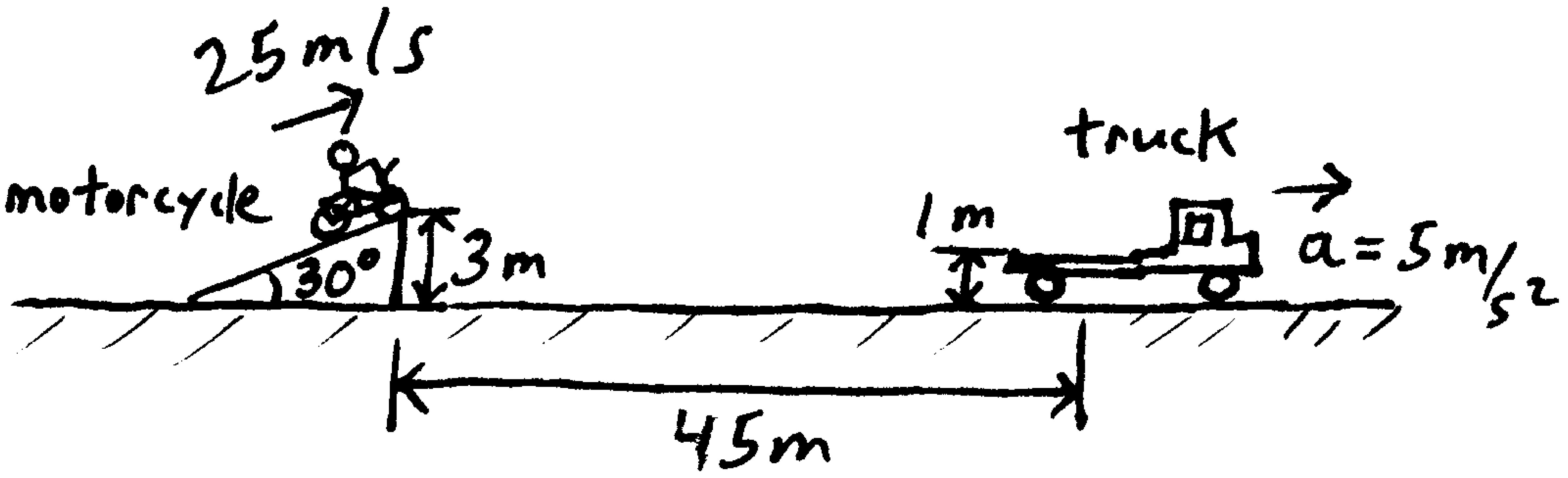



A stuntman rides his motorcycle at 25 m/s off a ramp that is inclined at 30°. He intends to land on the back of a truck. The driver of the truck must wait $T$ seconds after the motorcycle launches off the ramp, before accelerating, from rest, at 5 m/s², so that the motorcycle lands on the back of the truck. The edge of the ramp is 3 m high, the back of the truck is 1 m high, and the back of the truck is 45 m from the edge of the ramp, initially. What is the value of $T$?

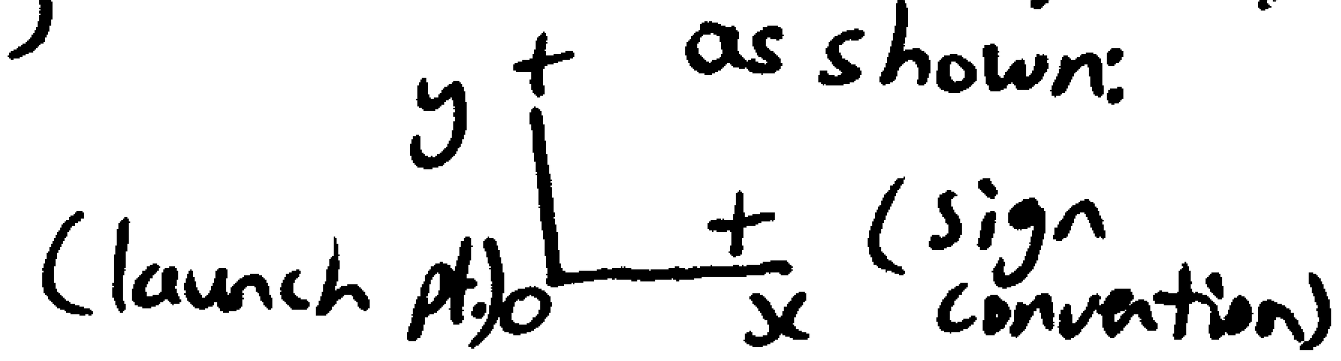
Solution: Assumptions:
- Ignore the dimensions of the motorcycle, and treat it as a particle
- Air resistance is negligible

The equation for horizontal motion is:

$$d_x = (v_0 \cos 30°)\,t \qquad (1)$$

$d_x = ?$ (horizontal displacement of motorcycle when it lands on truck)

Set up xy coordinate frame with origin at launch point of motorcycle, as shown:



$v_0 = 25\ m/s$ (magnitude of initial motorcycle velocity)

$t = ?$ (The airborne time of the motorcycle)

The equation for vertical motion is:

$$d_y = (v_0 \sin 30^\circ)t - \frac{1}{2} g t^2$$

$d_y = -2m$ (vertical displacement of the motorcycle when it lands on the truck)

$g = 9.8\ m/s^2$

Substitute:

$$-2 = (25 \sin 30^\circ)t - \frac{1}{2}(9.8)t^2$$

$$-4.9t^2 + 12.5t + 2 = 0$$

This is a quadratic equation. Solve for $t$.

$$t = \underbrace{-0.15s}_{\text{not valid}}, \text{ or } t = 2.70s$$

From equation (1):

$$d_x = (25 \cos 30^\circ)(2.70)$$

$$d_x = 58.5\ m$$

Therefore, the truck must move a distance of 58.5 m − 45 m = 13.5 m, in order for the motorcycle to land on the back of the truck.

Next, calculate how long it takes the truck to move 13.5 m.

$$d = v_1 t_1 + \frac{1}{2} a t_1^2$$

$v_1 \rightarrow 0$ (truck starts from rest)

$$d = 13.5\,m = \frac{1}{2}(5\,m/s^2)t_1^2$$

$$t_1 = 2.32\,s$$

Therefore, the truck driver must wait,

$T = 2.70 - 2.32 = 0.38\,s$ (answer)