

NEWTON'S 2ND. LAW: $F_{NET} = ma$ Units 6 & 7

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E-Mail Shows Toll of Crash On Submarine And Sailors



INTRODUCTION: This 6900 ton nuclear sub crashed at 30 knots into an under sea mountain and decelerated to 4 knots in 20 feet.

QUESTIONS: (a) Convert 6900 tons to pounds ?, (b) Find sub mass in slugs ? (c) Convert 30 knots and 4 knots to ft./s.? (d) Find time for sub to decelerate from 30 knots to 4 knots in 20 feet?, (e) Find deceleration of sub?, (f) Find force ON sub by undersea Mt.?

HINTS: 1.151 mph = 1 ft./s. ,
2000 lb./ ton., $V^2 = v_o^2 + 2 a x$,
 $v = v_o + a t$, $W = m g$, $g = 32 \text{ ft./s.}^2$

ANSWERS: (a) $1.38 \times 10^7 \text{ lb.}$
,(b) $m = 4.31 \times 10^5 \text{ slugs}$, (c) $V_o = 34.53 \text{ ft./s.}$, $V = 4.6 \text{ ft./s.}$, (d) $t = 0.7 \text{ s.}$, (e) $a = -63 \text{ ft./s.}^2$? (f) $F = 2.71 \times 10^7 \text{ lb.}$ or 13,560 tons

The **nuclear submarine that ran aground Saturday in the South Pacific hit so "incredibly hard" that about 60 of its 137 crew members were injured and the sailor who died was thrown 20 feet by the impact**, according to internal Navy e-mail messages sent by a top admiral. **The messages said the submarine's hull was severely damaged after the head-on crash** into what Navy officials believe was an **undersea mountain** that was not on the navigation charts. One message said the submarine, the San Francisco, **was traveling at high speed**, and **the impact practically stopped it in its tracks and caused flooding in parts of the bow**. The e-mail also indicated that about **60 crew members had been injured. All the Navy had said publicly was that 23 crew members were treated for broken bones, cuts and bruises.** "there were a lot of broken fingers, broken arms and legs and one fractured back." Navy officials said yesterday that the rest of the injuries were minor. The admiral's e-mail also said an **outer hull ripped open at the submarine's nose, causing flooding in a dome with sonar sensors and in four of the ballast tanks used to submerge the vessel or take it to the surface.** Sailors had to keep pumping pressurized air into the tanks to prevent the water from rising and to maintain buoyancy. An inner hull, which surrounds the crew's living and work spaces, held firm, the e-mail said. The nuclear reactor and critical propulsion systems were not damaged. Navy officials have said that the submarine, which was headed for Australia, **appeared to have smashed into an undersea mountain that was not on its charts. Navy officials said the San Francisco was traveling at 30 knots when it careened off some part of the undersea mountain range.** In one of the e-mail messages, Admiral Sullivan wrote that on impact, **the vessel made a "nearly instantaneous deceleration" to about 4 knots.**