Check Your Understanding

Unit 2 – Foundations of Linear Functions

Proportional Relationships, Linear Equations, and Functions

Questions 1–23 cover Artifact 14 (Proportional and Nonproportional Relationships)

1. The table shows a proportional relationship between x and y. Complete the table.

$k = \frac{y}{x} = \frac{9}{2} = 4.5$

x	2	3	5	8
y	9	13.5	22.5	36

(×4.5 from 2 to 9; ×4.5 from 3 to 13.5; ×4.5 from 5 to 22.5; ×4.5 from 8 to 36)

$\frac{22.5}{4.5} = 5$

2. A print shop charges the same price for every poster. An order of 6 posters costs \$40.50. Write an equation for the cost y, in dollars, of x posters, and identify the constant of proportionality.

$k = \frac{y}{x} = \frac{40.5}{6} = \$6.75 \text{ / poster}$

3. Which table represents a proportional relationship between x and y?

→ (A)

x	y
2 (×4.5)	9
4 (×4.5)	18
6 (×4.5)	27

(B)

x	y
1	3
2	5
3	7

$\frac{3}{1} \neq \frac{5}{2}$

(C)

x	y
2	4
3	9
4	16

$\frac{4}{2} \neq \frac{9}{3}$

(D)

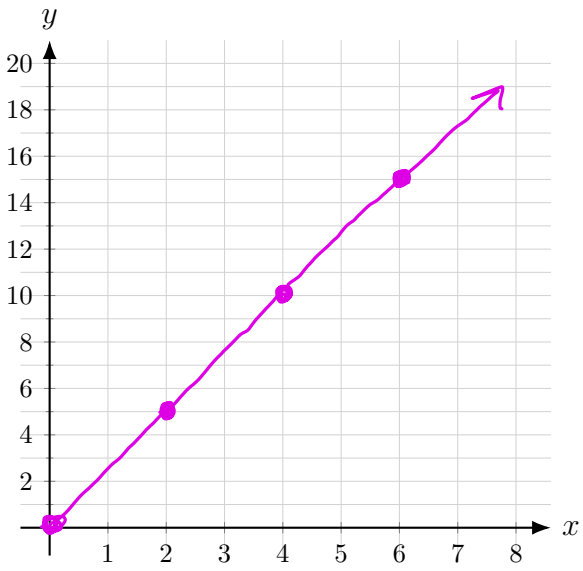
x	y
0	2
1	4
2	6

← y-int. not (0,0)

must have (0,0)

4. The table shows a proportional relationship. Graph the relationship on the grid. Plot at least three points and draw the line.

x	2	4	6
y	5	10	15



5. Which equation represents a proportional relationship?

(A) $y = 3x + 1$

(B) $y = 2x - 4$

(C) $y = x + 7$

(D) $y = \frac{x}{5}$ ⇐ $y = \frac{1}{5}x$

constant of proportionality

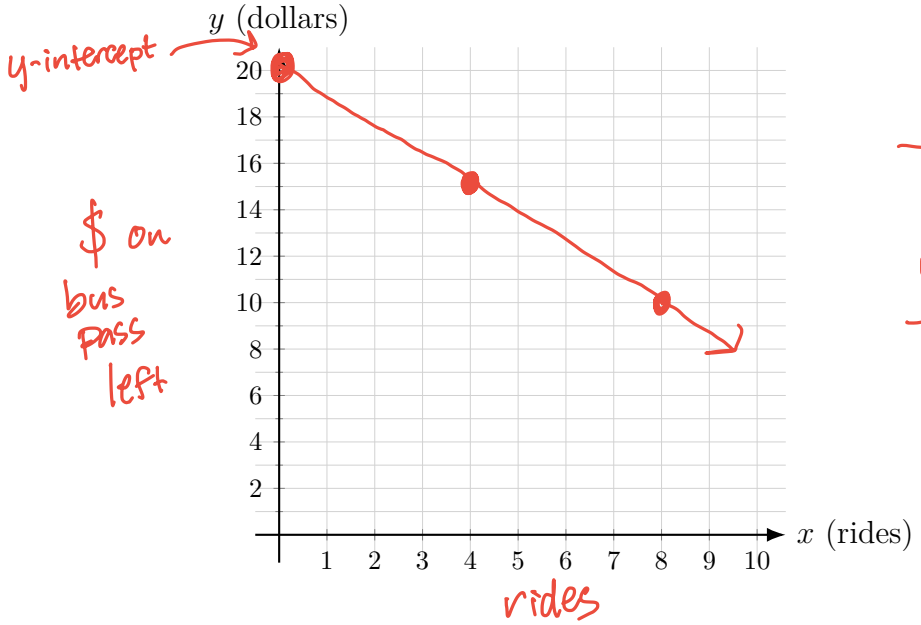
6. A rain barrel already holds 6 gallons of water. During a storm it collects 1.5 gallons each hour. Complete the table for the total number of gallons y in the barrel after x hours.

