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Question 1:

If action is always equal to the reaction, explain how a horse can pull a cart.

Answer 1:

A horse pushes the ground in the backward direction. According to Newton's third law of motion, a reaction force is exerted by the Earth on the horse in the forward direction. As a result, the cart moves forward.

Question 2:

Explain, why is it difficult for a fireman to hold a hose, which ejects large amounts of water at a high velocity.

Answer 2:

Due to the backward reaction of the water being ejected

When a fireman holds a hose, which is ejecting large amounts of water at a high velocity, then a reaction force is exerted on him by the ejecting water in the backward direction. This is because of Newton's third law of motion. As a result of the backward force, the stability of the fireman decreases.

Hence, it is difficult for him to remain stable while holding the hose.

Question 3:

From a rifle of mass 4 kg, a bullet of mass 50 g is fired with an initial velocity of 35 m s^{-1}. Calculate the initial recoil velocity of the rifle.

Answer 3:

Mass of the rifle, $m_1 = 4\ kg$

Mass of the bullet, $m_2 = 50g = 0.05\ kg$

Recoil velocity of the rifle = v_1

Bullet is fired with an initial velocity, $v_2 = 35\ m/s$

Initially, the rifle is at rest.

Thus, its initial velocity, $v = 0$

Total initial momentum of the rifle and bullet system = $(m_1 + m_2)v = 0$

Total momentum of the rifle and bullet system after firing:

$= m_1v_1 + m_2v_2 = 4(v_1) + 0.05 \times 35 = 4v_1 + 1.75$

According to the law of conservation of momentum:
Total momentum after the firing = Total momentum before the firing
$4v_1 + 1.75 = 0$
$\Rightarrow v_1 = -1.75/4 = -0.4375$ m/s
The negative sign indicates that the rifle recoils backwards with a velocity of 0.4375 m/s.

Question 4:
Two objects of masses 100g and 200g are moving along the same line and direction with velocities of 2 ms^{-1} and 1 ms^{-1}, respectively. They collide and after the collision, the first object moves at a velocity of 1.67 ms^{-1}. Determine the velocity of the second object.

Answer 4:
Mass of one of the objects, m_1 = 100 g = 0.1 kg
Mass of the other object, m_2 = 200 g = 0.2 kg
Velocity of m_1 before collision, v_1 = 2 m/s
Velocity of m_2 before collision, v_2 = 1 m/s
Velocity of m_1 after collision, v_3 = 1.67 m/s
Velocity of m_2 after collision = v_4

According to the law of conservation of momentum:
Total momentum before collision = Total momentum after collision
$m_1v_1 + m_2v_2 = m_1v_3 + m_2v_4$
$\Rightarrow 0.1\times2 + 0.2\times1 = 0.1\times1.67 + 0.2\times v_4$
$\Rightarrow 0.4 = 0.67 + 0.2\times v_4$
$\Rightarrow v_4 = 1.165$ m/s
Hence, the velocity of the second object becomes 1.165 m/s after the collision.