TEAMS
TESTS OF ENGINEERING APTITUDE, MATHEMATICS AND SCIENCE

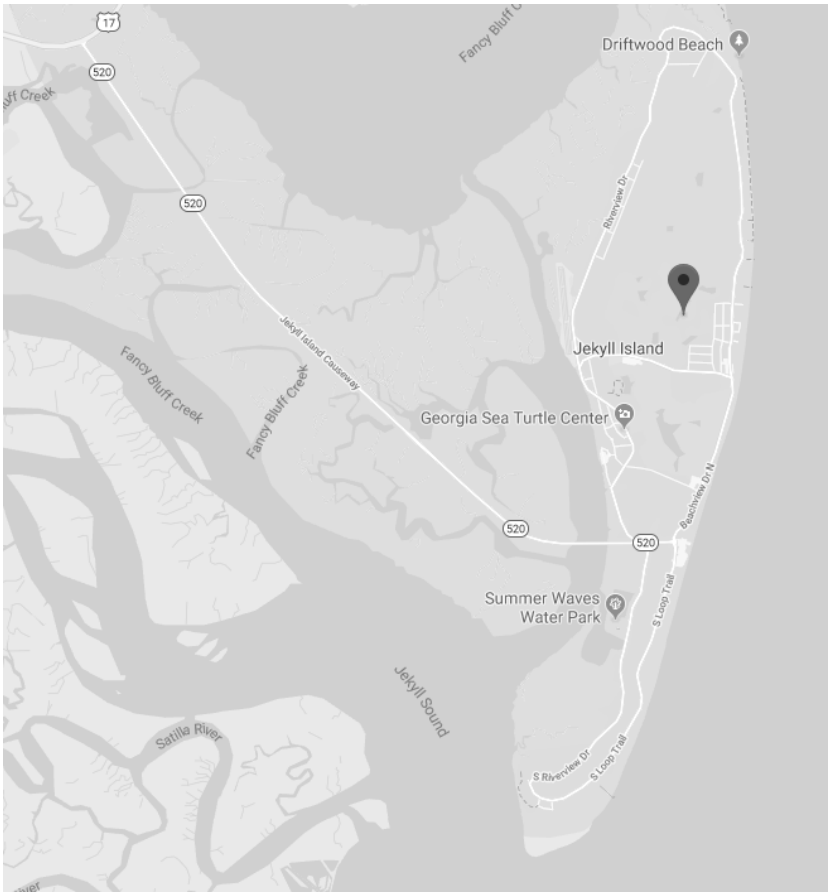
February Monthly Math Challenge
High School Level

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.

Wildlife Movement

Humans continue to develop areas of land, which had been natural habitats for wildlife. Part of road construction in marshy areas involves building a sufficient base over which traffic can flow. This can block paths where wildlife would normally travel, and are not only dangerous to the animals, but to the drivers on the road. In the U.S. alone, cars collide with large animals over 1 million times per year, which results in injuries and over $8 billion in repair cost.

One potential solution to accidents can be wildlife bridges, which give animals a manmade path over or under a road, thus avoiding collision. The design of such structures requires that the developers pay attention to the characteristics of the animals themselves, to ensure the animal will choose to use the crossover rather than continue into the street.

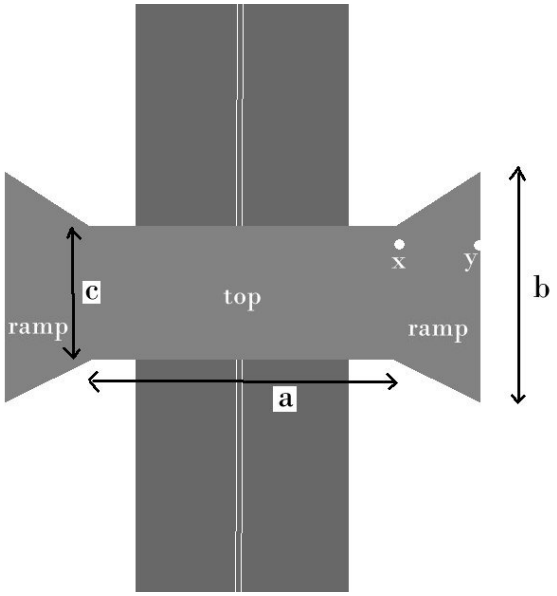


One example of a leger than average potential for collisions with wildlife is approaching Jekyll Island in Georgia. The Jekyll Island Causeway carries traffic from U.S> Route 17 to Jekyll Island, through an area populated by (among other wildlife) turtles and deer.

Your engineering team has been contacted and asked to design a wildlife bridge that would be suitable for turtles and deer, and allow both to cross over the Causeway.

The structure of the bridge will have a wide base at either end to encourage more wildlife to step onto the structure. The base on each side is identical.

Assume the width of the causeway (road) is 40 feet, and the top of the bridge must span double the width of the road. Assume the height of the bridge must be 5 yards. Also, assume the steepest practical angle for ramps has been determined to be 15 degrees for turtles and 25 degrees for deer.



Finally, assume length c is equal to the length measured along the ground from the base of the ramp to the start of the top of the bridge (along the ground from point y to point x as shown). Distance b is twice the distance c.

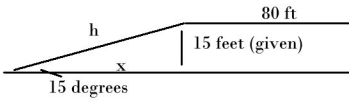
Question:

Find:

a.) the shortest length an animal will walk from entering to exiting the bridge, and
b.) the surface area of the bridge.

Solution: **a) 196 feet:** (acceptable answers must be between 195.92' – 196')
b) 14224 ft^2 (acceptable answers must be between 14,212.2 – 14,224 ft^2)

a) First, find the length of each part of the bridge. Given: an angle of 15 degrees (as this is the worst case) and a height of 15 feet:



We can find the length (h) by: $\sin 15° = {}^{15'}/_{h}$ h = 57.96 ≈ 58'.

Also, $\cos 15° = {}^{x}/_{58}$ = 55.98 ≈ 56'.

The length traveled is 2 ramps + the top, or 58+58+80' = 196 feet (note: answer must be between 195.92' – 196')

b) The length c is equal to the distance from x to y is x from part a: 56'. Therefore, b = 2c = 112'

$a_{trapezoid} = \frac{a+b}{2}\, h = \frac{56+112}{2}\, 58 = \ 4872 ft^2$

total area = 2 *ramp + top = 2 (4872) + (80*56) = 14224 ft^2

Note – acceptable answers must be between 14,212.2 – 14,224 ft^2