x (hours)	0	1	2	4
y (gallons)	6	7.5	9	12

x = 0 hours

+1.5 +1.5·2

7. A bus pass starts with \$20 on it, and each ride costs \$1.25. On the grid, graph the amount y, in dollars, left on the pass after x rides. Plot at least three points and draw the line.



8. Determine whether each representation shows a proportional or a nonproportional relationship. Place a check in the correct column for each row.

	Proportional	Nonproportional
$y = 3x - 2$	☐	☑
$y = \frac{x}{4}$	☑	☐
x: 1, 2, 4 / y: 5, 10, 20	☑	☐
x: 0, 1, 2 / y: 3, 5, 7	☐	☑

9. Which situation represents a proportional relationship between the two quantities?

(A) A parking garage charges \$4.00 to enter plus \$2.00 for each hour parked.

(B) Movie tickets cost \$9.50 each.

(C) A plant is 8 cm tall and grows 3 cm each week.

(D) A phone plan costs \$25.00 per month plus \$0.10 for each text sent.

10. Which situation represents a non-proportional linear relationship?

(A) Candy costs \$0.85 per piece.

(B) A train travels at a constant speed of 55 miles per hour.

(C) Raffle tickets cost \$2.00 each.

(D) A tutoring center charges a \$12.00 registration fee plus \$5.00 for each session.

11. The distance a spring stretches varies directly with the weight attached to it. A 12-pound weight stretches the spring 3 inches. Complete the table, then give the distance the spring stretches for a 30-pound weight.

proportional

x (pounds)	4	12	20	30
y (inches)	1	3	5	7.5

(×0.25) (×0.25) (×0.25)

A 30-pound weight stretches it 7.5 inches.

$\frac{y}{x} = \frac{3}{12} = 0.25$

12. The variable y varies directly with x. When $x = 6$, $y = 21$. What is the value of y when $x = 14$?

(A) 49

(B) 29

(C) 42

(D) 56

$k = \frac{y}{x} = \frac{21}{6} = 3.5$

$\times 3.5$

49

13. The cost of grapes varies directly with their weight. A bag weighing 5 pounds costs \$11.25. How many pounds of grapes can be bought for \$20.25? Show your work.

9 pounds

lbs	\$
5	11.25
9	20.25

$\times 2.25$

$\frac{y}{x} = \frac{11.25}{5} = 2.25$

$\frac{20.25}{2.25} = 9$

14. The table shows a relationship between x and y.

x	y
2	7
4	13
6	19

Determine whether the relationship is proportional or nonproportional. Justify your decision using attributes of the relationship.

$\frac{7}{2} = 3.5$

$\frac{13}{4} = 3.25$ ← There is no constant of proportionality — not proportional

$\frac{19}{6} = 3.17$

15. Which table represents a linear non-proportional relationship between x and y?

(A)

x	y
1	3
2	6
3	9

$k = 3$

(B)

x	y
0	0
2	7
4	14

$\frac{7}{2} = \frac{14}{4} = 3.5$ ✓

(C)

x	y
1	2
2	5
3	10

$\frac{2}{1} \neq \frac{5}{2}$

NO constant of proportionality

(D)

x	y
0	4
1	9
2	14

← y-intercept isn't (0,0)

16. A ride service charges the amounts shown in the table.

x (miles)	2	5	7
y (dollars)	8.50	17.50	23.50

$\frac{8.5}{2} = 4.25$ $\frac{17.5}{5} = 3.5$ $\frac{23.5}{7} = 3.36$

Determine whether the relationship is proportional or nonproportional. Justify your decision using values from the table.

