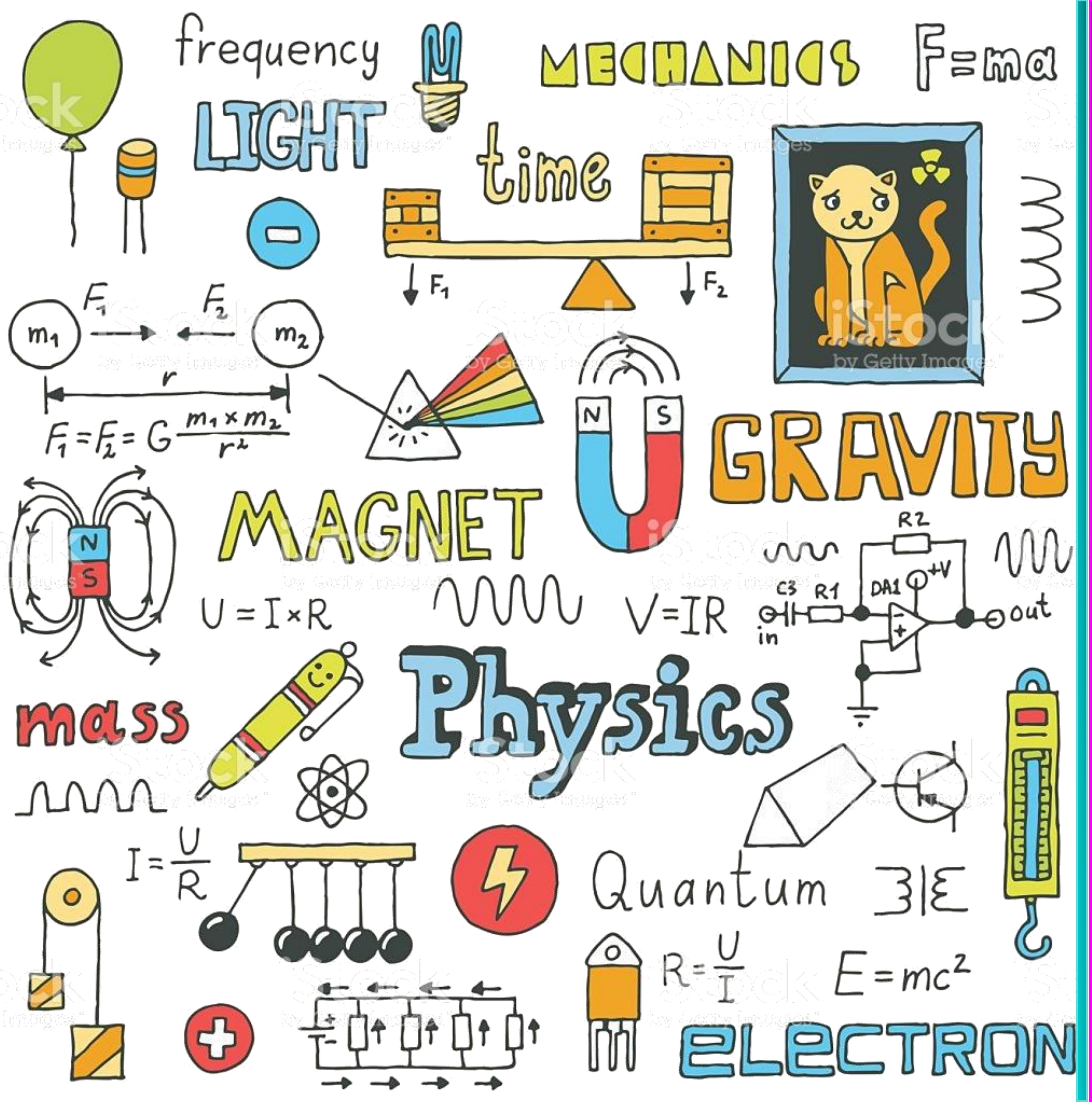

Physics

L2

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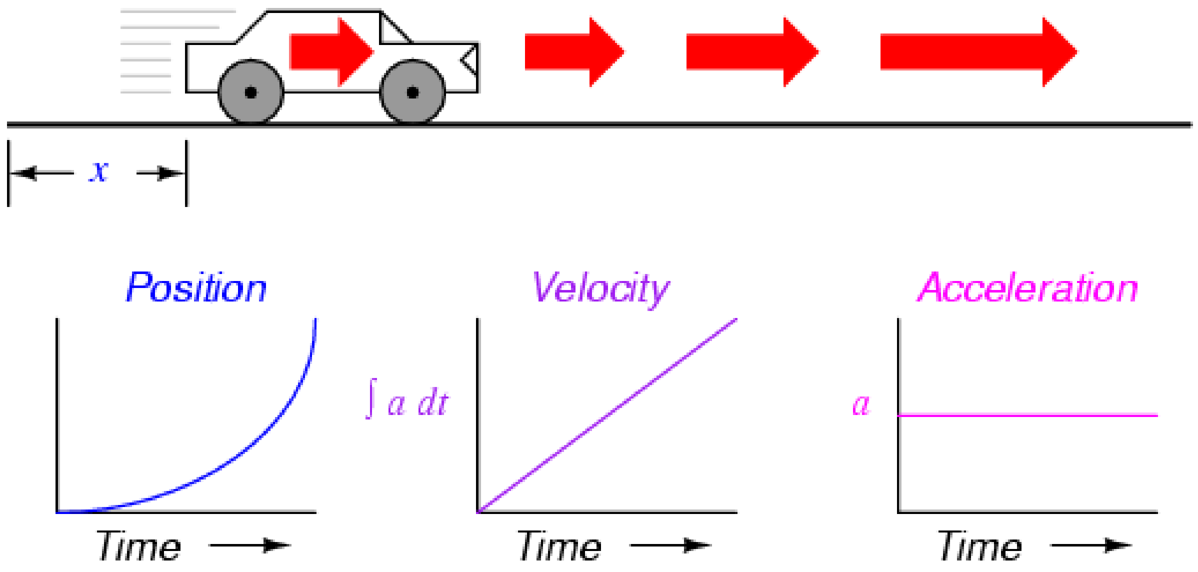
What are we going to talk about today?

Ch 1 : Motion in a Straight Line

- 1.4 Acceleration.
- 1.5 Finding the Motion of an object.
- 1.6 The Acceleration of Gravity and Falling Objects.



