PPP0101

PRINCIPLES OF PHYSICS

Foundation in Information

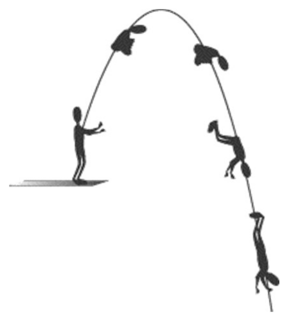
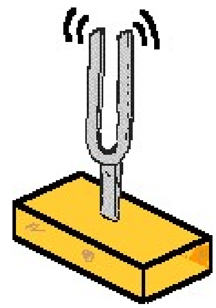
Technology

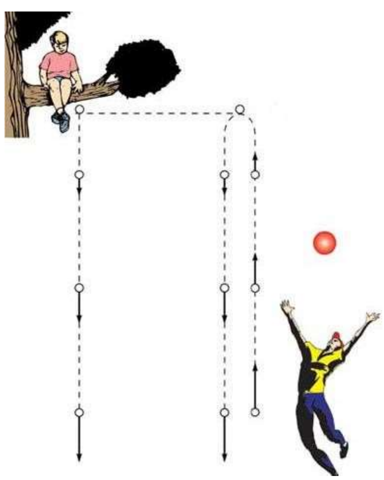
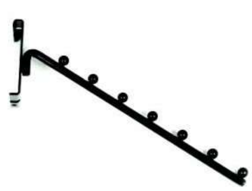
ONLINE NOTES

Chapter 2

Kinematics

2.1 Type of Motion

Type of Motion		
1. Translational 	**2.** Rotational 	3. Vibrational 

Motion in Straight Line	
 **Vertical**	 **Horizontal**
 Slanting	

2.2 Distance and Displacement

1. Distance and displacement are two quantities that may seem to mean the same thing yet have distinctly difference definition and meaning
2. Distance refer to how “how much ground an object had covered” during its motion and displacement refers to “how far out of place an object is”.

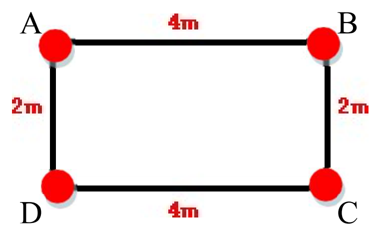


Diagram 1

3. Given as in diagram 1, the distance from A to D is

$$\begin{aligned}\text{Distance from A to D} &= AB + BC + CD \\ &= (4 + 2 + 4)\ \text{m} \\ &= 10\text{m}\end{aligned}$$

and the displacement from A to D is

$$\text{Displacement from A to D} = 2\text{m to south}$$

4. Given as in diagram 1 again, the distance from A to A is

$$\begin{aligned}\text{Distance from A to D} &= AB + BC + CD + DA \\ &= (4 + 2 + 4 + 2)\ \text{m} \\ &= 12\text{m}\end{aligned}$$

and the displacement from A to A is

$$\text{Displacement from A to D} = 0\text{m}$$

2.3 Speed and Velocity

1. Speed is a scalar quantity that refers to “how fast an object is moving”
2. Speed can be thought of as the rate at which an object covers distance.
3. The formula for speed is

$$\text{speed} = \frac{\text{distance travelled}}{\text{time elapsed}}$$

$$= \frac{s}{t}$$

4. The SI unit for speed is ms^{-1}
5. Meanwhile, velocity is a vector quantity refers to "the rate at which an object changes its position"
6. The formula to calculate velocity is

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

Where,
Δx = Change of displacement
Δt = Change of time
x_i = Initial position
x_f = final position
t_i = Initial time
t_f = final time

7. The SI unit is ms^{-1}
8. The velocity would be zero if starting and ending point are the same.

Instantaneous velocity

1. The velocity of a particle at any instant of time or at some point on a space-time graph.
2. Important when the average velocity in different time intervals is not constant.

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

2.4 Acceleration

1. **Acceleration** is a vector quantity that is defined as the rate at which an object changes its velocity. An object is accelerating if it is changing its velocity.
2. The formula to calculate the acceleration is:

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

Where,

Δv = Change of velocity
Δt = Change of time

x_i = Initial velocity
x_f = final velocity
t_i = Initial time
t_f = final time

3. The SI unit is ms^{-2}

Instantaneous Acceleration

1. The acceleration at a particular instant of time ($\Delta t \to 0$).

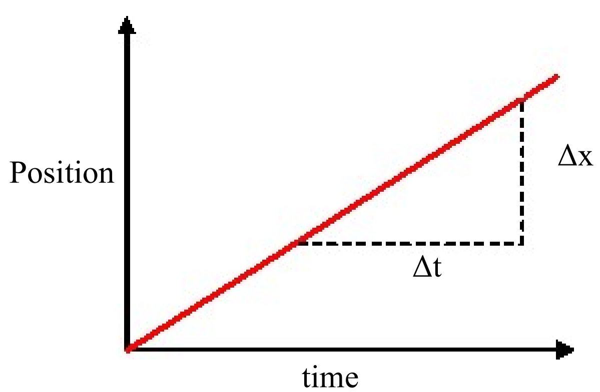
$$a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$

