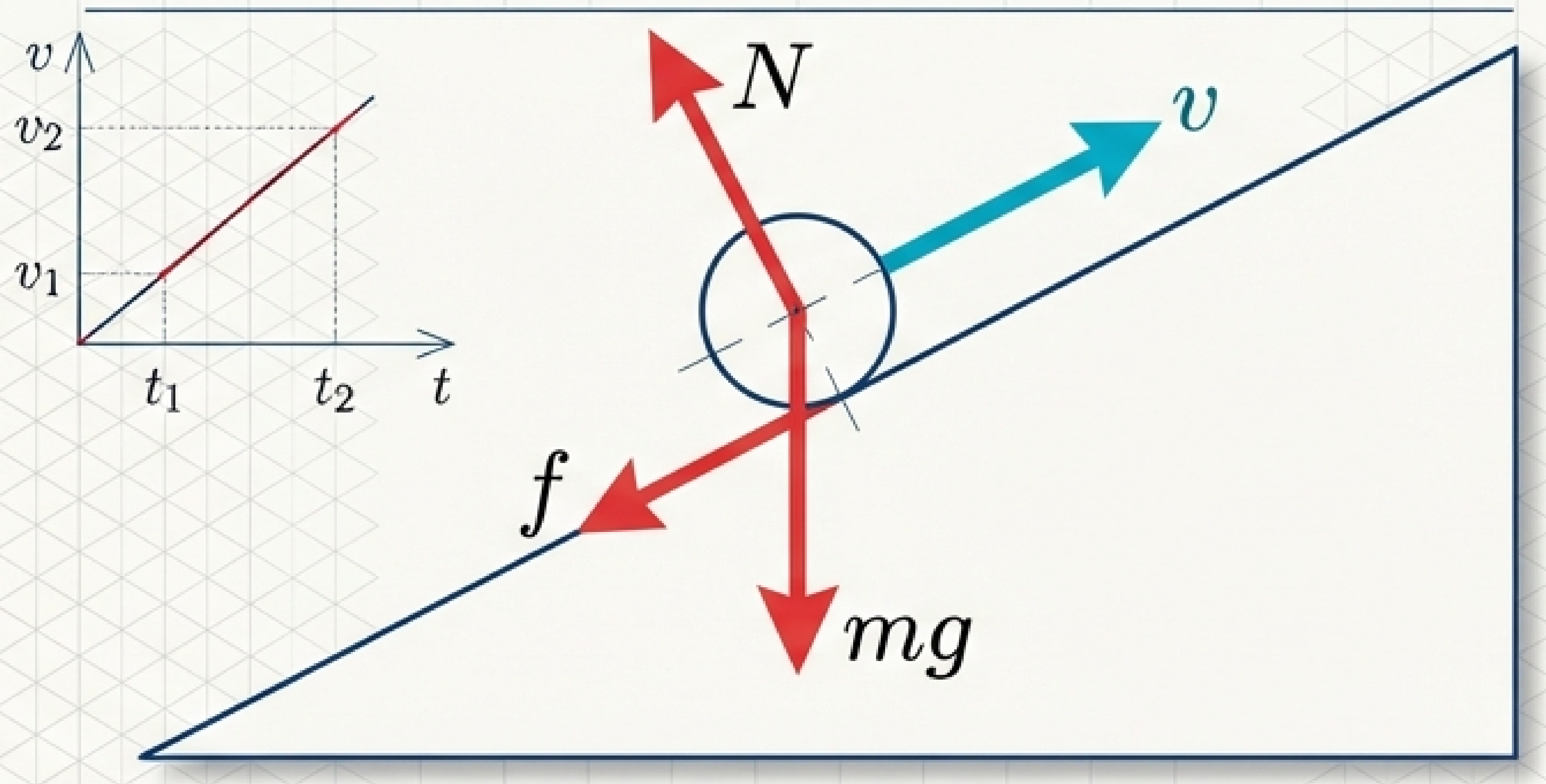
Mechanics 1: Exam Masterclass

The Ultimate 75-Mark Tactical Toolkit. Formulas, Frameworks, and Problem-Solving Strategies.



