15. [Substitution]

Skill 15.1 Substituting one value into expressions involving +, –, · and ÷

- Replace the letter (variable) with the given value.
- Solve the mathematical sentence to find the value of the expression.
- Use the order of operations rules: Multiply (·) and/or divide (÷) in order from left to right.
  Add (+) and/or subtract (–) in order from left to right.

Q. If $x = 4$, find the value of $18 - 3x$

A. $18 - 3x =$ ($3x = 3 \cdot x$)
$= 18 - 3 \cdot x$ Substitute $x = 4$
$= 18 - 3 \cdot 4$ Multiply 3 by 4
$= 18 - 12$ Subtract 12 from 18
$= \mathbf{6}$

a) If $c = 5$, find the value of $36 + c$

$36 + c = 36 + 5$ $= \boxed{41}$

b) If $k = 7$, find the value of $k + 56$

..... $= \boxed{}$

c) If $z = 20$, find the value of $25 - z$

..... $= \boxed{}$

d) If $a = 40$, find the value of $a - 28$

..... $= \boxed{}$

e) If $e = 35$, find the value of $e - 30$

..... $= \boxed{}$

f) If $x = 8$, find the value of $7x$

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

g) If $b = 12$, find the value of $12b$

..... $= \boxed{}$

h) If $y = 22$, find the value of $5y$

..... $= \boxed{}$

i) If $j = 3$, find the value of $\frac{48}{j}$

..... $= \boxed{}$

j) If $p = 4$, find the value of $\frac{56}{p}$

..... $= \boxed{}$

k) If $u = 5$, find the value of $4u - 19$

.....
$=$ ..... $= \boxed{}$

l) If $f = 6$, find the value of $25 - 3f$

.....
$=$ ..... $= \boxed{}$

m) If $x = 8$, find the value of $2x + 6$

.....
$=$ ..... $= \boxed{}$

n) If $z = 3$, find the value of $15 + 6z$

.....
$=$ ..... $= \boxed{}$

Skill 15.2 Substituting two values into expressions involving +, –, · and ÷

- Replace the two letters (variables) with the given values.
- Solve the mathematical sentence to find the value of the expression.
- Use the order of operations rules: Multiply (·) and/or divide (÷) in order from left to right.
  Add (+) and/or subtract (–) in order from left to right.

Q. If $x = 4$ and $y = 8$,
find the value of $\dfrac{4x - y}{2}$

A. $\dfrac{4x - y}{2} =$ ($4x = 4 \cdot x$)

$= \dfrac{4 \cdot x - y}{2}$ Substitute $x = 4$ and $y = 8$

$= \dfrac{4 \cdot 4 - 8}{2}$ Multiply 4 by 4

$= \dfrac{16 - 8}{2}$ Subtract 8 from 16

$= 8 \div 2$ Divide 8 by 2

$= \mathbf{4}$

a) If $c = 5$ and $d = 3$,
find the value of $3c - 5d$

$3 \cdot c - 5 \cdot d$

$= 3 \cdot 5 - 5 \cdot 3 = 15 - 15$ $=$ 0

b) If $v = 6$ and $w = 7$,
find the value of $4v - 3w$

$=$ $=$

c) If $p = 6$ and $q = 8$,
find the value of $\dfrac{pq}{4}$

$=$ $=$

d) If $x = 6$ and $y = 1$,
find the value of $\dfrac{2xy}{3}$

$=$ $=$

e) If $y = 1$ and $z = 9$,
find the value of $\dfrac{z}{3} - y$

$=$ $=$

f) If $d = 12$ and $e = 2$,
find the value of $\dfrac{d}{4} - e$

$=$ $=$

g) If $m = 2$ and $l = 6$,
find the value of $\dfrac{m + 3l}{4}$

$=$ $=$

h) If $j = 5$ and $k = 4$,
find the value of $\dfrac{2j - k}{3}$

$=$ $=$

Skill 15.3 Substituting into rules.

