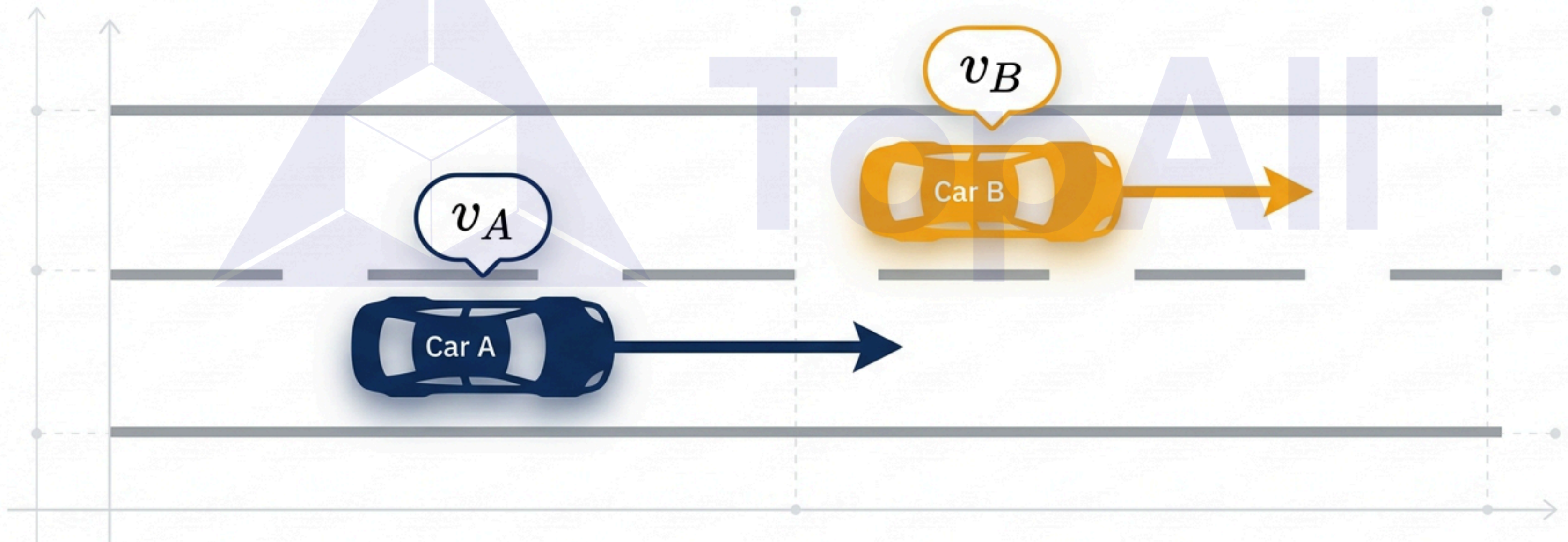
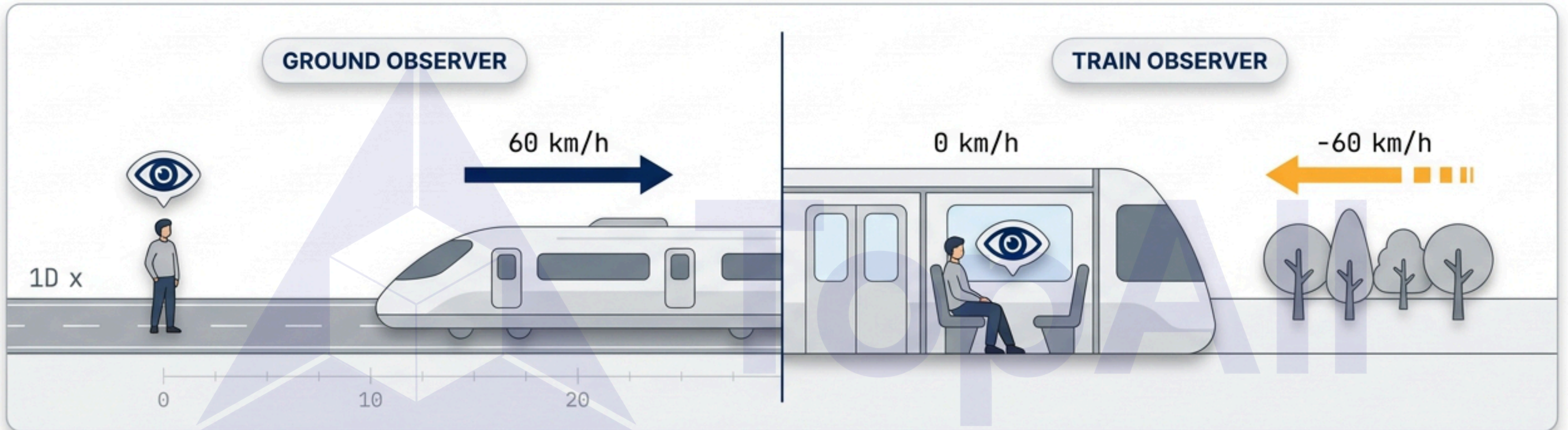