The Assessment Landscape & Problem-Solving Cycle

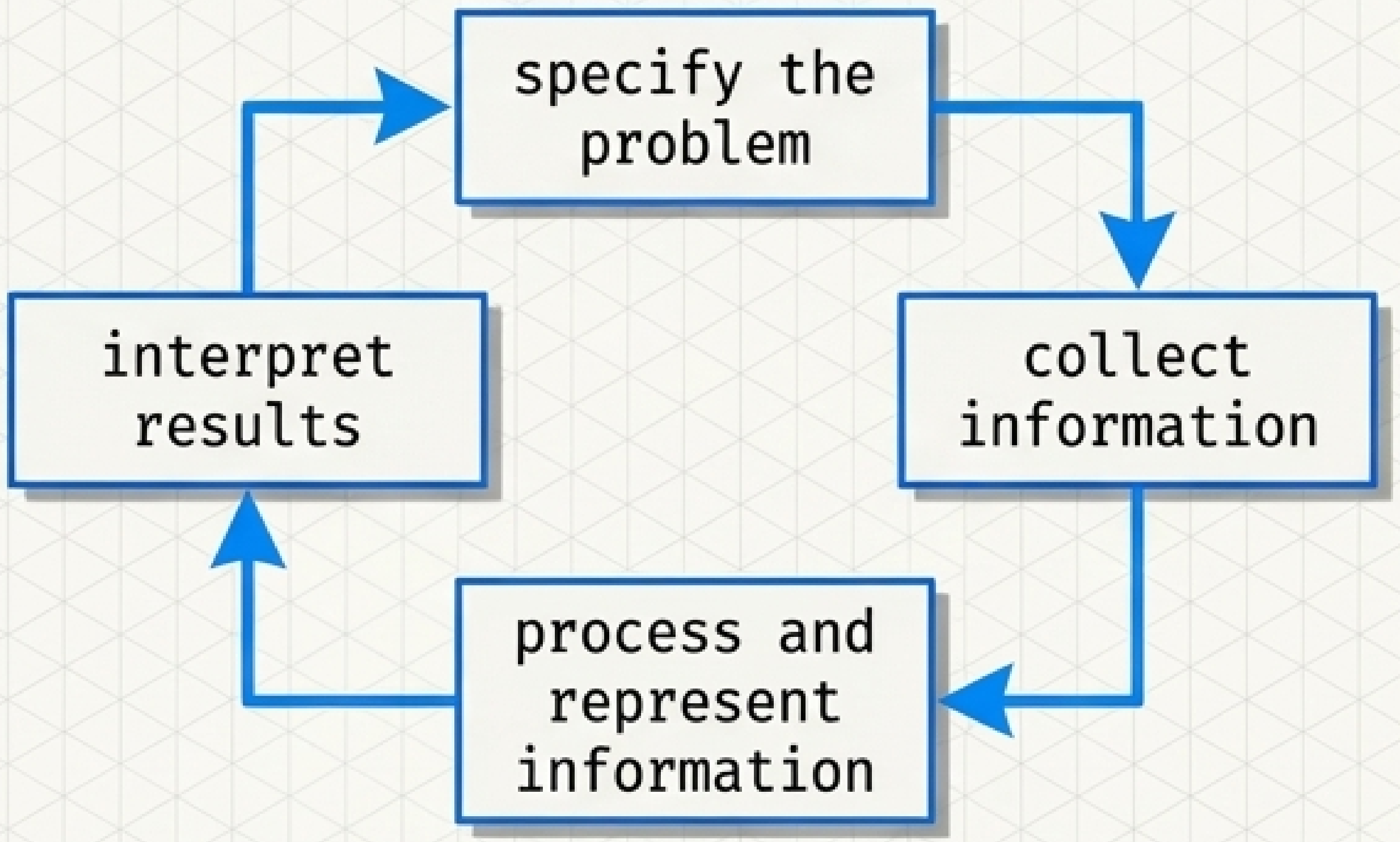
The Constraints

Time: 1 hour 30 mins

Marks: **75**

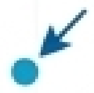
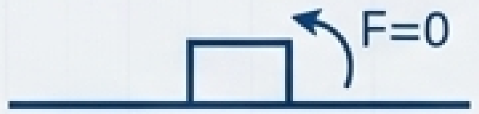
Core Objective: Mathematical translation (AO3/AO4)

The Engine

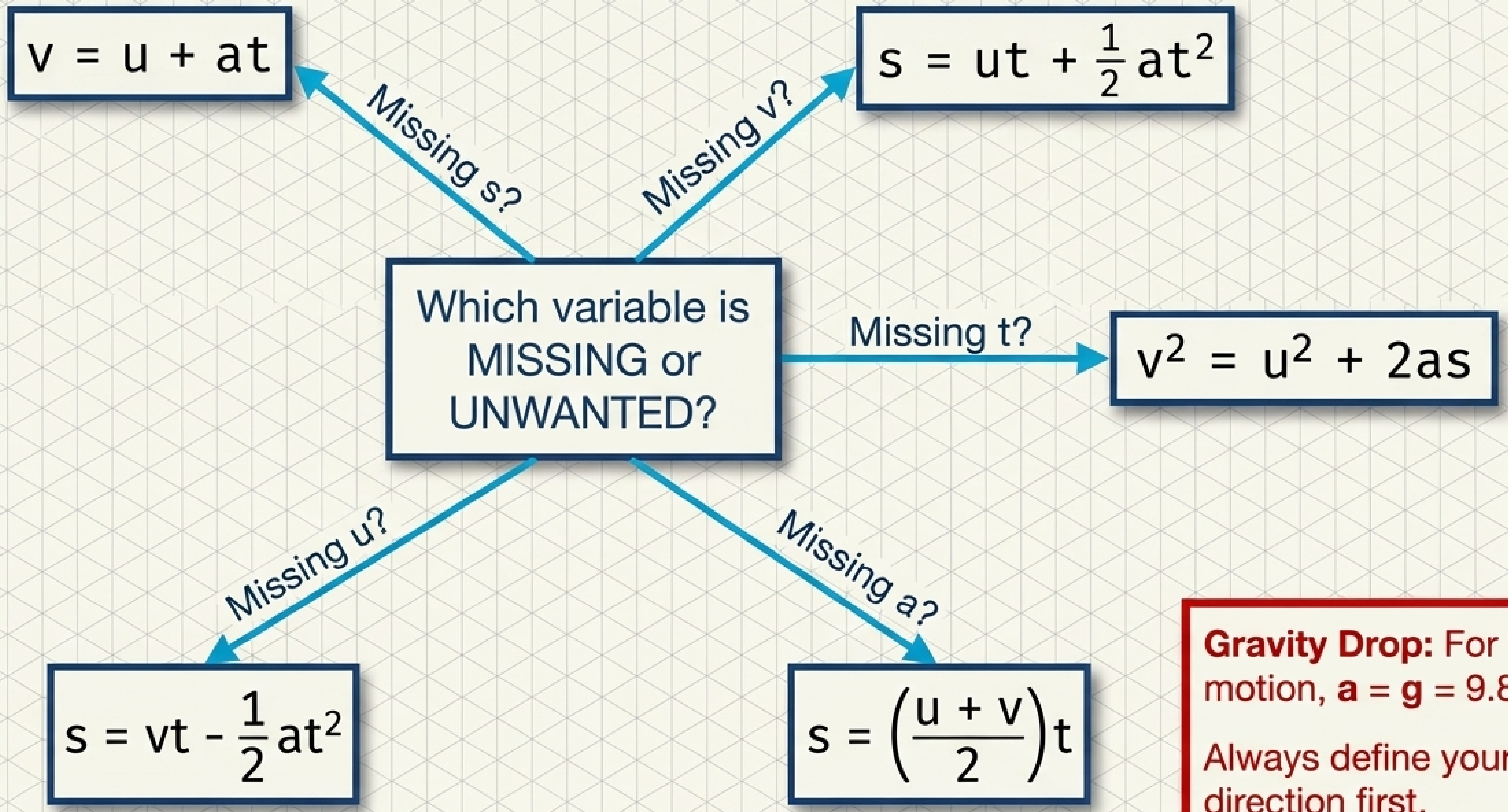


M1 is not just about memorizing formulas; it's about translating real-world text into mathematical models.

The Modeler's Translation Matrix

Exam Keyword	Mathematical Consequence
Particle 	Mass is concentrated at a single point; ignore rotational forces.
Light string 	Mass is zero; tension is identical at both ends.
Inextensible string 	Acceleration (***a***) is identical for connected bodies.
Smooth surface 	Friction (***F***) = 0.
Rough surface 	Frictional force opposes motion.
Uniform body 	Center of mass is exactly in the geometric center.

