

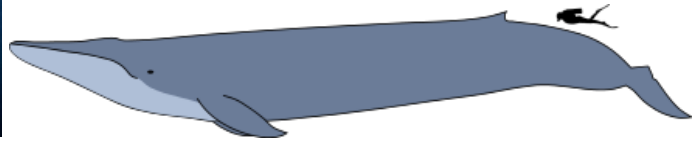
# FLUIDS

Unit 18, Dr. John P. Cise, Professor of Physics, Austin Com. College, Northridge Campus, Austin Tx. [jpcise@austincc.edu](mailto:jpcise@austincc.edu) & New York Times May 24, 2017 by Nicholas St. Fleur

## How Whales Became the Biggest Animals on the Planet



**INTRODUCTION:** Wikipedia states Blue whales can be 80 to 100 ft. long. We will take our blue whale below to be 80 ft. long. Blue whale flesh density is  $\rho_{BW} = 1028 - 1034 \text{ kg./m.}^3$ . This is just slightly more than sea water density  $\rho_{SEA} = 1020 - 1029 \text{ kg./m.}^3$ .  $\rho_{BW} = m/V$ . We will take density of whale flesh to be mid way about 1031 kg./m.<sup>3</sup>. The goal of this application is to find the average radius of this blue whale's long sleek body.



A blue whale off the coast of California.

Whales are big. Really big. Enormously big. Tremendously big.

Fin whales can be 140,000 pounds. Bowhead whales tip the scales at 200,000 pounds. **And the big mama of them all, the blue whale, can reach a whopping (((380,000 pounds))) — making it the largest animal to have ever lived.** But for as long as whales have awed us with their great size, people have wondered how they became so colossal. In a study published Tuesday in the journal *Proceedings of the Royal Society B*, a team of researchers investigated gigantism in baleen whales, the filter-feeding leviathans that include blue whales, bowhead whales and fin whales. The marine mammals became jumbo-size relatively recently, they found, only within the past 4.5 million years. **The cause? A climatic change that allowed the behemoths to binge-eat.** "Plentiful food everywhere isn't going to get you giant whales," said [Graham Slater](#), an evolutionary biologist at the University of Chicago and the study's lead author. "They have to be separated by big distances." Because the ecological cycles that fuel the explosions of krill and zooplankton occur seasonally, Dr. Slater said the whales must migrate thousands of miles from food patch to food patch. Bigger whale ancestors that had bigger fuel tanks had a better chance of surviving the long seasonal migrations to feed, while smaller baleen whales became extinct. If the food patches were not far apart, Dr. Slater said, the whales would have grown to a certain body size that was comfortable for that environment, but they would not be the giants we see today. "A blue whale is able to move so much further using so much less energy than a small-bodied whale," Dr. Slater said. "It became really advantageous if you're going to move long distances if you're big."

**QUESTIONS:** (a) Convert the 80 ft. length(L) of blue whale to meters?, (b) Convert the 380,000 lb. weight of blue whale to kg. ?, (c) Find the volume V of this blue whale knowing density  $\rho_{BW}$  (given above) and mass (m) from  $\rho_{BW} = m/V$  ?, (d) Considering the whale to be cylindrical in shape. Thus,  $V = A L = \pi r^2 L$ . Find average radius(r) of whale's body?, (e) Does the radius and diameter of blue whale determined seem reasonable considering the 80 ft. length of whale (see graphic picture of whale above)?

**HINTS:** 0.3048 m./ft. , 0.454 kg./lb.,

**ANSWERS:** (a)  $L = \sim 24.4 \text{ m.}$ , (b)  $m = 172,520 \text{ kg.}$ , (c)  $V = 167.33 \text{ m.}^3$ , (d)  $r = \sim 1.5 \text{ meters}$ , which with 3.28 ft./meter makes  $r = 4.92 \text{ ft.}$ , or diameter of blue whale about twice  $r = D = 9.84 \text{ ft.} \sim 10 \text{ ft.}$ , (e) So looking at 80 ft. whale above, the determined 10 ft. diameter seems quite reasonable. The length to width ratio of 8:1 seems quite reasonable for the long slender blue whale.