Answer on Question #44293-Physics-Mechanics-Kinematics-Dynamics

An airplane is flying vertically upwards with a uniform speed of $v_{10} = 500\frac{m}{s}$. when it is at a height of $h_{10} = 1000m$ above the ground a shot is fired at it with a speed of $v_2 = 700\frac{m}{s}$ from a point directly below it. What should be the uniform acceleration of the airplane now so that it may escape from being hit?

Solution

For escape from a shot when a shot and the airplane would have the same height then they have the same velocity. That's why the velocity of a shot relatively the airplane is zero.

$$h_1 = h_{10} + v_{10}t + \frac{at^2}{2}.$$

$$h_2 = v_2 t.$$

$$v_2 = v_1 = v_{10} + at \to t = \frac{v_2 - v_{10}}{a}.$$

$$h_1 = h_2 \to h_{10} + v_{10}t + \frac{at^2}{2} = v_2 t \to h_{10} - (v_2 - v_{10})t + \frac{at^2}{2} = 0.$$

Put $t = \frac{v_2 - v_{10}}{a}$:

$$h_{10} - (v_2 - v_{10})\left(\frac{v_2 - v_{10}}{a}\right) + \frac{a\left(\frac{v_2 - v_{10}}{a}\right)^2}{2} = 0 \to h_{10} - \frac{1}{2a}(v_2 - v_{10})^2 = 0$$

$$a = \frac{(v_2 - v_{10})^2}{2h_{10}} = \frac{\left(700\frac{m}{s} - 500\frac{m}{s}\right)^2}{2 \cdot 1000m} = 20\frac{m}{s^2}.$$

Answer: $20\frac{m}{s^2}$.