since $v = \dfrac{dx}{dt}$ so,

$$a = \frac{dv}{dt} = \frac{d}{dt}\left(\frac{dx}{dt}\right)$$

Therefore $$a = \frac{d^2x}{dt^2}$$

2.5 Motion Graph

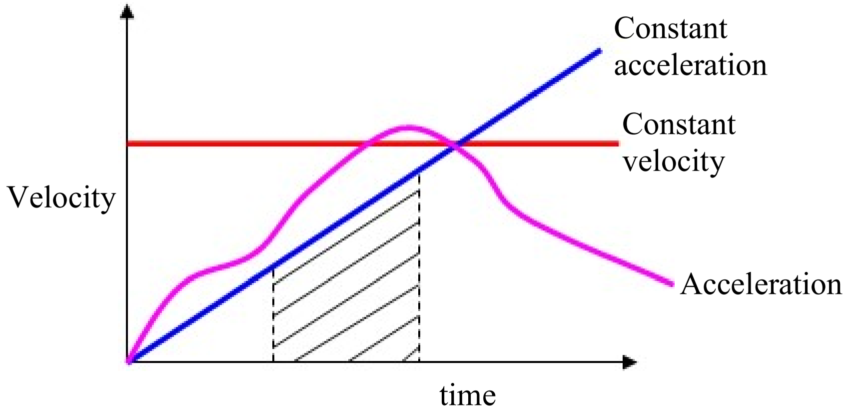


Graph 1 Position versus time graph

1. Graph 1 is an example graph of position vs. time for an object moving at a uniform velocity .
2. From the graph,

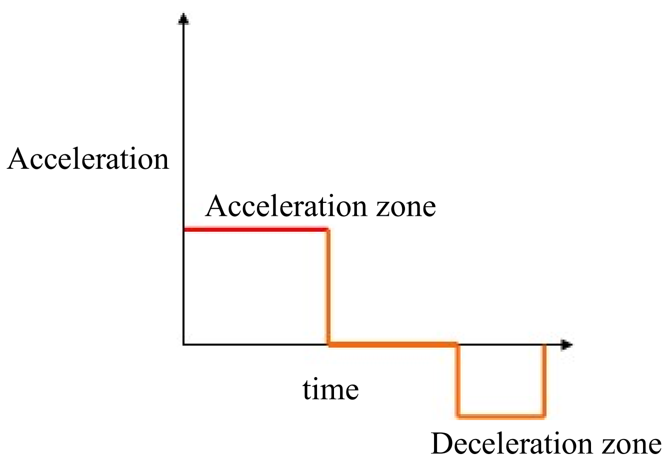
$$\text{Slope} = \frac{\Delta x}{\Delta t}$$

- The slope of the x versus t is equal to the velocity.
- The slope of the x versus t is everywhere the same if the velocity is constant. But if the velocity changes, the slope of the x versus t graph also varies.



Graph 2 Velocity versus time graph

3. Graph 2 is an example graph of velocity vs. time for an object moving at a uniform acceleration.
    - The area under the velocity–time curve between two time intervals is equivalent to the displacement during that time interval.
    - The slope of the tangent to the velocity-time graph at a point is it acceleration.



Graph 3 Acceleration versus time graph

4. Graph 3 is an example graph of acceleration versus time for an object.

2.6 Equation of Linear Motion

1. Many practical situations occur in which the acceleration is constant or close enough that we can assume it is constant. That is the acceleration doesn't change over time.
2. We now treat this situation when the magnitude of the acceleration is constant and the motion is in a straight line.
3. In this case, the instantaneous and average acceleration are equal.
4. To simplify our notation, let us take
    a. the initial time in any discussion to be zero
    b. the elapsed time, t
    c. initial velocity , v_0
    d. the position at time t is s
    e. the velocity at time t is v
5. Following is the equation of linear motion

$$v = v_o + at$$

$$s = \left(\frac{v_o + v}{2}\right)t$$

$$s = v_o t + \frac{1}{2}at^2$$

$$v^2 = v_o^2 + 2as$$

2.7 Free Falling Objects Under Gravity

1. Freely falling bodies: any object moving freely under the influence of gravity, regardless of its initial motion.
2. Object thrown upward / downward, will both experience the same acceleration as an object released from rest.
3. This acceleration is called acceleration due to gravity on the Earth, and we give it the symbol, g. Its magnitude is approximately, $9.8ms^{-2}$
4. Neglect air resistant (and assume that the free fall acceleration does not very with altitude), the vertical motion of a freely falling object is equivalent to motion in one dimension under constant acceleration.
5. Kinematics equations for constant acceleration can be applied where for ***a*** we use the value of ***g*** given above.
6. It is arbitrary whether we choose *y* to be positive in the upward direction or in the downward direction; but we must be consistent about it throughout a problem's solution.
    a. Thrown downward $\Rightarrow$ a = g = $+9.80ms^{-2}$
    b. Thrown upward $\Rightarrow$ a = g = $-9.80ms^{-2}$

End Of Chapter 2