

The JETS Challenge

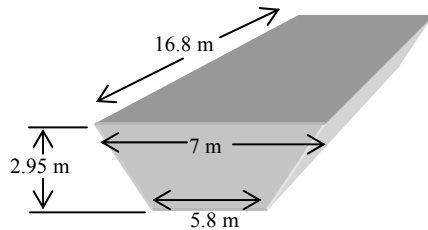
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Challenge 93 – The Jamestown Challenge

Problem:

The year 2007 is the 400th anniversary of Jamestown, VA, the first permanent English settlement in North America. According to the captain's log, they crossed the Tropic of Cancer on March 14th, 1607 with three ships. The lead ship was the *Susan Constant* with 70 men and boys aboard commanded by Captain John Smith (of Pocahontas fame). The ship's keel was 16.8 m long at the waterline and the cross-sectional shape can be approximated as a right trapezoid. The beam (width at the waterline) was 7.0 m and 5.8 m across the flat bottom. The draft (depth of ship under water) was 2.95 m. A ship's size is defined by the mass of water (measured in metric tons where 1 T = m³ of water) displaced by the volume of the ship below the water line.

Find the displacement (tons) of the Susan Constant.



Solution:

$$PV = m \left(\frac{R}{M} \right) T$$

$$= 8,31447 \frac{\text{kPam}}{\text{kmol-K}}$$

$$T = 293 \text{ K}$$

$$M = 29 \frac{\text{kg}}{\text{kmol}}$$

Need V

$$V = \frac{4}{3} \pi r^3$$

$$= \frac{4}{3} \pi \left(\frac{.232m}{2} \right)^3$$

$$= .0065383m^3$$

Need P

$$P = 101.1 + 55.158 \text{ kPa}$$

$$= 156.258 \text{ kPa}$$

$$PV = m \left(\frac{R}{M} \right) T$$

$$m = \frac{PV}{\left(\frac{R}{M} \right) T}$$

$$m = \frac{(156.258)(.00665383)}{(8.31447/29)(293)}$$

$$m = \frac{1.02166}{84.0048}$$

$$= .012 \text{ kg}$$