2.5 Relative Velocity

Understanding 1D motion through the lens of different observers.



Why Motion Is Relative



No Absolute Rest

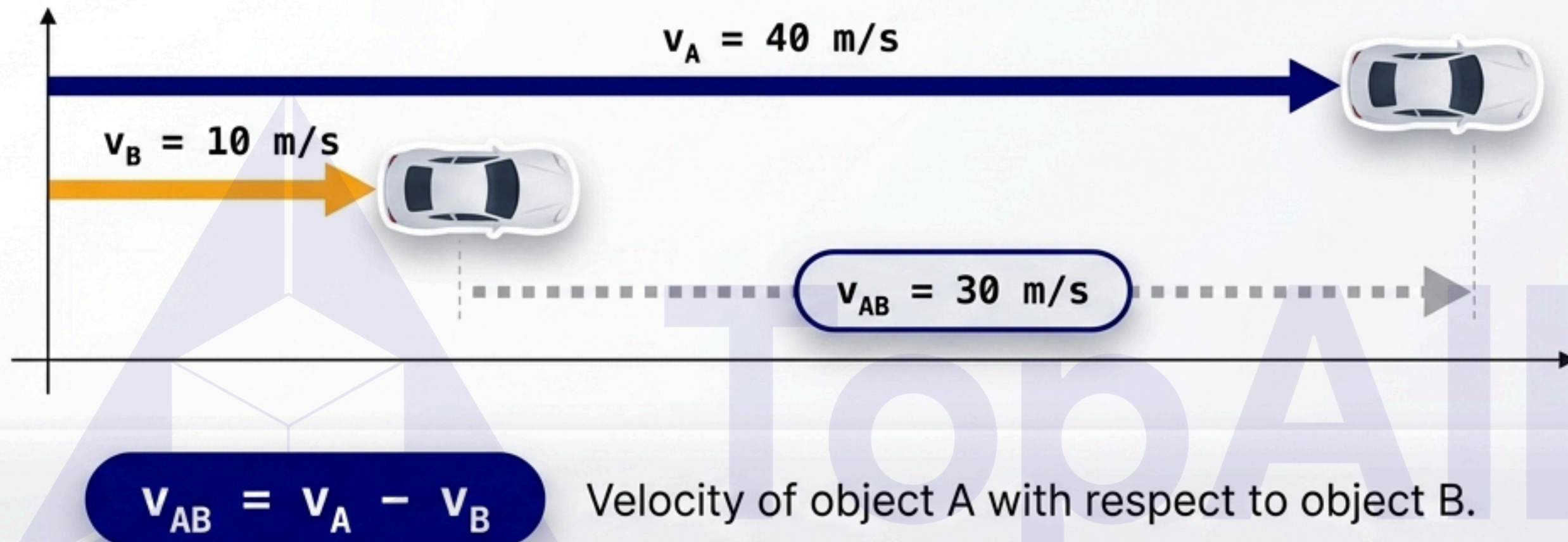
Every object in the universe is moving. We must always define motion with respect to a specific observer.

The Anchor Point

A coordinate system attached to an observer. If you are the frame of reference, you consider yourself to be perfectly still ($v = 0$).

$$v_{\text{observer}} = 0$$

Same Direction Motion



The “Tailgate” Effect

When two objects move in the same direction, they “eat up” each other’s speed. To observer B, object A appears to be moving slower than its actual ground speed. Magnitudes are subtracted.



