# Chapter 2 Linear Equations and Functions

## Ex 2.1

### Answer 1e.

We know that $x$ is the input variable and $y$ is the output variable.
The input variable is the independent variable and the output variable is the dependent variable.
The variable $x$ is the independent variable and $y$ is the dependent variable.
Therefore, the given statement can be completed as:
"In the equation $y = x + 5$, $x$ is the independent variable and $y$ is the dependent variable."

### Answer 1gp.

**(a)** The domain is the set of all input values. This means that the domain consists of all the $x$-coordinates.

The domain of the given relation is $-4$, $-2$, 0, and 1.

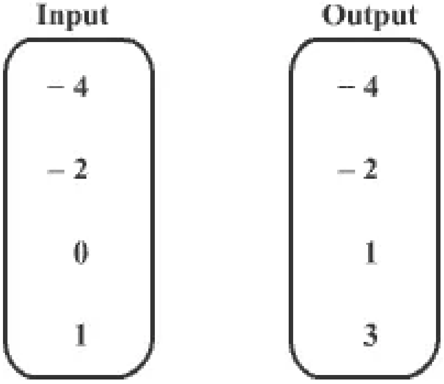
The range is the set of all output values. Thus, the range consists of all the $y$-coordinates.

The range of the given relation is 3, 1, $-2$, and $-4$.

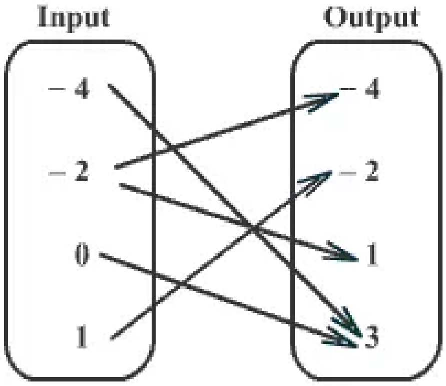
**(b)** Represent the relation in a table.

| | | | | | |
|---|---|---|---|---|---|
| $x$ | $-4$ | $-2$ | 0 | 1 | $-2$ |
| $y$ | 3 | 1 | 3 | $-2$ | $-4$ |

We need to represent the relation using a mapping diagram. For this, first sort the input values and the output values in the ascending order. Then, write the input and the output values side by side in two rounded rectangles.



Draw an arrow from each input value to the corresponding output value.




**Answer 2e.**

From the set of ordered pairs, at first we need to find all the distinct input values, $x$. The set of all input values $x$ is the domain.
From the set of ordered pairs, at first we need to find all the output values $y$. The set of all output values $y$ is the range.

**Answer 2gp.**

The given table is shown below:

| | | | | | |
|---|---|---|---|---|---|
| $x$ | $-2$ | $-1$ | 0 | 1 | 3 |
| $y$ | $-4$ | $-4$ | $-4$ | $-4$ | $-4$ |

We need to say whether the relation is a function.

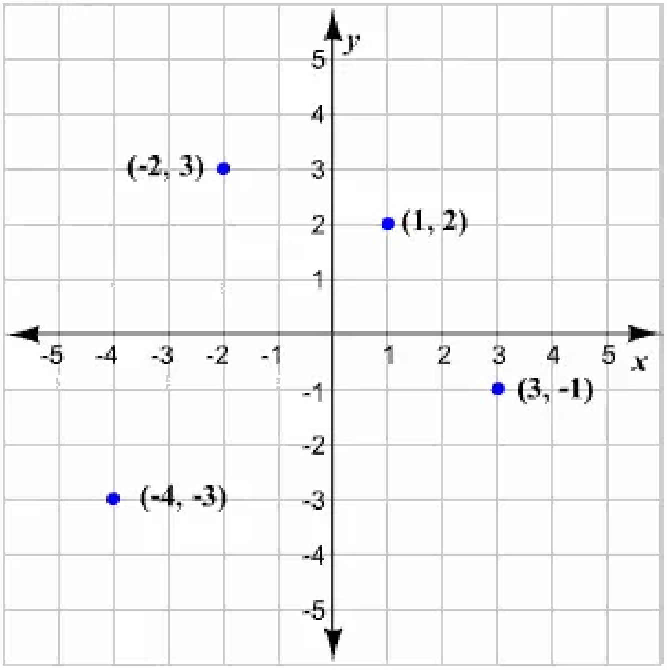
A function is a relation for which each input has exactly one output. If any input of a relation has more than one output, the relation is not a function.
In the table shown above, each input has only one output $-4$.
Therefore the relation is $\boxed{\text{a function}}$.

**Answer 3e.**

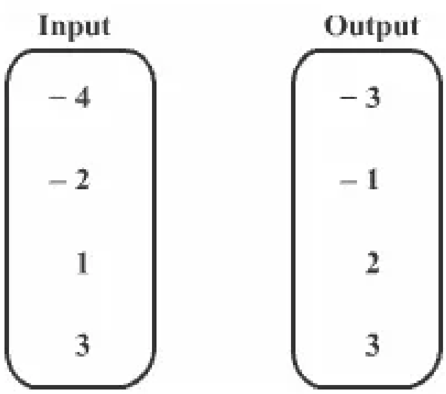
The domain is the set of all input values. This means that the domain consists of all $x$-coordinates.
The domain of the given relation is $-4$, $-2$, 1, and 3.

Now, the range is the set of all output values. Thus, the range consists of all $y$-coordinates.
The range of the given relation is $-3$, $-1$, 2, and 3.

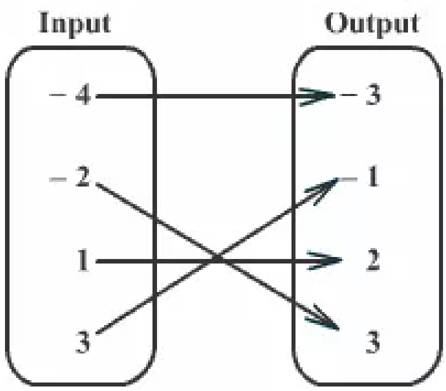
In order to represent the relation using a graph, plot each ordered pair on a coordinate plane.




We need to represent the relation using a mapping diagram. For this, first sort the input values and the output values in the ascending order. Then, write the input and output values side by side in two rounded rectangles.

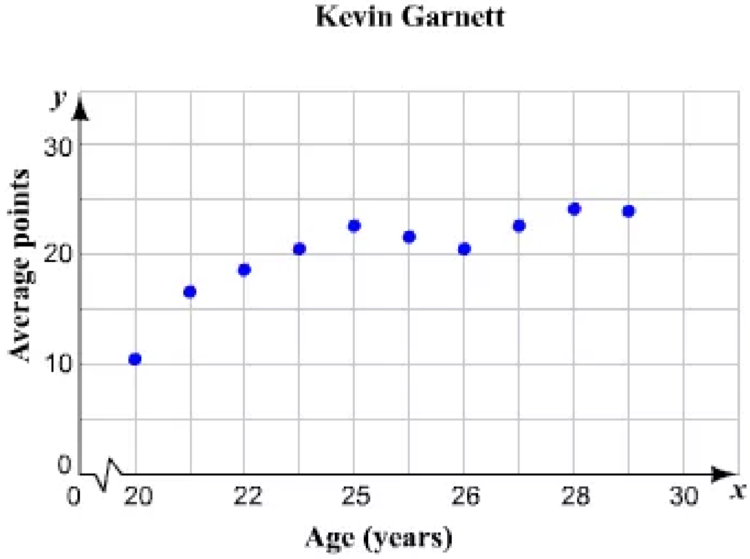



Draw an arrow from each input value to the corresponding output value.



**Answer 3gp.**

The graph of the person for the first ten seasons is as shown.




A function is a relation for which each input has exactly one output. From the graph, it is clear that no vertical line intersects the graph at more than one point.

Therefore, the relation is still a function.

**Answer 4e.**

The ordered pairs are

$$(5,-2),(-3,-2),(3,3),(-1,-1)$$

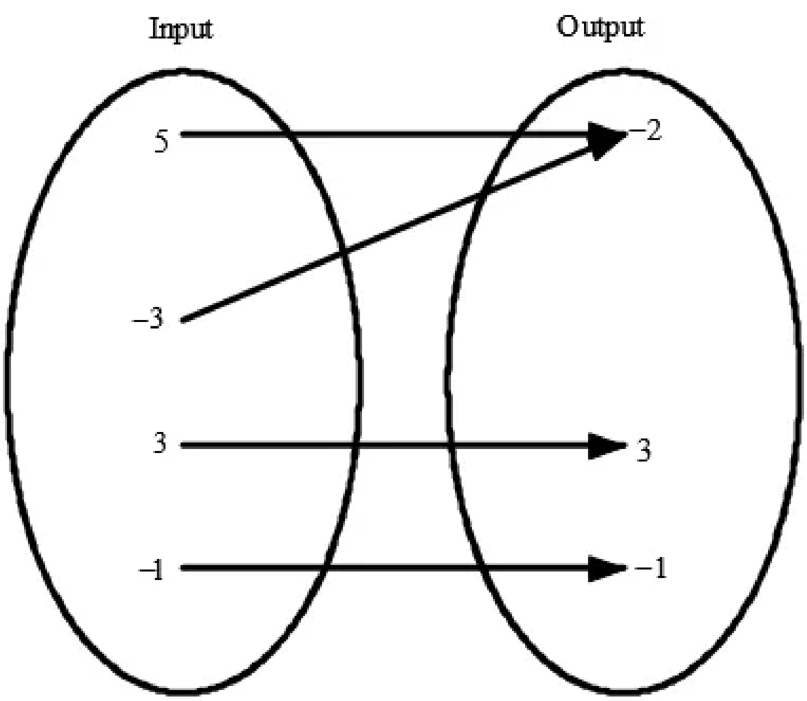
From the set of ordered pairs, at first we need to find all the distinct input values $x$. The set of all input values $x$ is the domain.

The domain consists of all the $x$ coordinates: $\boxed{5,-3,3,-1}$

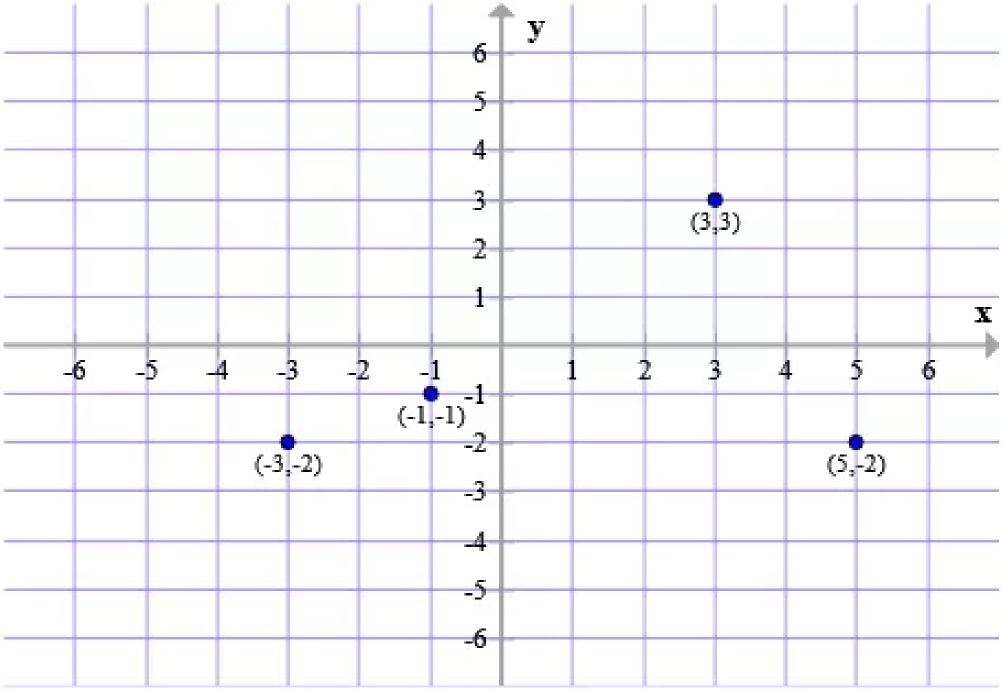
From the set of ordered pairs, at first we need to find all the output values $y$. The set of all output values $y$ is the range.

The range consists of all the $y$ coordinates: $\boxed{-2,3,-1}$

The mapping diagram is shown below:



The graph is shown below:



## Answer 4gp.

We need to graph the equation

$$y = 3x - 2 \qquad \text{...... (1)}$$

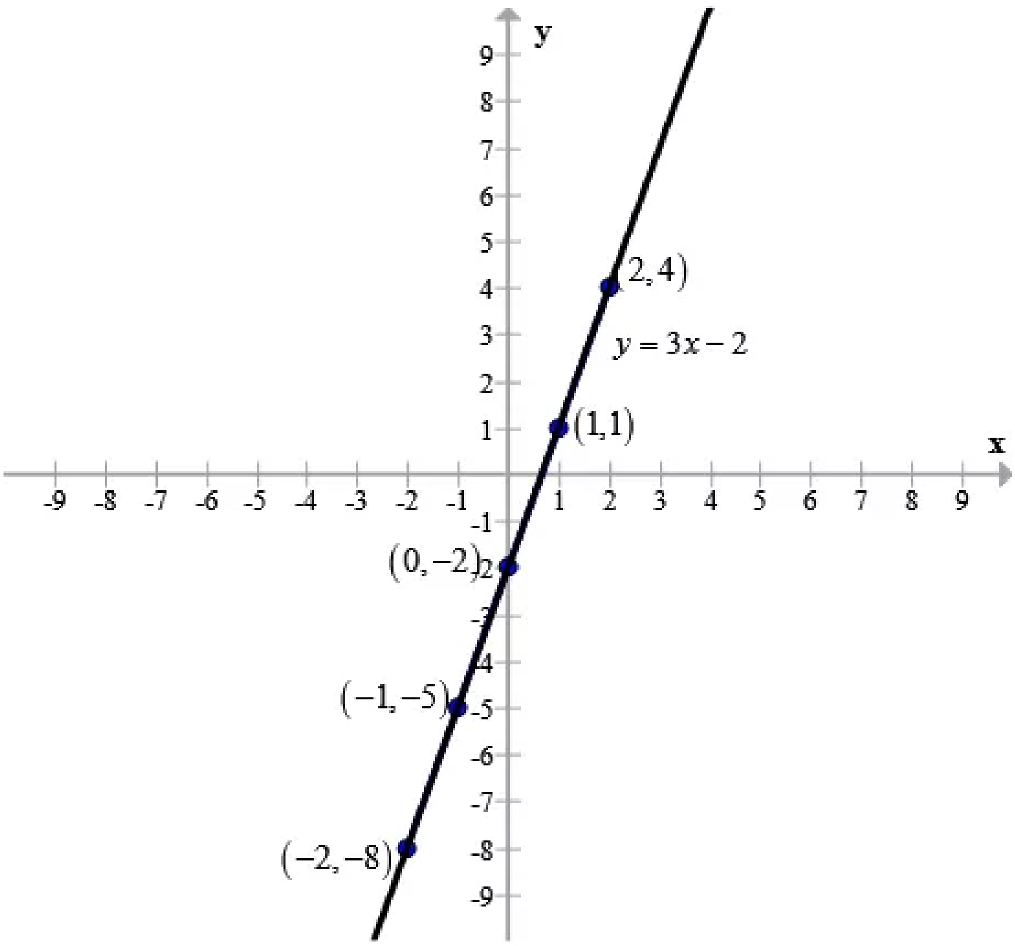
The equation (1) is linear and represent a line.
Substituting $x = 0$ in equation (1), we have

$$y = 3 \cdot 0 - 2$$
$$= -2$$

Similarly, for the other values we construct a table of values.

| | | | | | |
|---|---|---|---|---|---|
| $x$ | 0 | −1 | 1 | −2 | 2 |
| $y$ | −2 | −5 | 1 | −8 | 4 |

We plot all the points from the table and draw a line through these points to get the graph of the equation as shown below.