1.2 Displacement; Average Velocity.

Example 1.5, P:8 at $t_i = 5$ s, a car is at $x_i = 600$ m, and at $t_f = 15$ s, it is at $x_f = 500$ m. Find its average velocity. Ans $(-10\ m/s)$

1–Draw Diagram:

2–Identify Data:

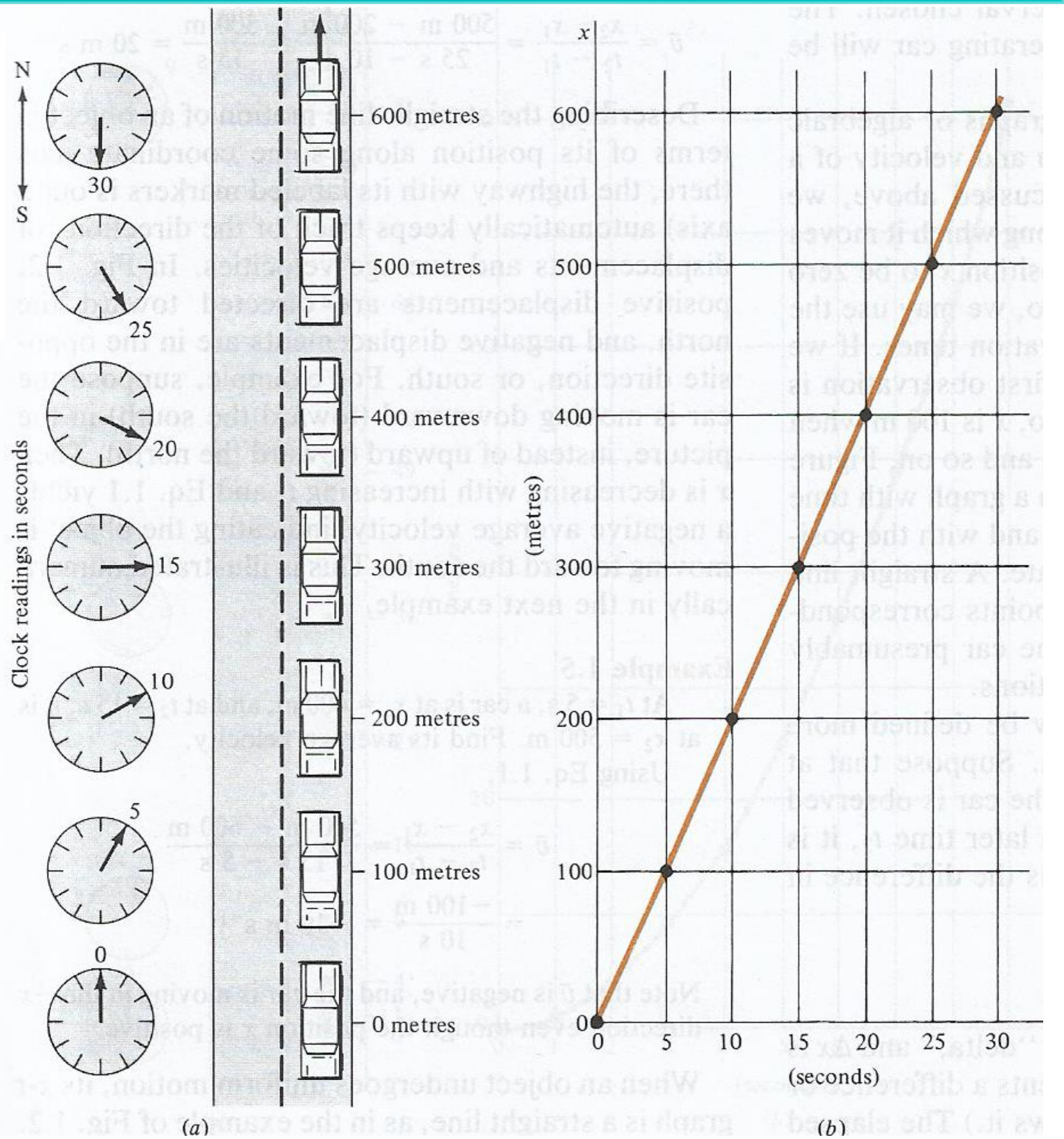
3–Choose Equation:

4– Solve Equation:

1.2 Displacement; Average Velocity.

Ex2: **What is the average velocity of the car in the figure during the interval that the clock reading changes from 5 to 10 seconds?**

