SS1 PHYSICS – FIRST TERM

WEEK 8 – 9 : RECTILINEAR ACCELERATION

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1. INTRODUCTION

Motion is a fundamental concept in physics and our daily lives. Whether it's a car speeding down the road, a ball rolling, or a rocket launching — these involve motion. When this motion happens in a **straight line** and involves changes in **velocity**, we refer to it as **Rectilinear Acceleration**.

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2. WHAT IS ACCELERATION?

Acceleration is the **rate at which velocity changes with time**. It tells us how quickly something is **speeding up or slowing down**.

Formula:

a=v−uta = \frac{v - u}{t}a=tv−u

Where:

- aaa = acceleration (in m/s2m/s^2m/s2)
- vvv = final velocity (in m/sm/sm/s)
- uuu = initial velocity (in m/sm/sm/s)
- ttt = time taken (in seconds)

💡 **Note**: If a>0a > 0a>0, the object is **speeding up**. If a<0a < 0a<0, it is **slowing down**.

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3. WHAT IS RECTILINEAR ACCELERATION?

Rectilinear acceleration is acceleration that occurs **along a straight line**. The word **"rectilinear"** comes from **Latin**:

- *Rectus* = straight
- *Linea* = line

⚙️ Real-Life Examples of Rectilinear Acceleration:

Scenario	Type of Acceleration	Explanation
A car speeding up on a straight road	Uniform	Same increase in velocity every second
A bus braking to stop	Deceleration	Velocity decreases every second
An object in free fall	Uniform (due to gravity)	Acceleration = 9.8 m/s29.8 \, m/s^29.8m/s2 downwards
A sprinter leaving the blocks	Non-uniform	Initial acceleration increases rapidly

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4. TYPES OF ACCELERATION

a) Uniform Acceleration

Occurs when **velocity changes by equal amounts in equal time intervals**.

🧪 **Example**: A body increases its velocity by 2 m/s2 \, m/s2m/s every second.

b) Non-Uniform Acceleration

Occurs when the **rate of velocity change is irregular**.

🧪 **Example**: A car stuck in traffic, speeding up and slowing down unpredictably.

c) Deceleration (Negative Acceleration)

Occurs when an object is **slowing down**.

🧪 **Example**: A ball rolling uphill or a vehicle applying brakes.

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5. GRAPHICAL REPRESENTATION

✅ Velocity-Time Graphs

a) Uniform Acceleration

Straight slanted line → constant increase in velocity

b) Uniform Deceleration

Line slopes downward → velocity decreases steadily

c) Non-uniform Acceleration

Curved line → variable rate of change

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6. EQUATIONS OF MOTION (FOR UNIFORMLY ACCELERATED RECTILINEAR MOTION)

These are the **three golden equations** used in problems involving **constant acceleration**:

1. **First Equation**:

   $v = u + at$

2. **Second Equation**:

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

3. **Third Equation**:

   $v^2 = u^2 + 2as$

Where:

- s = displacement (in meters)
- a = acceleration (in m/s^2)

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7. SOLVED EXAMPLES

🧮 Example 1

A car accelerates uniformly from rest at $3 \, m/s^2$ for 6 seconds. Find its final velocity.

Solution:

- $u = 0$
- $a = 3 \, m/s^2$
- $t = 6 \, s$

Using: $v = u + at$

$v = 0 + 3 \times 6 = 18 \, m/s$

✅ **Answer:** $18 \, m/s$

🧮 Example 2

A cyclist reduces speed from 15 m/s15 \, m/s15m/s to 5 m/s5 \, m/s5m/s in 4 seconds. Find acceleration.

Solution:

- u=15 m/su = 15 \, m/su=15m/s
- v=5 m/sv = 5 \, m/sv=5m/s
- t=4 st = 4 \, st=4s

Using: a=v−uta = \frac{v - u}{t}a=tv−u

a=5−154=−104=−2.5 m/s2a = \frac{5 - 15}{4} = \frac{-10}{4} = -2.5 \, m/s^2a=45−15 =4−10=−2.5m/s2

✅ **Answer:** −2.5 m/s2-2.5 \, m/s^2−2.5m/s2 (Negative means deceleration)

🧮 Example 3

A stone falls freely for 3 seconds. How far has it fallen? (Use g=9.8 m/s2g = 9.8 \, m/s^2g=9.8m/s2)

Solution:

- u=0u = 0u=0
- a=9.8a = 9.8a=9.8
- t=3t = 3t=3

Using: s=ut+12at2s = ut + \frac{1}{2}at^2s=ut+21at2

s=0+12×9.8×32=12×9.8×9=44.1 ms = 0 + \frac{1}{2} \times 9.8 \times 3^2 = \frac{1}{2} \times 9.8 \times 9 = 44.1 \, ms=0+21×9.8×32=21×9.8×9=44.1m

✅ **Answer:** 44.1 m44.1 \, m44.1m

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8. EXPERIMENTAL DEMONSTRATION

You can demonstrate rectilinear acceleration using:

🎓 Slope and Toy Car Experiment

- Use a board as an inclined plane.
- Release a toy car from the top.
- Mark distances and measure time using stopwatch.
- Calculate velocity and plot velocity-time graph.

➡️ Observe uniform acceleration due to gravity.

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9. PRACTICAL APPLICATIONS IN REAL LIFE

Real-Life Application	Physics Explanation
🚗 **Driving a car**	Car accelerates/decelerates when gas/brake pedals are pressed.
🎢 **Roller Coaster**	Rapid acceleration and deceleration cause thrill.
🛰️ **Rocket Launch**	Rocket accelerates from 0 to very high speeds in seconds.
🏃 **Athletics**	Sprinters show high acceleration at race start.
🍎 **Falling Apple**	Free fall shows uniform acceleration due to gravity.