TESTS OF ENGINEERING APTITUDE, MATHEMATICS AND SCIENCE

February Monthly Math Challenge
Middle School Level

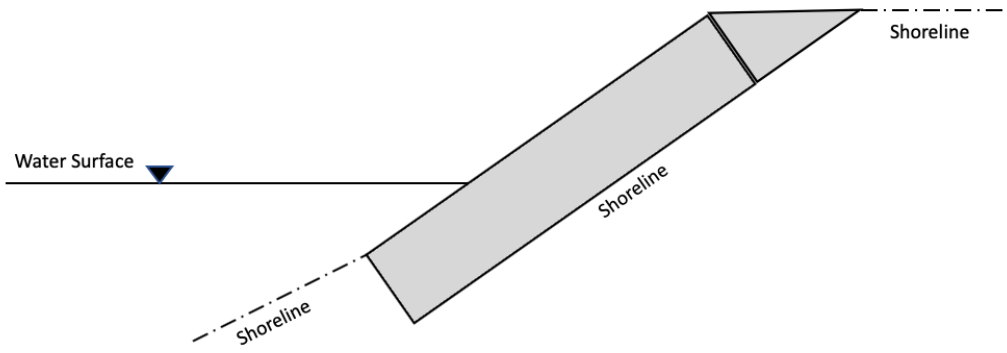
Instructions: TEAMS coaches submit student answers to the question(s) below using the submission link on the TEAMS website. All submissions must be made during the month of February. Those submissions with correct answers will be entered into a drawing for a $25 Visa gift card, which will be sent to the student in care of the TEAMS coach.

Lakeshore Erosion Control

Lakeshore erosion results in the transport of soil and sediment away from the shoreline, leading to degraded habitat and weakened soil structure. Where erosion is severe and development is present, the eroded shoreline may result in exposed and destabilized infrastructure. Without a strong structural foundation built on stabilized soils, infrastructure (including roadways, stabilization walls, turnouts, and drainage features) may fail. While lakeshore erosion is natural, engineers are often called in to prevent or rehabilitate shoreline erosion whenever erosion is occurring along lakeshore and threatening ecosystem services and/or built infrastructure. Erosion control measures, including rip-rap walls (consisting of large stones and boulders), are often used to stabilize the shoreline.

Question:

A rip-rap wall with the following geometry (a rectangle and a right triangle) is proposed:



If the dimensions of each shape are given as:
Rectangle length along shoreline = 15 ft
Rectangle height off of shoreline = 4 ft
Right triangle hypotenuse = 10 ft

What is the total volume of rip-rap over a 10 ft section of shoreline?

Solution:

Volume = 783 ft^3

First determine the area of the triangle

$$Area\ of\ right\ triangle = \frac{1}{2} base\ x\ height$$

While the triangle hypotenuse (10 ft) and base (4 ft) are both given within the dimensions. Use the Pythagorean theorem to determine the height of the triangle (which is the length along the shoreline).

$a^2 + b^2 = c^2$
$4^2 + b^2 = 10^2$
Solving for b yields 9.16

Therefore, the area of the triangle is $\frac{1}{2}(4)\ x\ 9.16$ = 18.3 ft^2

Next determine the area of the rectangle

Area = length x width

Therefore, 15ft x 4 ft = 60 ft^2

Finally, calculate the volume of rip-rap over the shoreline section that spans 10 ft in length

Volume = Area triangle x 10 ft + Area rectangle x 10 ft

Volume = 18.3 ft^2 x 10ft + 60 ft^2 x 10 ft = 783 ft^3