Answer on Question 68206, Physics, Molecular Physics, Thermodynamics

Question:

The man of steel is well known of simply bouncing off his chest the bullets and other missiles fired at him. Suppose that a gangster sprays Superman's chest with 5 g bullets at the rate of 110 bullets per minute, and the speed of each bullet is 510 m/s. Suppose too that the bullets rebound straight back with no change in speed. What is the magnitude of the average force on Superman's chest from the stream of bullets?

Solution:

We can find the magnitude of the average force on Superman's chest from the definition of the impulse:

$$J = \Delta p = m\Delta v = \bar{F}\Delta t,$$

here, Δp is the change in the linear momentum per collision given to Superman, $\bar{F}$ is the magnitude of the average force on Superman's chest from the stream of bullets, m is the mass of the bullet, Δv is the change in the velocity of the bullet, Δt is the time interval over which the average force on the Superman's chest is applied.

From this formula we can find $\bar{F}$:

$$\bar{F} = \frac{\Delta p}{\Delta t} = R\Delta p,$$

here, $R = 110\ \frac{bullets}{min} = 1.83\ \frac{bullets}{s}$ is the collision rate.

Then, we get:

$$\bar{F} = R\Delta p = Rm\Delta v = Rm\big(v - (-v)\big) = 2Rmv =$$
$$= 2 \cdot 1.83\ \frac{bullets}{s} \cdot 0.005\ \frac{kg}{bullets} \cdot 510\ \frac{m}{s} = 9.3\ N.$$

Answer:

$\bar{F} = 9.3\ N.$