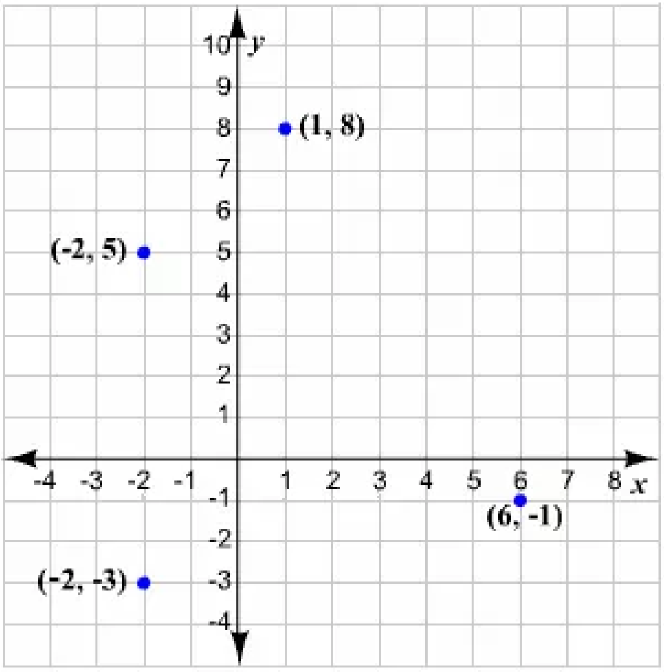

From the graph, it is seen that all the points lie in a line.

## Answer 5e.

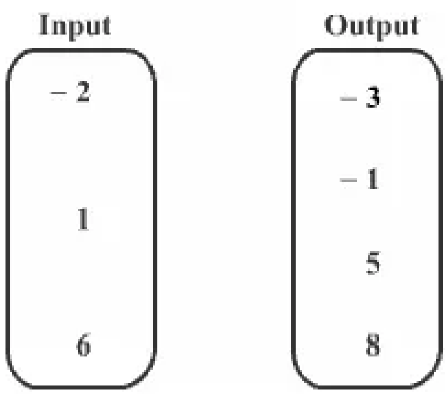
The domain is the set of all input values. This means that the domain consists of all the $x$-coordinates.
The $x$-coordinates are 6, −2, 1, and −2. We use the repeated values only once.
The domain of the given relation is −2, 1, and 6.

Now, the range is the set of all output values. Thus, the range consists of all the $y$-coordinates.
The range of the given relation is −3, −1, 5, and 8.

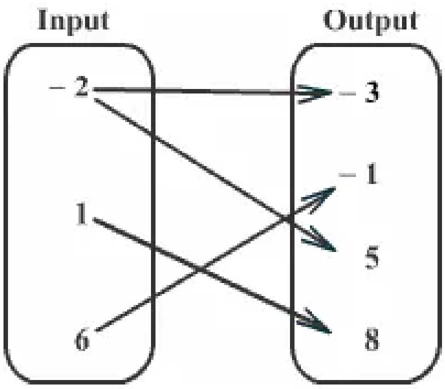
In order to represent the relation using a graph, plot each ordered pair on a coordinate plane.




We need to represent the relation using a mapping diagram. For this, first sort the input values and the output values in the ascending order. Then, write the input and output values side by side in two rounded rectangles.



Draw an arrow from each input value to the corresponding output value.




**Answer 5gp.**

A function is linear if it can be written in the form $y = mx + b$ or $f(x) = mx + b$, where $m$ and $b$ are constants.

We note that the given function contains $x^3$-term. Hence, the given function is not linear.

Substitute $-2$ for $x$ in the given function to find $f(2)$.
$f(-2) = -2 - 1 - (-2)^3$

Evaluate.

$$\begin{aligned} f(-2) &= -2 - 1 - (-2)^3 \\ &= -2 - 1 - (-8) \\ &= -2 - 1 + 8 \\ &= 5 \end{aligned}$$

The given function evaluates to 5.

**Answer 6e.**

The ordered pairs are

$$(-7,4),(2,-5),(1,-2),(-3,6)$$

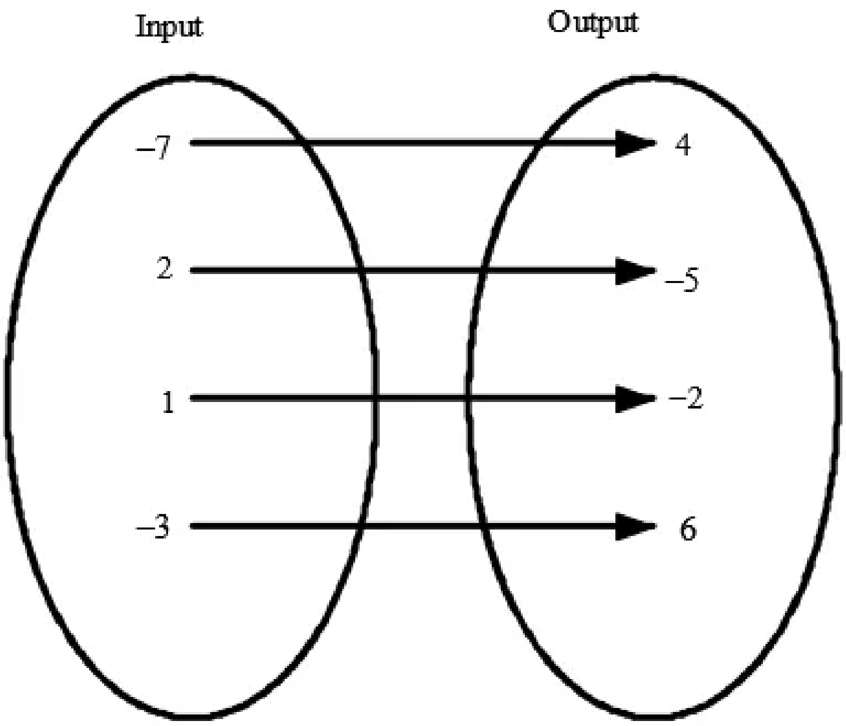
From the set of ordered pairs, at first we need to find all the distinct input values, $x$. The set of all input values $x$ is the domain.

The domain consists of all the $x$ coordinates: $\boxed{-7,2,1,-3}$

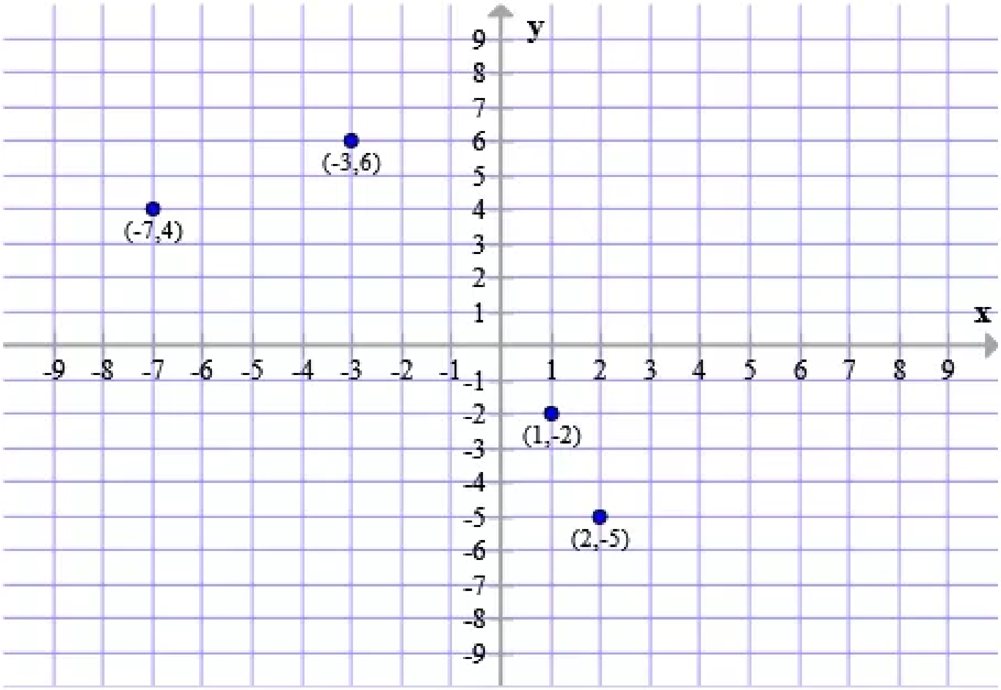
From the set of ordered pairs, at first we need to find all the output values $y$. The set of all output values $y$ is the range.

The range consists of all the $y$ coordinates: $\boxed{4,-5,-2,6}$

The mapping diagram is shown below:



The graph is shown below:




## Answer 6gp.

The given function is

$$g(x) = -4 - 2x \qquad \ldots\ldots (1)$$

We need to say whether the function is linear and to evaluate the value when $x = -2$

A function will be linear only if it can be written in the form $y = mx + b$, where $m$ and $b$ are constants.

The equation (1) is a linear function as because it can be written in the form $y = mx + b$.

When $x = -2$,

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

$$= -4 + 4 \qquad \left[\text{Multiplying}\,(-ve)\times(-ve) = (+ve)\right]$$

$$= 0$$

Therefore the required value of $\boxed{g(-2) = 0}$

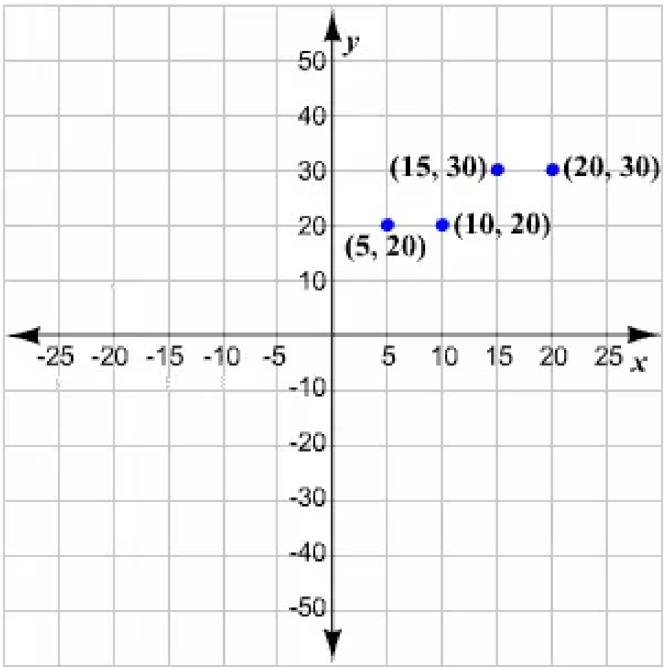
## Answer 7e.

The domain is the set of all input values. This means that the domain consists of all $x$-coordinates.

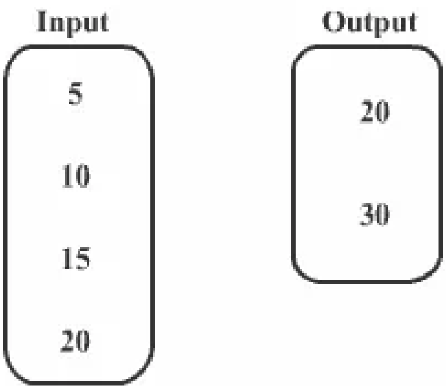
The domain of the given relation is 5, 10, 15, and 20.

Now, the range is the set of all output values. Thus, the range consists of all $y$-coordinates.
The $y$-coordinates are 20, 20, 30, and 30. We use the repeated values only once.
The range of the given relation is 20 and 30.

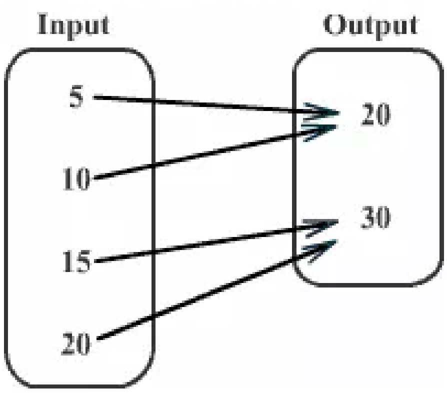
In order to represent the relation using a graph, plot each ordered pair on a coordinate plane.




We need to represent the relation using a mapping diagram. For this, first sort the input values and the output values in the ascending order. Then, write the input and output values side by side in two rounded rectangles.




Draw an arrow from each input value to the corresponding output value.



## Answer 8e.

The ordered pairs are

$$(4,-2),(4,2),(16,-4),(16,4)$$

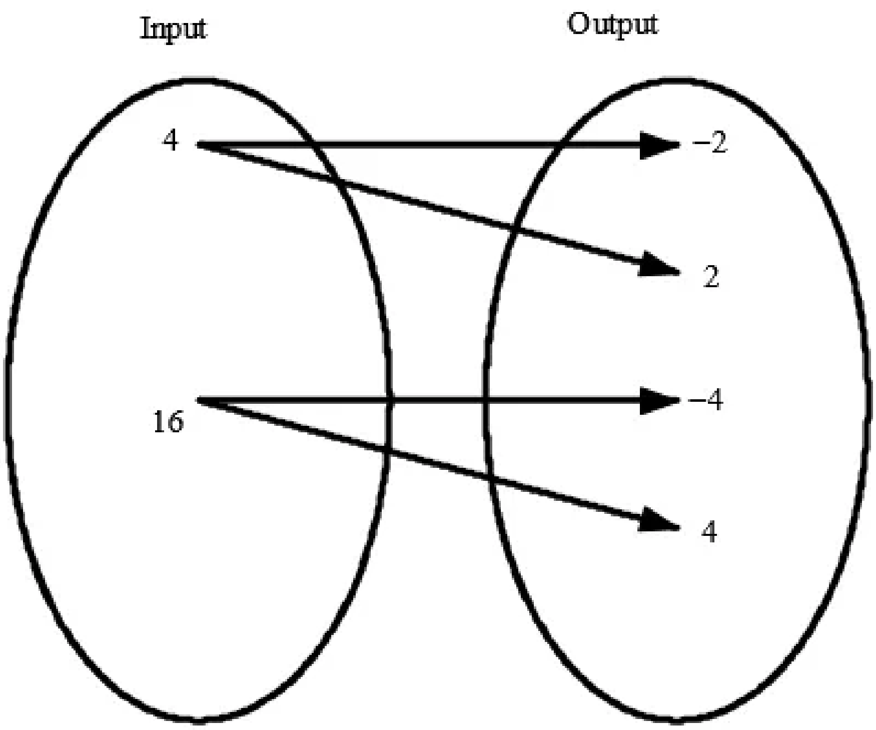
From the set of ordered pairs, at first we need to find all the distinct input values $x$. The set of all input values $x$ is the domain.

