Answer Question #60861 Physics – Mechanics – Relativity

A small car of mass 610 kg is parked behind a small truck of mass 1604 kg on a level road. The brakes of both the car and the truck are off so that they are free to roll with negligible friction. A 24 kg woman sitting on the tailgate of the truck shoves the car away by exerting a constant force on the car with her feet. The car accelerates at 1.3 m/s2. What is the acceleration of the truck? Answer in units of m/s2.

Solution. According to Newton, whenever objects A and B interact with each other, they exert forces upon each other. Formally stated, Newton's third law is:

For every action, there is an equal and opposite reaction.

The statement means that in every interaction, there is a pair of forces acting on the two interacting objects. The size of the forces on the first object equals the size of the force on the second object. The direction of the force on the first object is opposite to the direction of the force on the second object. Forces always come in pairs - equal and opposite action-reaction force pairs.

Hence the force with which the woman pushes the car equal to the force with which the car pushes the truck and the woman.

$$F_1 = F_2$$

F_1 – the force applied to the car;

F_2 – the force applied to the truck and the woman.

Using Newton's second law:

The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object.

Therefore acceleration of the vehicle equal to $a_1 = \frac{F_1}{m_1}$ (m_1 – mass car).

The acceleration of the truck and women equal $a_2 = \frac{F_2}{m_2}$ (m_2 – mass truck+woman).

According to the statement of the problem $m_1 = 610\text{kg}$ and $m_2 = 1604 + 24 = 1628\text{kg}$, $a_1 = 1.3\text{m/s2}$.

From $F_1 = F_2$ get $m_1 a_1 = m_2 a_2$. $\rightarrow a_2 = \frac{m_1 a_1}{m_2} = \frac{610 \cdot 1.3}{1628} \approx 0.49$ m/s2

Answer: 0.49 m/s2.