There is no constant of proportionality → not proportional

17. The table represents a proportional relationship between x and y.

x	y
4	7
6	10.5
12	?

$k = \frac{7}{4} = 1.75$

What is the missing value of y when $x = 12$? $12 \cdot 1.75 = 21$

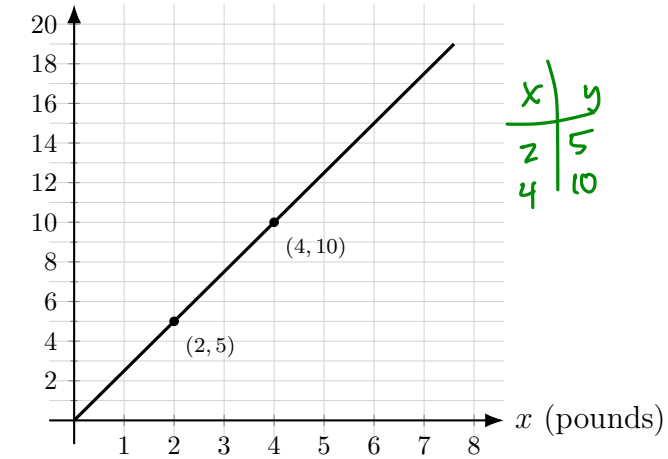
~~(A)~~ 14

~~(B)~~ 17.5

→ (C) 21

~~(D)~~ 24

18. The graph shows the cost y, in dollars, of x pounds of pecans at a farmers market stand.



x	y
2	5
4	10

$y = kx$

(a) Write an equation for the relationship shown in the graph.

$k = \frac{y}{x} = \frac{5}{2} = 2.5$ $y = 2.5x$

(b) Explain how the graph shows the relationship is proportional.

The straight line (constant rate) passes through the origin.

19. A proportional relationship between x and y includes the point $(4, 10)$. What is the unit rate of the relationship?

→ (A) 2.5

~~(B)~~ 0.4

~~(C)~~ 6

~~(D)~~ 40

$\frac{y}{x} = \frac{10}{4} = 2.5$

20. The table shows the cost y, in dollars, of bowling x games at Lane Ten. The cost at Strike Zone is given by $y = 4.5x + 10$.

x (games)	2	4	6
y (dollars)	14	28	42

$\frac{14}{2} = \frac{28}{4} = \frac{42}{6} = 7$

Determine which bowling alley's cost is proportional to the number of games. Then a student says, "Strike Zone always costs less, because it charges less for each game." Decide whether the student is correct. Use values to justify your decision.

Lane 10: $k = 7$ → There is a constant of proportionality → proportional

Strike Zone: $y = 4.5x + 10$ ← nonproportional equation

21. A conveyor belt moves 8.5 meters each second. Which equation represents the total distance y, in meters, the belt moves in x seconds?

(A) $y = x + 8.5$

(B) $y = 8.5x + 8.5$

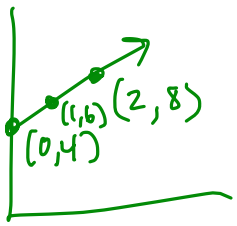
(C) $y = 8.5x$

(D) $y = \frac{x}{8.5}$

22. Determine whether each situation represents a proportional or a nonproportional relationship. Place a check in the correct column for each row.

	Proportional	**Nonproportional**
A gym charges \$25 to join plus \$15 each month	☐	☑
Trail mix costs \$3.40 per pound	☑	☐
A rideshare charges \$2.50 plus \$1.75 per mile	☐	☑
A printer prints 22 pages each minute	☑	☐

23. A student graphs a relationship and says, "The graph is a straight line, so the relationship is proportional." Decide whether the student is correct. Use a labeled example, with values, to justify your decision.