The domain consists of all the $x$ coordinates: $\boxed{4,16}$

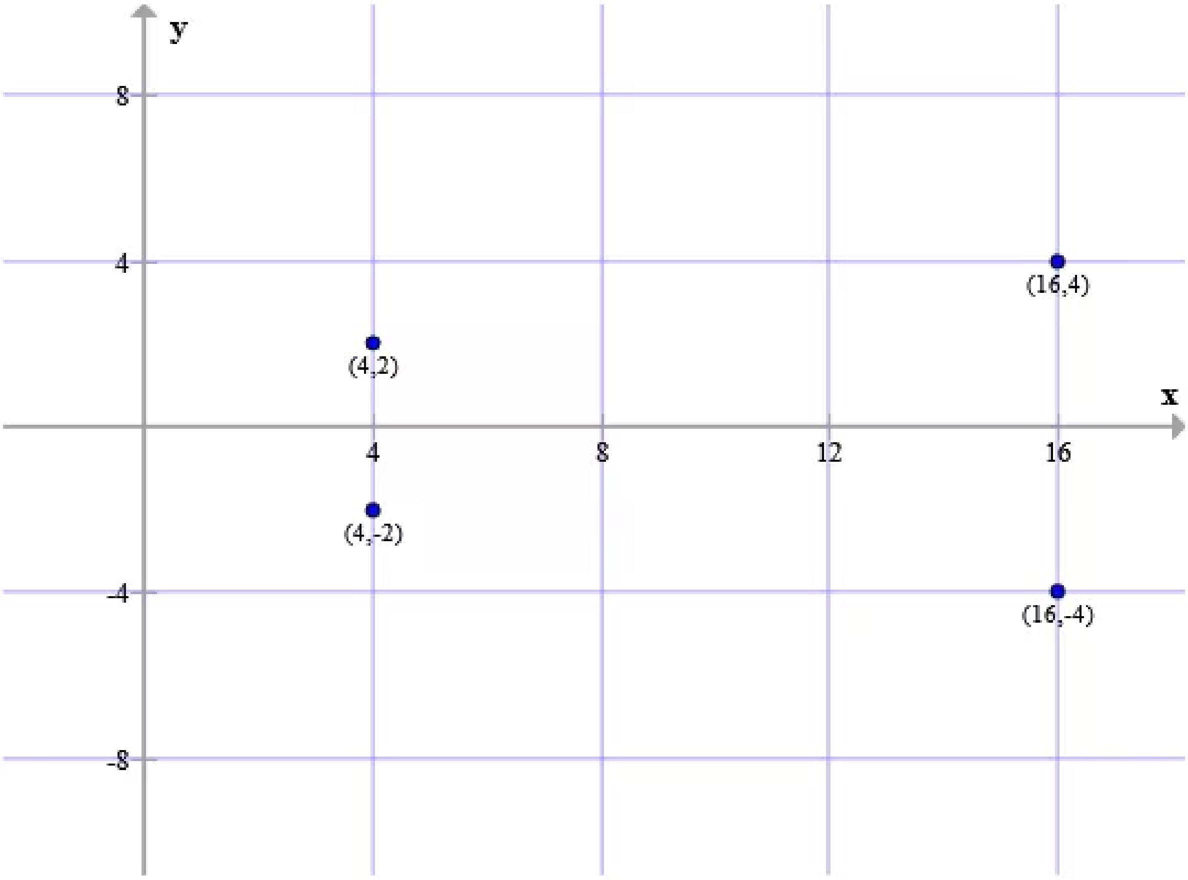
From the set of ordered pairs, at first we need to find all the output values $y$. The set of all output values $y$ is the range.

The range consists of all the $y$ coordinates: $\boxed{-2,2,-4,4}$

The mapping diagram is shown below:



The graph is shown below:




## Answer 9e.

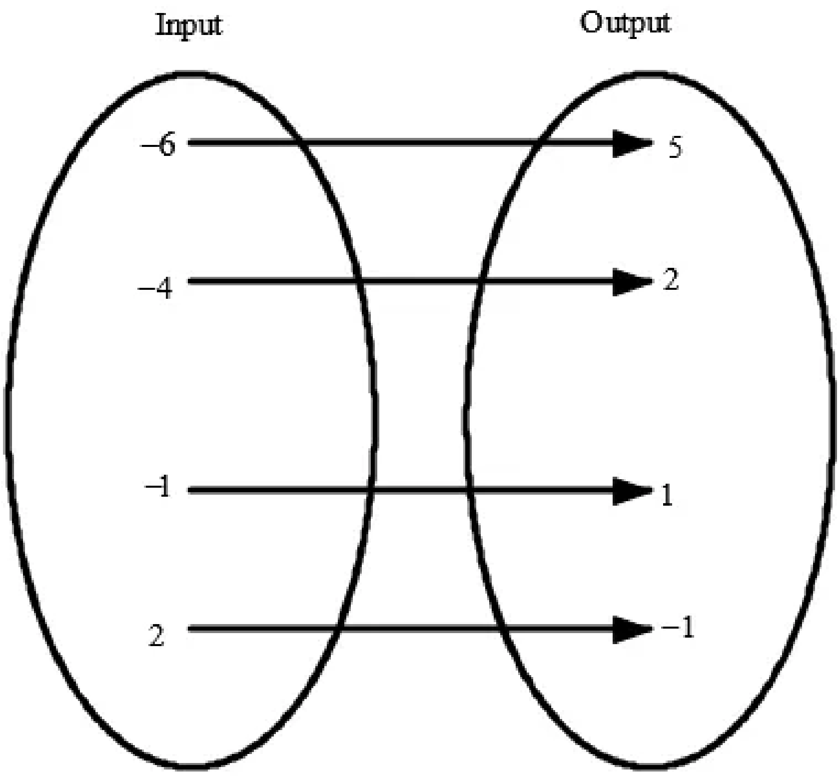
Domain is the set of input values and consists of all the $x$-coordinates.

The domain of the given relation will be $-4$, $-1$, 1, and 2. We note that this result matches with the data in choice **B**.

Therefore, the domain of the given relation will be the numbers in choice **B**.

## Answer 10e.

The given diagram is shown below:




A function is a relation for which each input has exactly one output. If any input of a relation has more than one output, the relation is not a function. The relation is also a function if two distinct inputs have got the same output.
In our case, all the input has exactly one output, so the relation is a function

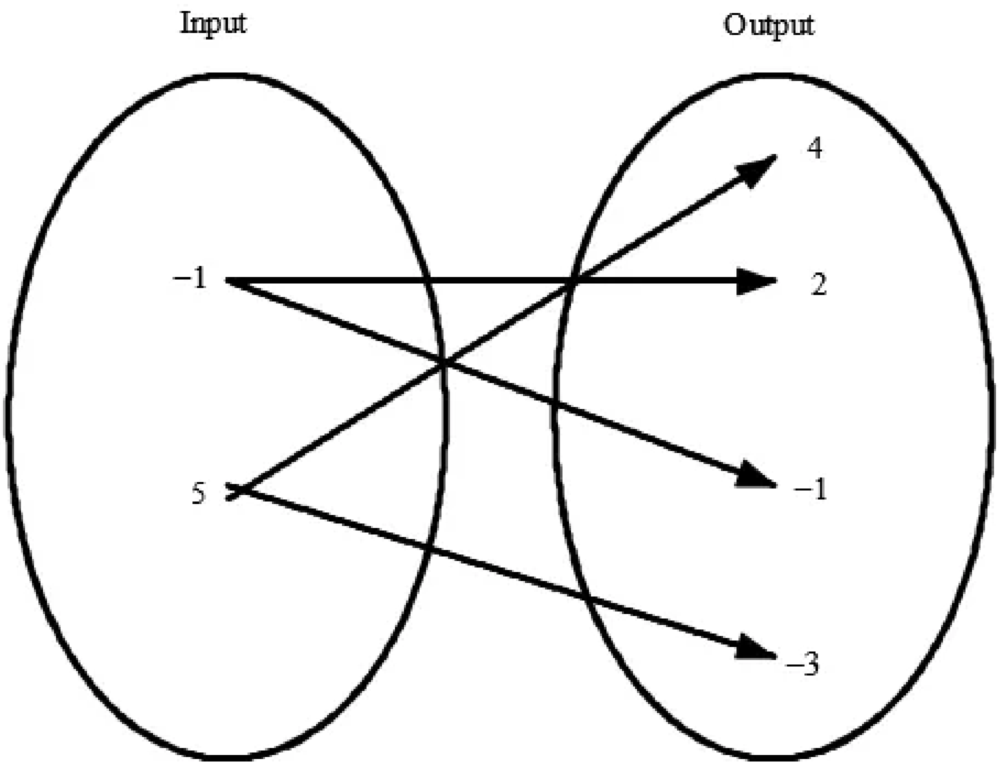
## Answer 11e.

A relation will be a function only when each input corresponds to exactly one output.

From the figure, we can see that each input is mapped onto exactly one output.
Therefore, the given relation is a function.

## Answer 12e.

The given diagram is shown below:




A function is a relation for which each input has exactly one output. If any input of a relation has more than one output, the relation is not a function. The relation is also a function if two distinct inputs have got the same output.
In our case, all the input has exactly two outputs, so the relation is **not function**

## Answer 13e.

A relation will be a function only when each input corresponds to exactly one output.

From the figure, we can see that each input is mapped onto exactly one output.
Therefore, the given relation is a function.

## Answer 14e.

It is given that the relation given by the ordered pairs $(-4,2),(-1,5),(3,6)$ and $(7,2)$ is not a function because the inputs $-4,7$ are both mapped to the output 2.
The given statement is **wrong** and we need to correct the same.

A function is a relation for which each input has exactly one output. If any input of a relation has more than one output, the relation is not a function. The relation is also a function if two distinct inputs have the same output.
In our case, $-4,7$ are two distinct inputs and that is mapped to the output 2, so the relation is a **function**.

## Answer 15e.

We know that a function is a relation for which each input has exactly one output.

In the table, $x$ corresponds to the input values and $y$ corresponds to the output values.
We can see that the input 0 is mapped onto two output values 5 and 9. Similarly, the input 1 is mapped onto 6 and 8.
The inputs 1 and 0 each have more than one output.

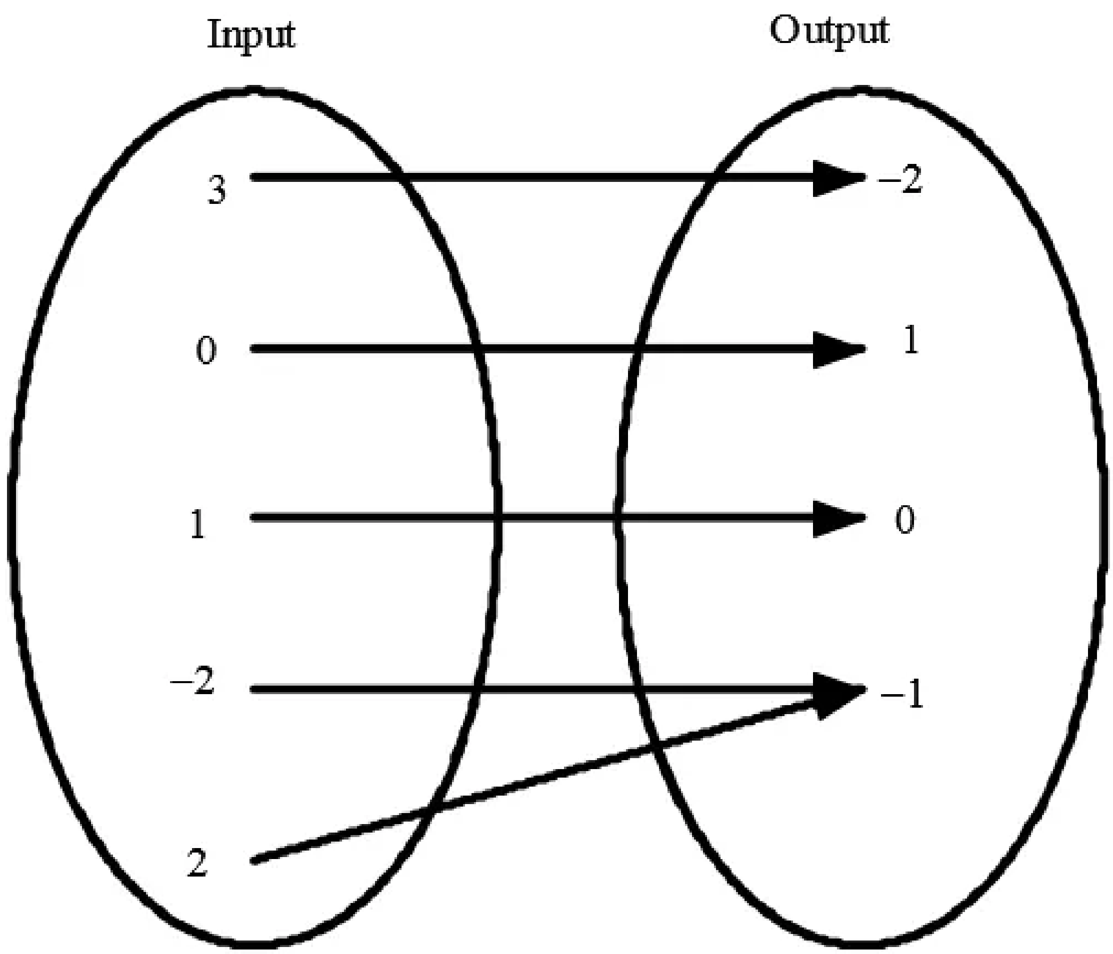
Therefore, the given relation is not a function.

## Answer 16e.

The ordered pairs are

$$(3,-2),(0,1),(1,0),(-2,-1),(2,-1)$$

We need to tell whether the relation is a function.
The mapping diagram is shown below:




A function is a relation for which each input has exactly one output. If any input of a relation has more than one output, the relation is not a function. If two of the inputs have got the same output, even then the relation can be called function.
In our case, 3 of the inputs are mapped to distinct output and the other two inputs have got the same output, so the relation is a function

## Answer 17e.

A function is a relation in which each input has exactly one output. This means that for each $x$-coordinate, there should be exactly one $y$-coordinate.

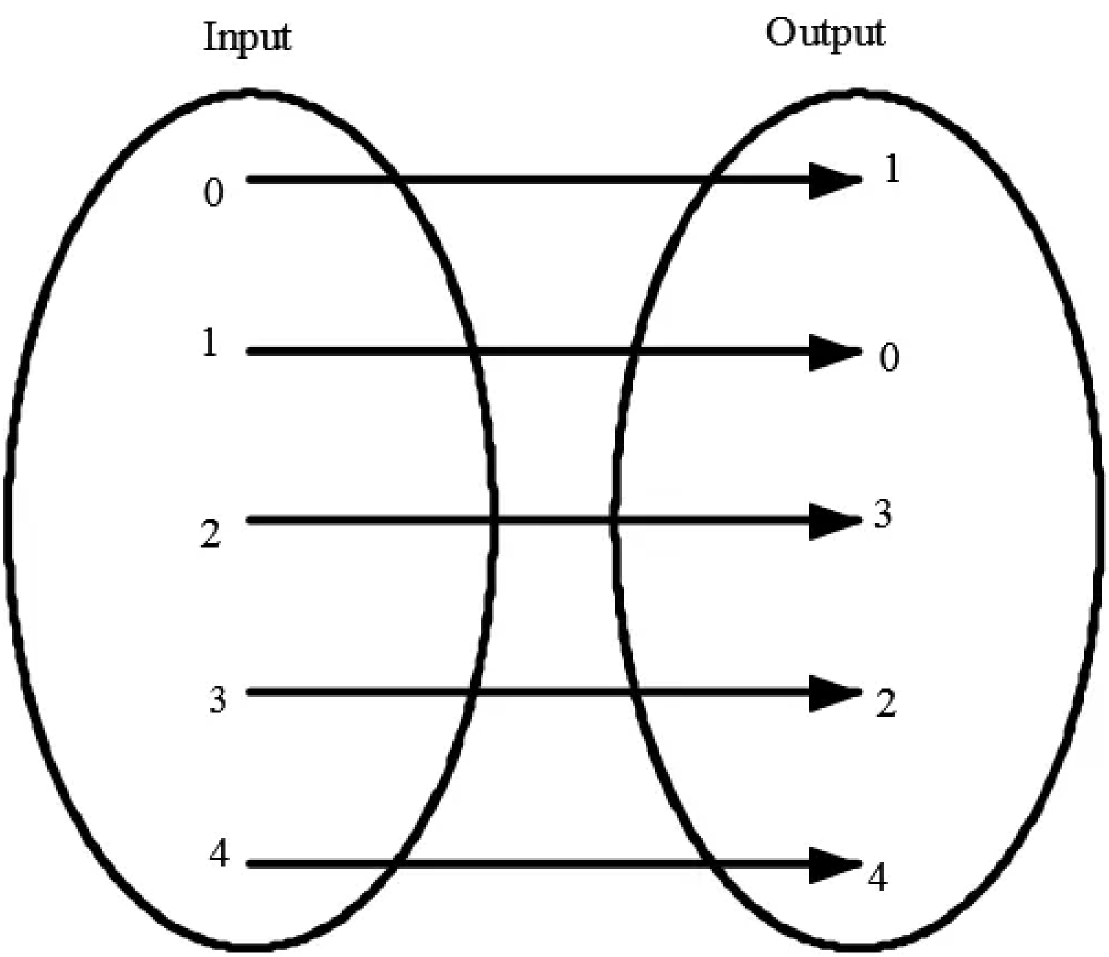
In the given relation, each input is paired onto exactly one output. Therefore, the given relation is a function.