- Replace the letter (variable) x with the given value.
- Solve the mathematical sentence to find the value of y.
- Use the order of operations rules: Multiply ($\cdot$) and/or divide ($\div$) in order from left to right.
  Add (+) and/or subtract (–) in order from left to right.

Q. If $y = 4x^2 - 3$, find y when $x = 2$

A. $y = 4x^2 - 3$ ($4x^2 = 4 \cdot x^2$)

$= 4 \cdot x^2 - 3$ Substitute $x = 2$

$= 4 \cdot 2^2 - 3$ Evaluate 2^2

$= 4 \cdot 4 - 3$ Multiply 4 by 4

$= 16 - 3$ Subtract 3 from 16

$= \mathbf{13}$

a) If $y = x - 9$, find y when $x = 12$

$y = 12 - 9 = 3$

b) If $y = 25 - x$, find y when $x = 7$

$y =$ ..... $=$ ☐

c) If $y = 4x + 8$, find y when $x = 2$

$y = 4 \cdot 2 + 8 = 8 + 8$ $=$ ☐

d) If $y = 3x - 9$, find y when $x = 9$

$y =$ ..... $=$ ☐

e) If $y = 5x - 6$, find y when $x = 3$

$y =$ ..... $=$ ☐

f) If $y = 2x + 7$, find y when $x = 12$

$y =$ ..... $=$ ☐

g) If $y = \frac{18}{x} - 7$, find y when $x = 2$

$y = 18 \div 2 - 7 = 9 - 7$ $=$ ☐

h) If $y = \frac{24}{x} - 10$, find y when $x = 6$

$y =$ ..... $=$ ☐

i) If $y = x^2 + 18$, find y when $x = 3$

$y =$ ..... $=$ ☐

j) If $y = x^2 - 7$, find y when $x = 4$

$y =$ ..... $=$ ☐

k) If $y = 3x^2 + 2$, find y when $x = 5$

$y =$ ..... $=$ ☐

l) If $y = 5x^2 - 18$, find y when $x = 2$

$y =$ ..... $=$ ☐

m) If $y = \frac{3x}{4}$, find y when $x = 8$

$y =$ ..... $=$ ☐

n) If $y = \frac{6x}{5}$, find y when $x = 10$

$y =$ ..... $=$ ☐

Skill 15.4 Substituting into formulae.

- Replace the letters (variables) with the given values.
- Solve the mathematical sentence to find the requested value in the formula.
- Use the order of operations rules: Multiply (·) and/or divide (÷) in order from left to right.
  Add (+) and/or subtract (–) in order from left to right.

Q. Use $V = \pi r^2 h$ to find the volume (V) of a cylinder when $r = 10$, $h = 5$ and $\pi \approx 3.14$

A. $V = \pi r^2 h$ ($\pi r^2 h = \pi \cdot r^2 \cdot h$)

$= \pi \cdot r^2 \cdot h$

$\approx 3.14 \cdot 10^2 \cdot 5$ — Substitute $r = 10$, $h = 5$ and $\pi \approx 3.14$ and evaluate 10^2

$= 3.14 \cdot 100 \cdot 5$ — Multiply 3.14 by 100

$= 314 \cdot 5$ — Multiply the result by 5

$= \mathbf{1570}$

a) Use $P = 4l$ to find the perimeter (P) of a square when $l = 4.5$

$P = 4 \cdot l = 4 \cdot 4.5$ $= 18$

b) Use $M = 0.6K$ to find the number of miles (M) when $K = 2000$

$=$

c) Use $A = lw$ to find the area (A) of a rectangle when $l = 12$ and $w = 8$

$A = l \cdot w =$ $=$

d) Use $C = \pi d$ to find the circumference (C) of a circle when $d = 15$ and $\pi \approx 3.14$

$=$

e) Use $A = \frac{d_1 d_2}{2}$ to find the area (A) of a rhombus when $d_1 = 15$ and $d_2 = 6$