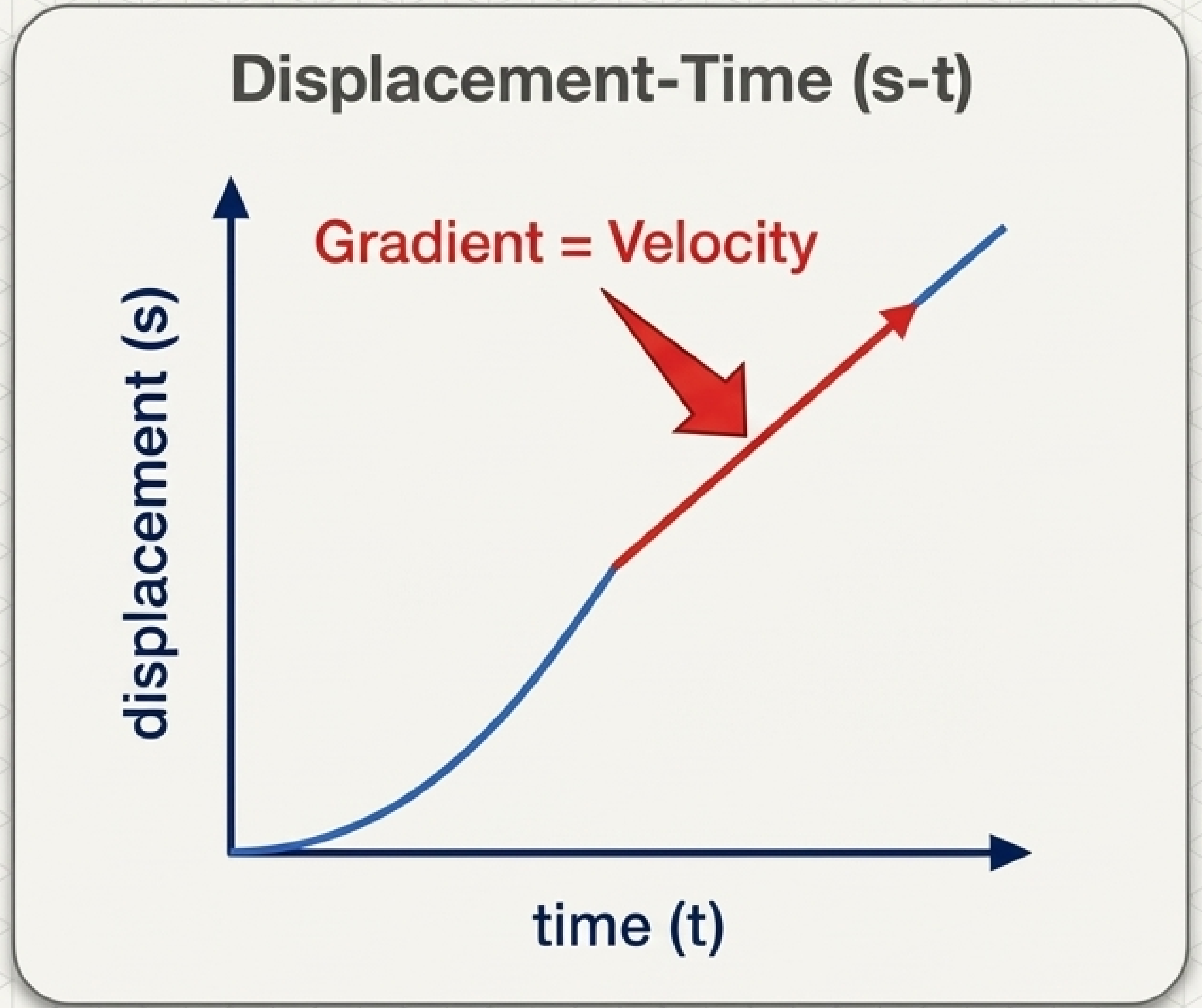
Kinematics: The ‘suvat’ Diagnostic Tree

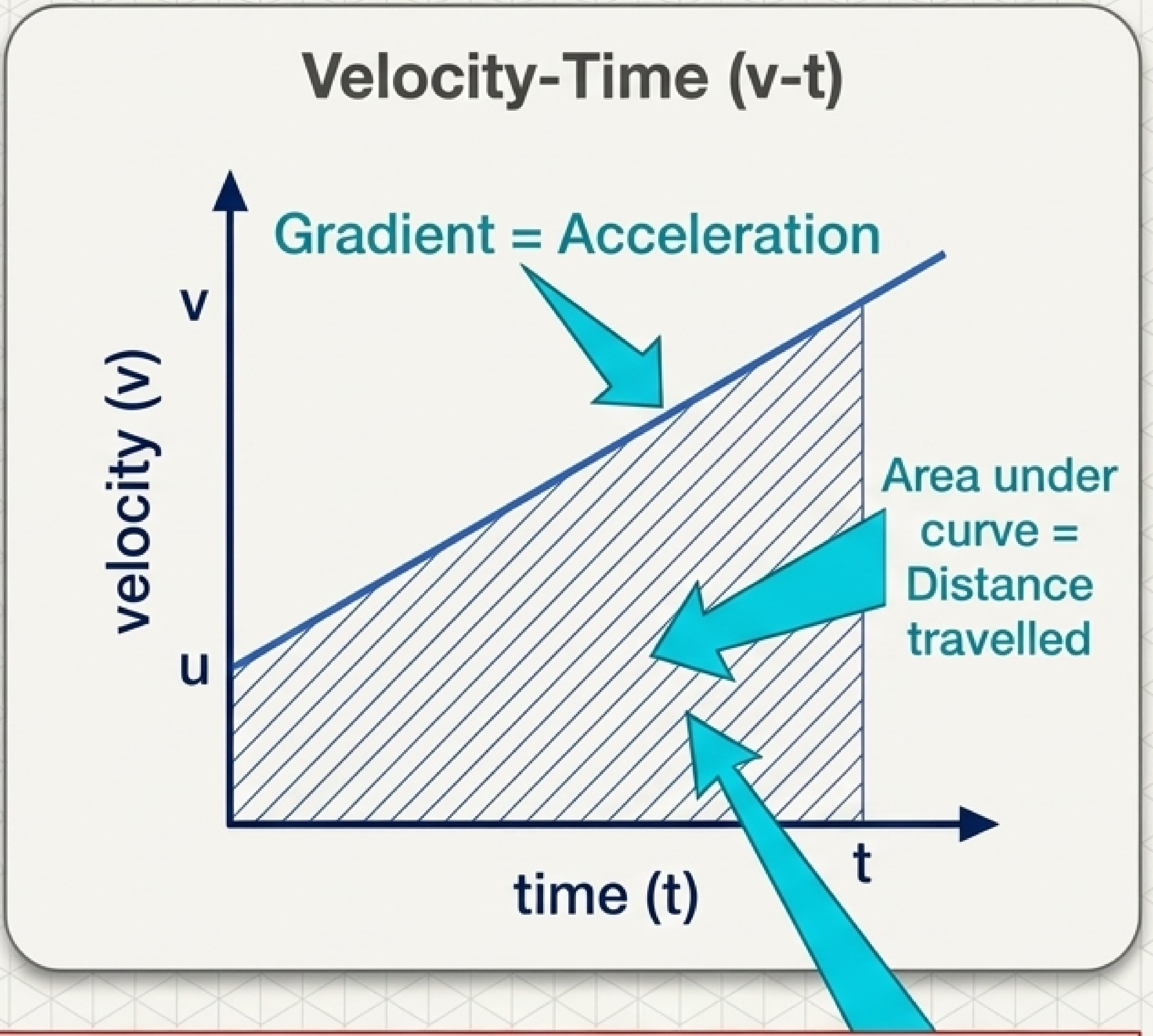


Gravity Drop: For vertical motion, **a** = **g** = 9.8 m s^{-2}.