## Answer 18e.

The ordered pairs are

$$(0,1),(1,0),(2,3),(3,2),(4,4)$$

We need to tell whether the relation is a function.
The mapping diagram is shown below:




A function is a relation for which each input has exactly one output. If any input of a relation has more than one output, the relation is not a function. If two of the inputs have got the same output, even then the relation can be called function.
In our case, all the inputs have got a distinct output and so the relation is called $\boxed{\text{function}}$.

## Answer 19e.

A function is a relation in which each input has exactly one output. This means that for each $x$-coordinate, there should be exactly one $y$-coordinate.

In the given relation, the input $-1$ is paired onto the outputs $-1$ and $-5$. Therefore, the given relation is not a function.

## Answer 20e.

It is given that the relation given by the ordered pairs $(-6,3),(-2,4),(1,5)$ and $(4,0)$ is a function. We need to include the pair with the above relation which also forms a function.

The given pairs are

$$(1,-5),(6,3),(-2,19),(4,4)$$

A function is a relation for which each input has exactly one output. If any input of a relation has more than one output, the relation is not a function. The relation is also a function if two distinct inputs have got the same output.

For the pair $(1,-5)$, the pair cannot be included because $(1,5)$ has its output at 5 and for the pair $(1,-5)$ it has its output at $-5$

For the pair $(6,3)$, the pair can be included because there is no input which has 6 in the $x$ coordinate.

For the pair $(-2,19)$, the pair cannot be included because $(-2,4)$ has its output at 4 and for the pair $(-2,4)$ it has its output at $4$.

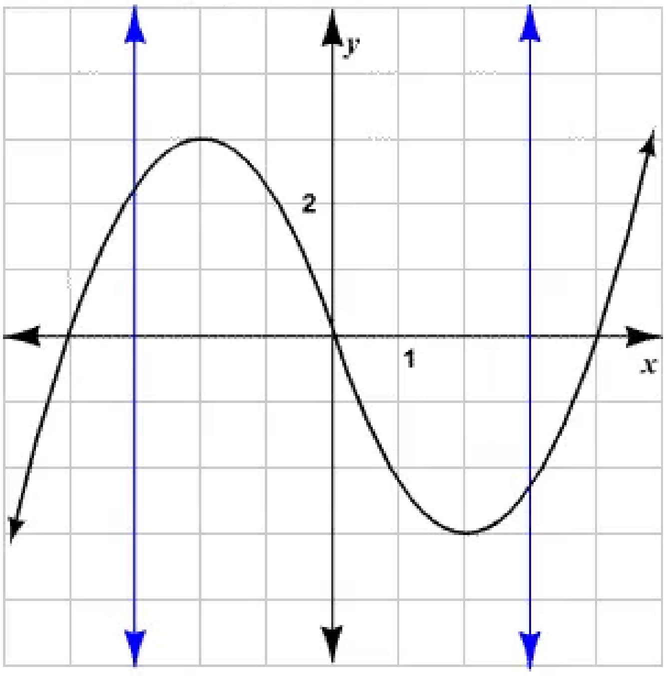
For the pair $(4,4)$, the pair cannot be included because $(4,0)$ has its output at 0 and for the pair $(4,4)$ it has its output at $4$.

The only pair which can be include in the relation is $\boxed{(6,3)}$

**Answer 21e.**

According to the vertical line test, if any vertical line drawn through the graph intersects the graph of the relation at more than one point, then the relation is not a function.

Draw two verticals line in the graph and check whether any of these vertical lines intersect the graph of the relation at more than one point.

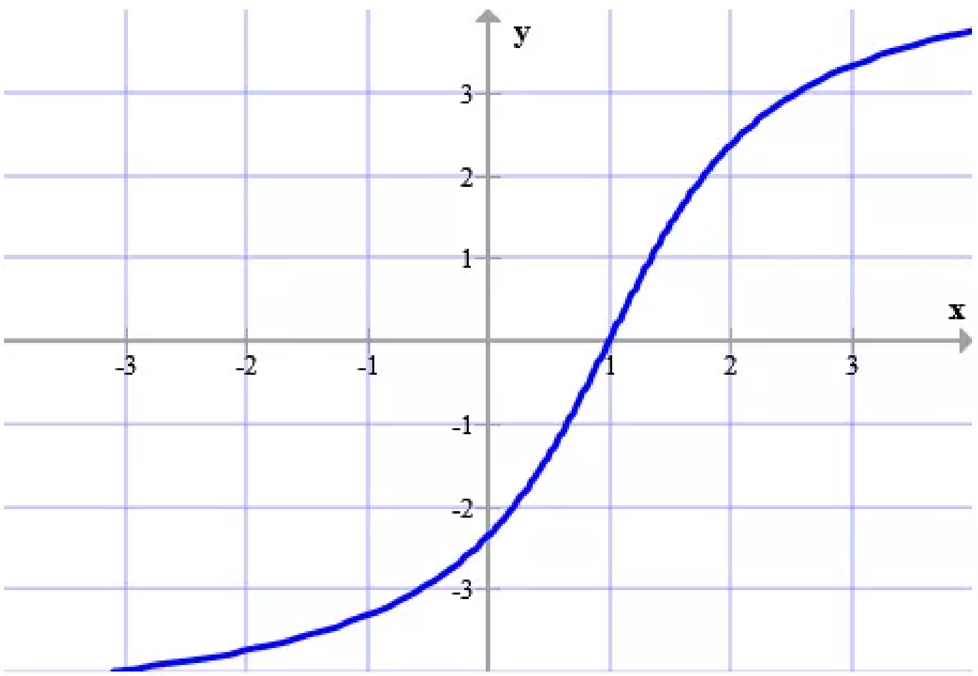



We note that the vertical lines intersect the graph of the relation at one point.

Therefore, the given relation is a function.

**Answer 22e.**

The given graph is shown below:

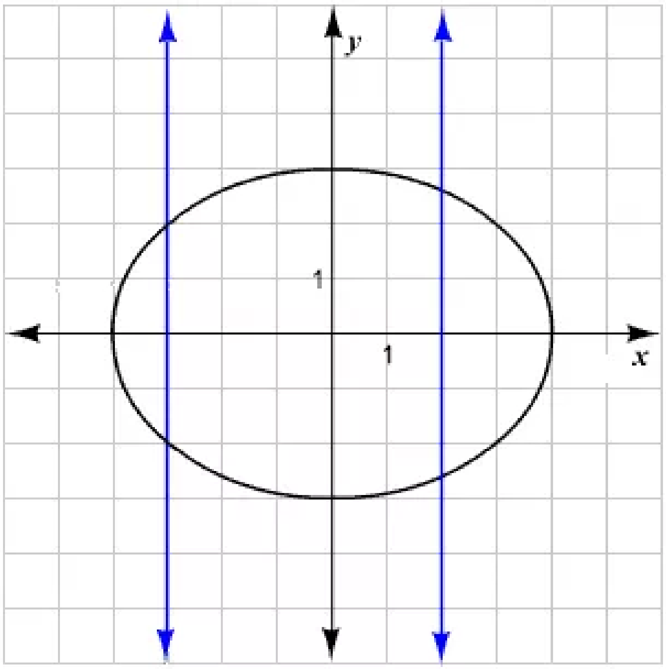



By drawing a vertical line to the graph, it is seen that the vertical line intersects the graph at only one point and the relation is a function if and only if no vertical line intersects the graph of the relation at more than one point.

## Answer 23e.

According to the vertical line test, if any vertical line drawn through the graph intersects the graph of the relation at more than one point, then that relation is not a function.

Draw two verticals line in the graph and check whether any of these vertical lines intersect the graph of the relation at more than one point.




We note that the vertical lines intersect the graph of the relation at more than one point.

Therefore, the given relation is not a function.

## Answer 24e.

A relation is a function if and only if no vertical line intersects the graph of the relation at more than one point. But the relation is not a function if the vertical line intersects the graph of the relation more than once because for a given input, it has got more than one output so the relation is not a function.

## Answer 25e.

***Step 1*** **Construct a table of values.**

We have to find a point on the graph. For this, substitute any value, say, 1 for $x$ in the given equation and evaluate.

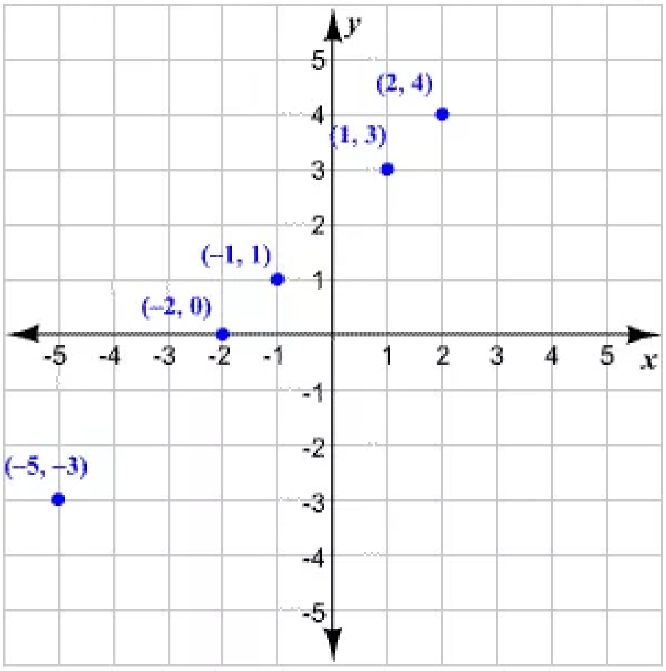
$$y = 1 + 2$$
$$= 3$$

One point is (1, 3). Similarly, take some more values of $x$ and find the corresponding $y$-values. Construct a table of values.

| | | | | |
|---|---|---|---|---|
| $x$ | $-5$ | $-1$ | 2 | $-2$ |
| $y$ | $-3$ | 1 | 4 | 0 |

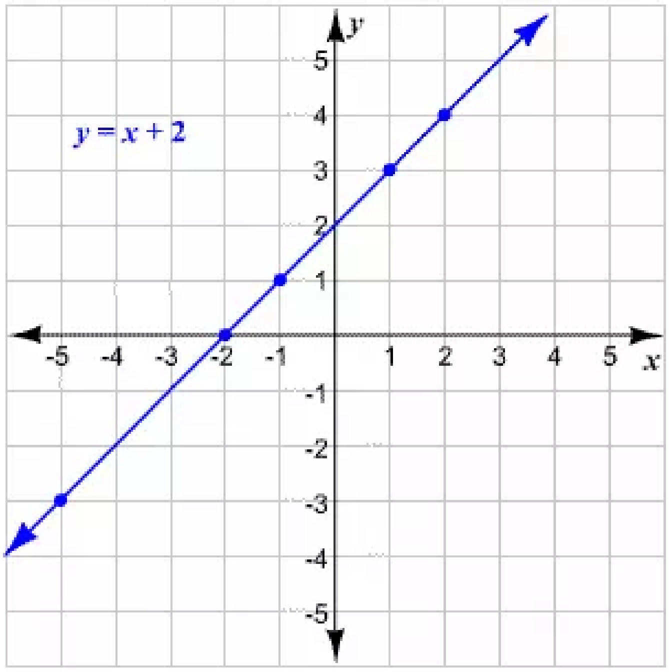
***Step 2*** **Plot the points.**

Plot the points from the table on a coordinate plane.




***Step 3*** **Connect the points with a line or curve.**

We note that these points can be joined using a line.



## Answer 26e.

We need to graph the equation

$$y = -x + 5 \qquad \ldots\ldots (1)$$

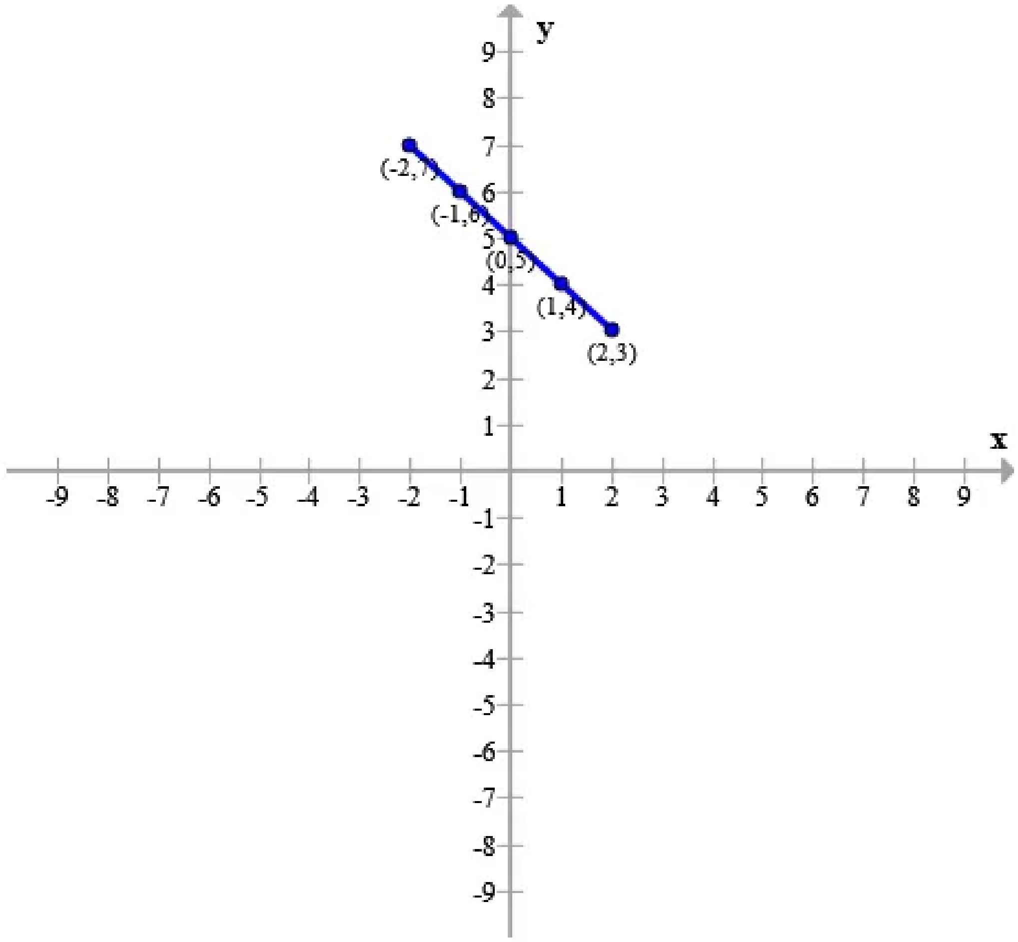
Substituting $x = 0$ in equation (1), we have

$$y = -0 + 5$$
$$= 5$$

Similarly, for the other values we construct a table of values.

| | | | | | |
|---|---|---|---|---|---|
| $x$ | 0 | −1 | 1 | −2 | 2 |
| $y$ | 5 | 6 | 4 | 7 | 3 |

We point all the points in the graph.




