Experiment 3
Study of projectile motion and collision

Physics Lab 1

Spring 2021-22

Department of Physics

American International University-Bangladesh

Objectives:

- To construct a projectile and study the basic quantities of the projectile motion.
- To study the elastic collision between a ball and fixed surface.

Outcomes:

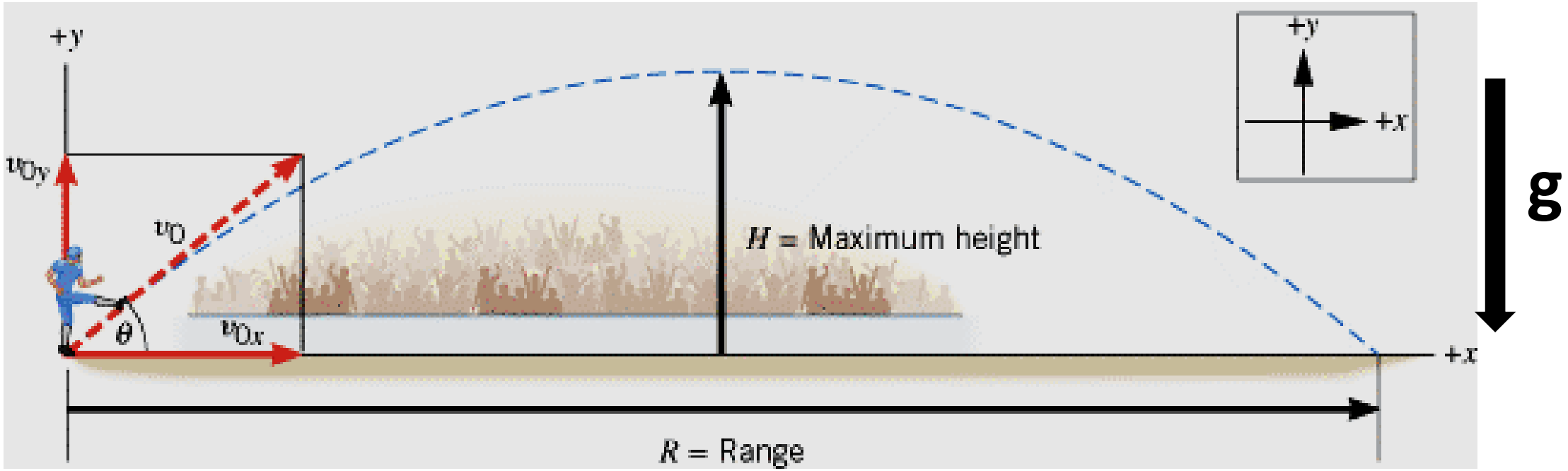
After completing this lab work student will be able to answer the following questions:

- What is a projectile motion and how its horizontal and vertical components of velocities change with time?
- For a projectile how the quantities: velocity at any time (both value and direction), time of flight, range and maximum height can be calculated?
- How momentum and energy are conserved for an elastic collision?
- What is Impulse? How it could be calculated for a collision?