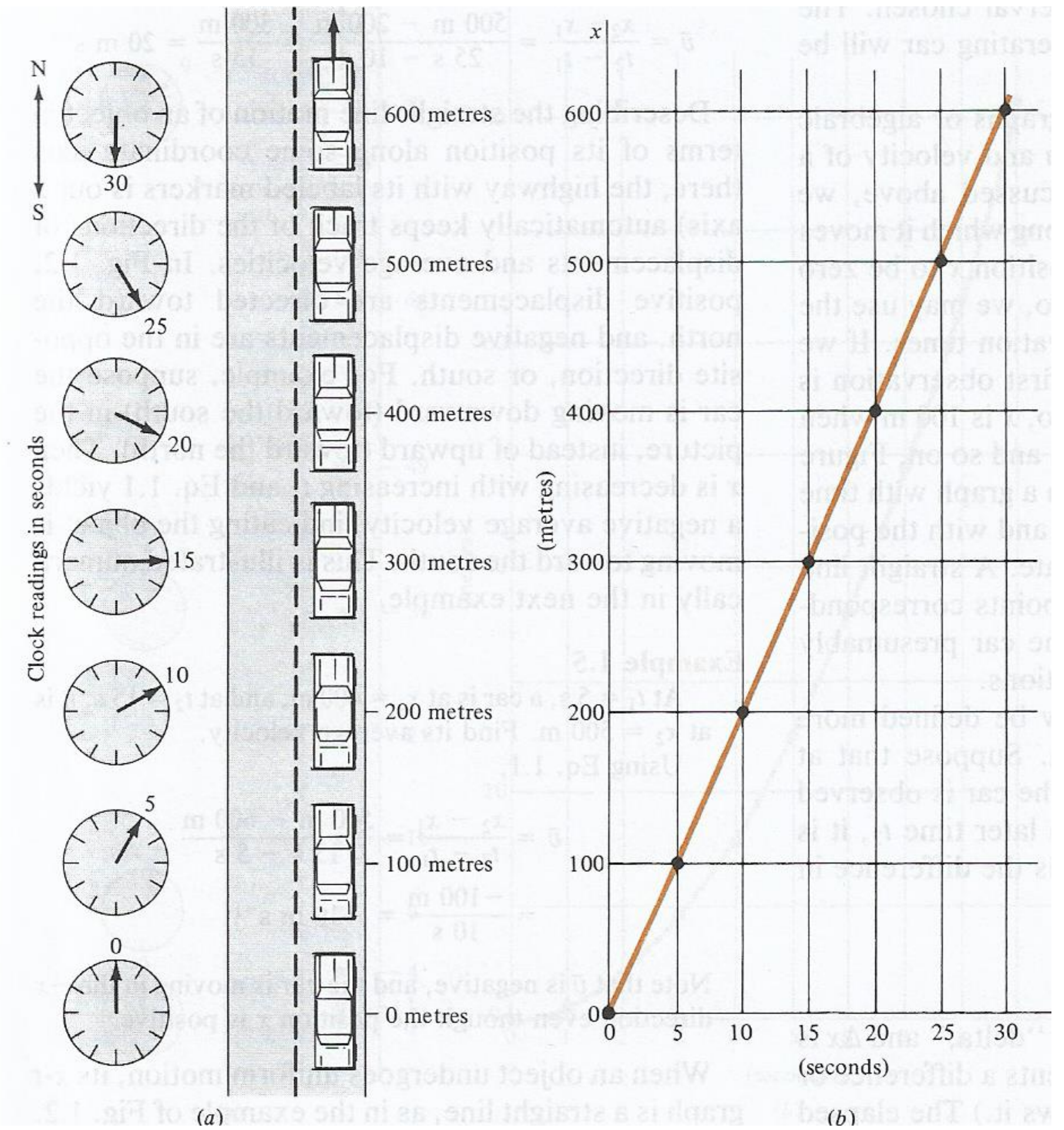
Ans $(20\ m/s)$



1.2 Displacement; Average Velocity.

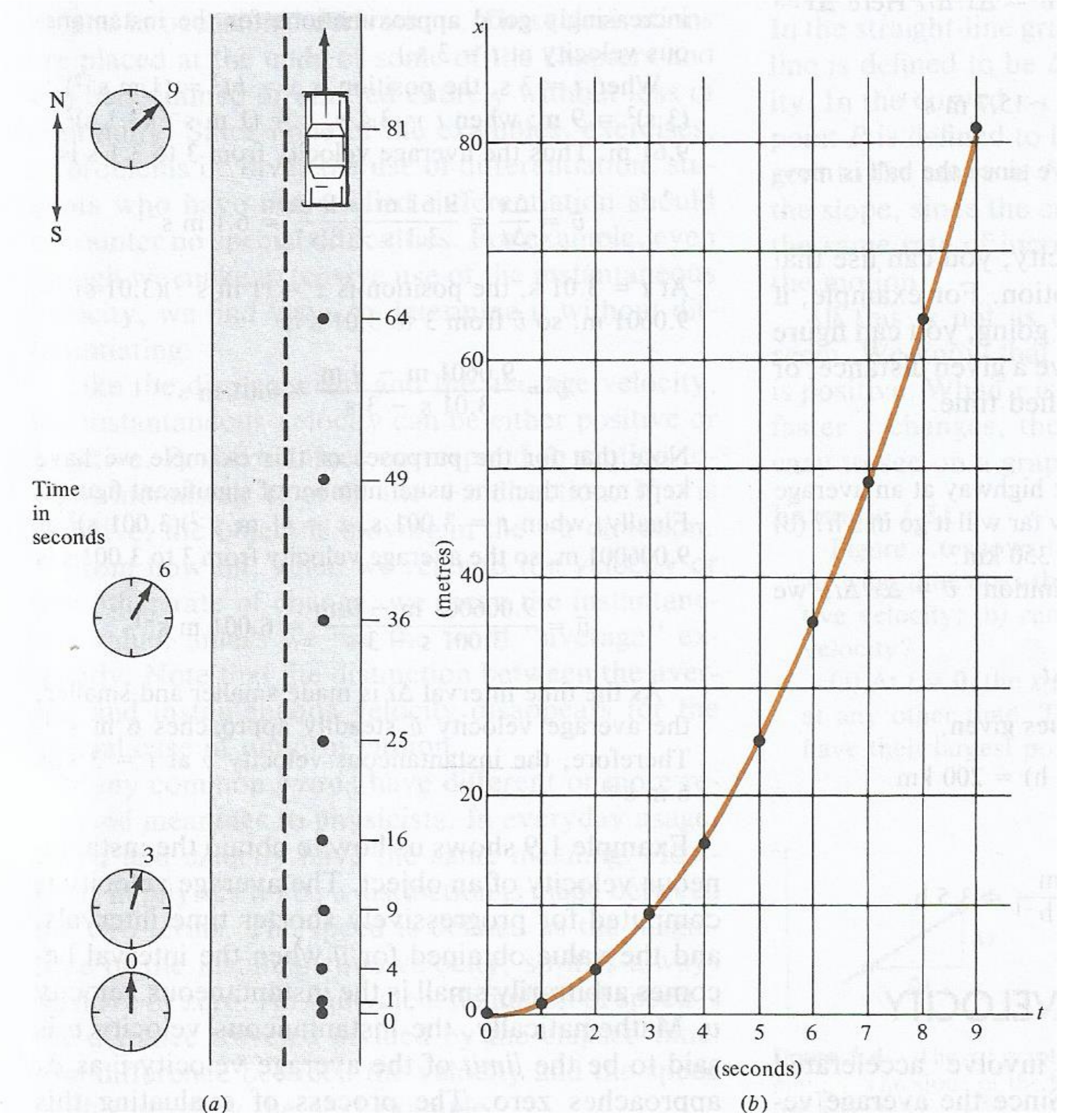
Example 1.4, P:8 What is the average velocity of the car in the figure during the interval that the clock reading changes from 10 to 25 seconds?

Ans $(20\ m/s)$



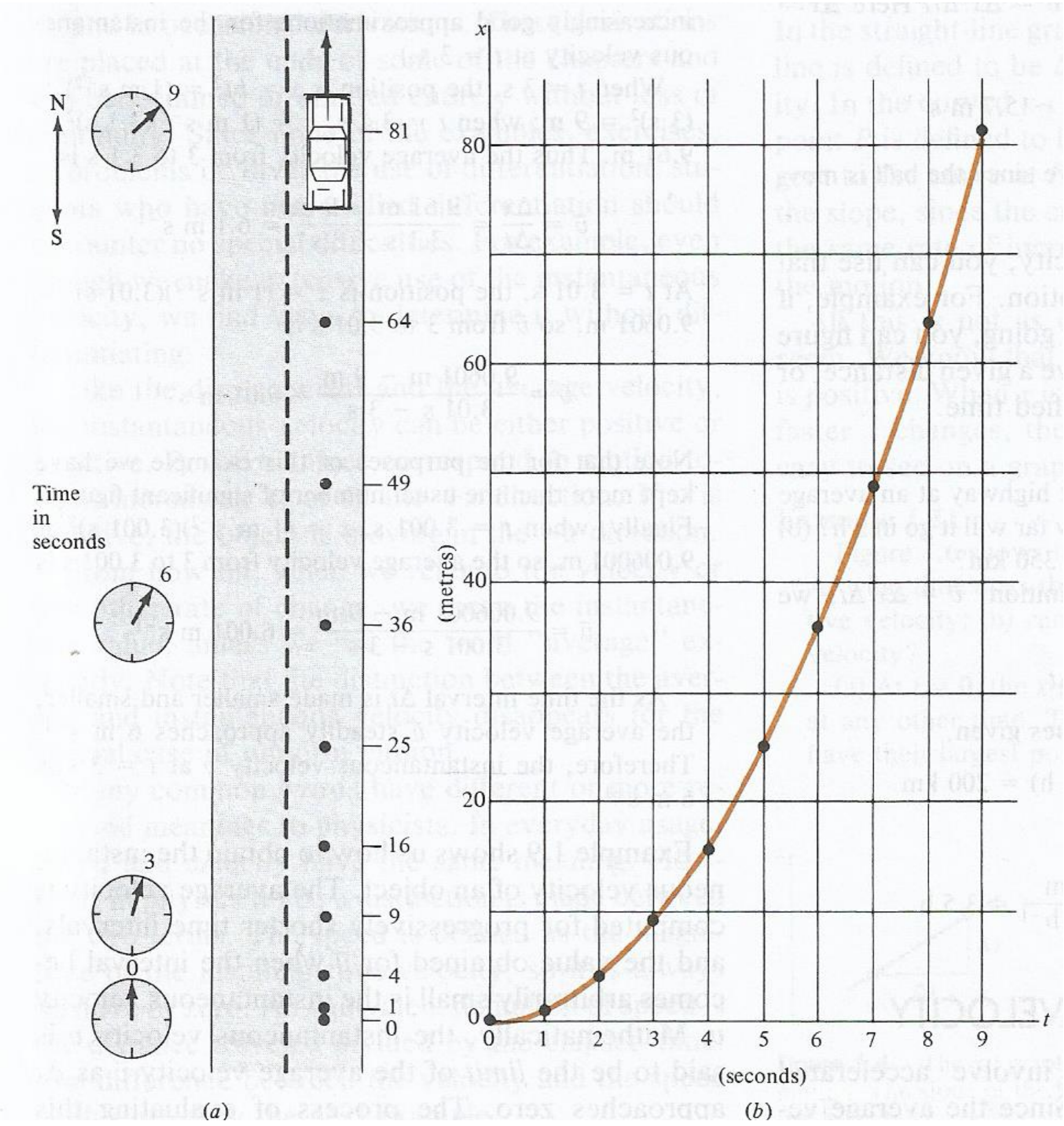
1.2 Displacement; Average Velocity.

