MODULE 5

SUVAT WITHOUT FEAR

INTRODUCTION

Once you understand acceleration, Physics becomes more predictable. Why? Because acceleration connects three things that always matter in motion:

1) *How fast you started moving (initial velocity, u)?*
2) *How fast you ended up moving (final velocity, v)?*
3) *How long the change took (time, t)?*

When acceleration is constant (uniform acceleration), these quantities are linked by powerful formulas called the **equations of motion** (or **SUVAT equations**).

Meaning of SUVAT

These letters remind you of the five variables used:

1) **S** = displacement (m)
2) **U** = initial velocity (m/s)
3) **V** = final velocity (m/s)
4) **A** = acceleration (m/s^2)
5) **T** = time (s)

The Three Main Equations of Motion

When acceleration is constant, the following equations apply:

1. **First equation:**

$$v = u + at$$

2. **Second equation:**

$$s = ut + 1/2at^2$$

3. **Third equation:**

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

Understand These Simple Tactics!

- If the question involves time, think of either: $v = u + at$ or $s = ut + 1/2at^2$
- If the question does not include time, use: $v^2 = u^2 + 2as$
- If it asks about **average velocity**, remember:

$$\text{Average velocity} = \frac{u + v}{2}$$

And thus:

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

Quick Reminder: Always pick the equation that matches the quantities given in the question.

Before the equations start arguing among themselves, let us invite a few worked examples to settle the matter!

BINDER Example 10

A car starts from rest and accelerates uniformly at $3m/s^2$ for 5s. Find its final velocity.

Solution

"Starts from rest" means initial velocity is zero. Thus u = 0 m/s

Using the first equation of motion: $v = u + at$

Where: u = 0m/s, a = $3m/s^2$, t = 5s

Substituting $v = (0\text{m/s}) + \left(3\frac{\text{m}}{\text{s}^2}\right)(5\text{s}) = 15\text{m/s}$

The final velocity of the car is 15m/s.

Making Sense of the Answer: *Each second, the car gains* ***3m/s****. After 5 seconds it has gained* ***15m/s****.*

Think Like a Physicist: *If you start from rest, the final velocity after time t depends only on a and t; that is* $v = at$.

REAL Example 11

Kipute is late for class. She runs from the school gate with an initial velocity of 2m/s and accelerates uniformly at 1.5m/s² for 6s. Find her final velocity.

Solution

Again using: $v = u + at$

Where: u = 2m/s, a = 1.5m/s², t = 6s

Substituting $v = (2\text{ m/s}) + \left(1.5\frac{\text{m}}{\text{s}^2}\right)(6\text{ s}) = 11\text{m/s}$

The Kipute's final velocity is 11m/s.

Making Sense of the Answer: *Kipute already had some speed (2m/s), then she added another 9m/s due to acceleration.*

Think Like a Physicist: *Never ignore the initial velocity; it can change the entire answer.*

HOT Example 12

A bus moving at 25m/s slows down uniformly and comes to rest after travelling 100m. Find its acceleration.

Solution

"Comes to rest" means the final velocity is zero. Thus v = 0m/s.

Using the third equation of motion: $v^2 = u^2 + 2as$.

Where: u = 25m/s, s = 100m, v = 0m/s.

Substituting $\left(0\,\frac{m}{s}\right)^2 = \left(25\,\frac{m}{s}\right)^2 + 2(a)(100\text{ m});\, a = -3.125\text{ m/s}^2$

The acceleration is $-3.125 m/s^2$.

Making Sense of the Answer: *The negative sign shows deceleration. The bus loses speed steadily until it stops.*

Think Like a Physicist: *When time is missing, don't panic, use the equation that eliminates time.*

As the worked examples quietly leave the table, vertical motion under gravity arrives; not to overwhelm us, but to be understood and enjoyed!