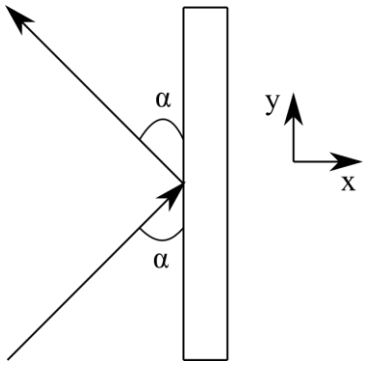
Answer on Question 65453, Physics, Mechanics, Relativity

Question:

A bullet of mass $20\ g$, travelling at a speed of $350\ ms^{-1}$, strikes a steel plate at an angle of 30° with the plane of the plate. It ricochets off at the same angle, at a speed of $320\ ms^{-1}$. What is the magnitude of the impulse that the steel plate gives to the projectile? If the collision with the plate takes place over a time $\Delta t = 10^{-3} s$, what is the average force exerted by the plate on the bullet?

Solution:

a)



Let's first find x- and y-components of the impulse that the steel plate gives to the projectile (we take the positive x- and y-directions as in the picture above):

$$J_x = \Delta p_x = mv_{fx} - mv_{ix} = m\left(-v_{fx}sin\alpha - v_{ix}sin\alpha\right) =$$
$$= 0.02\ kg \cdot (-320\ ms^{-1} \cdot sin30^{\circ} - 350\ ms^{-1} \cdot sin30^{\circ}) = -6.7\ N \cdot s,$$

$$J_y = \Delta p_y = mv_{fy} - mv_{iy} = m\left(v_{fy}cos\alpha - v_{iy}cos\alpha\right) =$$
$$= 0.02\ kg \cdot (320\ ms^{-1} \cdot cos30^{\circ} - 350\ ms^{-1} \cdot cos30^{\circ}) = -0.52\ N \cdot s.$$

We can find the magnitude of the impulse that the steel plate gives to the projectile from the Pythagorean theorem:

$$J = \sqrt{J_x^2 + J_y^2} = \sqrt{(-6.7\ N \cdot s)^2 + (-0.52\ N \cdot s)^2} = 6.7\ N \cdot s.$$

b) We can find the average force exerted by the plate on the bullet from the definition of the impulse:

$$J = \bar{F}\Delta t,$$

$$\bar{F} = \frac{J}{\Delta t} = \frac{6.7\ N \cdot s}{10^{-3}\ s} = 6700\ N.$$

Answer:

a) $J = 6.7\ N \cdot s.$

b) $\bar{F} = 6700\ N.$