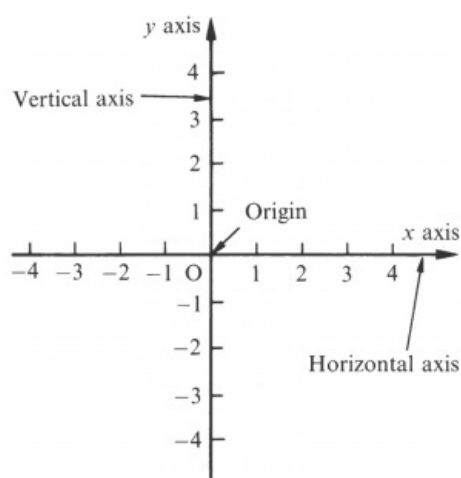


# Cheatsheet - Graphs of Functions and Kinematics

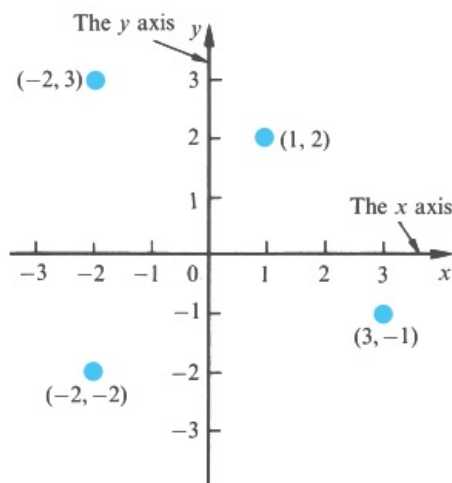
Fabio Lama – fabio.lama@pm.me

## 1. Intro

We introduce horizontal and vertical axes. These axes intersect at a point  $O$  called the origin. The horizontal axis is used to represent the **independent** variable, commonly  $x$ , and the vertical axis is used to represent the **dependent** variable, commonly  $y$ . The region shown is then referred to as the  $x$ - $y$  plane.



**Figure 17.1**  
The  $x$ - $y$  plane



**Figure 17.2**  
Several points in the  $x$ - $y$  plane

## 2. Intervals

We only need part of the  $x/y$  axis when plotting graphs. Each coordinate on the axis is called an **interval**. There are three types of intervals:

- *Closed interval*: includes its end-points, e.g.  $\{x : x \in \mathbb{R}, 1 \leq x \leq 3\}$ , denoted as  $[1, 3]$  (square brackets).
- *Open interval*: does not include its end-points, e.g.  $\{x : x \in \mathbb{R}, 1 < x < 3\}$ , denoted as  $(1, 3)$  (round brackets).
- *Semi-open and semi-closed interval*: may be open at one end and closed at the other, e.g.  $\{x : x \in \mathbb{R}, 1 < x \leq 3\}$ , denoted as  $(1, 3]$  (round and square bracket).

Closed intervals use the filled marking,  $[-3, 4]$ :



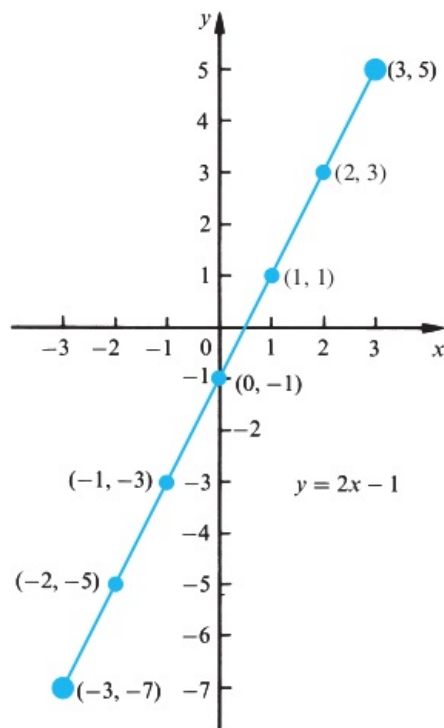
Open intervals used the hollow marking,  $(1, 4)$ :



## 3. Plotting Graphs of a Function

Plotting a graph of  $y = 2x - 1$  for  $-3 \leq x \leq 3$ :

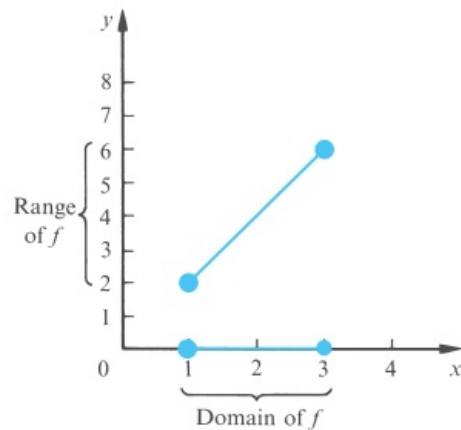
|     |    |    |    |    |   |   |   |
|-----|----|----|----|----|---|---|---|
| $x$ | -3 | -2 | -1 | 0  | 1 | 2 | 3 |
| $y$ | -7 | -5 | -3 | -1 | 1 | 3 | 5 |



## 4. Domain and Range of Function

The set of values that we allow the independent variable to take is called the **domain** of the function. If the domain is not specified, we take the largest set possible. The set of values taken by the output is called the **range** of function. The domain and range can extend indefinitely (infinite) in one or both directions.

For example, the function  $f$  is given by  $y = f(x) = 2x$ , for  $1 \leq x \leq 3$ .



## 5. Kinematics

Describes the motion of objects without reference to forces, hence **acceleration will always be constant**.

Basic definitions:

$d$  = displacement

$v$  = velocity

$a$  = acceleration

$t$  = time

**Velocity** and **displacement** can have subscripts that indicate initial conditions:

$v_o = v_i$  = initial velocity

$v_t = v_f$  = final velocity

Fundamental equations:

- $v_t = v_i + at$

- The velocity of any object at time  $t$  is equal to the *initial* velocity plus the acceleration times  $t$

- $x_t = x_o + v_i t + \frac{1}{2}at^2$ 
  - The position of the object at time  $t$  is equal to the *initial* position  $x_o$  plus its *initial* velocity  $v_i$  multiplied by time  $t$  plus  $\frac{1}{2}at^2$ .
- $v_f^2 = v_i^2 + 2ad$ 
  - Velocity squared at time  $t$  is equal to the *initial* velocity squared plus  $2ad$ .

Additionally:

$$d = v_i t + \frac{1}{2}at^2$$

$$v_f^2 = v_i^2 + 2ad$$

$$v_f = v_i + at$$

$$d = \left( \frac{v_i + v_f}{2} \right) t$$

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