Q1. A 91 kg man lying on a surface of negligible friction shoves a stone away from himself giving it a speed of 4.0 m/s. if the speed of the man after the shove is $3*10^{-3}$ m/s in the backward direction then what is the mass of the stone?

Ans.

Since there in no external force, so we will use law of conservation of momentum.
Momentum before the collision = Momentum after the collision

$M_i v_{m_i} + M_s v_{s_i} = M_f v_{m_f} + M_s v_{s_f}$

Subscript "m" is for the man and subscript "s" is for the stone.

$91 \times 0 + M_s \times 0 = 91 \times -3 \times 10^{-3} + M_s \times 4$

$M_s \times 4 = 91 \times 3 \times 10^{-3}$

$4M_s = 273 \times 10^{-3} = 0.273$

$M_s = \frac{0.273}{4} = 0.068$ kg

Q2.

A rifle of mass 4kg is initially at rest but free to recoil. It fires a bullet of mass 100g and velocity 200m/s (relative to the ground). After firing, what is the velocity of the rifle (relative to the ground)?

Ans

Law of conservation of momentum is:
Momentum before the collision = Momentum after the collision

$M_r v_{r_i} + M_B v_{B_i} = M_r v_{r_f} + M_B v_{B_f}$

$0 + 0 = 4 \times v_{r_f} + 0.100 \times 200$

$4 \times v_{r_f} = -0.100 \times 200 = -20$

$v_{r_f} = \frac{-20}{4} = -5$ m/s

Q3.

75 kg man is riding in a30 kg cart at 2.0 m/s. He jumps off the cart in such a way as to land on the ground with no horizontal velocity. What is the resulting change in the speed of the cart?

Ans.

Law of conservation of momentum is:
Momentum before the collision = Momentum after the collision

$M_m v_{m_i} + M_c v_{c_i} = M_m v_{m_f} + M_c v_{c_f}$

$75 \times 2 + 30 \times 2 = 0 + 30 \times v_{c_f}$

$210 = 30 \times v_{c_f}$

$v_{c_f} = \frac{210}{30} = 7$ m/s

The change in the speed of the cart is: $\Delta v_C = v_{c_f} - v_{c_i} = 7 - 2 = 5\ m/s$