Example 1.6, B:9 A car moves as shown in Figure. Find its average velocity from t=0 to t=1s. *Ans* (1 m/s)

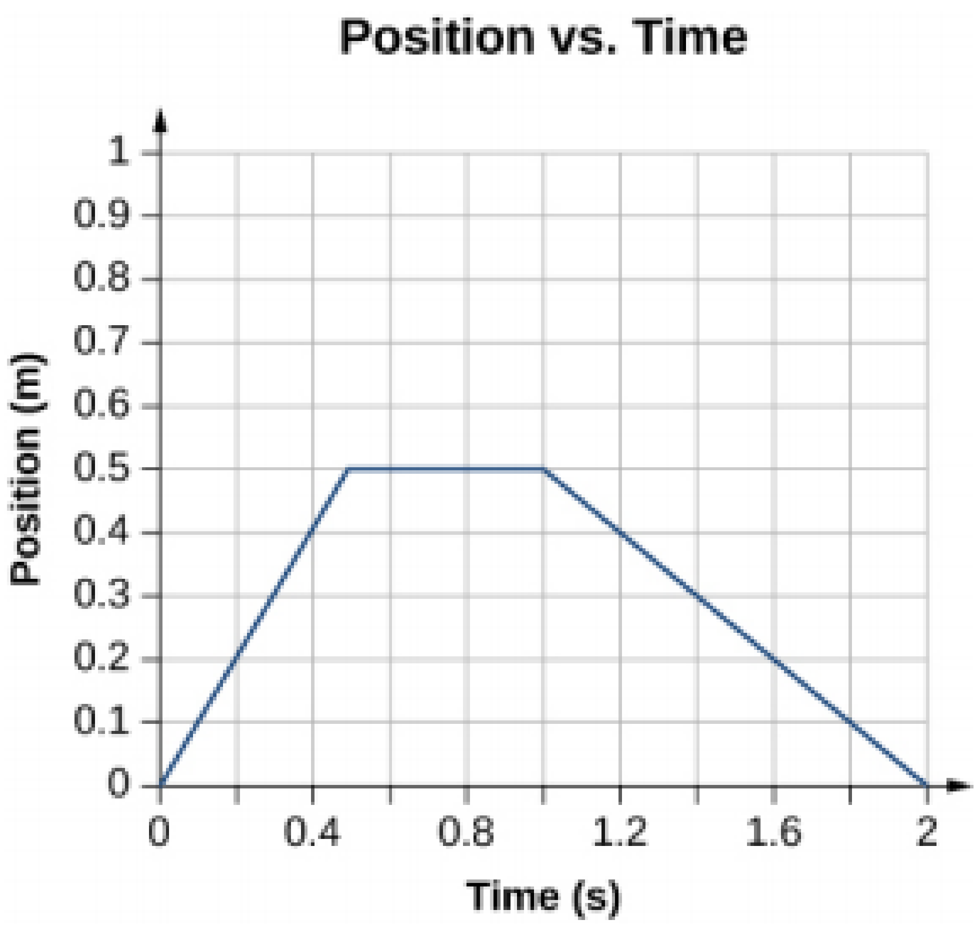


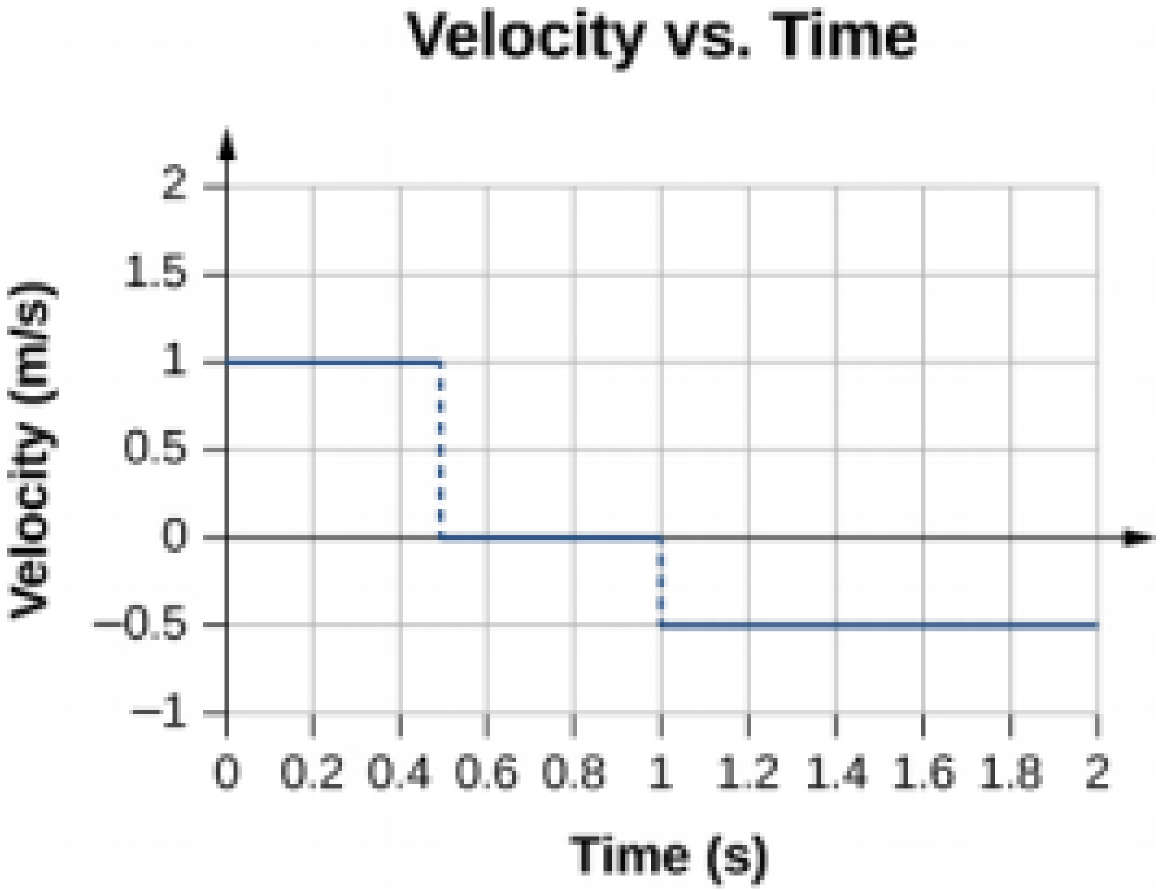
1.2 Displacement; Average Velocity.

Example 1.6, B:9 **A car moves as shown in Figure. Find its average velocity from 1 s to 2 s.** ***Ans*** **(3 m/s)**



Ex3: **Given the position–versus–time graph, find the velocity–versus–time graph.**





1.2 Displacement; Average Velocity.

Example 1.7, B:10 ball is dropped from a 50 m tall building at time t=0 s. Its height x above the ground at time t after it is released is given by the formula $x = 50 - 4.9t^2$.