From the graph, it is seen that all the points lie in a line.

## Answer 27e.

***Step 1*** **Construct a table of values.**

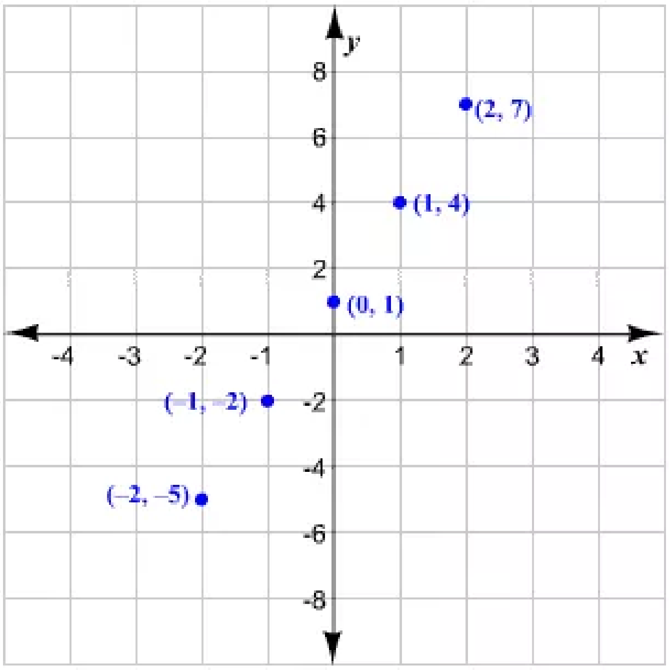
We have to find a point on the graph. For this, substitute any value, say, 0 for $x$ in the given equation and evaluate.

$$y = 3(0) + 1$$
$$= 1$$

One point on the graph is (0, 1). Similarly, choose several values for $x$ and find the corresponding values of $y$.

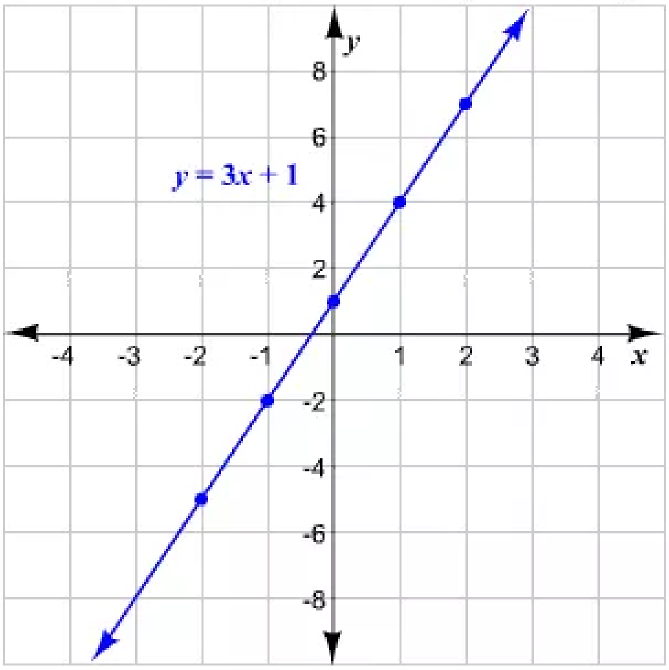
| | | | | | |
|---|---|---|---|---|---|
| $x$ | −2 | −1 | 0 | 1 | 2 |
| $y$ | −5 | −2 | 1 | 4 | 7 |

***Step 2*** **Plot the points.**




***Step 3*** **Connect the points with a line or curve.**

We note that these points can be joined using a line.



**Answer 28e.**

We need to graph the equation

$$y = 5x - 3 \qquad \text{...... (1)}$$

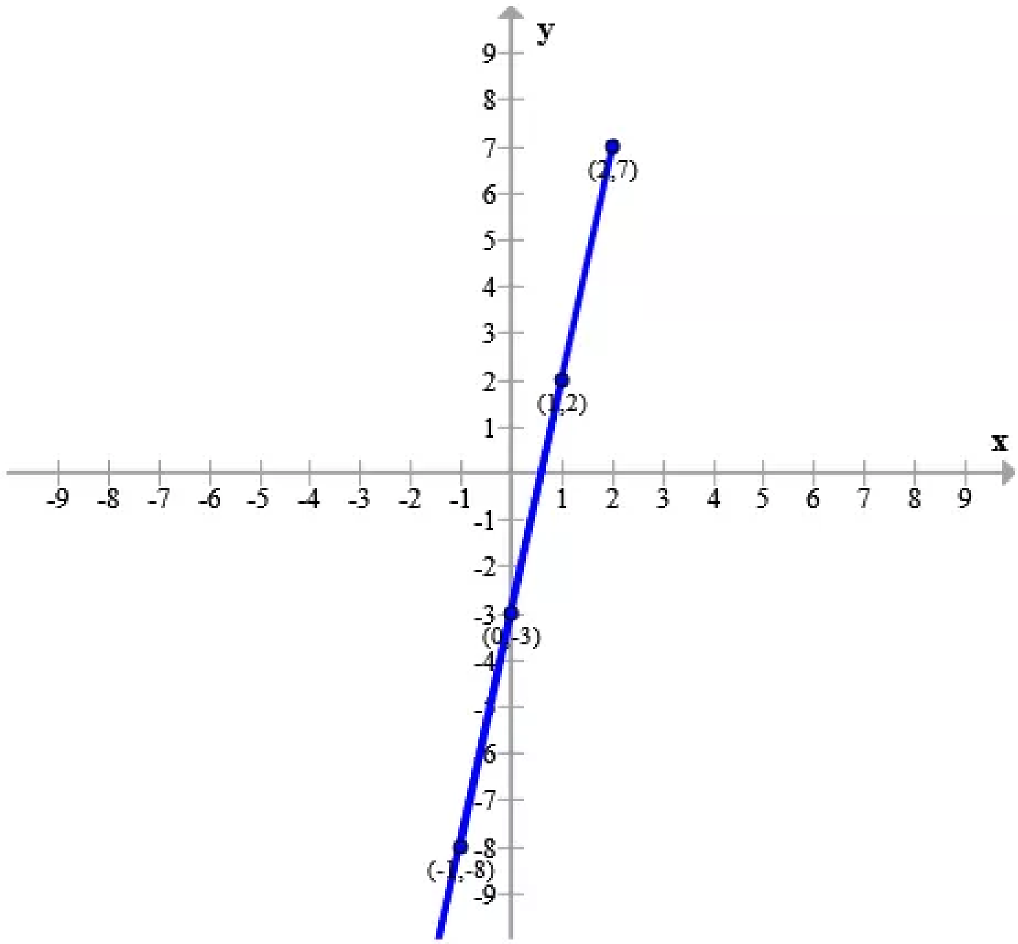
Substituting $x = 0$ in equation (1), we have

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

Similarly, for the other values we construct a table of values.

| $x$ | 0 | −1 | 1 | −2 | 2 |
|---|---|---|---|---|---|
| $y$ | −3 | −8 | 2 | −13 | 7 |

We point all the points in the graph.




From the graph, it is seen that all the points lie in a line.

**Answer 29e.**

***Step 1*** **Construct a table of values.**

We have to find a point on the graph. For this, substitute any value, say, 1 for $x$ in the given equation and evaluate.

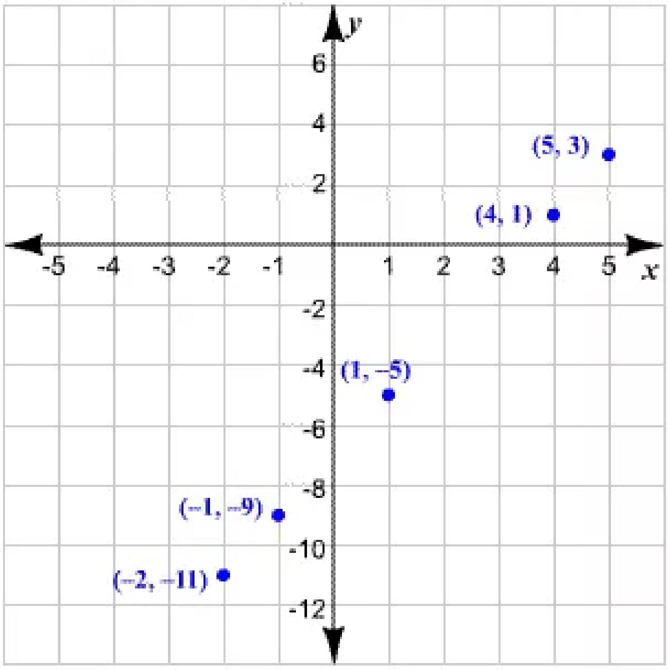
$$y = 2(1) - 7$$
$$= -5$$

One point is (1, −5). Similarly, take some more values of $x$ and find corresponding $y$-values. Construct a table of values.

| $x$ | − 1 | 4 | 5 | − 2 |
|---|---|---|---|---|
| $y$ | − 9 | 1 | 3 | − 11 |

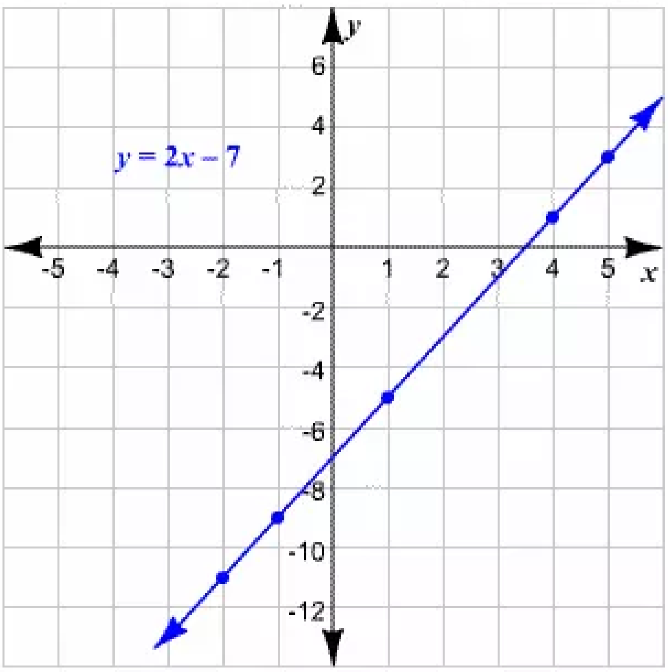
***Step 2*** **Plot the points.**

Plot the points from the table on a coordinate plane.




***Step 3*** **Connect the points with a line or curve.**

We note that these points can be joined using a line.



## Answer 30e.

We need to graph the equation

$$y = -3x + 2 \qquad \text{...... (1)}$$

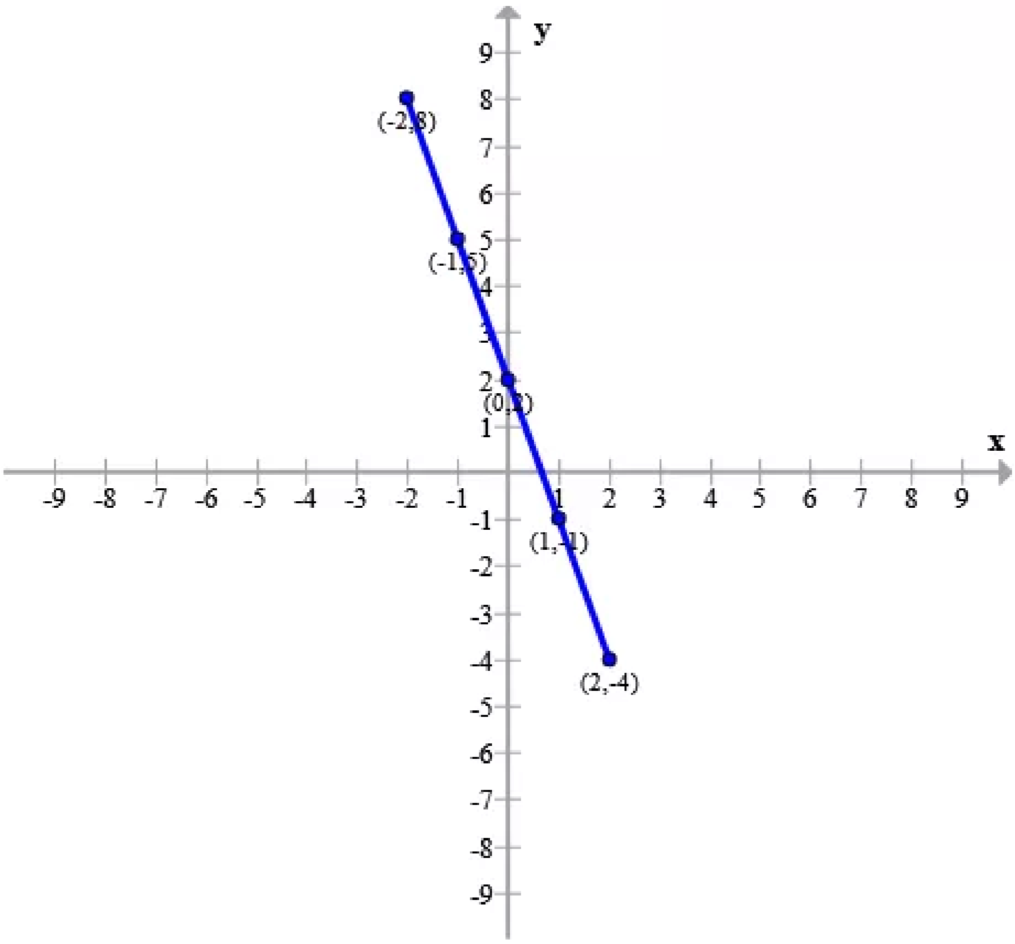
Substituting $x = 0$ in equation (1), we have

$$y = -3 \cdot 0 + 2$$
$$= 0 + 2$$
$$= 2$$

In this way, for the other values we construct a table for $y$.

| $x$ | 0 | −1 | 1 | −2 | 2 |
|---|---|---|---|---|---|
| $y$ | 2 | 5 | −1 | 8 | −4 |

We point all the points in the graph.




From the graph, it is seen that all the points lie in a line.