$=$

f) Use $M = \frac{1}{2}(x + y)$ to find the average (M) of $x = 20$ and $y = 16$

$=$

g) Use $r = \frac{d}{t}$ to find the speed (r) when $d = 400$ and $t = 5$

$=$

h) Use $A = \frac{l^2\sqrt{3}}{4}$ to find the area (A) of an equilateral triangle when $l = 4$ and $\sqrt{3} \approx 1.73$

$=$

i) Use $V = lwh$ to find the volume (V) of a prism when $l = 5$, $w = 3$ and $h = 10$

$=$

j) Use $S.A. = 6l^2$ to find the surface area ($S.A.$) of a cube when $l = 20$

$=$

k) Use $S.A. = 4\pi r^2$ to find the surface area ($S.A.$) of a sphere when $r = 10$ and $\pi \approx 3.14$

$=$ $=$

l) Use $a^2 = c^2 - b^2$ to find the value of $a > 0$ when $c = 15$ and $b = 9$

$a =$

Skill 15.5 Substituting into rules, expressions and formulae with brackets.

- Replace the letters (variables) with the given values.
- Solve the mathematical sentence to find the value of the expression.
- Use the order of operations rules: Simplify within the brackets.
  Multiply (·) and/or divide (÷) in order from left to right.
  Add (+) and/or subtract (–) in order from left to right.

Q. If $y = (x + 3)(x - 4)$, find y when $x = 6$

A.
$y = (x + 3)(x - 4)$
$= (x + 3) \cdot (x - 4)$ Substitute $x = 6$
$= (6 + 3) \cdot (6 - 4)$ Evaluate each bracket.
$= 9 \cdot 2$ Multiply the results.
$= \mathbf{18}$

a) If $y = 4(x + 3)$, find y when $x = 0$

$y = 4 \cdot (0 + 3) = 4 \times 3$ = 12

b) If $y = 5(x - 2)$, find y when $x = 6$

$y = 5 \cdot (6 - 2)$ =

c) If $y = -3(x - 6)$, find y when $x = 10$

$y =$ =

d) If $y = -4(x + 8)$, find y when $x = 0$

$y =$ =

e) If $y = x(x - 7)$, find y when $x = 9$

$y =$ =

f) If $y = x(x + 2)$, find y when $x = 0$

$y =$ =

g) If $y = (x + 1)(x - 3)$, find y when $x = -2$

$y =$ =

h) If $y = (x - 1)(x + 5)$, find y when $x = 11$

$y =$ =

i) Use $S = (n - 2) \cdot 180°$ to find the sum (S) of all interior angles when $n = 6$ (hexagon).

=

j) Use $S.A. = \pi r(r + s)$ to find the surface area ($S.A.$) of a cone when $r = 2$, $s = 3$ and $\pi \approx 3.14$

=

k) If $c = 5$ and $d = 15$,
find the value of $c(d - 10)$

$c \cdot (d - 10) =$

$= 5 \cdot (15 - 10) = 5 \cdot 5$ =

l) If $x = 2$ and $y = 4$,
find the value of $y(x + 16)$

$y \cdot (x + 16) =$

= =

m) If $j = 2$ and $k = 1$,
find the value of $3j(2k - j)$

=

n) If $a = 5$ and $b = 0$,
find the value of $4a(a - 3b)$

=

Skill 15.6 Substituting negative values into rules and expressions.

- Replace the letters (variables) with the given values.
- Solve the mathematical sentence to find the value of the expression.
- Use the order of operations rules: Simplify within the brackets.
  Multiply (·) and/or divide (÷) in order from left to right.
  Add (+) and/or subtract (–) in order from left to right.
- Use the sign rules: + + = + – – = + + – = – – + = – (see skill 8.3, page 91)

