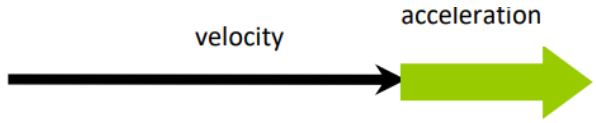
Acceleration 2

For the case of rectilinear motion (just to remind – this is the motion along a straight line) there are **two major cases**:

1)Acceleration is directed along the velocity.

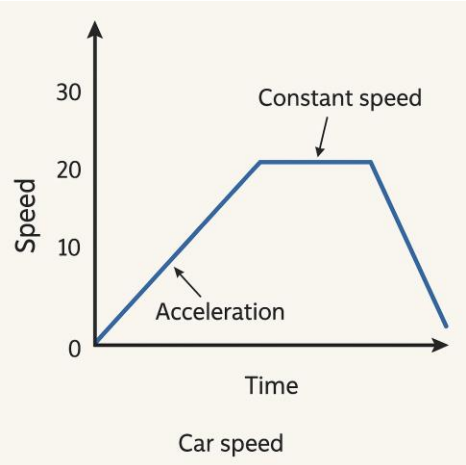


In this case the velocity and acceleration have same sign and speed of the object is increasing with time. The acceleration magnitude gives us the rate of speed increase. For example, acceleration of 5 meters per second per second (this is not a typo!) means that the speed increases for 5m/s every second. It is usually denoted as $5m/s^2$ (five meter per second square).

2)

In this case the velocity and acceleration have opposite signs and speed of the object decreases with time. The acceleration magnitude gives us the rate of the speed decrease. For example, acceleration of $-5m/s^2$ means that the speed decreases by 5m/s every second.

We can **draw a diagram** to interpret speed and time.



On the x – axis we put time, and speed on the y – axis.

From this graph, we can see three things: how fast something is moving (speed), how far it goes (distance), and how its speed changes (acceleration). The speed is shown on the graph, the distance is the area under the line – we will discuss it next class, and the **acceleration is how steep the line is – its slope**.

In the case of uniform acceleration, the **average velocity** can be calculated as:

$$V_{average} = \frac{V_{initial} + V_{final}}{2} = \frac{V_{initial} + V_{initial} + at}{2} = \frac{2 \cdot V_{initial} + at}{2} = V_{initial} + \frac{at}{2}$$

Homework:

1) Tesla's Model S Plaid is one of the fastest-accelerating production cars. It reaches 60 mph in just 2 seconds.

a. Find its acceleration and compare it to the **Gravitational acceleration** *g* (note that you will need some unit conversion to carry out the comparison!).

b. Now assume that a car traveling at a speed of 60 mph starts braking with acceleration -4 m/s^2. How long would it take to stop?

c. What is average velocity of the car during braking?

2) If in the future humans are to reach the nearby stars, they would need spaceships traveling at a speed close to the speed of light. Imagine that a spaceship is accelerating with acceleration 10 m/s^2.

a. How long would it take such a ship to reach 1/10 of the **speed of light**? (Speed of light is $3x10^8 m/s$).

b. How long would it take such a ship to reach the Alpha Centauri system which is about 4 light-years away from the Earth and is the star system closest to us? Assume that the spaceship moves with 1/10 of the speed of light.

Hint: A **light-year** is the distance that light travels in vacuum in one Julian year (365.25 days).