Q- A 25 g bullet is fired into a block of wood sitting on a skateboard. The block and skateboard have combined mass of 22.9 kg. The bullet lodges in the block and the combined system moves away at a velocity of 0.21 m/s. Calculate the initial velocity of the bullet.

These types of the problems can easily solved using law of conservation of momentum, which says that if there is no net external force acting on the system, its linear momentum remains conserved. This law holds well in both, elastic and inelastic collisions.

As there is no external horizontal force other then the action and reaction forces between the block and the bullet, and these forces are considered as internal forces of the system, hence the net linear momentum in horizontal direction will remain conserved.

Mass of the bullet = 25 g = 0.025 kg

Let the initial velocity of the bullet be v_o

Hence momentum of the bullet before collision = $0.025*v_o$

Initial velocity of the block with skateboard is zero hence initial momentum of the block +skateboard = 0

Thus total initial momentum of the system

$$P_1 = 0.025*v_o + 22.9*0 = 0.025*v_o$$

The combined mass of the system = 0.025 + 22.9 = 22.925 kg

Velocity of combined mass = 0.21 m/s

Hence momentum of combined mass after collision will be

$$P_2 = 22.925*0.21 = 4.81 \text{ kg m /s}$$

Applying the law of conservation of momentum we have

$$P_1 = P_2$$

Or $0.025*v_o = 4.81$

Or $v_o = 4.81/0.025 = 192.4$ m/s

Hence initial velocity of the bullet was 192.4 m/s