

Patriots Over Israel

On December 20, 2012, Iran launches an intermediate range ballistic missile (IRBM) carrying a WMD warhead at Israel. Israel is protected along its borders by US supplied Patriot missile batteries.

At $t = 0$ seconds, one of the US Patriot missile batteries detects the incoming IRBM warhead at a height of 220,000 ft and having a vertical downward velocity of 4107 ft / second. Assume the Patriot launches with an initial upwards velocity of 8115 ft/sec.

Case I: If a Patriot missile can be launched no earlier than 12 seconds after detection, determine the altitude and time (in seconds) after detection the Patriot can intercept the incoming IRBM warhead.



Case II: If the *minimum altitude* the IRBM can be intercepted is 2 miles, determine the *latest time* a Patriot can be launched to intercept an IRBM.

Case III: If a Patriot missile fails to intercept the IRBM, calculate the exact time of impact.

Include Excel graphs of both missiles' altitude vs. time in seconds showing where they intersect (the time and the height) for both the early and late launch cases.

Remember all ballistic motion for both the IRBM and the Patriot is governed by the equation:

$$h(t) = \left(\frac{-1}{2}\right) \cdot g \cdot t^2 + v_o \cdot t + s_o$$

Where:

$h(t)$ is the height at any time t (seconds)

$g = 32.2 \text{ ft/sec}^2$ [acceleration due to gravity]

v_o is the initial velocity (ft/sec, downwards is -, + is upwards)

s_o is the initial height (ft) above the ground

Present your solution work (INCLUDING GRAPHS) in a neat, ORGANIZED, word-processed format with no handwriting. Include this sheet as the cover page. E-mail me a copy the Excel spreadsheets and completed document.

Explicitly identify the answers for Case I and Case III!