## Answer 31e.

***Step 1*** **Construct a table of values.**

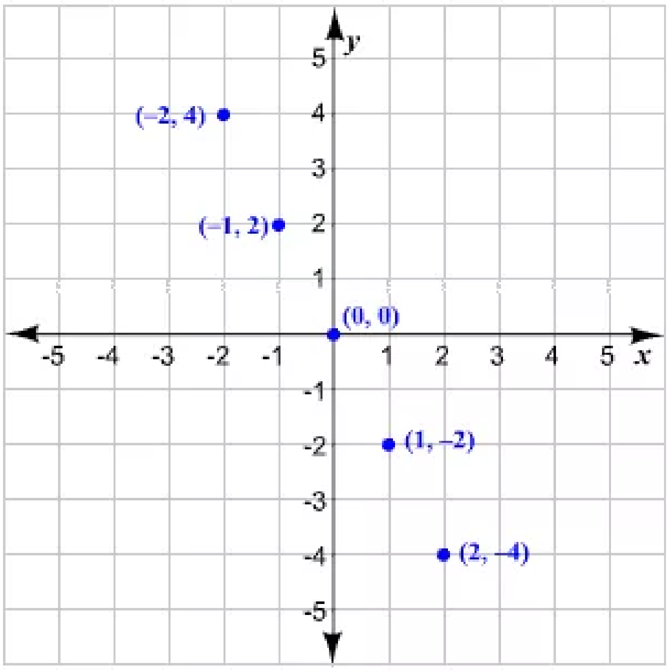
We have to find a point on the graph. For this, substitute any value, say, 0 for $x$ in the given equation and evaluate.

$$y = -2(0)$$
$$= 0$$

One point on the graph is (0, 0). Similarly, choose several values for $x$ and find the corresponding values of $y$.

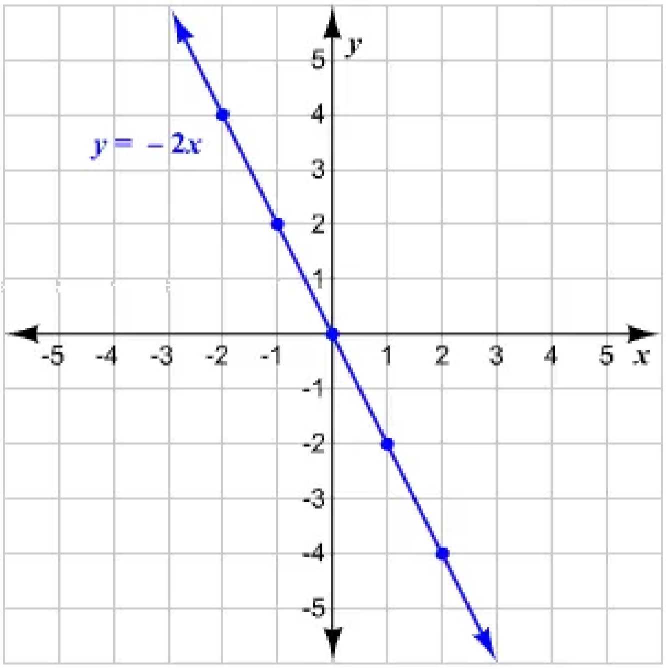
| $x$ | −2 | −1 | 0 | 1 | 2 |
|---|---|---|---|---|---|
| $y$ | 4 | 2 | 0 | −2 | −4 |

***Step 2*** **Plot the points.**




***Step 3*** **Connect the points with a line or curve.**

We note that these points can be joined using a line.



## Answer 32e.

We need to graph the equation

$$y=\frac{1}{2}x+2 \qquad \ldots\ldots (1)$$

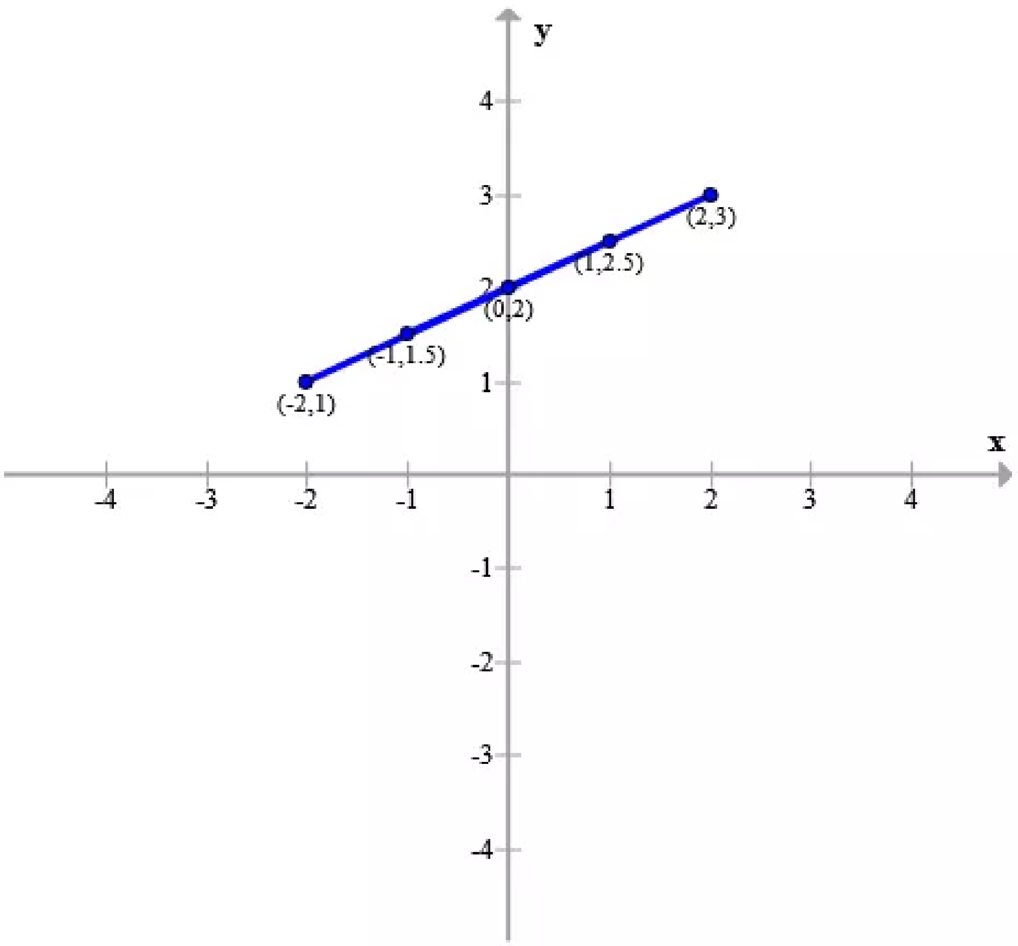
Substituting $x=0$ in equation (1), we have

$$y=\frac{1}{2}\cdot 0+2$$
$$=0+2$$
$$=2$$

In this way, for the other values we construct a table for $y$.

| | | | | | |
|---|---|---|---|---|---|
| $x$ | 0 | −1 | 1 | −2 | 2 |
| $y$ | 2 | 1.5 | 2.5 | 1 | 3 |

We point all the points in the graph.




From the graph, it is seen that all the points lie in a line.

## Answer 33e.

***Step 1*** **Construct a table of values.**

We have to find a point on the graph. For this, substitute any value, say, 4 for $x$ in the given equation and evaluate.

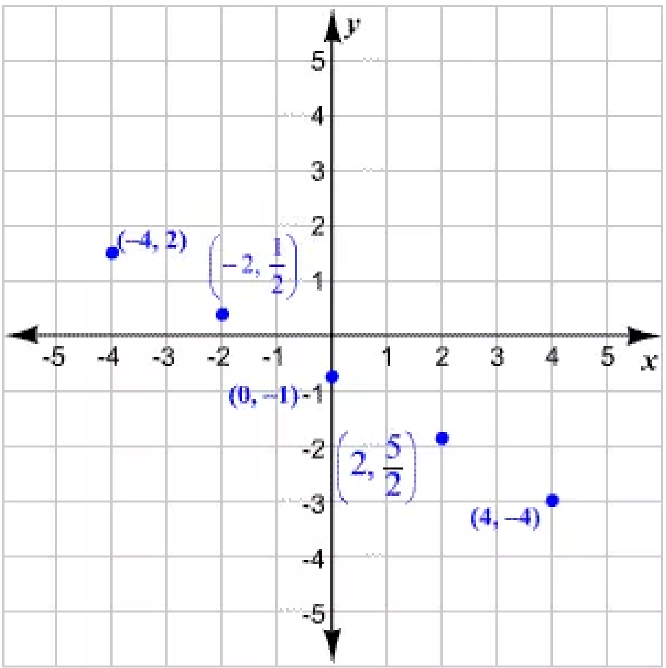
$$\begin{aligned} y &= -\frac{3}{4}(4) - 1 \\ &= -3 - 1 \\ &= -4 \end{aligned}$$

One point is (4, –4). Similarly, take some more values of $x$ and find corresponding $y$-values. Construct a table of values.

| $x$ | $-4$ | $0$ | $2$ | $-2$ |
|---|---|---|---|---|
| $y$ | $2$ | $-1$ | $-\frac{5}{2}$ | $\frac{1}{2}$ |

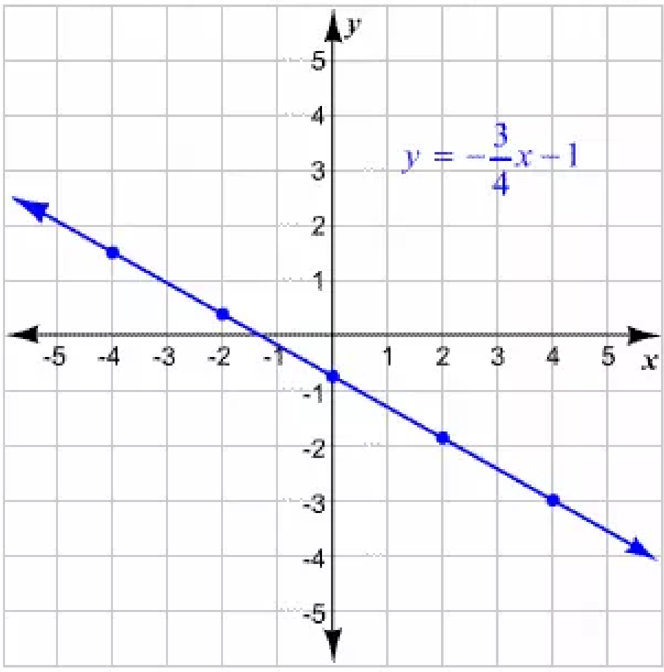
***Step 2*** **Plot the points.**

Plot the points from the table on a coordinate plane.



***Step 3*** **Connect the points with a line or curve.**

We note that these points can be joined using a line.




## Answer 34e.

The given function is

$$f(x) = x + 15 \quad \text{...... (1)}$$

We need to say whether the function is linear and to evaluate the value when $x = 8$

A function will be linear only if it can be written in the form $y = mx + b$, where $m$ and $b$ are constants.

The equation (1) is a linear function as because it can be written in the form $y = mx + b$.

When $x = 8$,

$$\begin{aligned} f(8) &= 8 + 15 \\ &= 23 \end{aligned}$$

Therefore the required value of $\boxed{f(8) = 23}$

## Answer 35e.

A function will be linear if it can be written in the form $y = mx + b$ or $f(x) = mx + b$, where $m$ and $b$ are constants.

We note that the given function is not of the form $f(x) = mx + b$.

Therefore, the given function is not a linear function.

Substitute $-3$ for $x$ in the given function to evaluate $f(-3)$.

$$f(-3) = (-3)^2 + 1$$

Simplify.

$$\begin{aligned} f(-3) &= 9 + 1 \\ &= 10 \end{aligned}$$

The given function evaluates to 10.

## Answer 36e.

The given function is

$$f(x)=|x|+10 \qquad \text{...... (1)}$$

We need to say whether the function is linear and to evaluate the value when $x=-4$

A function will be linear only if it can be written in the form $y=mx+b$, where $m$ and $b$ are constants.

The equation (1) is not a linear function as because $|x|$ is not included in the form

$$y=mx+b.$$

When $x=-4$,

$$f(-4)=|-4|+10$$

$$=4+10 \qquad \left[\text{Using}\,|x|=x\right]$$

$$=14$$

Therefore the required value of $\boxed{f(-4)=14}$

## Answer 37e.

A function is a linear function if it can be defined in the form $y=mx+b$ or $f(x)=mx+b$, where $m$ and $b$ are constants.

Rewrite the given function.

$f(x)=0x+6.$

We note that the given function is of the form $f(x)=mx+b$.

The given function is a linear function.

Substitute 2 for $x$ in the given function to evaluate $f(2)$.

$f(2)=0(2)+6$

Simplify.

$$f(2) = 0+6$$

$$= 6$$

The given function evaluates to 6.

## Answer 38e.

The given function is

$$g(x) = x^3 - 2x^2 + 5x - 8 \qquad \text{...... (1)}$$

We need to say whether the function is linear and to evaluate the value when $x = -5$

A function will be linear only if it can be written in the form $y = mx + b$, where $m$ and $b$ are constants.

The equation (1) is not a linear function as because $x^3, x^2$ is not included in the form $y = mx + b$.

When $x = -5$,

$$\begin{aligned} g(-5) &= (-5)^3 - 2(-5)^2 + 5(-5) - 8 \\ &= -125 - 50 - 25 - 8 \\ &= -208 \end{aligned}$$

Therefore the required value of $\boxed{g(-5) = -208}$

## Answer 39e.

A function will be linear if it can be written in the form $y = mx + b$ or $f(x) = mx + b$, where $m$ and $b$ are constants.

Rewrite the given function in the form $f(x) = mx + b$.

$$h(x) = \frac{-2}{3}x + 7$$

The given function is linear.

Substitute 15 for $x$ to evaluate $h(15)$.

$$h(15) = \frac{-2}{3}(15) + 7$$

Simplify.

$$\begin{aligned} h(15) &= -2(5) + 7 \\ &= -10 + 7 \\ &= -3 \end{aligned}$$

The given function evaluates to $-3$.