The student may be incorrect, as that straight line might not pass through the origin & thus be nonproportional (non-zero y-intercept), and not have a constant of proportionality.

x	y
0	4
1	6
2	8

Still a constant rate, but no constant of proportionality

$\frac{8}{2} \neq \frac{6}{1}$

Questions 24–38 cover Artifact 15 (Writing Linear Equations)

24. A school supply drive collects 750 notebooks. Each classroom that signs up receives 18 notebooks. Write an equation for the number of notebooks y left after x classrooms receive theirs.

start - y-intercept

$y = 750 - 18x$ -or- $y = -18x + 750$

25. The drama club paid to rent a stage, then sold tickets at a constant price. The table shows the club's profit y, in dollars, after x tickets are sold. Write an equation for the profit y after x tickets.

x	y
10	−30
25	60
40	150

$m = \frac{60-(-30)}{25-10} = \frac{90}{15} = 6$

$b = -90$

$y = 6x - 90$

26. The table shows a linear relationship between x and y.

x	y
0	8
3	23
6	38
9	53

y-intercept (6)

$m = \frac{23-8}{3-0} = \frac{15}{3} = 5$

$y = 5x + 8$

Which equation represents this relationship?

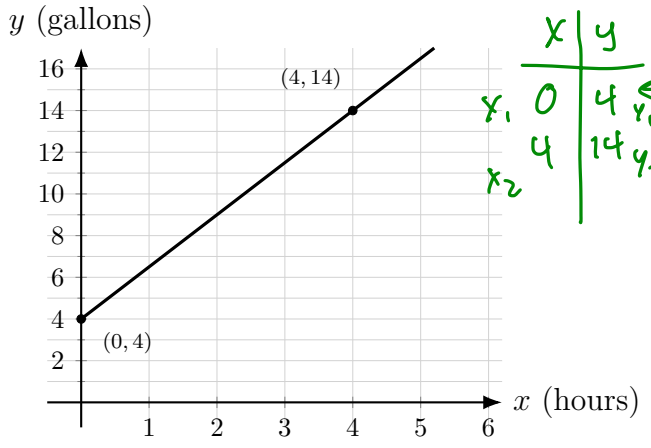
(A) $y = 8x + 5$

(B) $y = 5x + 8$

(C) $y = 15x + 8$

(D) $y = 5x$

27. The graph shows the total number of gallons y in a rain tank after x hours of steady rain.



x	y
0	4
4	14

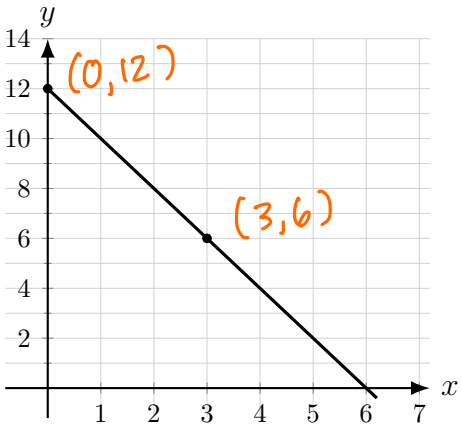
y-intercept (6)

Write an equation for the number of gallons y in the tank after x hours.

$m = \frac{14-4}{4-0} = \frac{10}{4} = \frac{5}{2} = 2.5$

$y = 2.5x + 4$

28. The graph of a linear relationship is shown.



x	y
0	12
3	6

y-int.

$m = \frac{6-12}{3-0} = \frac{-6}{3} = -2$

Which equation represents the graph?

(A) $y = 2x + 12$

(B) $y = 12x - 2$

(C) $y = -2x + 12$

(D) $y = -12x + 2$

$m = -0.6$

29. A candle burns down at a constant rate of 0.6 centimeter each hour. After 5 hours of burning, the candle is 17 centimeters tall. Write an equation for the height y, in centimeters, of the candle after x hours. Show how you found the starting height.

x	y
0	?
5	17

(0, 14) ← y-intercept

$+5 \cdot 0.6$

$17 + 3 = 20$

$y = 20 - 0.6x$

-or-

$y = -0.6x + 20$

30. A moving company charges a flat fee plus a fixed rate per mile. A 3-mile move costs \$10.25, and an 8-mile move costs \$22.75. Which equation models the total cost y, in dollars, of a move of x miles?

