Negative sign because the gun recoils.

$F = n m_B v_B = 12 \times 0.02 \times 80 = 24\ N$

→ Homework → ① A 20 kg bullet can fire 10 bullets per sec. Mass of each bullet 0.2 kg. The muzzle speed of the bullet is 150 m/s. What is the recoil velocity of the gun? How much force is required to hold the gun?

→ By law of conservation of momentum

$m_G + v_G + m_B v_B = 0$

$v_G = -\frac{m_B v_B}{m_G} = \frac{0.2 \times 150}{20} = \frac{0.2 \times 150}{20}$

$= -1.5$ m/s

$v_G = -1.5$ m/s [Negative sign as it recoils]

→ $F = n m_B \times v_B = 10 \times 0.2 \times 150 = \boxed{300\ N}$

[n = no. bullets fired per sec]

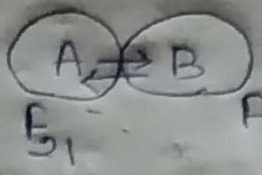
② State and prove law of conservation of momentum.

→ According to this law, the total momentum of a system of objects remains conserved before and after their interactions or collision. This can only happen if the system is a isolated system [when no external

force is acting on the system].
Consider two objects →

$u_1 > u_2$

Before collision



During collision

After collision

To prove → total momentum before collision = total momentum after collision,

$= m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$

Proof → from Newton's third law of motion, Force exerted on A due to B = force exerted on B due to A

$= f_{12} = f_{21}$

$\Rightarrow m_1 a_1 = -m_2 \times a_2$

$$\Rightarrow m_1 \times \left(\frac{v_1 - u_1}{t}\right) = -m_2 \times \left(\frac{v_2 - u_2}{t}\right)$$

$$\Rightarrow \frac{m_1 v_1 - m_1 u_1}{t} = -\left\{m_2 \times \left(\frac{v_2 - u_2}{t}\right)\right\}$$

$$\Rightarrow \frac{m_1 v_1 - m_1 u_1}{t} = \frac{m_2 u_2 - m_2 v_2}{t}$$

$$\Rightarrow m_1 v_1 - m_1 u_1 = m_2 u_2 - m_2 v_2$$

$$\Rightarrow m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2$$

$$= \boxed{m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2}$$

(3) A bomb explodes into several parts. Why these parts fly off in different directions

→ A bomb at rest explodes into several parts. Let the Mass of bomb be 'M' and let two pieces of bomb mass be 'm_1' and 'm_2'. According to conversation of momentum, $Mv = m_1 v_1 + M_2 v_2$

$v = 0$ [Bomb at rest]

$M \times 0 = m_1 v_1 + m_2 v_2$

$= 0 = m_1 v_1 + m_2 v_2$

$m_1 v_1 = -m_2 v_2$

* Hence negative sign indicates they fly off in different direction.

Homework → [only ans]

① Given → mass of object = 1.5 kg [m_1]

u = 5 m/s [u_1]

wooden block mass = 5kg [m_2]

u = 0 m/s [u_2]

① Total momentum after collision →

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

→ $1.5 \times 5 + 5 \times 0 = (m_1 + m_2)v$

⇒ $7.5 = (1.5 + 5)v$

$7.5 = 6.5v$

$\frac{7.5}{6.5} = v$

$1.150 = v$ [approx]

⇒ $(m_1 + m_2)v = 6.5 \times 1.15 = 7.5$ kg m/s

(c) 7.5 kg m/s

② (3) 1.15 m/s