(a) When will the ball land ?. $Ans\ (3.19\ s)$

(b) What is its average velocity during the fall ?. $Ans\ (-15.7\ m/s\ )$

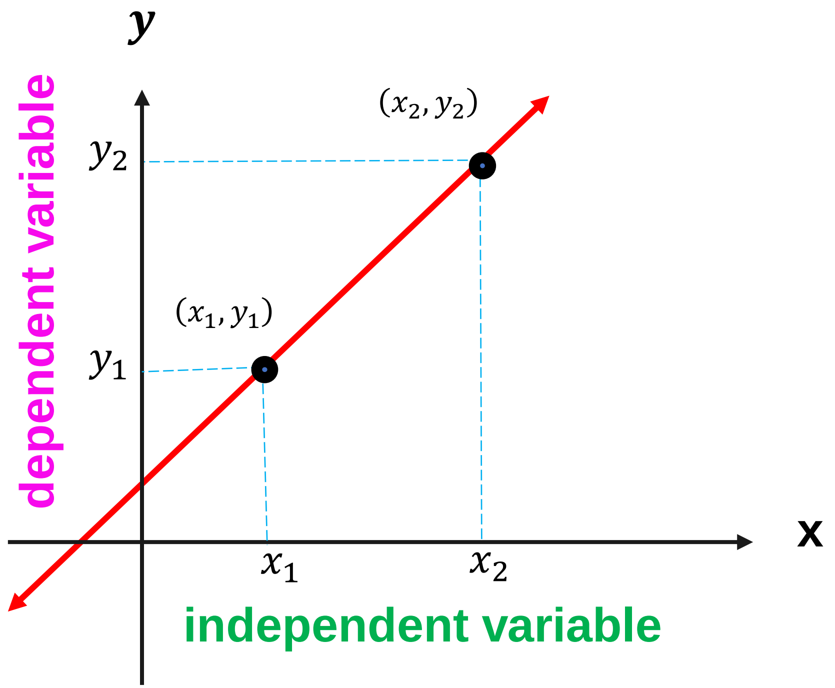
Revision: Slope of Line

The slope, represented by the letter m, measures the inclination of the line.

If the line passes by the points (x_1, y_1) and (x_2, y_2), the slope is obtained by the relation :

$$Slope = \frac{\text{Change in the dependent variable (y − axis)}}{\text{Change in the independent variable (x − axis)}}$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$



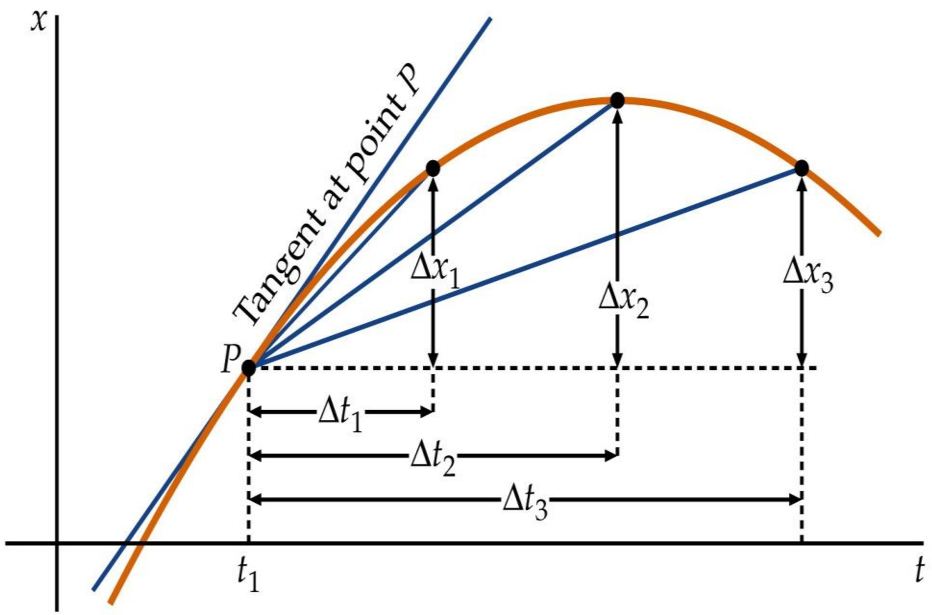
1.3 Instantaneous Velocity.

It can be calculated in two ways:

a) Mathematical (differentiation):

The instantaneous velocity is side to be the limit of the average velocity $\vec{v}$ as Δt approaches zero. This evaluating limit is called differentiation.

$$\vec{v} = \lim_{\Delta t \to 0} \frac{\Delta \vec{x}}{\Delta t} = \frac{d\vec{x}}{dt}$$



b) Graphical (tangent): The instantaneous velocity can be found graphically by drawing a tangent (straight line) to the (x–t) curve at the instant of time, then the velocity is to be found as shown in the figure

$$\vec{v} = Slope\ of\ tangent = \frac{\Delta \vec{x}}{\Delta t}$$

1.4 Acceleration.

- ## Average acceleration

Average acceleration is defined as the change of velocity divided by the elapsed time (Δt)

$$\vec{a}_{av} = \frac{\Delta\vec{V}}{\Delta t} = \frac{\overrightarrow{v_f} - \overrightarrow{v_i}}{t_f - t_i}$$

- Acceleration is a vector quantity.
- Acceleration can be negative, positive.
- Acceleration has a dimension L/T^2.
- Acceleration has SI unit m/ s^2.

Not that: a constant velocity means no change in velocity, so in this case the acceleration must be zero (no acceleration).

1.4 Acceleration.

Example 1.12, P:12 **A car accelerates from rest to 30 m/s in 10 s. What is its average acceleration?** *Ans* $(3\ m/s^2)$

1.4 Acceleration.

Example 1.14, P:12 The velocity of car is giving by the equation $v = 20 - t$. Find the average acceleration from t=1 s to t= 3 s.? Ans $(-3\ m/s^2)$

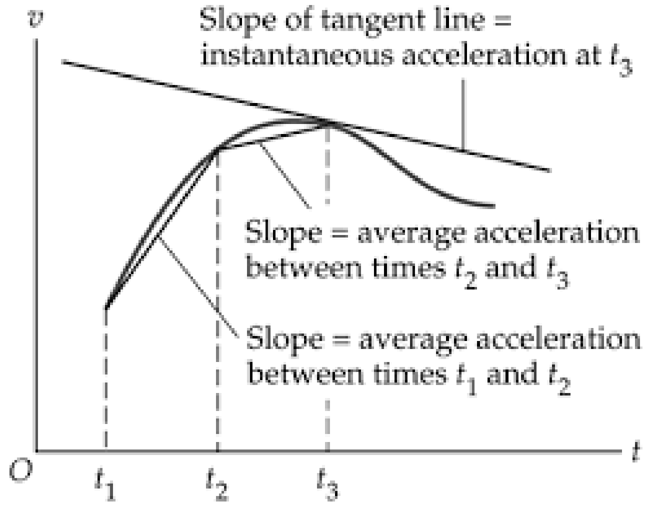
1.4 Acceleration.