Always define your positive direction first.

Visualizing Motion: Graph Mastery

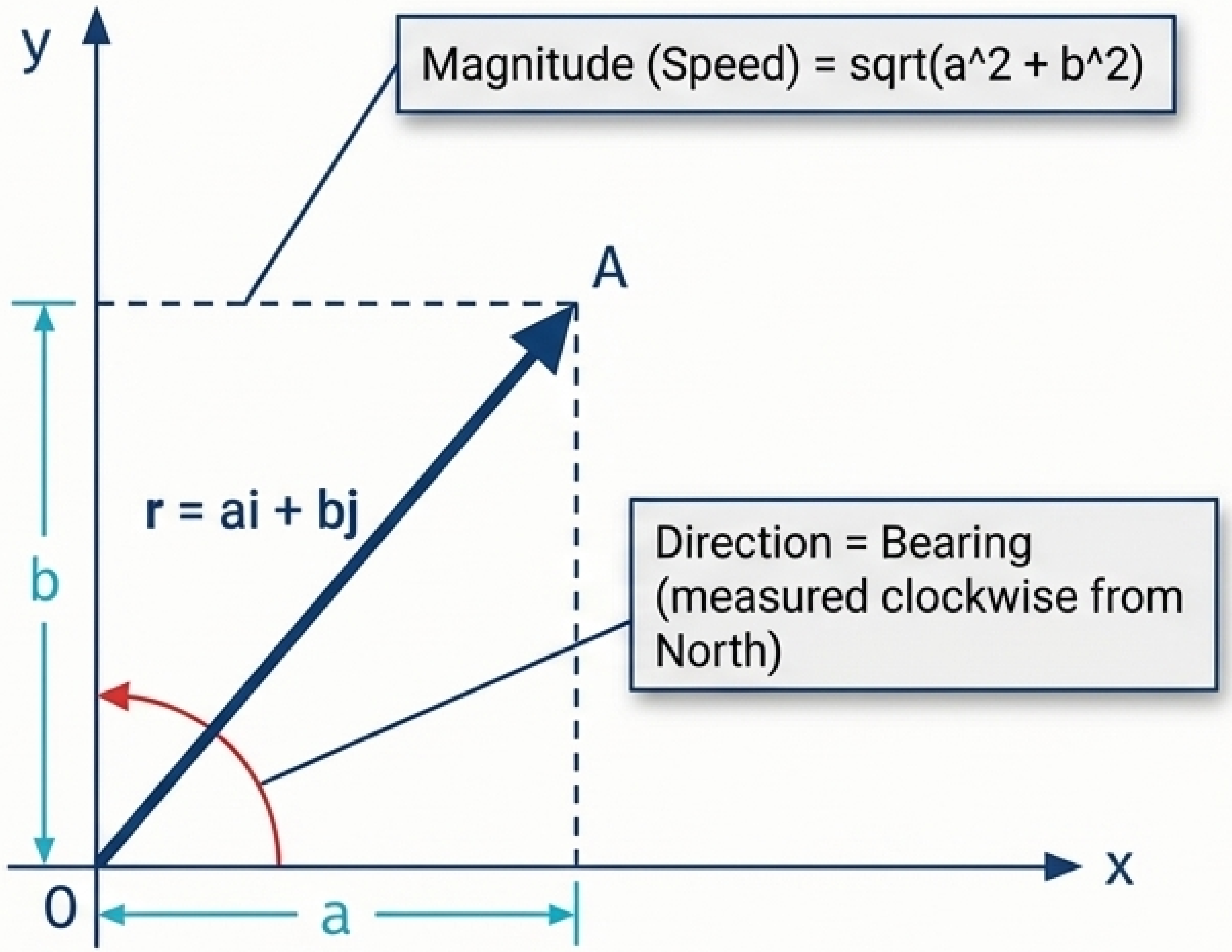




CRITICAL EXAM TRAP: Displacement can be negative. Total distance is always positive.

The Vector Toolbelt (2D Motion)

