FLUIDS Unit 18 Dr. John P. Cise, Professor of Physics, Austin Com. College, 1212 Rio Grande St., Austin Tx., 78701 jpcise@austincc.edu & New York Times , March 22, 2016 by Kenneth Chang. Dedicated to WernherVon Braun

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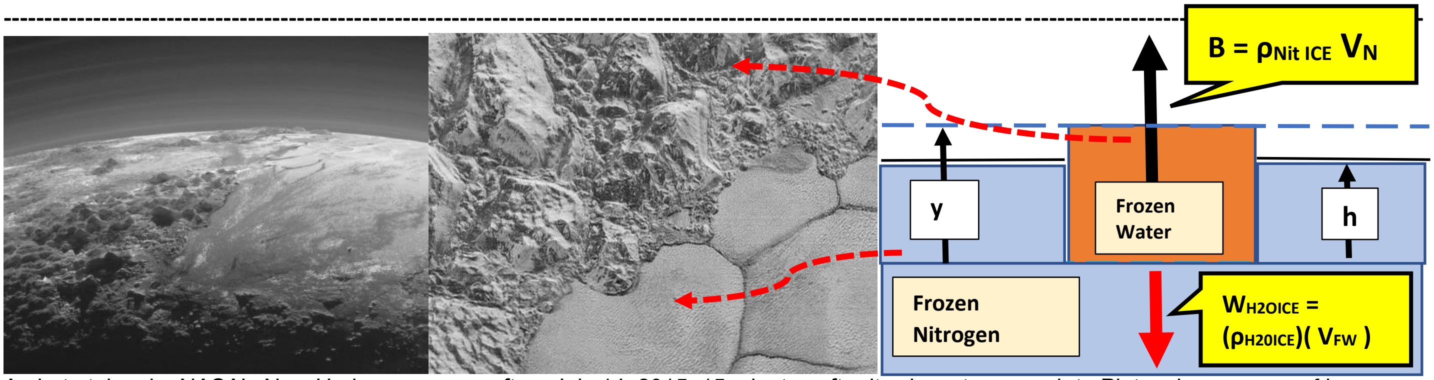

A photo taken by NASA's New Horizons spacecraft on July 14, 2015, 15 minutes after its closest approach to Pluto, shows areas of icy mountains as high as 11,000 feet and areas of flat ice plains. Researchers at NASA have analyzed data returned by the New Horizons probe that describe an icy terrain as bizarre as any in science fiction.

What we've learned of paradoxical Pluto

The frozen world of Pluto may not have always been completely frozen. In images taken by NASA's New Horizons spacecraft when it flew past Pluto in July, scientists have spotted dendritic features that look as if they have been carved by liquids. Researchers are using computer simulations to show how liquid might have flowed on Pluto. "Now we have the maps and a better understanding of the surface composition, we can turn sophisticated models to bear on our understanding of how Pluto has changed with time," Stern said. In the models, Pluto's atmosphere, wispy today at just 1/100,000th of the atmospheric pressure of that at sea level on Earth, fluctuated wildly over millions and billions of years. At times, the pressure was dense enough that liquid nitrogen could exist on the surface, to flow as streams and pool as lakes. **On Earth, the only ice is frozen water. On Pluto, nitrogen, methane and carbon monoxide also freeze solid.** That had been known for years. "The ingredients that are there — none of them surprise us," said William Grundy, of Lowell Observatory in Arizona, who leads the team analyzing the composition of Pluto's surface on NASA's New Horizons mission. The deluge of data the spacecraft collected revealed a complex world with an unexpected diversity of landscapes, from flat plains to soaring mountains. Scientists are beginning to study how the interplay of the different ices — New Horizons' measurements also showed that the abundances of each varied from place to place — shaped the surface. "What's really exciting for me is seeing how the ingredients interact among themselves to build this interesting geology," Grundy said. The most striking feature revealed on Pluto was a heart-shape region now named Tombaugh Regio after Clyde Tombaugh, the discoverer of Pluto. The left half is covered by mostly nitrogen snow, probably filling an ancient impact crater; the right side is more methane ice. **At Pluto's ultrafrigid temperatures — minus-390 degrees F at the surface — water ice is rigid and unbending, like bedrock on Earth. But the other ices are more malleable, especially nitrogen.** "It's somewhat like Silly Putty," said Jeffrey Moore of NASA's Ames Research Center in California, who leads the mission's geophysics and imaging team. "That's the new physics that needs to be learned," Grundy said. **Nitrogen ice is also denser(0.995 g./cc from Wikipedia) than water ice (0.92 g./cc), so it could have flowed into cracks beneath the water ice bedrock, creating the jumbled blocks of mountains. Amid the flat plains in the middle of Tombaugh Regio are darker pieces, which could be icebergs of water ice floating on top of the nitrogen.** **The ices on Charon, Pluto's largest moon, are much simpler. It's just water ice. Water ice also probably covers the four smaller moons: Styx, Nix, Kerberos and Hydra.**

INTRODUCTION: Objects less dense will float on more dense material. Goal here is to find %,(h/y), ice water on Pluto is submerged in nitrogen ice, in order to float(see graphic in upper right). Consider a block of water ice of volume V_{FW} = A y. Consider the volume of nitrogen displaced V_N = A h . By Archimedes principle the weight (W_{H20ICE}) of block of water ice = weight (B) of displaced nitrogen ice.

QUESTIONS: (a) Set up working equation where B = W_{H20ICE} ?, (b) Find ratio of depth(h) ice block is submerged in Nitrogen ice to height (y) of ice block? h/y = ?, (c) Find % ice block is out of nitrogen ice?

ANSWERS: (a) h A ρ_{NITICE} = y A ρ_{H20ICE} , (b) h/y = 0.924 or 92.4 % , (c) (1 – h/y) = ~ 7.6 %