It can be calculated in two ways:

a) Mathematical (differentiation):

Instantaneous acceleration is defined as the acceleration of an object at a given instant

$$\vec{a} = \lim_{\Delta t \to 0} \frac{\Delta \vec{v}}{\Delta t} = \frac{dv}{dt}$$



b) Graphical (tangent): The instantaneous acceleration can be found graphically by drawing a tangent (straight line) to the $(v - t)$ curve at the instant of time, then the acceleration is to be found as shown in the figure

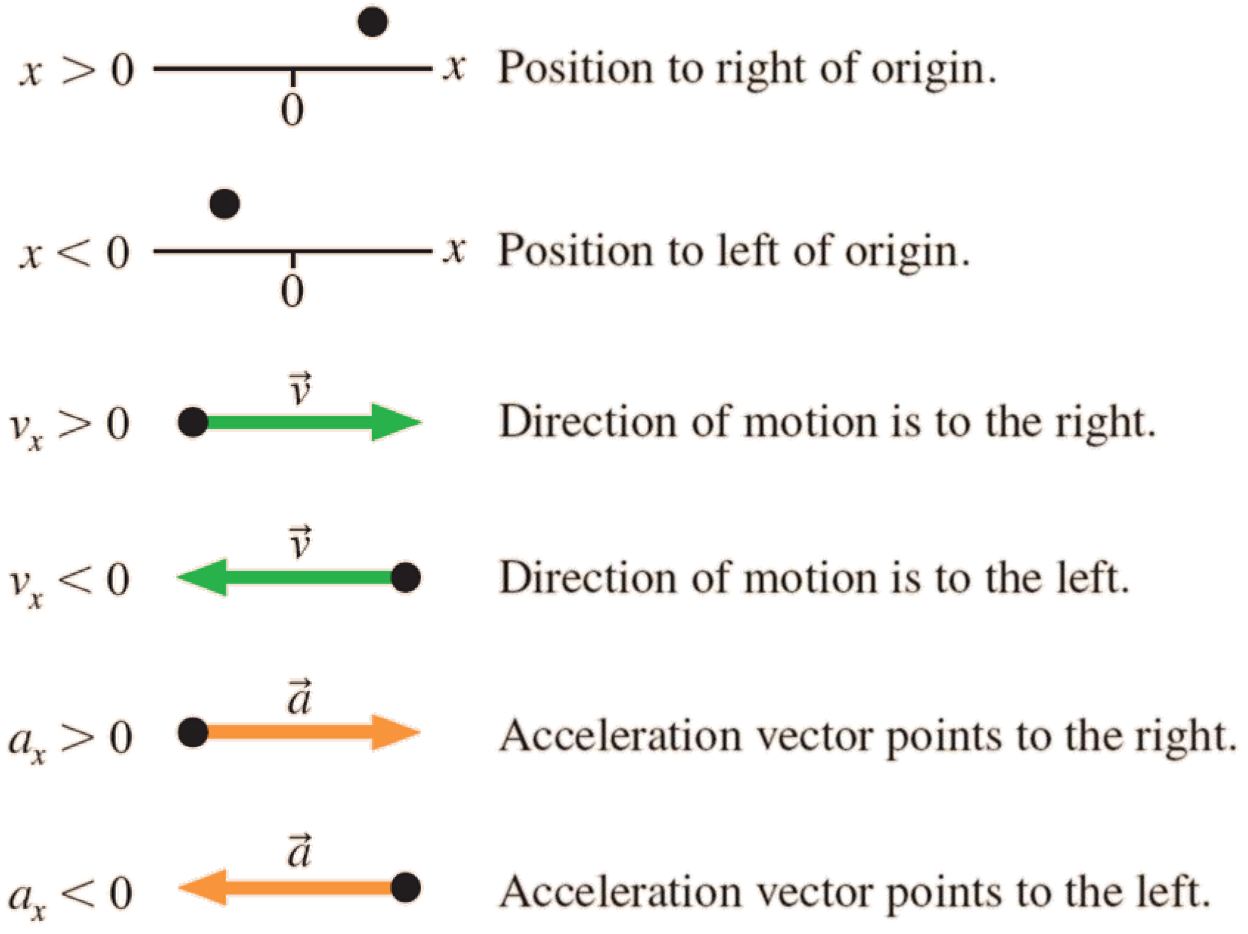
$$\vec{a} = Slope\ of\ tangent = \frac{\Delta \vec{v}}{\Delta t}$$

Acceleration can be either uniform or nonuniform. In this course acceleration is uniform

1.4 Acceleration.

■ $\vec{x}$, $\vec{v}$, $\vec{a}$ a direction :

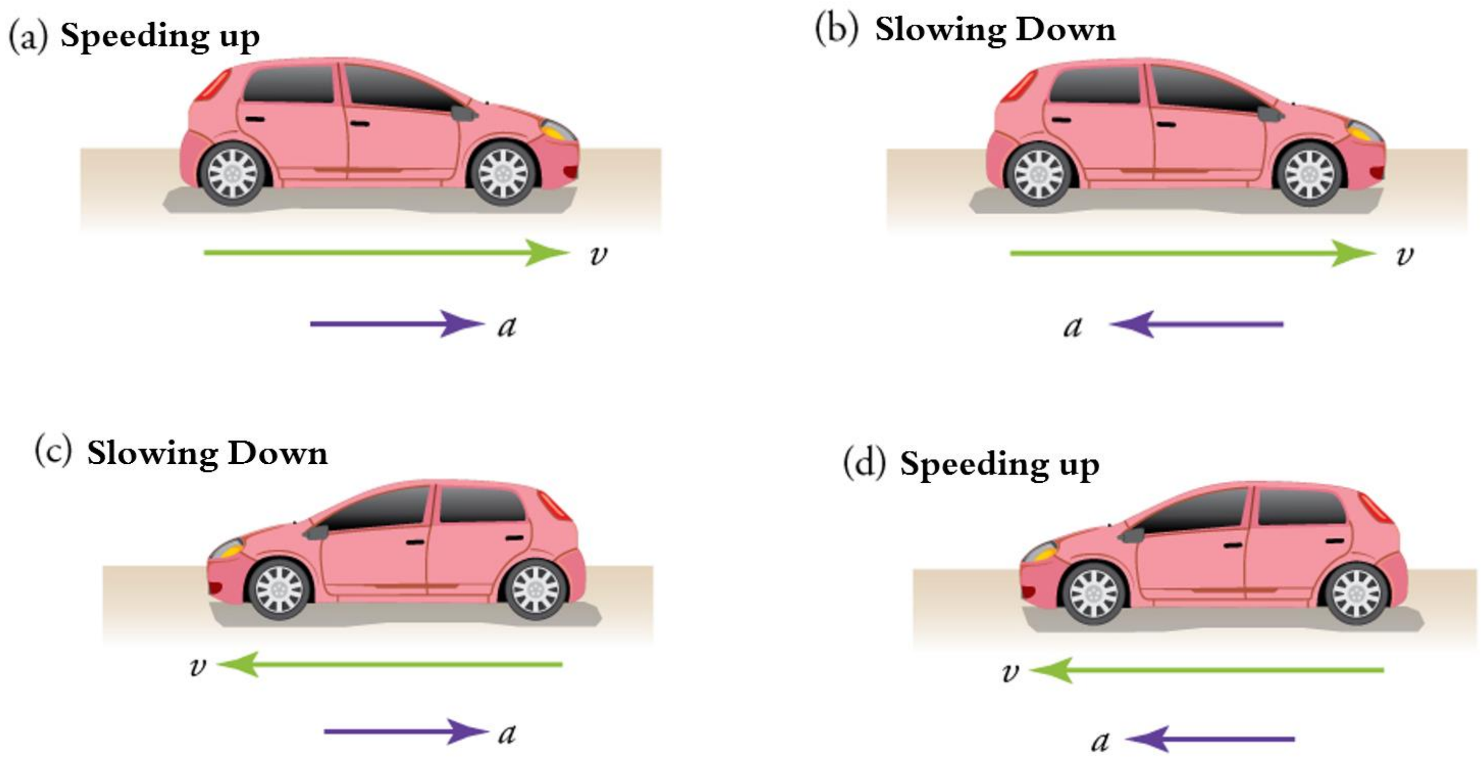
- A positive velocity simply means that the object is moving in the positive direction, as defined by the coordinate system, while a negative velocity means the object is traveling in the other direction.
- Moreover, even if an object has a positive acceleration, it does not mean that the object is speeding up! A positive acceleration means that the change in the velocity points in the positive direction.



