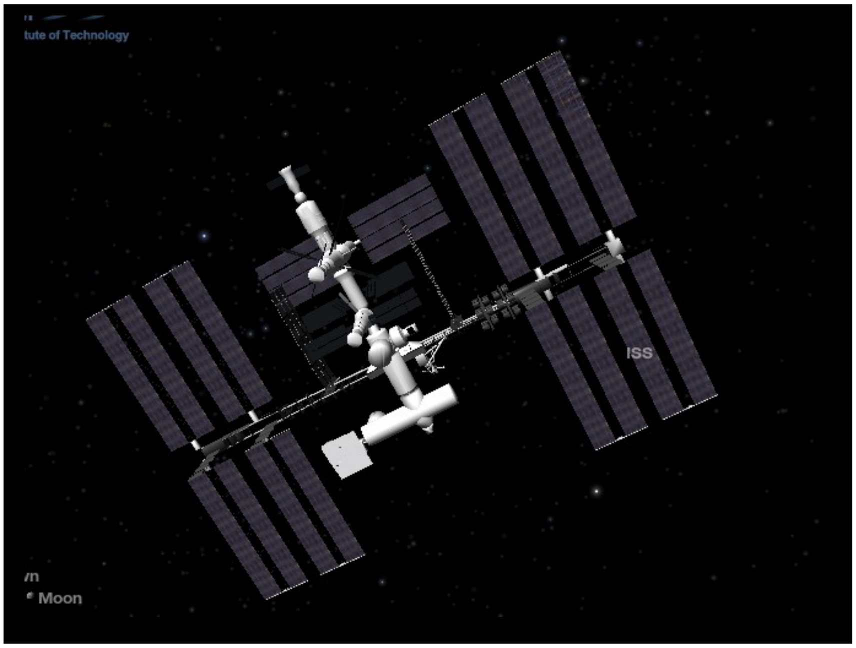
Eye Spy – What if ISS were a Donut-Shaped Station?



Get the Data

Visit EOSS **http://1.usa.gov/VQux1i** to recreate the scene above. Recommended operating system: MS Vista or later; Browser: MS Internet Explorer 8 or later.

Step 1 – Click on the 'Visual Controls' tab and make sure that the following items are selected with a 'white spot': spacecraft, planets, labels, orbit lines, trails and metric.

Step 2 - Move the cursor to change the orientation to a view that shows details on the ISS, especially the cylindrical crew and lab modules.

Answering Questions

The volume of a torus (donut) is just the volume of a cylinder with a radius ,r, wrapped around the circumference of the torus with $C = 2\pi R$, where R is the radius of the midline of the cylinder.

Problem 1 – What is the formula for the volume of a torus with radii r and R?

Problem 2 - The total pressurized volume of the International Space Station is 837 cubic meters. If the radius, r, of the crew compartment was the same as for the ISS (r=2.1 meters), what would be the radius, R, of the torus with an equal pressurized volume to the ISS?

Math Challenge

Challenge Problem:

If Torus Station is rotated about its axis, astronauts inside will feel 'artificial gravity' created by centrifugal forces if they are walking on the inside surface. The formula for the force they feel is given by: $A = 4\pi^2 (R/3600)RPM^2$ To get 1 Earth Gravity ($a = 9.8 \text{ m/sec}^2$) how many rpm must the station spin for the radius you calculated in Problem 2?

Answer Key

Problem 1 – What is the formula for the volume of a torus with radii r and R?

Answer: V = Area x Circumference

$V = \pi r^2 \times 2 \pi R$

$V = \mathbf{2\pi^2 r^2 R}$

Problem 2 - The total pressurized volume of the International Space Station is 837 cubic meters. If the radius, r, of the crew compartment was the same as for the ISS (r=2.1 meters), what would be the radius, R, of the torus with an equal pressurized volume to the ISS?

Answer:

$837 = 2 (3.141)^2 (2.1)^2 R$ solve for R to get **R = 9.6 meter**s.

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Answer: $9.8 = 4 (3.141)^2 (9.6/3600)\ RPM^2$

So RPM2 = 93.1 so RPM = **9.6 RPM**.

Torus Station needs to spin at nearly 10 Revolutions Per Minute in order for astronauts to feel 1 Earth gravity inside!