Geometry



The Engine

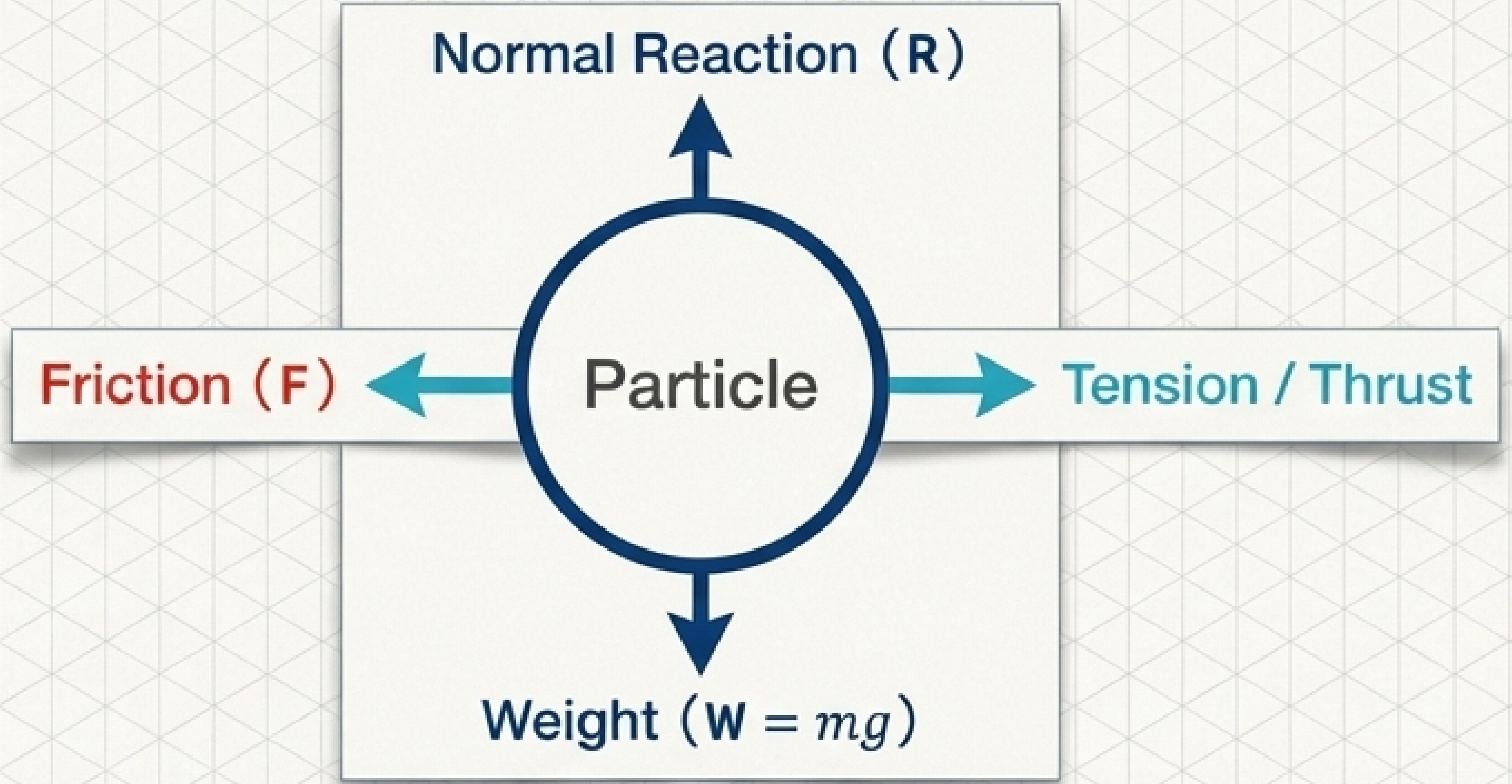
$$r = r_0 + vt$$

Position = Initial + Velocity x Time

$$v = u + at$$

Velocity = Initial + Acceleration x Time

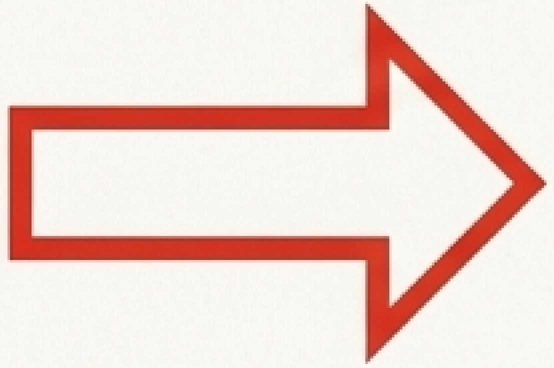
Forces & Newton's Laws Ecosystem



Newton's 1st Law: EQUILIBRIUM

Resultant Force is ZERO.
Object is at rest or moving with constant velocity.

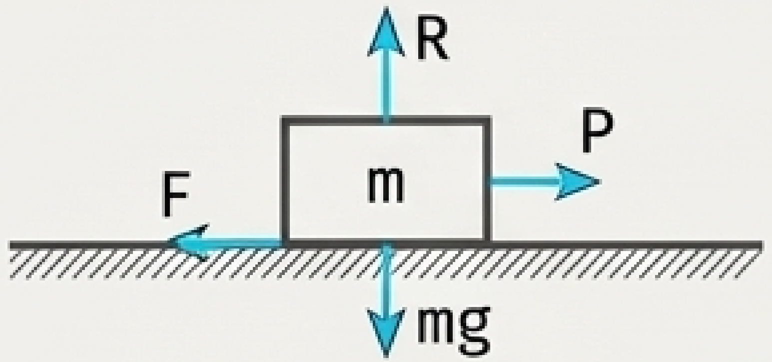
Newton's 2nd Law: ACCELERATION



Resultant Force = ma.
The equation of motion is strictly $F = ma$.

The Friction Framework

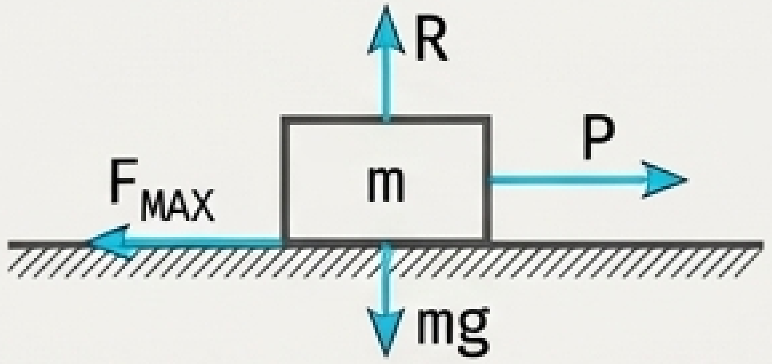
State 1: Stationary



F < mu R

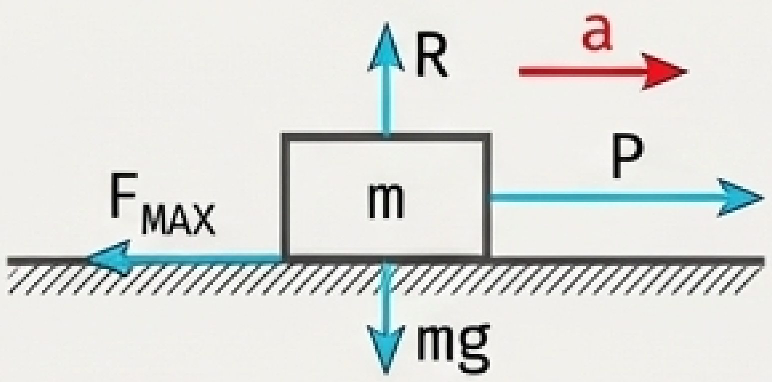
State 2:
Limiting Equilibrium

On the point of moving.



F = mu R (Maximum limit reached)