## Answer 40e.

The given equations are

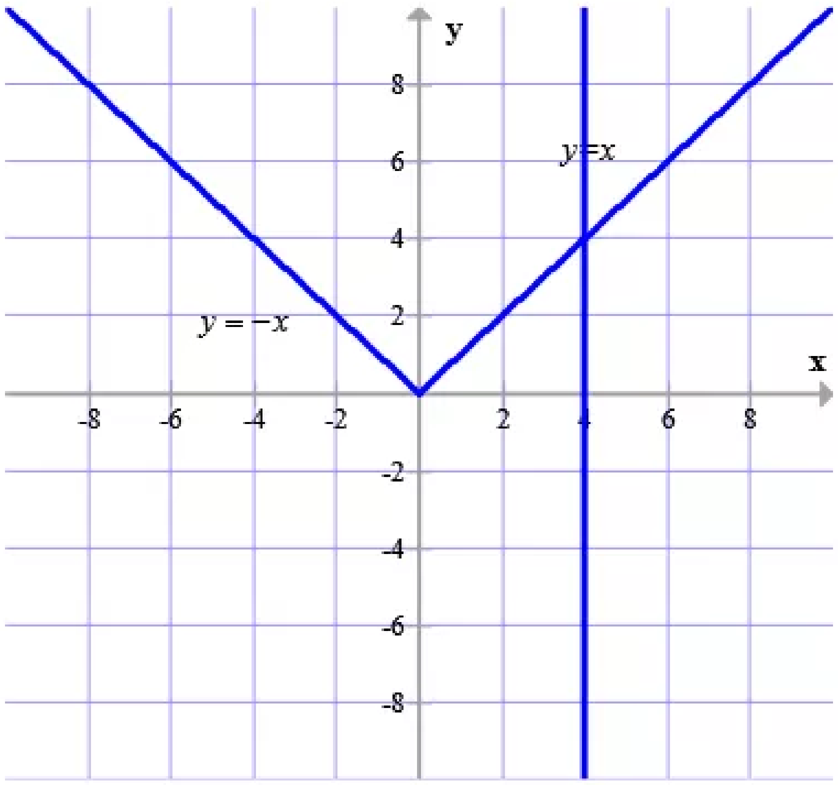
$$y = |x|, x = |y| \text{ and } |y| = |x|$$

We need to determine which relation is a function

Rewrite the function $y = |x|$

$$y = \begin{Bmatrix} x, x \geq 0 \\ -x, x < 0 \end{Bmatrix}$$

The graph of $y = |x|$ is shown below:

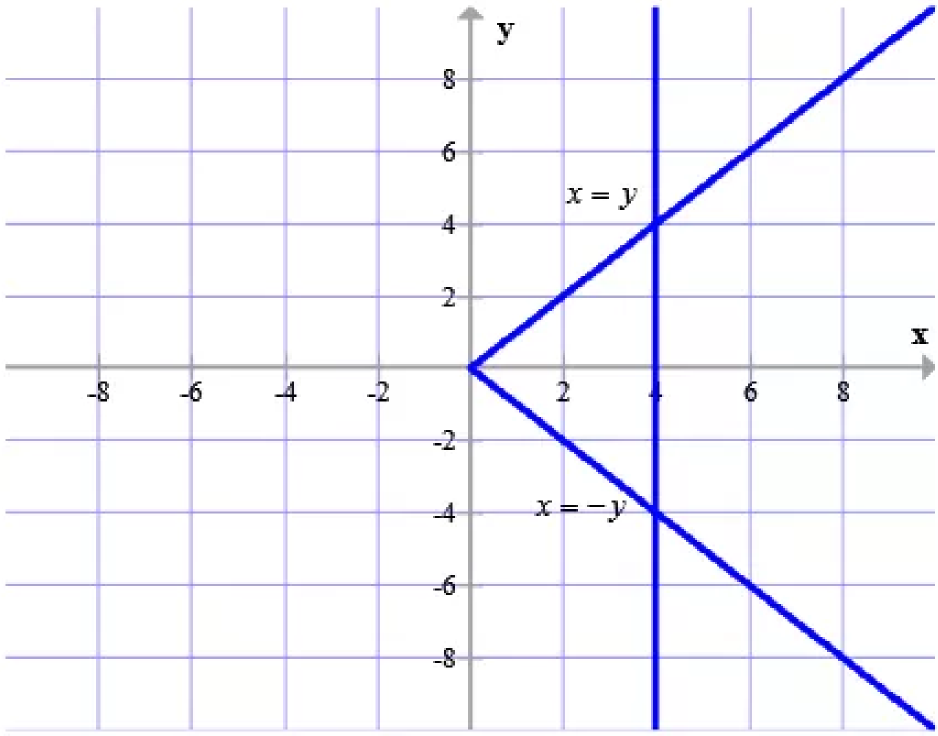



From the graph, it is seen that from the vertical test, for a single input, it has got only one output. Therefore the relation is a function.

Rewrite the function $x=|y|$

$$x=\begin{Bmatrix} y, y\geq 0 \\ -y, y<0 \end{Bmatrix}$$

The graph of $x=|y|$ is shown below:

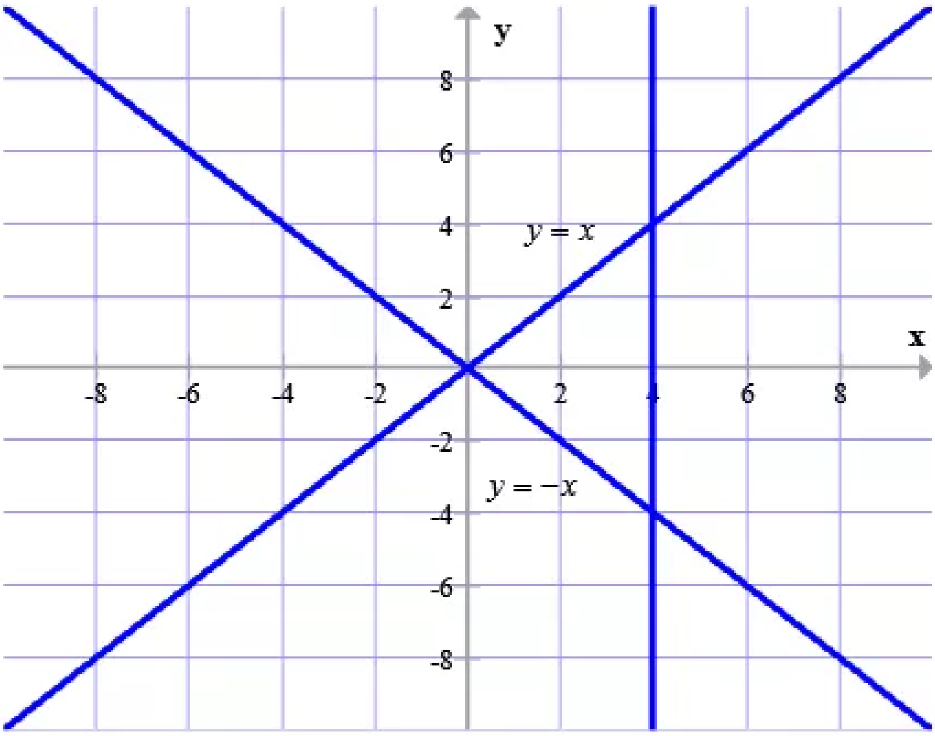



From the graph, it is seen that from the vertical test, for a single input, it has got two outputs. Therefore the relation is not a function.

$$y = |x|, y \geq 0$$
$$= -|x|, y < 0$$

$$y = \begin{cases} x, x \geq 0, y \geq 0 \\ -x, x < 0, y \geq 0 \\ -x, x \geq 0, y < 0 \\ x, x < 0, y < 0 \end{cases}$$

The graph of $|y| = |x|$ is shown below:




From the graph, it is seen that from the vertical test, for a single input, it has got two outputs. Therefore the relation is not a function.

## Answer 41e.

Replace $b$ with $a$ in $f(a+b) = f(a) + f(b)$.

$f(a+a) = f(a) + f(a)$

Simplify.

$$f(a+a) = f(a) + f(a)$$
$$f(2a) = 2 \cdot f(a)$$

Thus, we can see that $f(2a) = 2 \cdot f(a)$.

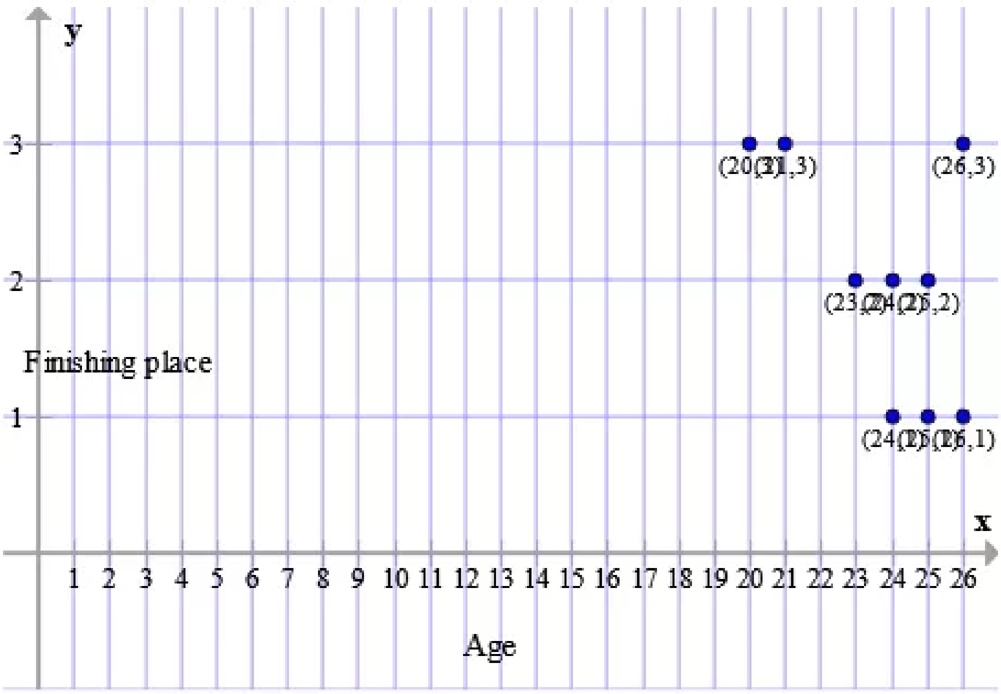
In order to find $f(0)$, substitute 0 for $a$ in $f(2a) = 2 \cdot f(a)$.

$$f[2(0)] = 2 \cdot f(0)$$
$$f(0) = 0$$

Thus, we can see that $f(0) = 0$.

## Answer 42e.

The graph is shown below:




The given ordered pairs are

$$(20,3),(21,3),(23,2),(24,1),(24,2),(25,1),(25,2),(26,1),(26,3)$$

A function is a relation for which each input has exactly one output. If any input of a relation has more than one output, the relation is not a function.

In the given ordered pairs, $(24,1),(24,2)$ the input 24 has got two outputs 1 and 2 respectively. Again in the ordered pairs, $(26,1),(26,3)$, the input 26 has got two outputs 1 and 3 respectively.

Therefore the given ordered pairs

$(20,3),(21,3),(23,2),(24,1),(24,2),(25,1),(25,2),(26,1),(26,3)$ is **not a function**.

## Answer 43e.

A function is a relation in which each input has exactly one output. This means that for each $x$-coordinate, there should be exactly one $y$-coordinate.

From the given graph, we note that for each input value there is exactly one output value.

Therefore, the ordered pairs (starts, wins) represent a function.

## Answer 44e.

It is given that the volume of a cube with edge length $s$ is given by the function

$$V(s) = s^3.$$

We need to find $V(4)$

Here , $s = 4$

Therefore, the volume is

$$V(4) = 4^3$$

$$\boxed{V(4) = 64}$$

$V(4)$ represents the volume of a cube with edge length $\boxed{4}$

## Answer 45e.

Substitute 6 for $r$ in the given function to evaluate $V(6)$.

$$V(6) = \frac{4}{3}\pi(6)^3$$

Simplify.

$$\begin{aligned} \frac{4}{3}\pi(6)^3 &= 288\pi \\ &= 904.7786842 \\ &\approx 905 \end{aligned}$$

Thus, the given function evaluates to 905 approximately.

The function $V(6)$ represents the volume of the sphere when the radius is 6.

**Answer 46e.**

It is given that for the period1999-2004, the average number of acres $w$ in thousands used to grow watermelons in the United States can be modeled by the function

$$w(t) = -6.26t + 172 \qquad \ldots\ldots (1)$$

Where $t$ is the number of years since 1999. We need to determine a reasonable domain and range for $w(t)$.

For the period 1999-2004, number of years

$$= 2004 - 1999$$
$$= 5$$

In the year 1999, $t = 0$

Substituting the value of $t = 0$ in equation (1), we have

$$w(0) = -6.26 \times 0 + 172$$
$$= 172$$

Substituting the value of $t = 5$ in equation (1), we have

$$w(5) = -6.26 \times 5 + 172$$
$$= 140.7$$

The reasonable domain is $\boxed{0,5}$ and

The reasonable range is $\boxed{172,140.7}$

The average number of acres $w$ in thousands used to grow watermelons from the year 1999-2004 is 172-140.7. As the number of years increases, the range , the number of acres goes on decreasing.

**Answer 47e.**

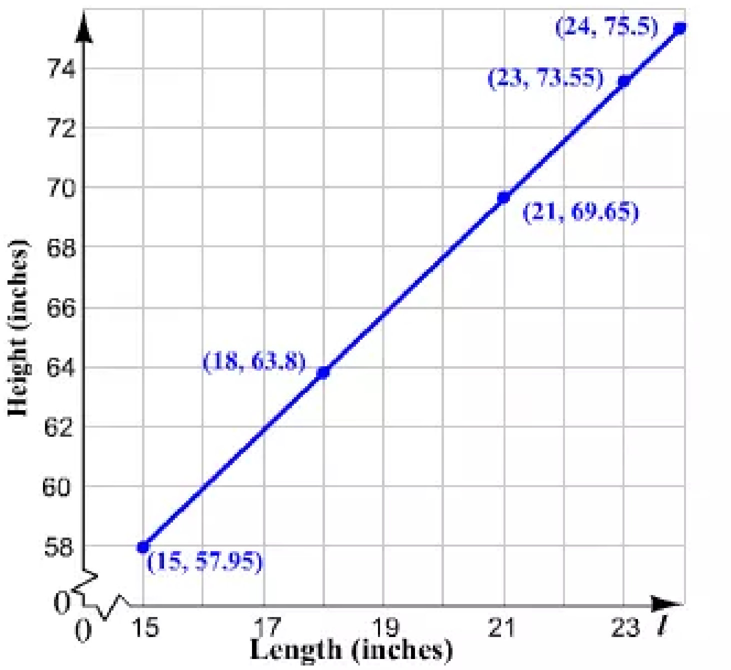
**a.** We have to find a point on the graph. For this, substitute any value, say, 15 for $l$ in the given equation and evaluate.

$$h(15) = 1.95(15) + 28.7$$
$$= 29.25 + 28.7$$
$$= 57.95$$

One point on the graph is (15, 57.95). Similarly, choose several values for $l$ and find the corresponding values of $h(l)$.

| $l$ | 15 | 18 | 21 | 23 | 24 |
|---|---|---|---|---|---|
| $h(l)$ | 57.95 | 63.8 | 69.65 | 73.55 | 75.5 |

Connect these points using a line segment.




From the graph, we can see that the length varies from 15 to 24. Thus, a reasonable domain will be $15 \le l \le 24$.

We note that the minimum value of $h(l)$ is at $h(15)$, which is 57.95 and the maximum value is at $h(24)$, which is 75.5. A reasonable range will be $57.95 \le h(l) \le 75.5$

**b.** For a length of 15.5 inches, the height of the bone will be equal to $h(15.5)$.

Substitute 15.5 for $l$ in the given equation and evaluate.

$$\begin{aligned} h(15.5) &= 1.95(15.5) + 28.7 \\ &= 30.225 + 28.7 \\ &= 58.925 \\ &\approx 59 \end{aligned}$$

The female will be about 59 inches tall.

**c.** The height of a female is given as 5 feet 11 inches. This means that $h(l)$ will be 5 feet 11 inches or 71 inches.

Substitute 71 for $h(l)$ in the given equation to determine $l$.

$71 = 1.95l + 28.7$

Subtract 28.7 from both sides of the equation.

$$71 - 28.7 = 1.95l + 28.7 - 28.7$$
$$42.3 = 1.95l$$

Divide both the sides by 1.95.

$$\frac{42.3}{1.95} = \frac{1.95l}{1.95}$$
$$21.6923 = l$$
$$21.7 \approx l$$

The length of the bone, for a height of 5 feet 11 inches, will be 21.7 inches.