Q. If $x = -2$ and $y = 3$, find the value of $-3y - x$

A. $-3y - x =$ ($3y = 3 \cdot y$)
$= -3 \cdot y - x$ Substitute $x = -2$ and $y = 3$
$= -3 \cdot 3 - (-2)$ Multiply –3 by 3
($- - = +$)
$= -9 + 2$ Add –9 and 2
$= -7$

a) If $y = -x + 5$, find y when $x = -3$

$y = -(-3) + 5 = 3 + 5$ ($- - = +$) $=$ 8

b) If $y = -3 + x$, find y when $x = -6$

$y = -3 + (-6)$ ($+ - = -$) $=$

c) If $y = 8x$, find y when $x = -4$

$y =$ $=$

d) If $y = -3x$, find y when $x = -2$

$y =$ $=$

e) If $y = \frac{15}{x}$, find y when $x = -5$

$y =$ $=$

f) If $y = \frac{12}{x}$, find y when $x = -6$

$y =$ $=$

g) If $y = 2x - 5$, find y when $x = -3$

$y = 2 \cdot (-3) - 5 = -6 - 5$ $=$

h) If $y = 3x - 4$, find y when $x = -1$

$y =$ $=$

i) If $m = -5$ and $n = 0$, find the value of $2m - 3n$

$2 \cdot m - 3 \cdot n =$

$= 2 \cdot (-5) - 3 \cdot 0 = -10 - 0$ ($+ - = -$) $=$

j) If $a = 6$ and $b = -2$, find the value of $2b - 5a$

$=$ $=$

k) If $p = 2$ and $q = -10$, find the value of $p(3p + q)$

$=$ $=$

l) If $y = 1$ and $z = -4$, find the value of $8 - 3z + 2y$

$=$ $=$

Skill 15.7 Substituting into more complex rules and expressions.

- Replace the letters (variables) with the given values.
- Solve the mathematical sentence to find the value of the expression.
- Use the order of operations rules: Simplify within the brackets.
  Multiply (·) and/or divide (÷) in order from left to right.
  Add (+) and/or subtract (–) in order from left to right.

Q. If $a = 2$, $b = -5$ and $c = 3$,
find the value of $\frac{1}{2a}(3b - c)$

A. $\frac{1}{2a}(3b - c) =$ ($3b = 3 \cdot b$)

$= \frac{1}{2 \cdot a} \cdot (3 \cdot b - c)$ Substitute $a = 2, b = -5$ and $c = 3$

$= \frac{1}{2 \cdot 2} \cdot [3 \cdot (-5) - 3]$ Evaluate the bracket

Multiply 2 by 2

$= \frac{1}{4} \cdot (-15 - 3)$

$= \frac{1}{4} \cdot (-18)$ Multiply the results

$= \mathbf{-4.5}$

a) If $y = x^3 + 2$, find y when $x = 3$

$y = 3^3 + 2 = 27 + 2$ = ☐

b) If $y = x^3 - 100$, find y when $x = 5$

$y =$ = ☐

c) If $x = 5$ and $y = 2$,
find the value of $\frac{x}{3} + \frac{y}{5}$

$\frac{5}{3} + \frac{2}{5} = \frac{25 + 6}{15} = \frac{31}{15}$ = $2\frac{1}{15}$

d) If $a = 7$ and $b = 3$,
find the value of $\frac{a}{5} - \frac{b}{7}$

= ☐

e) If $y = \frac{3x - 5}{x}$, find y when $x = 5$

$y =$ = ☐

f) If $y = x^2(x + 2)$, find y when $x = -3$

$y =$ = ☐

g) If $a = 8$ and $b = -10$,
find the value of $\frac{a}{4}(b - 12)$

= ☐

h) If $x = -3$, $y = 3$ and $z = 6$,
find the value of $\frac{9}{y}(yz + x)$

= ☐

i) If $x = -4$,
find the value of $\frac{x^2 - 3x}{2}$

= ☐

j) If $a = -4$ and $b = -10$,
find the value of $a^2 + \frac{2b}{5}$

= ☐

Skill 15.8 Substituting into more complex formulae.