Projectile Motion

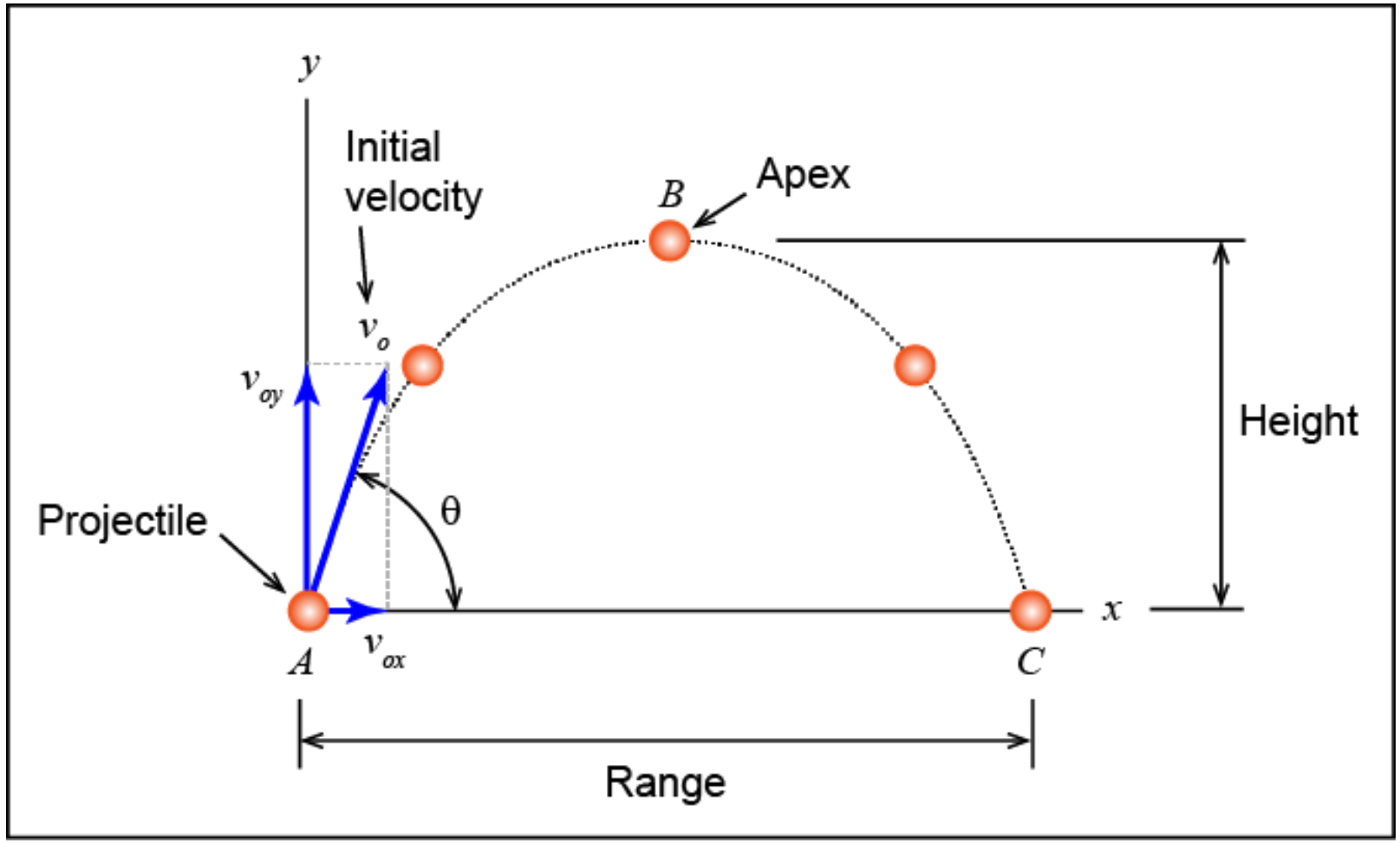
Theory: Projectile

The motion of projectiles is a two-dimensional motion.



The trajectory of a projectile is parabolic as the figure shows.

Acceleration and velocity of a Projectile



- Acceleration:

$a_x = 0$

$a_y = -g$

- Velocity:

