Q- A truck with mass 5000 kg is heading east at 20 m/s. Meanwhile a car with mass 2500 kg is heading north at 30 m/s. The two vehicles collide at an intersection, get stuck together and the wreckage keeps moving to some direction.

(a) Is the collision elastic or inelastic?

(b) Find the speed of the wreckage and the direction it moves to, just after the collision.

(a)

Whenever the two bodies collide elastically their velocity of approach is equal to their velocity of separation. For inelastic collision velocity of separation is less than velocity of approach. When the bodies stick together after collision means the velocity of separation is zero the collision is called perfectly inelastic collision. Hence

The collision is perfectly inelastic collision.

(b)

Taking east as x direction and north as y direction and $\hat{\imath}$ and $\hat{\jmath}$ as unit vectors in x and y directions respectively

Initial velocity of the truck $\vec{u}_x = 20\,\hat{\imath}$: Initial velocity of the car $\vec{u}_y = 30\,\hat{\jmath}$

Let the final velocity of the wreckage $\vec{v} = ?$

Initial momentum of the truck $5000{*}\vec{u}_x = 5000 * 20\,\hat{\imath} = 10^5\,\hat{\imath}$

Initial momentum of the car $2500{*}\vec{u}_y = 2500 * 30\,\hat{\jmath} = 7.5 * 10^4\,\hat{\jmath}$

Final velocity of the wreckage $(5000 + 2500)\vec{v} = 7500\,\vec{v}$

As there is no external force on the system in horizontal direction the momentum of the system remains conserved and hence

Final momentum = initial momentum

Or $7500\,\vec{v} = 10^5\,\hat{\imath} + 7.5 * 10^4\,\hat{\jmath}$

Or $\vec{v} = 13.33\hat{\imath} + 10\hat{\jmath}$

Hence the magnitude of the velocity will be

$$v = \sqrt{13.33^2 + 10^2} = 16.67 \text{ m/s}$$

And the angle of the direction of motion of wreckage with x axis is

$$\theta = tan^{-1}\frac{10}{13.33} = tan^{-1}0.75 = 36.9^0 \text{ North of east}$$

Top view