(A) $y = 2.75x + 2.50$

(B) $y = 2.50x + 2.75$

(C) $y = 2.50x + 10.25$

(D) $y = 2.50x$

x	y
3	10.25
8	22.75

$m = \frac{22.75 - 10.25}{8 - 3} = 2.5$

$10.25 = 2.5(3) + b$

$10.25 = 7.5 + b$

$b = 2.75$

$y = 2.5x + 2.75$

31. Write an equation in the form $y = mx + b$ or $y = kx$ for each relationship described.

(a) a \$12 sign-up fee plus \$8 each month

$y = 8x + 12$

(b) the table

x	0	2	4
y	15	27	39

$m = \frac{27-15}{2-0} = \frac{12}{2} = 6$

$y = 6x + 15$

(c) starts at 25 and decreases by 4 each week

$y = 25 - 4x$

(d) the table

x	1	2	3
y	9	16	23

$\frac{16-9}{2-1} = 7$

$y = 7x + 2$

32. A food truck sells tamales for \$2.75 each, with no other charges. Write an equation for the total cost y, in dollars, of x tamales, and state the value of b in your equation.

$y = 2.75x$

$b = 0$

b=100 m=-12

33. A phone battery is fully charged at 100% and loses 12 percentage points each hour of video playback. Which equation models the battery percentage y after x hours?

(A) $y = 12x + 100$

(B) $y = 100x - 12$

(C) $y = -100x + 12$

(D) $y = -12x + 100$

34. The table pairs the number of weeks x with the amount y, in dollars, left on a student lunch account: $(1, 76)$, $(3, 48)$, $(5, 20)$. Write an equation for the amount y left after x weeks. Show your work.

x	y
0	90
1	76
3	48

+14

$m = \frac{76-48}{1-3} = \frac{28}{-2} = -14$ $\quad y = -14x + 90$

35. The equation $y = 32 + 2.5x$ gives the length y, in centimeters, of a bamboo shoot x days after it is first measured. A student says, "The shoot was 2.5 centimeters long when it was measured, and it grows 32 centimeters each day." Decide whether the student is correct. Then determine the length of the shoot on day 12.

Not correct - the two numbers are swapped. The shoot being 32 cm long at the start is what the eq. shows w/ 32 being y-intercept (b). It would grow 2.5 cm each day as the slope.

36. Which table represents the equation $y = 4x - 3$?

(A)

x	y
1	1
2	5
3	9

0 -3 -4 +4 +4

(B)

x	y
1	4
2	8
3	12

(C)

x	y
1	7
2	11
3	15

(D)

x	y
1	1
2	4
3	7

37. Two students each write an equation for the line that passes through the points $(-2, 1)$ and $(4, 4)$. Student A writes $y = 0.5x + 2$. Student B writes $y = 2x + 5$. Determine which equation, if either, represents the line. Justify your decision using both points.

x	y
-2	1
0	2
4	4

+2

$m = \frac{4-1}{4-(-2)} = \frac{3}{6} = \frac{1}{2}$ (0.5)

$4 - (0.5) \cdot 4 = 2$

$y = 0.5x + 2$

Student A is correct.

38. Two tanks are filling with water. The tables show the number of gallons y in each tank after x minutes.

Tank P

x	0	2	4
y	30	38	46

Tank Q

x	0	2	4
y	18	32	46

$m = \frac{38-30}{2-0} = 4$ $b = 30$ $b = 18$ $m = \frac{32-18}{2-0} = \frac{14}{2} = 7$

Write an equation for each tank. Then determine which tank has the greater rate of change and which has the greater starting value, and state what each of those values means in this situation.

$y = 4x + 30$ $y = 7x + 18$

how many gallons at the start

greater starting value

(how many gal. filled/min)

greater rate of change (m)

Questions 39–50 cover Artifact 16 (Identifying Functions)

39. Which set of ordered pairs represents a function?

(A) $\{(2,4), (2,6), (3,1), (5,2)\}$ ← Repeating x's

(B) $\{(1,3), (2,3), (4,6), (5,1)\}$ ✓

(C) $\{(0,2), (1,5), (0,7), (3,3)\}$

(D) $\{(1,1), (3,4), (3,7), (6,2)\}$

Repeating y's are ok.

No repeating x's

40. Write a set of four ordered pairs that uses only the inputs 1, 3, and 5 and is *not* a function. Explain what makes your set not a function.

