Answer on Question #66014, Physics / Mechanics | Relativity

Question:

A truck of mass 2000 kg moving on a highway experiences an average frictional force of 800 N. If its speed increases from 25 ms^{-1} to 35 ms^{-1} over a distance of 500 m, what is the force generated by the truck?

Solution:

Let m be the truck's mass, F_{fr} — average frictional force, F_t — force generated by the truck, v_1 — initial truck's speed, v_2 — its final speed, D — distance, a — acceleration of the truck, and t — time spent for increasing the speed.

According to Newton's second law of motion $\vec{F} = \vec{F}_t + \vec{F}_{fr} = m\vec{a}$.

In scalar form we may write it like $F_t - F_{fr} = ma$, because frictional force is contradirectional to the force generated by truck. So, $F_t = F_{fr} + ma$.

Let's determine truck's acceleration.

For uniformly accelerated motion

$$v_2 = v_1 + at \qquad (1)$$

$$D = v_1 t + \frac{at^2}{2} \qquad (2)$$

From 1st equation $t = \frac{v_2 - v_1}{a}$ and then $= v_1 \frac{v_2 - v_1}{a} + \frac{a\left(\frac{v_2 - v_1}{a}\right)^2}{2} = v_1 \frac{v_2 - v_1}{a} + \frac{(v_2 - v_1)^2}{2a} = \frac{v_2^2 - v_1^2}{2a}$.

Finally, $a = \frac{v_2^2 - v_1^2}{2D}$ and $F_t = F_{fr} + m\frac{v_2^2 - v_1^2}{2D}$.

$$F_t = 800 + 2000\frac{35^2 - 25^2}{2 \cdot 500} = 2000\ N$$

Answer:

$2000\ N$