- Replace the letters (variables) with the given values.
- Solve the mathematical sentence to find the value of the expression.
- Use the order of operations rules: Simplify within the brackets.
  Multiply (·) and/or divide (÷) in order from left to right.
  Add (+) and/or subtract (–) in order from left to right.

Q. Use $A = \pi r^2$ to find the area (A) of a circle when $\pi \approx 3.14$ and $r = 5$

A. $A = \pi r^2$
$= 3.14 \times 5^2$
$= 3.14 \times 25$
$= \mathbf{78.5}$

a) Use $c^2 = a^2 + b^2$ to find the value of $c > 0$ when $a = 3$ and $b = 4$

$c = 3^2 + 4^2$

$= \sqrt{9 + 16} = \sqrt{25}$ $= \boxed{5}$

b) Use $b^2 = c^2 - a^2$ to find the value of $b > 0$ when $c = 2.5$ and $a = 2$

$=$ $=$

c) Use $S.A. = 2(lw + lh + wh)$ to find the surface area ($S.A.$) of a rectangular prism when $l = 11$, $w = 4$ and $h = 7$

$=$ $=$

d) Use $B = \dfrac{m}{h^2}$ to find the body mass index (B) when $m = 42$ kg and $h = 1.2$ m
[Give your answer correct to 2 decimal places.]

$=$ $=$

e) Use $V = \dfrac{l^2 h}{3}$ to find the volume (V) of a square pyramid when $l = 9$ and $h = 5$

$=$ $=$

f) Use $V = \dfrac{\pi r^2 h}{3}$ to find the volume (V) of a cone when $\pi \approx 3.14$, $r = 10$ and $h = 9$

$=$ $=$

g) Use $A = h\left(\dfrac{b_1 + b_2}{2}\right)$ to find the area (A) of a trapezoid when $b_1 = 17$, $b_2 = 9$ and $h = 8$

$=$ $=$

h) Use $V = \dfrac{2\pi r^3}{3}$ to find the volume (V) of a hemisphere when $\pi \approx 3.14$ and $r = 6$

$=$ $=$

Skill 15.9 Substituting into quadratic rules.

- Replace the letter (variable) x with the given value.
- Solve the mathematical sentence to find the value of y.
- Use the order of operations rules: Multiply (·) and/or divide (÷) in order from left to right.
  Add (+) and/or subtract (–) in order from left to right.

Q. If $y = 3x^2 + x - 6$, find y when $x = -2$

A.

$y = 3x^2 + x - 6$	
$= 3 \cdot x^2 + x - 6$	Substitute $x = -2$
$= 3 \cdot (-2)^2 + (-2) - 6$	Evaluate $(-2)^2$
$= 3 \cdot 4 - 2 - 6$	Multiply 3 by 4
$= 12 - 2 - 6$	Subtract 2 and 6 from 12
$= \mathbf{4}$	

a) If $y = x^2 + 2x$, find y when $x = 4$

$y = 4^2 + 2 \cdot 4 = 16 + 8$ = 24

b) If $y = x^2 + 3x$, find y when $x = 0$

$y =$ ____

c) If $y = x^2 - 3x + 2$, find y when $x = 1$

$y =$ ____

d) If $y = x^2 - 4x + 3$, find y when $x = 3$

$y =$ ____

e) If $y = x^2 + 6x - 5$, find y when $x = 2$

$y =$ ____

f) If $y = x^2 - 4x - 10$, find y when $x = 5$

$y =$ ____

g) If $y = 2x^2 - 3x + 1$, find y when $x = 1$

$y =$ ____

h) If $y = 3x^2 - 11x + 6$, find y when $x = 3$

$y =$ ____

i) If $y = 4x^2 + x - 7$, find y when $x = 2$

$y =$ ____

j) If $y = 5x^2 - 2x - 1$, find y when $x = 0$

$y =$ ____

k) If $y = x^2 - 3x - 4$, find y when $x = -2$

$y =$ ____

l) If $y = x^2 + 2x - 9$, find y when $x = -3$

$y =$ ____