State 3: Accelerating



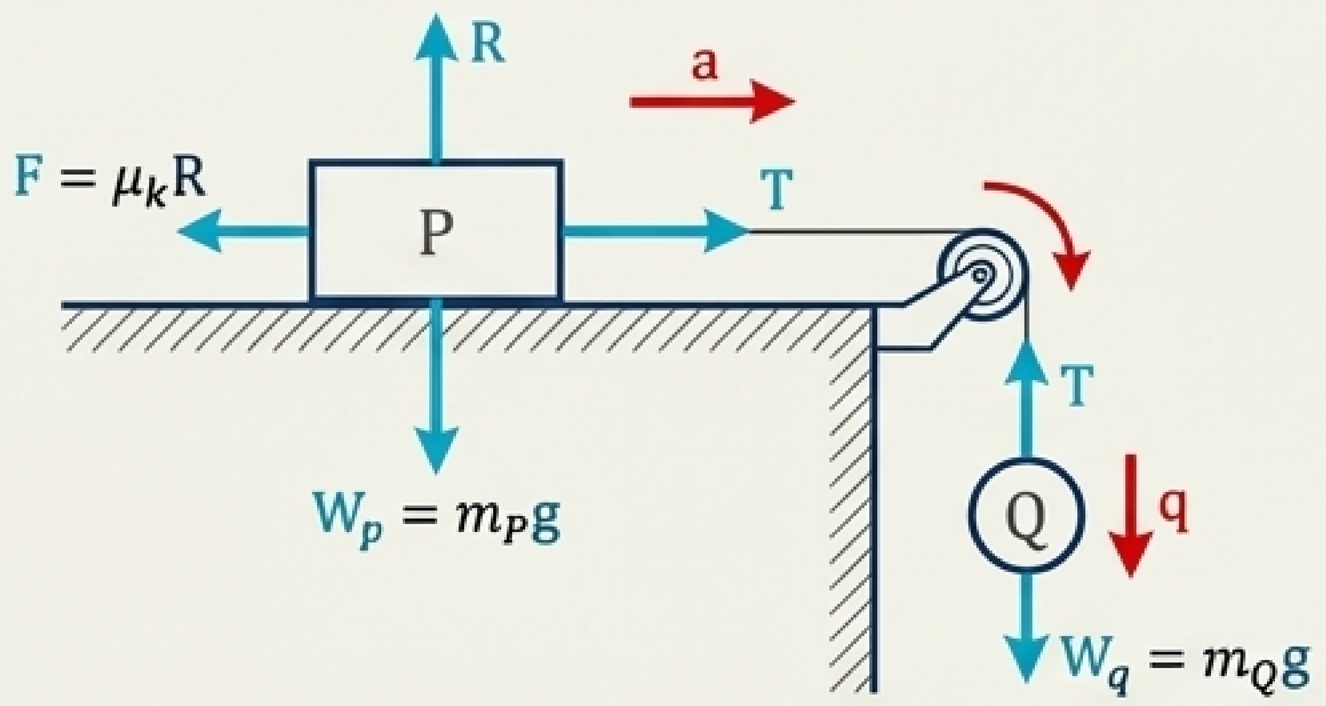
F = mu R (Friction remains at max while moving)

The coefficient of friction (mu) represents surface roughness.

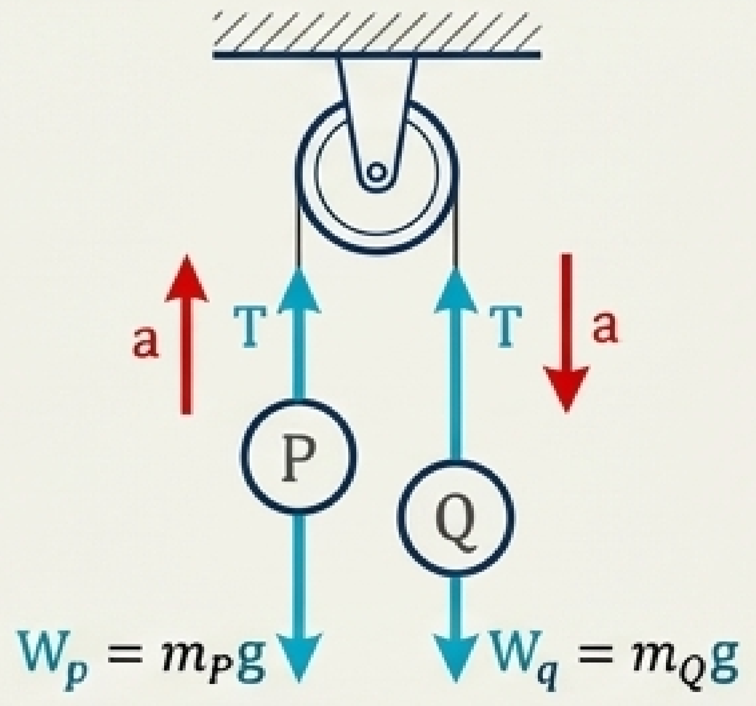
mu = 0 means a perfectly smooth surface.

Connected Particles Masterclass

Scenario 1: Horizontal & Vertical Motion



Scenario 2: Atwood Machine



The 4-Step Execution Plan

1. Map the System

Draw **ALL forces** (Tension, Weight, Friction) on large diagrams.

2. Isolate Body A

Write the $F = ma$ equation purely for the first mass.

3. Isolate Body B

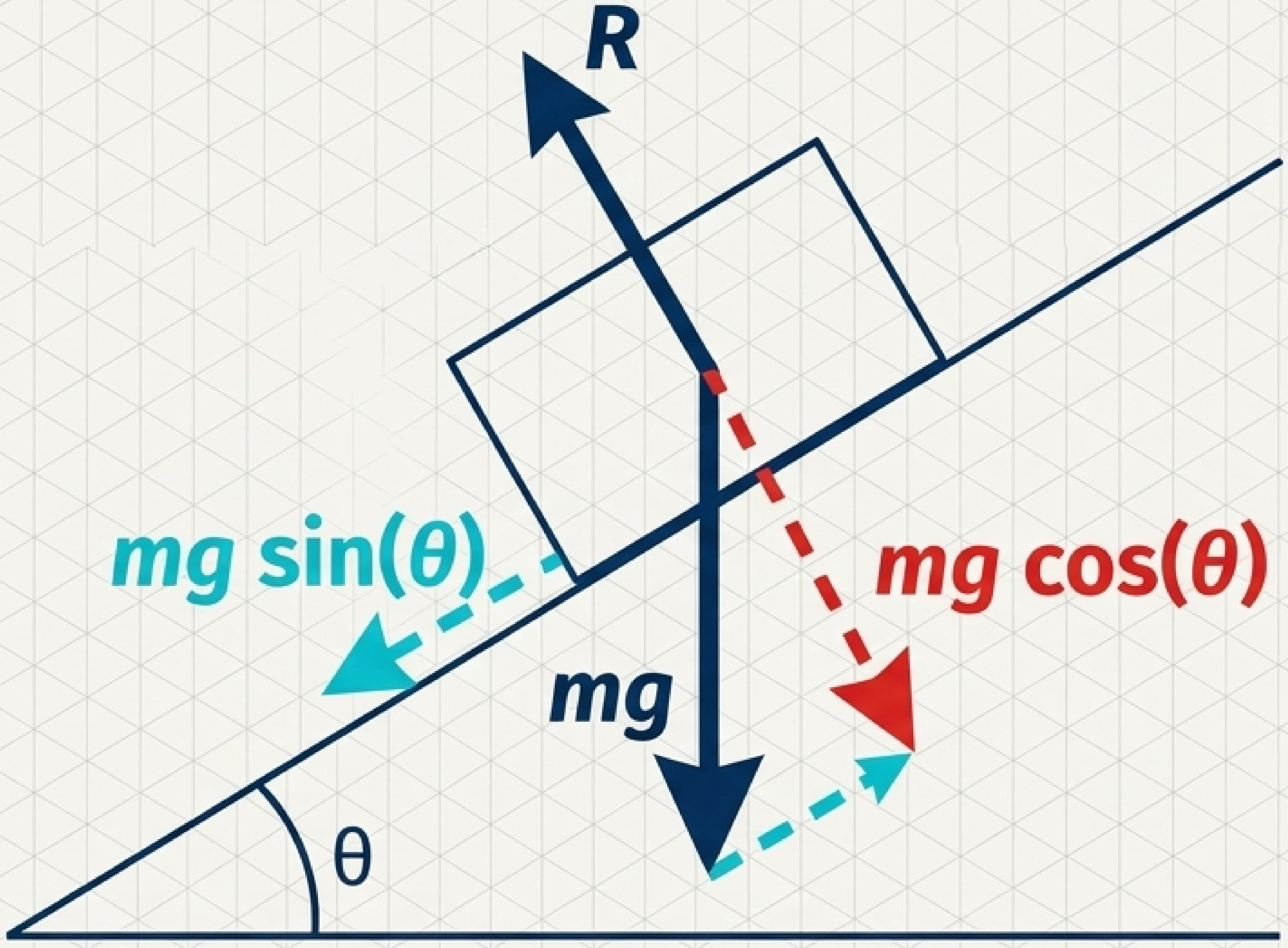
Write the $F = ma$ equation purely for the second mass.