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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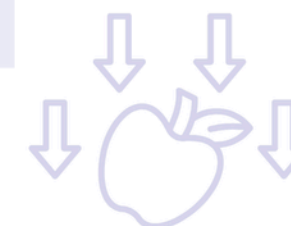
Practice Now



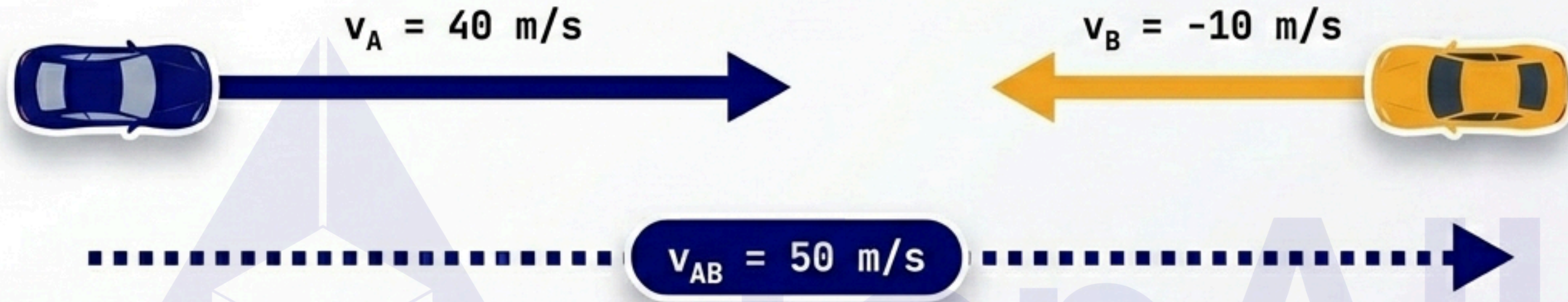
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Opposite Direction Motion



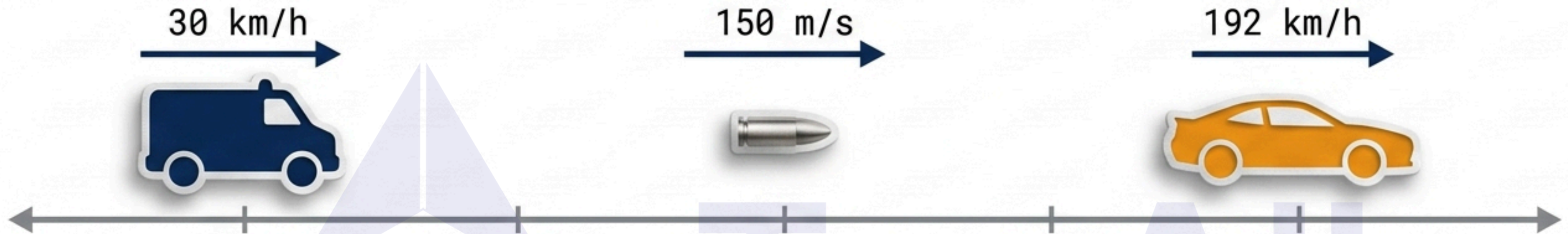
$$v_{AB} = v_A - (-v_B) = v_A + v_B$$

Subtracting a negative velocity results in addition.

The “Head-On” Effect

When directions oppose, relative speed amplifies. To observer B, object A appears to be approaching much faster than its ground speed. Magnitudes are added.

Application Case: Highway Chase



Gather & Convert

Pro-Tip: km/h $\rightarrow$ m/s

Police Van (v_p):

$$30 \times (5/18) = 8.33 \text{ m/s}$$

Thief Car (v_t):

$$192 \times (5/18) = 53.33 \text{ m/s}$$

Bullet Muzzle (v_{bp}):

150 m/s (relative to van)

Bullet True Speed

(w.r.t Ground)

Logic: Bullet speed +
Van speed

$$\begin{aligned} v_{bg} &= 150 + 8.33 \\ &= 158.33 \text{ m/s} \end{aligned}$$

The Impact

(Bullet w.r.t Thief)

Logic: Same direction
motion (Subtract)

$$v_{\text{impact}} = v_{bg} - v_t =$$

$$158.33 - 53.33 = \mathbf{105 \text{ m/s}}$$



Motion is Relative

There is no absolute state of rest. A velocity measurement is only valid when attached to a specific observer.



Frame of Reference Matters

The observer acts as the zero point ($v=0$) for any given system. Changing the frame changes the math.



Direction Dictates Magnitude

In 1D kinematics, same-direction relative speeds shrink (subtraction), while opposite-direction relative speeds amplify (addition).



You've Learned the Theory.

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