A **relation** is a set of ordered pairs. The set of first components of the ordered pairs is called the **domain** and the set of second components of the ordered pairs is called the **range**.

<table>
<thead>
<tr>
<th>input value</th>
<th>output value</th>
</tr>
</thead>
<tbody>
<tr>
<td>independent variable</td>
<td>dependent variable</td>
</tr>
</tbody>
</table>

**Ex1:** For each of these, state whether it is a relation, and if it is, list the elements in the domain and in the range.

a) \{(1,5), (5,-2), (5,4), (3,2)\}  
b) Bud  
May  
Ezi  
Zhu  
Tia  

c)  
d) Input values: days of the week  
Output values: final letter in word  

e) \{\text{name}, \text{rank}, \text{serial number}\}
A **function** is a relation in which any two ordered pairs with the same first component also have the same second component.

Ex 2: From example 1, which of the relations are functions?

a) \{(1,5), (5,-2), (5,4), (3,2)\}

b) 
<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bud</td>
<td>15</td>
</tr>
<tr>
<td>May</td>
<td>16</td>
</tr>
<tr>
<td>Ezi</td>
<td>17</td>
</tr>
<tr>
<td>Zhu</td>
<td>18</td>
</tr>
<tr>
<td>Tia</td>
<td>19</td>
</tr>
</tbody>
</table>

c)

d) Input values: days of the week  
Output values: final letter in word

An equation in two variables can be a relation as can a 2-dimensional graph.

Ex 3: Which of these are functions?

a) \(x+3 = y^2\)

b) \(2y = \sqrt{x-1}\)

c) \(x^2 + y^2 = 9\)

d) \{(3,1), (2,1), (5,1), (6,2)\}
**The Vertical Line Test:** A graph represents a function if no vertical line intersects it at more than one point.

Ex 4: Use the vertical line test to determine if these relations are functions.

\[ R_1 = \{(1,5), (5,-2), (5,4), (3,2)\} \quad R_2 = \{(3,1), (2,1), (5,1), (-3,2)\} \]

![Graphs](image1.png) ![Graphs](image2.png)

**Function Notation**

Ex 5: Evaluate these functions for the given values.

a) \( f(x) = \sqrt{x + 8} + 2 \)

\[ f(-8) \quad f(x-8) \]

b) \( g(x) \)

\[ g(2) = \quad g(0) = \quad g(a) = -2 \text{ for } a = \]

\[ g(x) \]
**Domain of Functions**

The **domain** of a function is the set of all input values for which the function is defined.

**Implicit domain**

**Explicit domain**

---

**Ex 6:** Determine the domain for each of these functions and identify as implicit or explicit.

a) \( f(x) = \sqrt[3]{x} + 4 \)

c) \( g(x) = \frac{3}{x^2 - 2x} \)

d) \( f(x) = \frac{\sqrt{x + 4}}{4 + x} \)

e) \( h(x) = 5x - 3, \quad x > -1 \)