

$$A = \boxed{12.6} \text{ cm}^2$$

Answer:

$$\begin{aligned} A &= \pi r^2 \\ &= \pi \times (2)^2 \quad \text{(substituting } r = 2\text{)} \\ &= \pi \times 4 \\ &= 12.56637\ldots \text{ cm}^2 \\ &\approx 12.6 \text{ cm}^2 \end{aligned}$$

Ex 75:



The area formula is $A = b \times h$. Calculate the area of the parallelogram with $b = 10$ m and $h = 7$ m.

$$A = \boxed{70} \text{ m}^2$$

Answer:

$$\begin{aligned} A &= b \times h \\ &= 10 \times 7 \quad \text{(substituting } b = 10, h = 7\text{)} \\ &= 70 \text{ m}^2 \end{aligned}$$