Repeating x-value of 1 $\{(1,2), (1,3), (3,2), (5,6)\}$

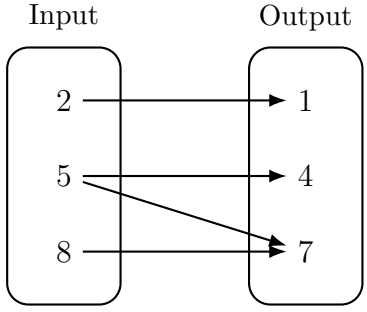
41. The table shows a relation. Determine whether the relation is a function. Explain why or why not.

x	1	2	3	4
y	6	6	9	9

Yes → each input has only one output (no repeating x's)

#Repeating y's are okay

42. The mapping diagram shows a relation. Determine whether the relation is a function. Explain why or why not.



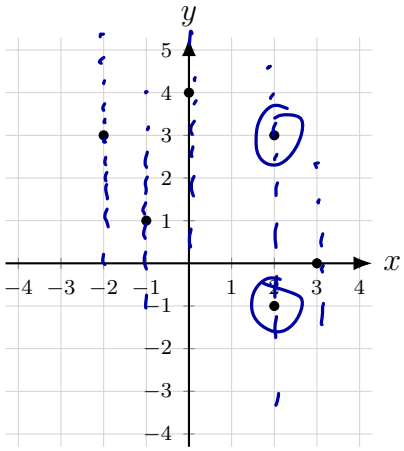
(2, 1)

(5, 4) ← x=5 has 2 outputs,

(5, 7) can only have one → NOT a function

(8, 7)

43. The points shown on the grid are the complete relation. Determine whether the relation is a function. Explain why or why not.



This fails the Vertical Line Test as 2 points pass through the same x-value

(2, 3)
(2, −1)

↑ Repeating x's

44. A relation contains the points $(2, 7)$, $(3, 1)$, and $(6, 5)$. Which point can be added to the relation so that it remains a function?

(A) $(2, 9)$ ← would repeat a current x-value
(B) $(6, 2)$
→ (C) $(4, 7)$ ✓
(D) $(3, 3)$

45. A relation contains the points $(-3, 4)$, $(0, 4)$, and $(2, -1)$. A student adds the point $(4, 4)$ and says, "Now 4 is an output three times, so the relation is no longer a function." Decide whether the student is correct. Then give one point that, if added, would make the relation not a function.

The student is not correct → an output can correspond to two different inputs (repeating y's are okay); it's just that an input can't have 2 different outputs. This would still be a function.

46. Which table does *not* represent a function?

(A)

x	y
1	4
2	4
3	4
4	4

✓

(B)

x	y
0	1
2	5
4	9
6	13

✓

(C)

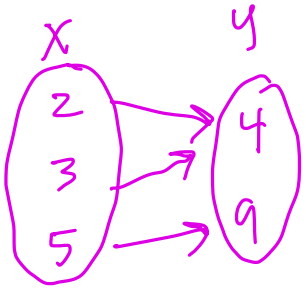
x	y
1	7
2	5
3	3
4	1

→ (D)

x	y
3	2
5	8
3	11
7	1

NOT a function
Repeating x-values

47. Write the relation $\{(2, 4),\ (3, 4),\ (5, 9)\}$ as a mapping diagram. Then determine whether the relation is a function, and explain how your diagram shows it.



Function ✓
Each input only goes to one output.

48. In which relation is y a function of x?

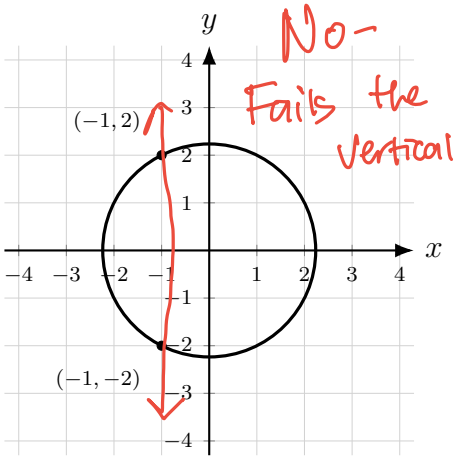
(A) x is a Longfellow student, and y is that student's date of birth. ← Each student only corresponds to one date of birth

(B) x is a date of birth, and y is a student born on that date.

(C) x is a grade level, and y is a student in that grade.

(D) x is a bus route, and y is a student who rides that route.

49. The graph of a relation is shown, with two of its points labeled. Determine whether the relation is a function. Explain why or why not, naming points from the graph as evidence.