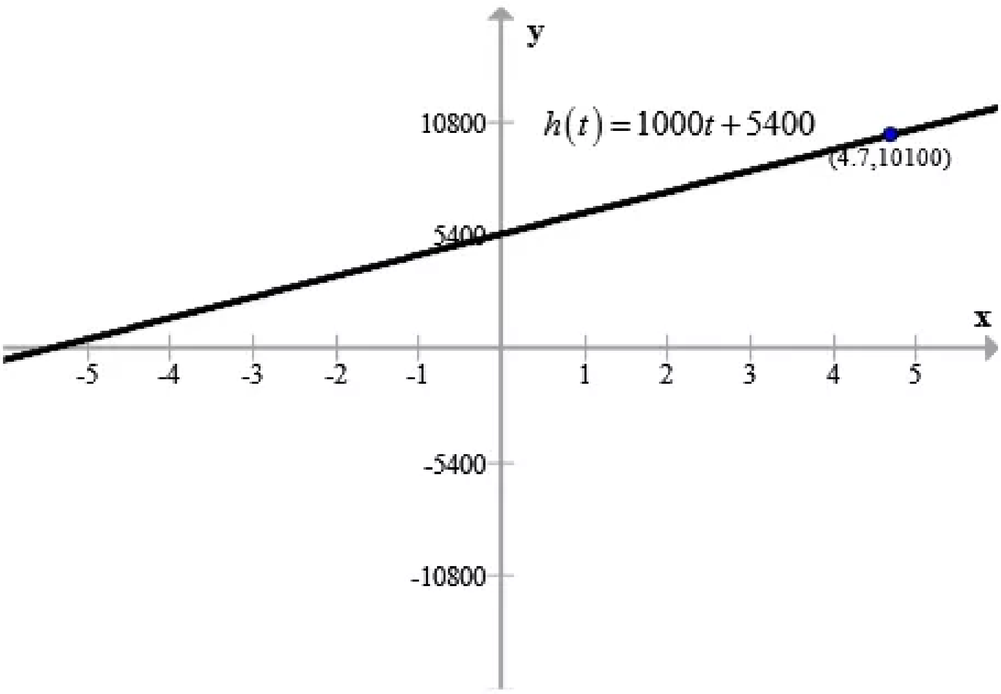
**Answer 48e.**

It is given that a climber on Mount Rainier in Washington hikes from an elevation of 5400 $ft$ above sea level to Camp Muir, which has an elevation of 10,100 $ft$. The elevation in $h$ in $ft$ can be modeled by

$$h(t) = 1000t + 5400 \qquad \ldots\ldots (1)$$

Where $t$ is the time in hours. We need to graph the function and determine the reasonable domain and range.

The graph of the equation (1) is shown below:




Substituting $h = 10100$, in equation (1), we have

$$10100 = 1000t + 5400$$
$$1000t = 10100 - 5400$$
$$1000t = 4700$$
$$t = \frac{4700}{1000}$$
$$t = 4.7$$

The reasonable domain is $\boxed{0, 4.7}$

The reasonable range is $\boxed{5400, 10100}$

When $t = 3.5 hours$,

Substituting $t = 3.5 hours$, in equation (1), we have

$$h(3.5) = 1000 \times 3.5 + 5400$$
$$= 8900$$

The climber's elevation after hiking 3.5 hours is

$$\boxed{8900 ft}$$

**Answer 49e.**

**(a)** We know that the set of input values ($x$-coordinates) is called the domain of a relation. Similarly, the set of output values ($y$-coordinates) is called the range of a relation.

It is given that the population ($p$) corresponds to $x$-coordinates and the electoral votes ($v$) correspond to $y$-coordinates.

Thus, the domain of the given relation is 11,350,000, 12,280,000, 12,420,000, 15,980,000, 18,980,000, 20,850,000, and 33,870,000.

Similarly, the range of the given relation is 20, 21, 27, 31, 34, and 55.

**(b)** We know that a function is a relation for which each input has exactly one output.

From the table, we can see that each input ($p$) is mapped onto only one output. The given relation is a function.

**(c)** In the ordered pairs $(v, p)$, the input is the electoral votes $v$, and the output is the population $p$ in millions.

From the table, we can see that input 21 is mapped onto more than one output. Therefore, the given relation is not a function.

## Answer 50e.

The table is shown below:

| Merchandise Cost | \$0.01-\$30.00 | \$30.01-\$60.00 | \$60.01-\$100.00 | Over \$100.00 |
|---|---|---|---|---|
| Shipping Cost | \$4.50 | \$7.25 | \$9.50 | \$12.50 |

(a)
A function is a relation for which each input has exactly one output. If any input of a relation has more than one output, the relation is not a function. The relation is also a function if two distinct inputs have got the same output.
The shipping cost is not a function of merchandise cost because for a single shipping cost, the merchandise cost varies in the interval.
(b)
The merchandise cost is a function of the shipping cost because any interval of merchandise cost, it has a single shipping cost.

## Answer 51e.

Substitute 6 for $x$, and 2 for $y$ in the given expression.

$$\frac{y-3}{x-4} = \frac{2-3}{6-4}$$

Perform the subtraction operations from left to right in the numerator and the denominator.

$$\frac{2-3}{6-4} = \frac{-1}{2}$$

$$= -\frac{1}{2}$$

The given expression evaluates to $-\frac{1}{2}$.

## Answer 52e.

We need to evaluate the expression

$$\frac{y-8}{x-2}, \text{ when } x=3, y=4$$

Substituting the value of $x=3, y=4$ in the expression $\frac{y-8}{x-2}$, we have

$$\frac{y-8}{x-2} = \frac{4-8}{3-2}$$

$$= \frac{-4}{1}$$

Therefore the value of the expression $\frac{y-8}{x-2}$, is

$\boxed{-4}$

## Answer 53e.

Substitute −3 for $x$ and −3 for $y$ in the given expression.

$$\frac{-3-(-5)}{-3-1}$$

The given expression is of the form $\frac{a}{b}$, where $a$ and $b$ are expressions with two or more operations. We can simplify expressions of this form by following the order of operations and working separately above and below the fraction bar.

By the order of operations, work above and below the fraction bar separately.
We can evaluate the expression above the fraction bar, −3 − (−5).
Subtract.

$$-3-(-5) = -3+5$$
$$= 2$$

Next, evaluate the expression below the fraction bar, −3 − 1.
Subtract.

$$-3-1=-4$$

Divide.

$$\frac{2}{-4} = -\frac{1}{2}$$

Thus, the given function evaluates to $-\frac{1}{2}$.

## Answer 54e.

We need to evaluate the expression

$$\frac{24-y}{15-x}, \text{ when } x=-17, y=8$$

Substituting the value of $x=-17, y=8$ in the expression $\frac{24-y}{15-x}$, we have

$$\frac{24-y}{15-x}=\frac{24-8}{15-(-17)}$$

$$=\frac{16}{15+17} \qquad [\text{Using } (-\text{ve})\times(-\text{ve})=(+\text{ve})]$$

$$=\frac{16}{32}$$

$$=\frac{1}{2}$$

Therefore the value of the expression $\frac{24-y}{15-x}$, is

$$\boxed{\frac{1}{2}}$$

## Answer 55e.

Subtract 16 from both sides of the equation.

$$3x + 16 - 16 = 31 - 16$$
$$3x = 15$$

Divide both the sides by 3 to solve for $x$.

$$\frac{3x}{3} = \frac{15}{3}$$
$$x = 5$$

***Check.***

Substitute 5 for $x$ in the original equation.

$$3x + 16 = 31$$
$$3(5) + 16 \stackrel{?}{=} 31$$
$$15 + 16 \stackrel{?}{=} 31$$
$$31 = 31 \checkmark$$

Therefore, the solution of the given equation is 5.

## Answer 56e.

To solve the equation

$$-4x - 7 = 17 \quad \ldots\ldots (1)$$

At first, we need to isolate the term containing $x$ ,we need to add $+7$ to both the sides of the equation (1),

$$-4x - 7 + 7 = 17 + 7$$
$$-4x = 24$$
$$x = \frac{24}{-4}$$
$$x = -6$$

The required value of $\boxed{x = -6}$

To check:

$$-4x - 7 = -4 \times (-6) - 7 \qquad [\text{Using } x = -6]$$
$$= 24 - 7$$
$$= 17$$

Hence checked.

## Answer 57e.

Add $3x$ to each side of the equation.

$$5x + 12 + 3x = -3x - 4 + 3x$$
$$8x + 12 = -4$$

Subtract 12 from each side.

$$8x + 12 - 12 = -4 - 12$$
$$8x = -16$$

Divide each side by 8.

$$\frac{8x}{8} = \frac{-16}{8}$$
$$x = -2$$

***Check.***

Substitute $-2$ for $x$ in the original equation and evaluate.

$$5x + 12 = -3x - 4$$
$$5(-2) + 12 \stackrel{?}{=} -3(-2) - 4$$
$$-10 + 12 \stackrel{?}{=} 6 - 4$$
$$2 = 2 \checkmark$$

Therefore, the value of $x$ is $-2$.

## Answer 58e.

To solve the equation

$$5 - 8z = 25 + 4z \qquad \ldots\ldots (1)$$

At first, we need to collect the terms containing $z$ to the left side and the constant terms to the right hand side of the equation (1)

$$-8z - 4z = 25 - 5$$
$$-12z = 20$$
$$z = \frac{20}{-12}$$
$$z = -\frac{5}{3} \qquad \text{[Dividing both numerator and denominator by 4]}$$

The required value of $\boxed{z = -\frac{5}{3}}$

To check:

$$5-8z=5-8\times\left(-\frac{5}{3}\right) \qquad \left[\text{Using } z=-\frac{5}{3}\right]$$

$$=5+\frac{40}{3}$$

$$=\frac{55}{3}$$

$$25+4z=25+4\times\left(-\frac{5}{3}\right)$$

$$=25-\frac{20}{3}$$

$$=\frac{55}{3}$$

Hence checked.

## Answer 59e.

Multiply both sides of the equation by the least common denominator 2.

$$2\left[\frac{5}{2}(3v-4)\right] = 2(30)$$

$$5(3v-4) = 60$$

Use the distributive property to open the parentheses.

$$5(3v)-5(4) = 60$$

$$15v-20 = 60$$

Add 20 to both sides of the equation.

$$15v-20+20 = 60+20$$

$$15v = 80$$

Divide both the sides by 15 to solve for $v$.

$$\frac{15v}{15} = \frac{80}{15}$$

$$v = \frac{16}{3}$$

*Check.*

Substitute $\frac{16}{3}$ for $v$ in the original equation.

$$\frac{5}{2}(3v-4) = 30$$

$$\frac{5}{2}\left[3\left(\frac{16}{3}\right)-4\right] \stackrel{?}{=} 30$$

$$\frac{5}{2}(16-4) \stackrel{?}{=} 30$$

$$\frac{5}{2}(12) \stackrel{?}{=} 30$$

$$30 = 30 \quad \checkmark$$

Therefore, the solution of the given equation is $\frac{16}{3}$.

**Answer 60e.**

To solve the equation

$$6(4w+1)=1.5(8w+18)$$

Using distributive law,

$$6\cdot(4w)+6\cdot(1)=1.5\cdot(8w)+1.5\cdot(18)$$

$$24w+6=12w+27 \qquad \ldots\ldots (1)$$

At first, we need to collect the terms containing $w$ to the left side and the constant terms to the right hand side of the equation (1)

$$24w-12w=27-6$$

$$12w=21$$

$$w=\frac{21}{12}$$

$$w=\frac{7}{4} \qquad \text{[Dividing both numerator and denominator by 3]}$$

The required value of $\boxed{z=\frac{7}{4}}$

To check:

$$6(4w+1)=6\cdot\left[4\cdot\left(\frac{7}{4}\right)+1\right] \quad \left[\text{Using } w=\frac{7}{4}\right]$$

$$=6\cdot[7+1]$$

$$=6\cdot 8$$

$$=48$$

$$1.5(8w+18)=1.5\left[8\cdot\left(\frac{7}{4}\right)+18\right] \quad \left[\text{Using } w=\frac{7}{4}\right]$$

$$=1.5[14+18]$$

$$=1.5[32]$$

$$=48$$

Hence checked.

## Answer 61e.

Add 6 to both sides of the inequality.

$$2x - 6 + 6 > 8 + 6$$

$$2x > 14$$

Divide both the sides by 2.

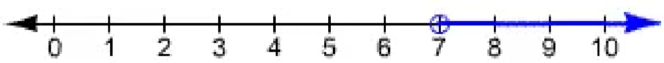
$$\frac{2x}{2} > \frac{14}{2}$$

$$x > 7$$

The solution includes all the numbers greater than 7.

Graph the solution set.

Shade all the regions to the right of 7. An open dot is used to indicate 7 is not a solution of the given inequality.




## Answer 62e.

To solve the inequality

$$\frac{1}{4}x + 7 > 0 \quad \ldots\ldots (1)$$

Adding $-7$ to both the sides of equation (1), we have

$$\frac{1}{4}x + 7 - 7 > -7$$

$$\frac{1}{4}x > -7$$

Multiplying the whole inequality with 4, we have

$$\boxed{x > -28}$$

The graph of $x > -28$ is shown below:

## Answer 63e.

Add $2x$ to both sides of the inequality.

$$15 - 2x - 15 \le 7 - 15$$

$$-2x \le -8$$

Divide both the sides by $-2$. Reverse the inequality since it is divided by a negative number.

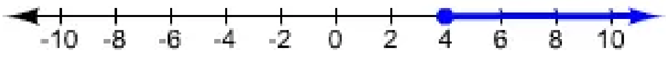
$$\frac{-2x}{-2} \ge \frac{-8}{-2}$$

$$x \ge 4$$

The solution includes all the numbers greater than or equal to 4.

Graph the solution set.

Shade the region to the right of 4. Use a shaded circle at 4 to denote that 4 is also included in the solution set.




## Answer 64e.

To solve the inequality

$$4 - x < 3 \qquad \ldots\ldots (1)$$

Adding $-4$ to both the sides of equation (1), we have

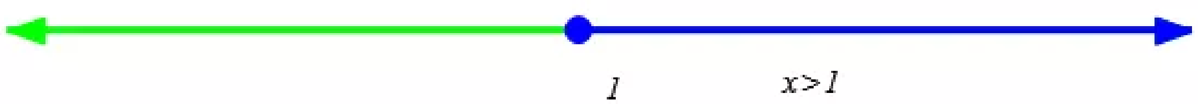
$$4 - x - 4 < 3 - 4$$

$$-x < -1$$

Multiplying the whole inequality with $-1$ to $-x < -1$, we have

$$\boxed{x > 1}$$

The graph of $x > 1$ is shown below:




## Answer 65e.

Add 1 to each expression.

$$-7+1 < 6x-1+1 < 5+1$$

$$-6 < 6x < 6$$

Divide each expression by 6.

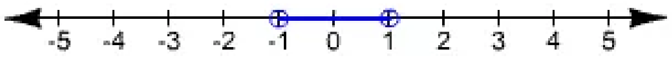
$$\frac{-6}{6} < \frac{6x}{6} < \frac{6}{6}$$

$$-1 < x < 1$$

The solution includes all real numbers greater than $-1$ and less than 1.

Graph the solution set.

Shade all the regions between $-1$ and 1. Open dots are used to indicate $-1$ and 1 are not solutions of the given inequality.




## Answer 66e.

To solve the inequality

$$x-2 \le 1 \text{ or } 4x+3 \ge 19$$

Adding 2 to both the sides of the inequality $x-2 \le 1$ we have

$$x-2+2 \le 1+2$$

$$x \le 3$$

Adding $-3$ to both the sides of the inequality we have

$$4x+3-3 \ge 19-3$$

$$4x \ge 16$$

$$x \ge \frac{16}{4}$$

$$x \ge 4$$

$$\boxed{x \ge 4}$$

The graph of $x > 1$ is shown below:


The solution of $\boxed{x = (-\infty, 3] \cup [4, \infty)}$