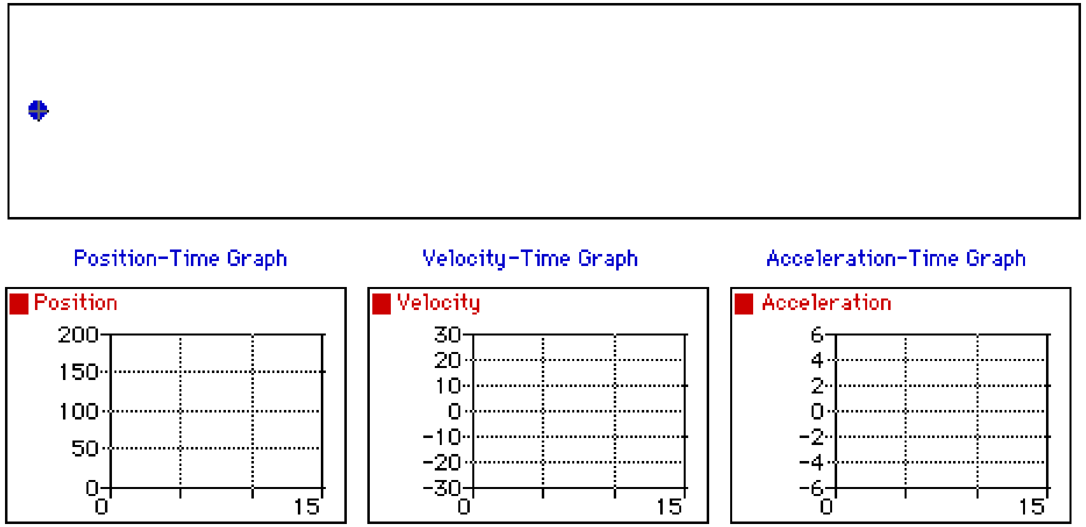
1.4 Acceleration.

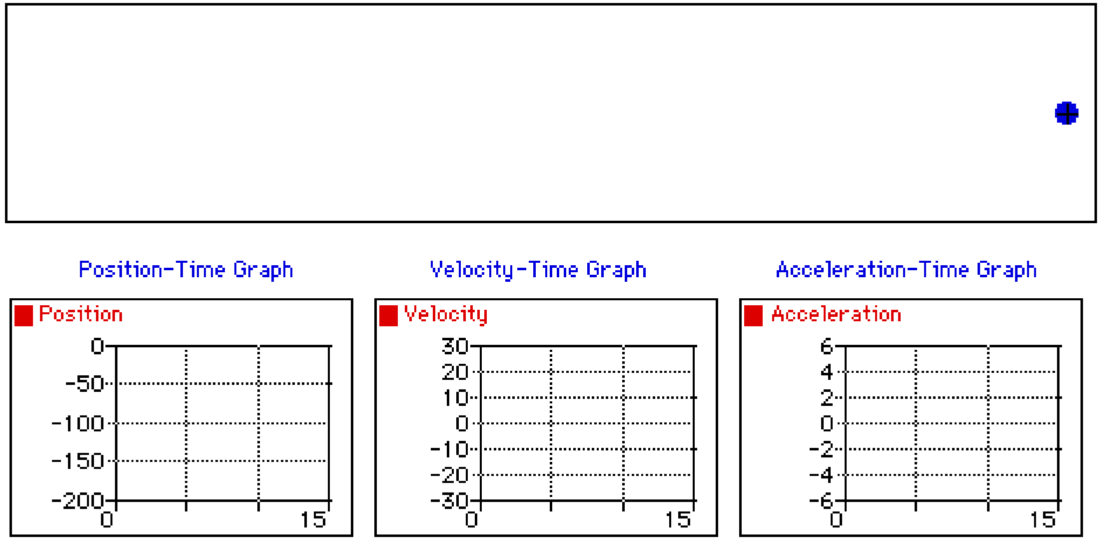
- **Speeding up and Slowing down:**

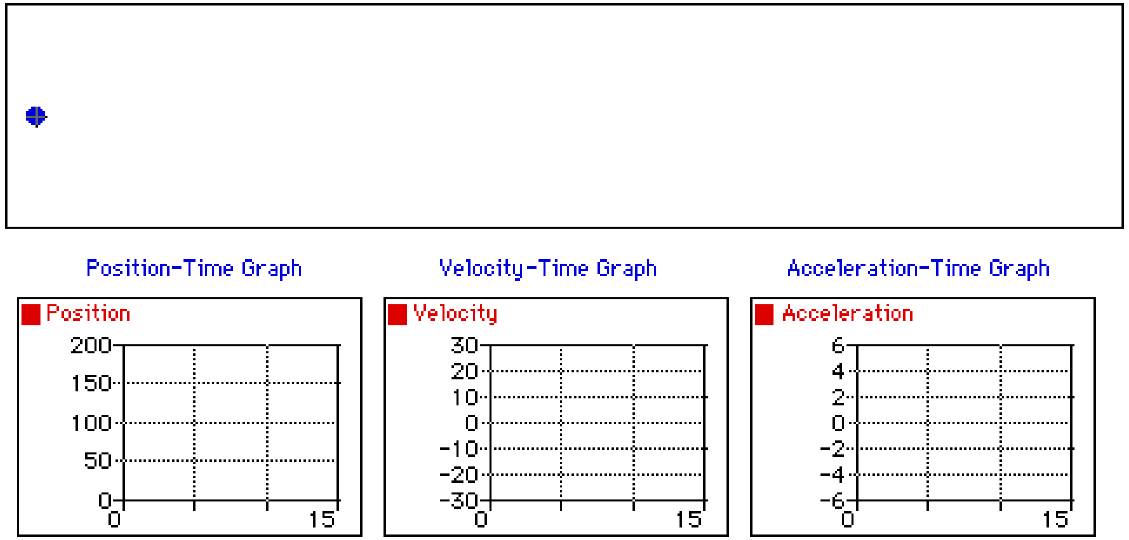
When an object's acceleration is in the same direction of its motion, the object will speed up. However, when an object's acceleration is opposite to the direction of its motion, the object will slow down.



1.4 Acceleration.







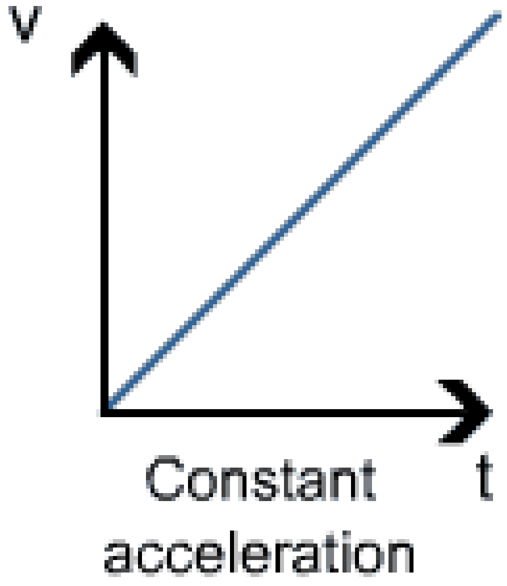
1.5 Finding the Motion of an object.