No - Fails the Vertical Line Test

Repeating x-values

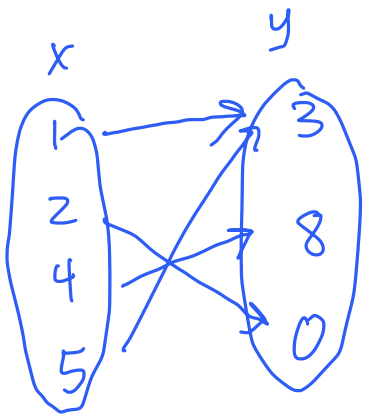
x	y
-1	2
-1	-2

50. The table shows a relation.

x	5	1	4	2
y	3	3	8	0

A student says, "The x-values are not in order, so this relation is not a function." Decide whether the student is correct, and explain using the definition of a function. Then draw the relation as a mapping diagram.

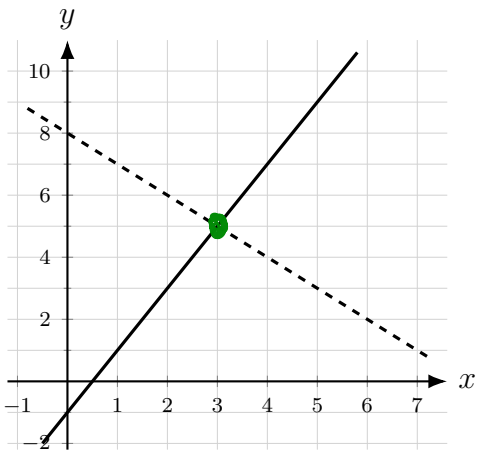
No, the student is not correct; as long as there are no repeating x-values, the relation is still a function.



*Each input still only has one output.

Questions 51–60 cover Artifact 17 (Points of Intersection)

51. The graphs of $y = 2x - 1$ and $y = -x + 8$ are shown.



(a) Write the coordinates of the point of intersection.

(3,5)

(b) Verify your ordered pair by substituting its coordinates into both equations. Show the check for each.

$5 = 2(3) - 1 = 5$ ✓

$5 = -(3) + 8 = 5$ ✓

$5 = x + 3$

52. Which ordered pair is the solution to $y = x + 3$ and $y = 3x - 1$?

(A) $(1, 4)$

(B) $(2, 5)$

(C) $(3, 8)$

(D) $(0, 3)$

$x = 2$

$-3 \quad -3$

$y - 3 = x$

$3(y-3) - 1 = y$

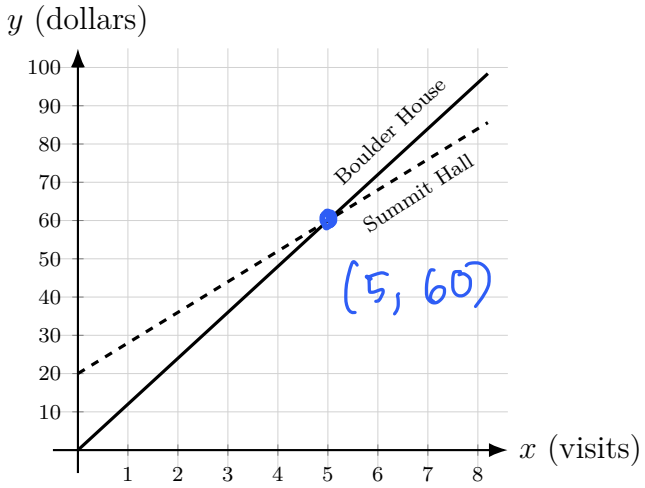
$3y - 9 - 1 = y$

$3y - 10 = y$

$2y = 10$

$y = 5$

53. The graph shows the total cost y, in dollars, of x visits at two climbing gyms. Boulder House charges \$12 per visit. Summit Hall charges a \$20 membership plus \$8 per visit.



(a) Write the coordinates of the point of intersection.

(5,60)

(b) Describe what each coordinate of the point of intersection represents in this situation.

At 5 visits, the cost for both gyms is the exact same amount ($60).