$v_x = v_{0x} =$ Constant

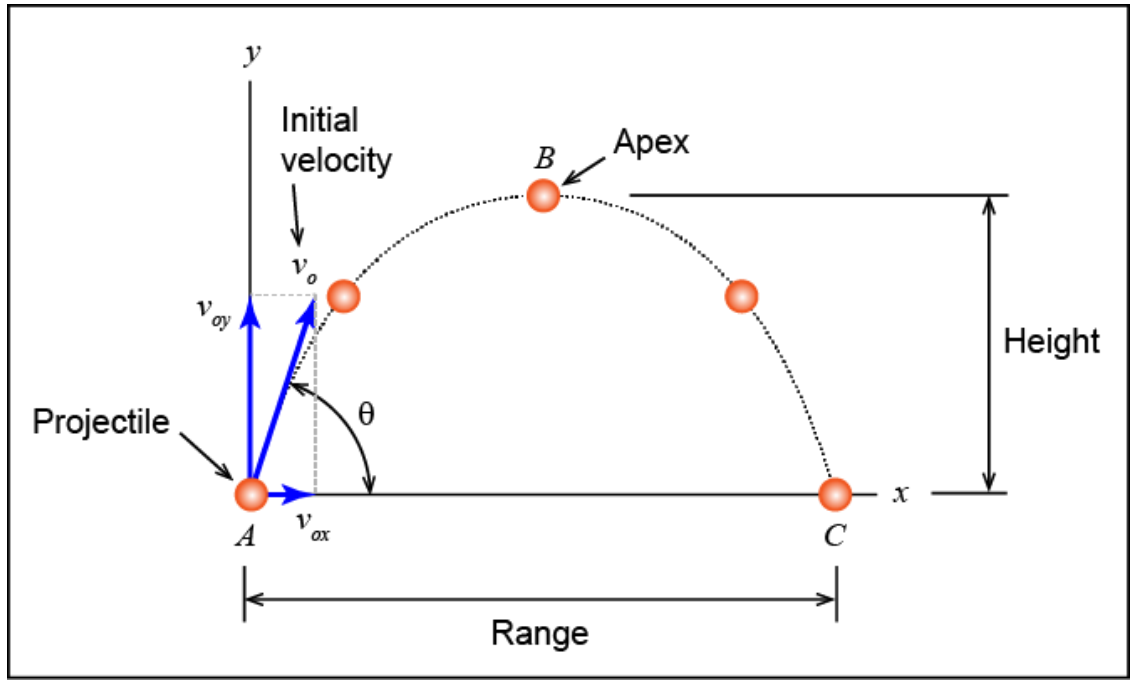
$v_y = v_{0y} - gt$

- Apex: $v_y = 0$

Basic Equations of Projectile Motion:

Quantity	Straight line (one dimensional) motion	Projectile (two dimensional) motion	
		Horizontal component	**Vertical component**
Initial velocity	u	$v_{0x} = v_0\cos\theta_0$	$v_{0y} = v_0\sin\theta_0$
Acceleration	a	$a_x = 0$	$a_y = -g$
Velocity at any point	$v = u + at$ $v^2 = u^2 + 2as$	$v_x = v_{0x}$	$v_y = v_{0y} - gt$ $v_y^2 = v_{0y}^2 - 2gy$
Distance	$s = vt$ (constant velocity) $s = ut + \frac{1}{2}at^2$	$x = v_{0x}t$	$y = v_{0y}t - \frac{1}{2}gt^2$

