This is a 1-D problem involving relative motion.

A cameraman is standing on the back of a pickup truck filming a scene for a movie. He videotapes a car traveling directly ahead of him moving at 45 mi/h faster than the truck. Suddenly, the car slows down, stops, and begins moving in the opposite direction at 60 mi/h, as measured by someone on the ground. If the pickup truck is moving at 35 mi/h, and the change in the car's velocity took 2.5 seconds, what was the acceleration of the car from the perspective of (a) the cameraman, and (b) the person on the ground?

Solution:

(a) Use the scalar equation: $v_P = v_B + v_{PB}$

(I) Initially:

v_{Pi} = ? (velocity of the car with respect to ground (initially))

$v_B = 35$ mi/h (velocity of the truck with respect to ground)

$v_{PBi} = 45$ mi/h (velocity of the car (initially) with respect to the truck)

Take the positive direction as the direction of motion of the truck.

Substitute:

$v_{pi} = 35\ mi/h + 45\ mi/h = 80\ mi/h$ (initial velocity of the car with respect to ground)

(II) Final:

$v_{pf} = -60\ mi/h$ (final velocity of the car with respect to ground)

$v_B = 35\ mi/h$ (same as in part (I))

$v_{PBf} = ?$ (final velocity of the car with respect to the truck)

Substitute:

$$-60\ mi/h = 35\ mi/h + v_{PBf}$$

$$v_{PBf} = -95\ mi/h$$

$$a_{PB} = \frac{v_{PBf} - v_{PBi}}{\Delta t}$$ (acceleration of car from the perspective of the cameraman)

Substitute:

$$a_{PB} = \frac{-95\ mi/h - 45\ mi/h}{2.5\ s} = -56\ \frac{mi}{h \cdot s}$$

$$= -25\ m/s^2$$ (answer)

(b) $$a_p = \frac{v_{pf} - v_{pi}}{\Delta t}$$

substitute: $$a_p = \frac{-60\ mi/h - 80\ mi/h}{2.5\ s} = -25\ m/s^2$$ (answer) (same as in (a))