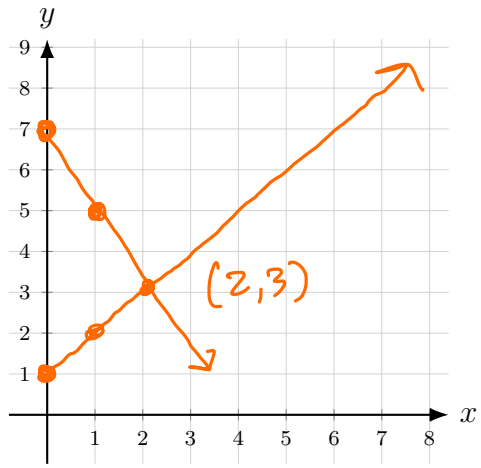
54. Graph $y = x+1$ and $y = -2x+7$ on the grid. Then write the coordinates of the point of intersection.

$y = x+1$

x	y
0	1
1	2
2	3

$y = -2x+7$

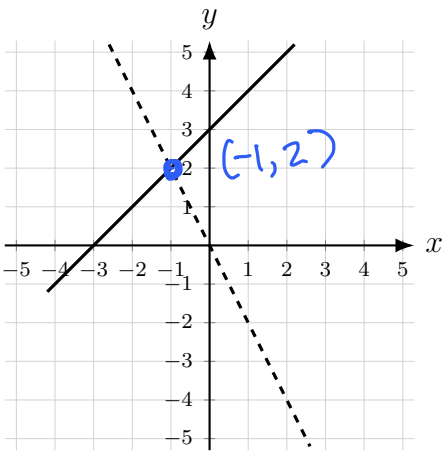
x	y
0	7
1	5
2	3



Point of intersection

(2,3)

55. The graphs of two linear equations are shown.



Which ordered pair gives the point of intersection of the two lines?

(A) $(2, -1)$

(B) $(1, 2)$

(C) $(-1, 2)$

(D) $(-1, -2)$

56. A student says $(4, 2)$ is the solution to $y = -x + 6$ and $y = 0.5x + 1$. Decide whether the student is correct by substituting the coordinates into both equations. Show the check for each equation.

$2 = -4+6$ ✓ $\quad 2 = 0.5(4)+1$ ✗

$2 \neq 3$

The student is not correct

57. The graphs showing the total cost y, in dollars, of x months at two gyms intersect at the point $(6, 45)$. What does this point represent?

(A) The gyms cost a total of \$45 for 6 months combined.

(B) One gym costs \$6 more per month than the other.

(C) Both gyms cost \$6 for 45 months of membership.

(D) Both gyms cost \$45 for 6 months of membership.

58. Two moving companies charge by the hour: $y = 2.5x$ and $y = 1.5x + 4$ give each cost y, in dollars, for x hours. Complete the table for both companies.

Intersection: (4, 10)

x (hours)	2	4	6
$y = 2.5x$	5	10	15
$y = 1.5x + 4$	7	10	13

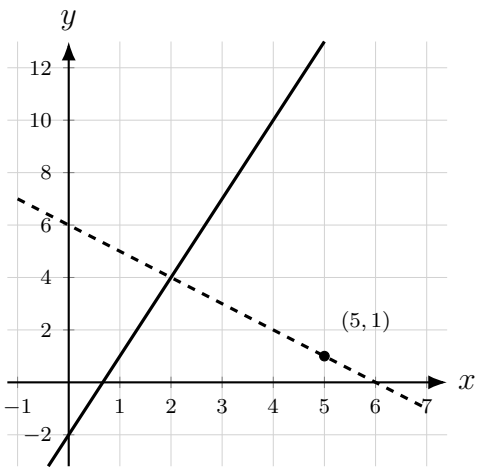
Then write the ordered pair where the two graphs would intersect, and explain how the table shows it.

At $x = 4$, both equations give the answer $y = 10$

59. The graphs of two linear equations intersect at the point $(3, 27)$. Write a real-world situation that the two equations could represent, and state what each coordinate of the point of intersection means in your situation.

One example: Two gyms' total cost after x months (3) is \$27. (y)

60. The graphs of $y = 3x - 2$ and $y = -x + 6$ are shown, with the point $(5, 1)$ labeled.



A student says $(5, 1)$ is a solution to both equations because it is on one of the lines. Decide whether the student is correct. Justify your decision by substituting the coordinates into both equations.

The student is incorrect. The solution must be the point of intersection where both lines meet: (2, 4).