When the acceleration is constant, we can find the equations of motion. In this case:

1– The average acceleration and the instantaneous acceleration are equal ($\vec{a}_{av} = \vec{a}$)

2– The average velocity is simply the average of the initial velocity and the final velocity

$$V_{av} = \frac{v_i + v_f}{2}$$



1.5 Finding the Motion of an object.

When the acceleration is constant, by take the initial time $t_i = 0$, then $\Delta t = t_f - t_i$ will be simply t, therefore following equations are obtained:

KINEMATICS equation: (motion in x–axis)

1	Average velocity	$V_{av} = \dfrac{v_{xi} + v_{xf}}{2}$	Relating the final velocity to the initial velocity.
2	Final velocity	$v_{xf} = v_{xi} + a_x t$	Relating the final velocity to the initial velocity and the acceleration,
3	Acceleration	$a_x = \dfrac{{v_{xf}}^2 - {v_{xi}}^2}{2\Delta x}$	Relating the final velocity to the initial velocity, the acceleration and the position Change.
4	Change in position	$\Delta x = v_{xi} t + \dfrac{1}{2} a_x t^2$	Relating the final position to the initial position, the initial velocity and the acceleration.

1.5 Finding the Motion of an object.

Solving Problems:

1. Read the whole problem and make sure you understand it. Then read it again.
2. Decide on the objects under study and what the time interval is.
3. Draw a diagram and choose coordinate axes.
4. Write down the known (given) quantities, and then the unknown ones that you need to find.
5. Which equations relate the known and unknown quantities? Are they valid in this situation? Solve algebraically for the unknown quantities, and check that your result is sensible (correct dimensions).
6. Look at the result—is it reasonable? Does it agree with a rough estimate?
7. Check the units again.

1.5 Finding the Motion of an object.

Example 1.16 P 14: A car, initially at rest at a traffic light, accelerates at $2m/s^2$ when the light turns green. After 4 seconds what are its

(a) Velocity (Ans: 8 m/s)

(b) Position (Ans: 16 m)

1.5 Finding the Motion of an object.

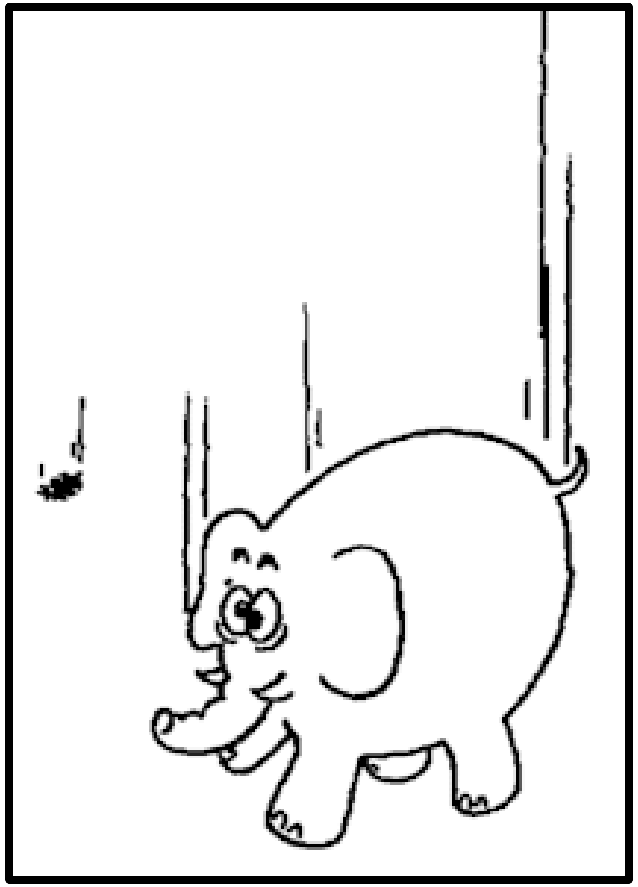
Example 1.17 P 14: A car reaches a velocity of $20\ m/s$ with an acceleration of $2\ m/s^2$. How far will it travel while it is accelerating if it is

(a) initially at rest. (Ans: 100 m)

(b) initially moving at $10\ m/s$ (Ans: 75m)

1.6 The Acceleration of Gravity and Falling Objects

Near the surface of the Earth, all objects accelerate at the same rate 9.8 m/s^2 (ignoring air resistance).



- Free–fall acceleration is independent of mass.
- Magnitude: g = 9.8 m/s^2 .
- Direction: always downward, so $\overrightarrow{a_y}$ is negative if we define "up" (y–axis) as positive, $\overrightarrow{a_y}$= −g = −9.8 m/s2

Which object–the elephant or the feather– will hit the ground first ?!

1.6 The Acceleration of Gravity and Falling Objects

When the $a_y = -g = -9.8\ m/s^2$, and by take the initial time $t_i = 0$, then $\Delta t = t_f - t_i$ will be simply t, therefore following equations are obtained (motion in y–axis) :

1	Average velocity	$V_{av} = \dfrac{v_{yi} + v_{yf}}{2}$	Relating the final velocity to the initial velocity
2	Final velocity	$v_{yf} = v_{yi} - gt$	Relating the final velocity to the initial velocity.
3	Change in position	$\Delta y = \dfrac{{v_{yi}}^2 - {v_{yf}}^2}{2g}$	Relating the final velocity to the initial velocity and the position Change.
4	Change in position	$\Delta y = v_{yi}t - \dfrac{1}{2}gt^2$	Relating the final position to the initial position and the initial velocity.

1.6 The Acceleration of Gravity and Falling Objects

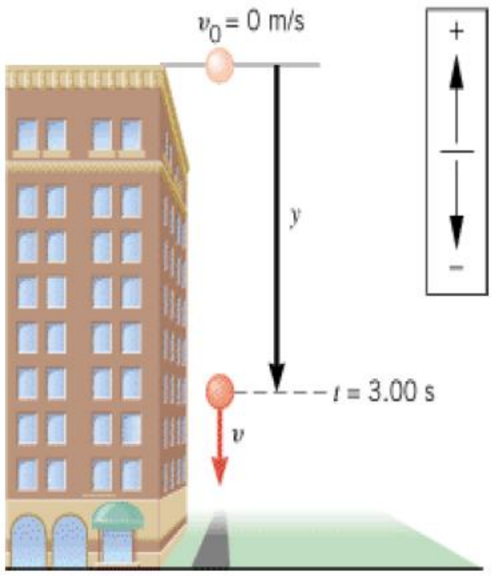
Example 1.15, P:13 A rock fall off a cliff from a rest. How fast will it be moving after 5 s? (Ans: –49 m/s)

1.6 The Acceleration of Gravity and Falling Objects

Example 1.20, P:17 A ball is dropped from a window 84 m above the ground .

(a) When dose the ball strike the ground? (Ans: 4.14s)

(b) What is the velocity of the ball when it strikes the ground? (Ans: –40.6 m/s)



Name: **Section**

- ## Homework 2

Ch1: [1.13, 1.16, 1.17, 1.22,1.28, 1.29, 1.38,1.45, 1.46, 1.47,1.49, 1.57, 1.59]

Final Answers [1.16 a(160Km), b(53.5 km/h) , 1.22 a(9.8 m/s), (–9.8 m/s), 1.28 [a(10m/s) , b(0), c(–20m/s), d(10m/s)], 1.38 [10 s],1.46[a(40 m/s), b(0)]]