Question

A rocket has an initial mass of 7×10^4kg and on firing burns its fuel at a rate 250kgs^{-1}. The exhaust velocity is 2.5×10^3ms^{-1}. If the rocket has a vertical ascent from resting on the earth, how long after the rocket engines fire will the rocket take off. What is wrong with the design of this rocket?

Answer

The rocket will lift off when the thrust just exceeds its weight.

Thrust $= u\alpha$

Weight $= mg = (m_0 - \alpha t)g$

Therefore $u\alpha = (m_0 - \alpha t)g \Rightarrow t = \dfrac{m_0}{\alpha} - \dfrac{u}{g}$

Thus using the data in the question it will lift off at 25 seconds after ignition. The design problem is that there is too much fuel on board.