Some Derived Equations: Projectile

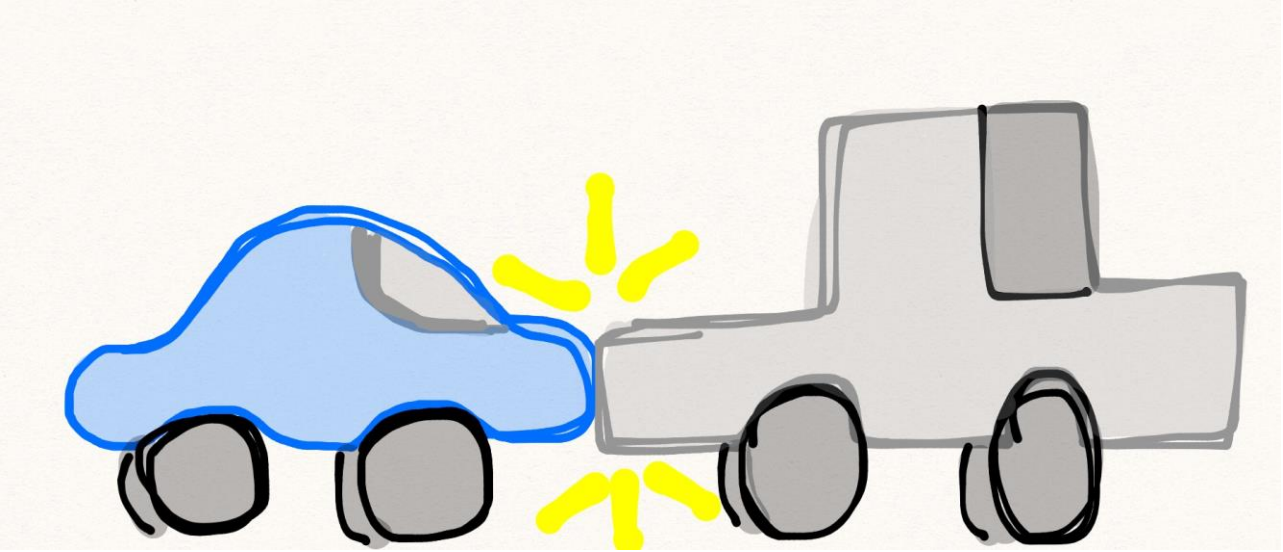


Time of flight $= \dfrac{2v_0 \sin\theta}{g}$

Maximum height reached $= \dfrac{v_0^2 \sin^2\theta}{2g}$

Horizontal range $= \dfrac{v_0^2 \sin 2\theta}{g}$

Theory: Collision

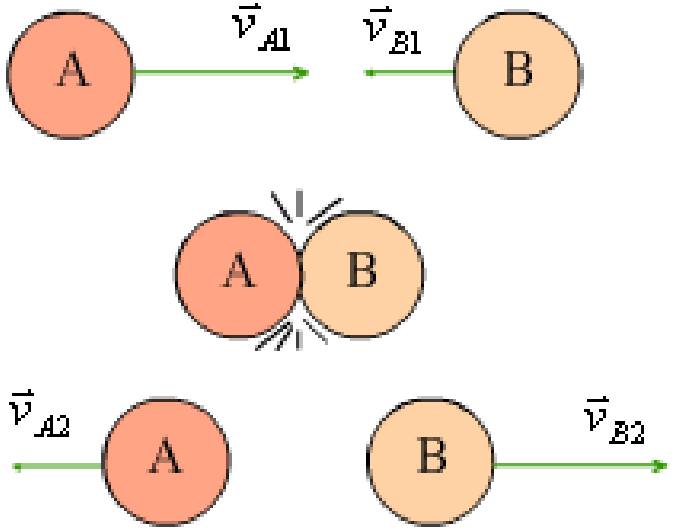


Collisions occur when one object strikes another.

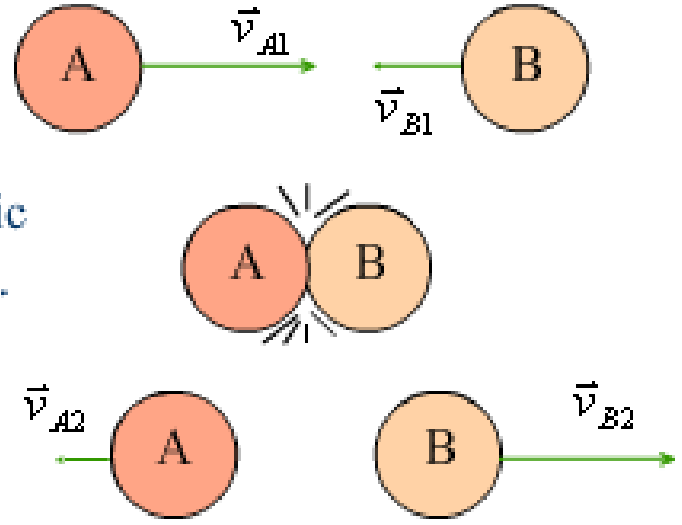
- Problems involving collisions are usually solved using conservation of momentum and conservation of energy Laws.
- There are two types of collisions:
  - Inelastic collisions: momentum is conserved,
  - Elastic collisions: momentum *and* kinetic energy are conserved.

Different types of Collision:

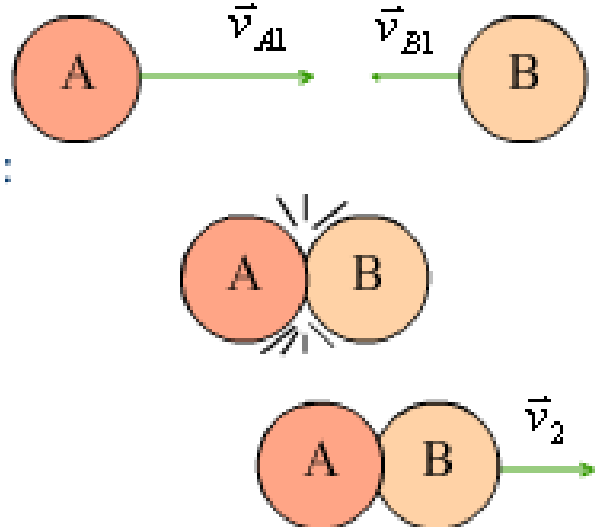
Elastic :
Kinetic energy conserved .



Inelastic :
Some kinetic energy lost .

