The James Webb Space Telescope, to be launched by NASA in 2014, is a telescope designed to explore galaxies and stars that formed soon after the Big Bang. Its unique design features a large mirror that consists of 18 hexagonal tiles; each tile is its own mirror.

Many of the largest telescope mirrors now being built for ground-based observatories use the hexagonal 'segmented' design. A single 1-meter wide hexagon, replicated dozens of times, is a lot easier to make than a single large mirror!

Suppose that in the problems below, the length of a side of the hexagon is \( L = 0.76 \) meters. New mirror designs are created from the Webb Space Telescope design by adding enough mirror tiles to complete a new outer ring. For example, the Webb Space Telescope mirror consists of two complete rings of hexagonal tiles.

Problem 1 - Using the sketch to the left as a guide, how many tiles will be in the assembled mirror if 1, 2 or 3 additional rings of hexagonal tiles are added?

Problem 2 - What is the total area of each mirror design if the area of a single hexagon is

\[
A = \frac{3}{2} \sqrt{3} L^2
\]

Compared to the Webb Space Telescope design of 18 tiles, by what factor do the three new mirror designs exceed the Webb Space Telescope collecting area?
Problem 1 - Using the sketch to the left as a guide, how many tiles will be in the assembled mirror if 1, 2 or 3 additional rings of hexagonal tiles are added?

Answer: From the shaded rings indicated below: One additional ring (green) = 18 + 18 = 36 tiles. Two rings = 36 + 24 = 60 tiles. Three rings = 60 + 30 = 90 tiles.

Problem 2 - What is the total area of each mirror design if the area of a single hexagon is

\[ A = \frac{3}{2} \sqrt{3} L^2 \]

Compared to the Webb Space Telescope design of 18 tiles, by what factor do the three new mirror designs exceed the Webb Space Telescope collecting area?

Answer: The hexagon area is

\[ A = 1.5 \times (1.732) \times (0.76)^2 = 1.5 \text{ meters}^2 \]

Webb Space Telescope Mirror: 18 tiles, Area = 18 x 1.5 = 27 meters².

One additional ring: Area = 36 x 1.5 = 54 meters².

Two additional rings: Area= 60 x 1.5 = 90 meters².

Three additional rings: Area = 90 x 1.5 = 135 meters².

The areas increase by factors of 2.0, 3.3 and 5.0 times the area of the Webb Space Telescope design.