Answer to the question #57470, Physics / Mechanics | Relativity

A man with a motorcycle driving on a straight road with a speed of 90 km / h . The mass of men along the bike of 100 kg .The officers chasing criminals from behind men using a helicopter , flying at an altitude of 500 m above the ground and at a speed of 144 km / h . The officer dropped the body of mass 400 kg (without giving the initial speed of the helicopter) . It turns out objects just overwrite the officer released the man .

In a system that consists of men along with the bike and the object is released attendant , find the acceleration of the center of mass and center of mass equation of motion.

Answer

$\mathrm{m_{mot}} + \mathrm{m_{men}} = 100$ kg, $\mathrm{m_o} = 400$ kg, $\mathrm{v_{mot}} = 90$ km / h, $\mathrm{v_{hel}} = 144$ km / h, $\mathrm{v_{hel}} = \mathrm{v_o}$ - initial speed of the odjects equals to the speed of helicopter

$\bar{\mathrm{r}}_\mathrm{c} = \frac{(\mathrm{m_{mot}}+\mathrm{m_{men}})\bar{\mathrm{r}}_{\mathrm{mot+men}}+\mathrm{m_o}\,\bar{\mathrm{r}}_\mathrm{o}}{\mathrm{m_{mot}}+\mathrm{m_{men}}+\mathrm{m_o}}$ — possition of the center of mass.

$\bar{\mathrm{v}}_\mathrm{c} = \frac{(\mathrm{m_{mot}}+\mathrm{m_{men}})\bar{\mathrm{v}}_{\mathrm{mot}}+\mathrm{m_o}\,\bar{\mathrm{v}}_\mathrm{o}}{\mathrm{m_{mot}}+\mathrm{m_{men}}+\mathrm{m_o}}$ — speed of the center of mass.

x-axis projection: $\mathrm{v_c} = \frac{(\mathrm{m_{mot}}+\mathrm{m_{men}})\mathrm{v_{mot}}+\mathrm{m_o}\,\mathrm{v_{hel}}}{\mathrm{m_{mot}}+\mathrm{m_{men}}+\mathrm{m_o}}$

y-axis projection: $\mathrm{v_c} = \frac{-\mathrm{gtm_o}}{\mathrm{m_{mot}}+\mathrm{m_{men}}+\mathrm{m_o}}$

$\bar{\mathrm{a}}_\mathrm{c} = \frac{(\mathrm{m_{mot}}+\mathrm{m_{men}})\bar{\mathrm{a}}_{\mathrm{mot}}+\mathrm{m_o}\,\bar{\mathrm{a}}_\mathrm{o}}{\mathrm{m_{mot}}+\mathrm{m_{men}}+\mathrm{m_o}}$ — acceleration of the center of mass.

x-axis projection: $\mathrm{a_c} = 0$

y-axis projection: $\mathrm{a_c} = \frac{-\mathrm{gm_o}}{\mathrm{m_{mot}}+\mathrm{m_{men}}+\mathrm{m_o}}$

$$\sum_i F_i = (\mathrm{m_{mot}} + \mathrm{m_{men}} + \mathrm{m_o})\mathrm{a_c} = (\mathrm{m_{mot}} + \mathrm{m_{men}} + \mathrm{m_o})\frac{-\mathrm{gm_o}}{\mathrm{m_{mot}} + \mathrm{m_{men}} + \mathrm{m_o}} = -\mathrm{gm_o}$$

$\sum_i F_i = -\mathrm{gm_o}$ — center of mass equation of motion, where $\sum_i F_i$ - the sum of external forces.

$\mathrm{a_c} = \frac{-\mathrm{gm_o}}{\mathrm{m_{mot}}+\mathrm{m_{men}}+\mathrm{m_o}} = -7.84\ \mathrm{m}/s^2$