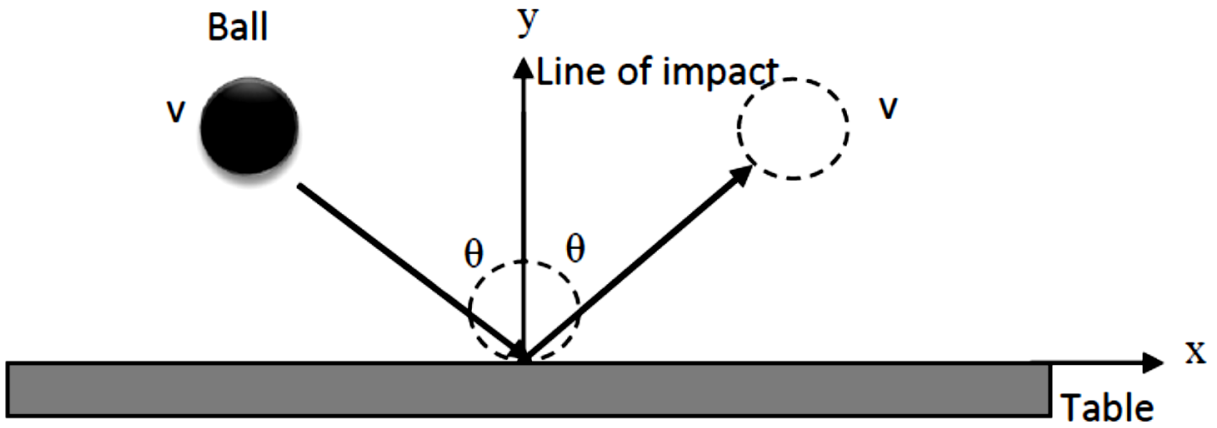


Completely inelastic :
Bodies have some final velocity .



Collision between Ball and Fixed Surface:

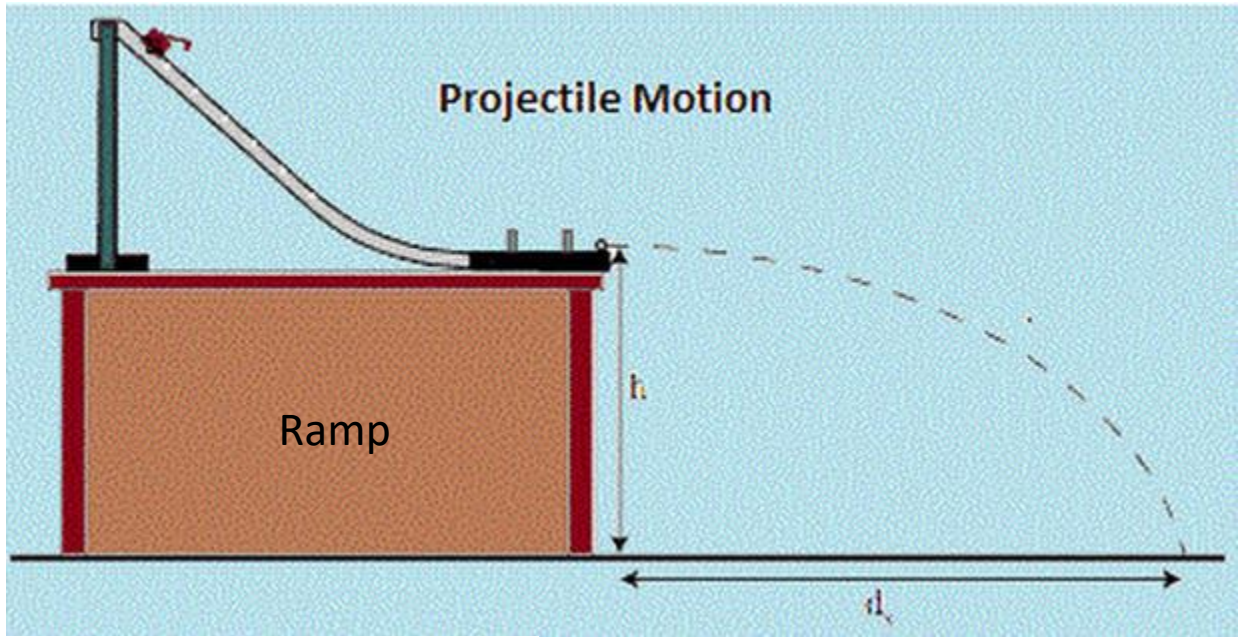
- Elastic Collision: Both the momentum and kinetic energy are conserved.
- Kinetic energy before collision = Kinetic energy after collision.
- The velocities just before and after the collision remain the same.



Impulse, J = Change in momentum, $\Delta p = p_f - p_i$

Apparatus:

- Marble, ramp, clamp.
- Meter scale, weighing scale, recording papers, carbon papers.




Carbon Papers


Marble

Data Collection and Analysis

- Follow the lab manual and video lecture for the experimental procedure.
- Try to understand the derivation of corresponding equations for different quantities of table 3.3 and 3.4.
- Now by using the sample data with the help of lab manual calculate the values of the quantities of table 3.3 and 3.4. You must write the units besides the magnitudes.