4. Execute Math

Solve the simultaneous equations by adding them to eliminate **Tension**.

Inextensible string = 'a' is identical.
Smooth pulley = 'T' is identical on both sides.

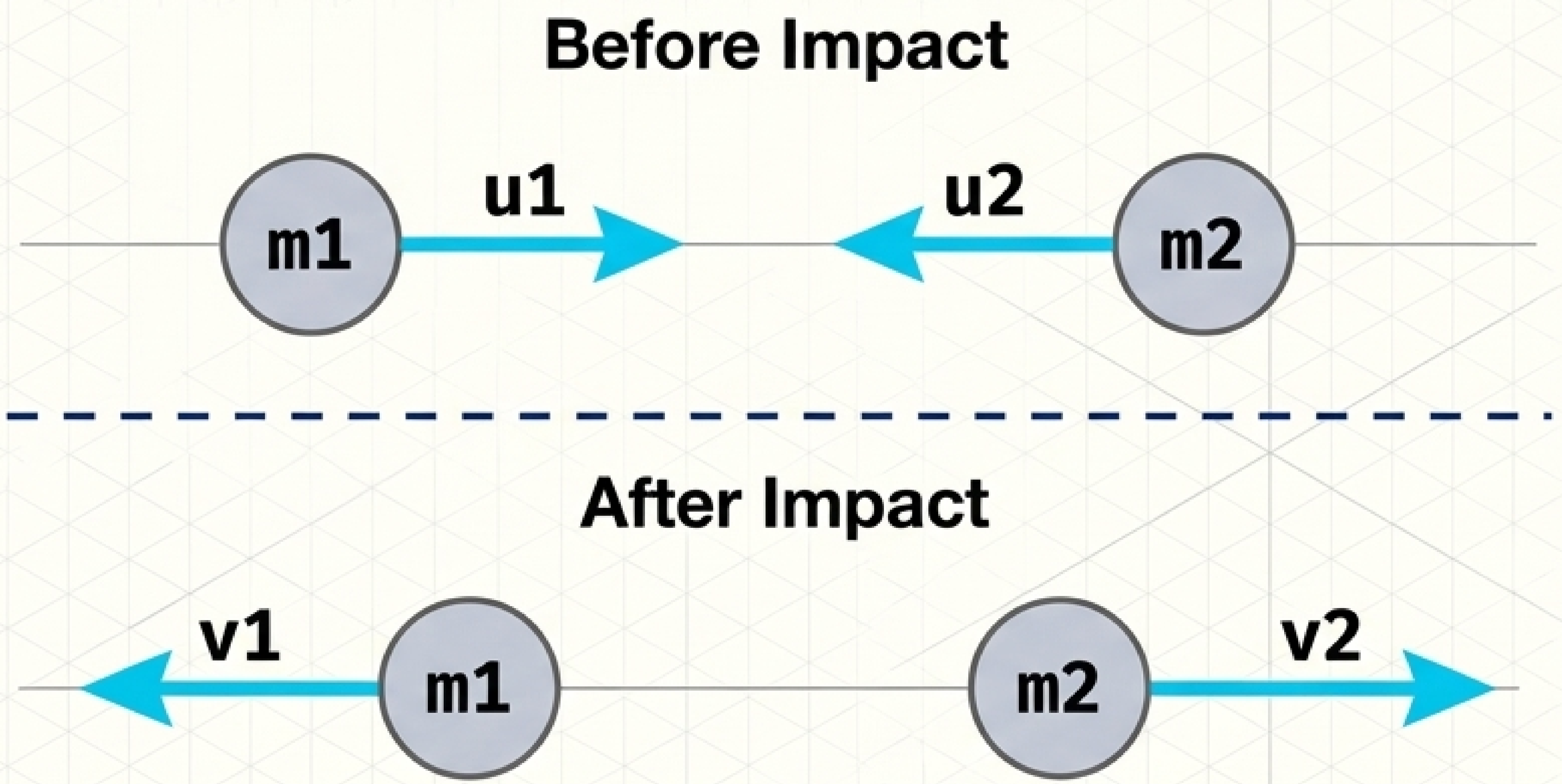
Statics & Resolving on an Incline



Quick Rules

- Reaction force: $\boldsymbol{R} = \boldsymbol{mg}\cos(\theta)$ (if no other vertical forces act).
- Force sliding down the plane: $mg\sin(\theta)$.
- Always resolve parallel and perpendicular to the plane, NEVER vertically and horizontally.

Momentum & Impulse Engine



Impulse Engine:

$$I = mv - mu$$

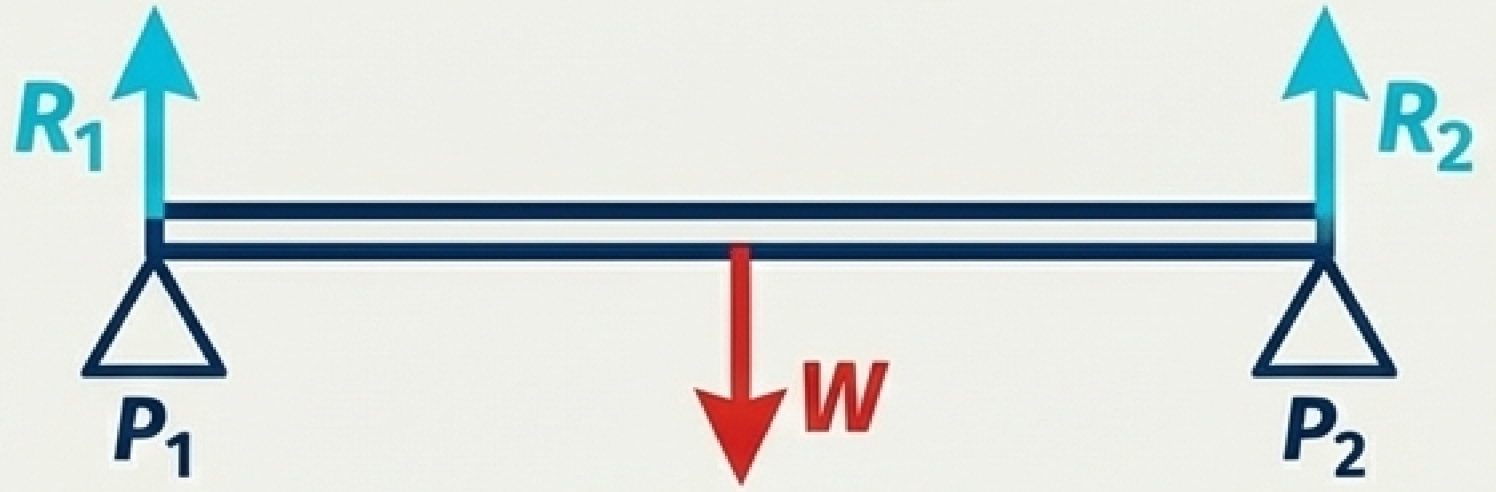
Conservation Principle:

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

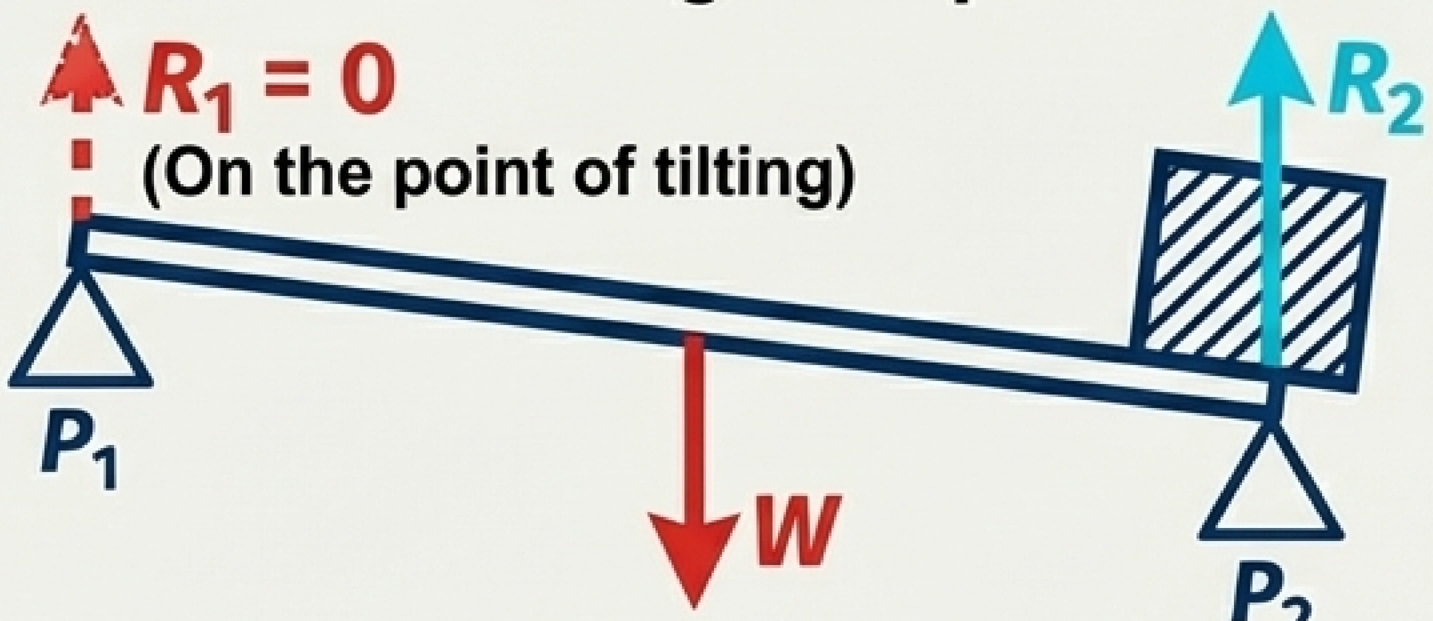
MOMENTUM IS A VECTOR. You MUST define a positive direction. If a particle rebounds, its velocity is NEGATIVE.

Moments & Rotational Equilibrium

Uniform Rod in Equilibrium



The 'Tilting' Blueprint



Definition:

`Moment = Force x Perpendicular Distance`

Equilibrium Principle:

`Total Clockwise Moments = Total Anticlockwise Moments`

Exam trigger: "On the point of tilting"

Mathematical translation: The **reaction force** at the furthest support becomes EXACTLY ZERO (**$R = 0$**).

Synthesis Arc: The Exam Translation Guide

Verbatim Exam Phrase → Algebraic Execution

VERBATIM EXAM PHRASE →	ALGEBRAIC EXECUTION
Starts from rest	Set $u = 0$
Constant velocity	Set $a = 0$ AND Resultant Force = 0
Comes to rest	Set $v = 0$
On the point of slipping	Friction is limiting, set $F = \mu R$
Reverses direction	Velocity changes sign (must pass through $v = 0$)
String goes slack	Tension $T = 0$, acceleration changes immediately

Top 5 Examiner Traps

01

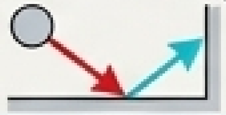
Mass vs. Weight: Confusing Mass (kg) with Weight (N).
You must multiply kg by g to get Weight.

02

The g Parameter: Using 9.81 or 10.
Pearson Edexcel explicitly requires $g = 9.8\ \text{m s}^{-2}$.

03

The Rebound Trap: Dropping negative signs in momentum calculations.
When a ball bounces off a wall.



04

Premature Friction: Using F = mu R when the object is stationary.
and NOT on the point of slipping.

05

Distance vs. Displacement: Assuming a negative result means a negative distance.
Assuming a negative integration/kinematic result.

Final Execution Protocol

- [ ] Draw large, rigorously labeled force diagrams.
- [ ] Always declare your positive direction.
- [ ] Show all intermediate algebraic steps for Method Marks (M1).
- [ ] State final answers to exactly 3 significant figures.

You possess the framework. Execute the blueprint.