

## **BASIC DATA**

$$G = 6.672 \times 10^{-11}$$

$$\text{Gravity on earth:} \quad 9.807 \text{ m/s}^2 = 9.807 \text{ N/kg}$$

$$\text{Mass of earth:} \quad 5.974 \times 10^{24} \text{ kg}$$

$$\text{Gravity on moon:} \quad 1.62 \text{ m/s}^2 = 1.62 \text{ N/kg}$$

$$\text{Ratio to earth:} \quad 6.05 : 1$$

$$\text{Mass of moon:} \quad 7.349 \times 10^{22} \text{ kg}$$

$$\text{Ratio to earth:} \quad 81.28 : 1$$

### ***Ryugu as a round object:***

*Volume of Ryugu (r = 400m):*

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

$$V_{\text{Ryugu}} = 2.681 \times 10^8 \text{ m}^3$$

*Mass of Ryugu (e.g. Granite 2,700 kg / m<sup>3</sup>):*

$$M = V \times D$$

$$M_{\text{Ryugu}} = 2.681 \times 10^8 \text{ m}^3 \times 2,700 = 7.238 \times 10^{11} \text{ kg}$$

*Gravitational force:*

$$F_g = G \times M_1 \times M_2 / r^2$$

$$F_{g_{\text{Ryugu}}} = 6.672 \times 10^{-11} \times 1 \text{ kg} \times 7.238 \times 10^{11} \text{ kg} / (400\text{m})^2 = 0,0003018 \text{ N}$$

$$F_{g_{\text{Ryugu}}} = 0,0003018 \text{ N/kg}$$

$$\text{Gravity on Ryugu} = 0.0003018 \text{ m/s}^2 = 0.0003018 \text{ N/kg}$$

$$\text{Ratio to earth:} \quad 32,492 : 1$$

*Circumference:*

$$C_{\text{Ryugu}} = 2\pi \times r = 2 \times 3,1415 \times 400\text{m} = 2,513.2 \text{ m}$$

*Velocity:*

$$V_{\text{Ryugu}} = C_{\text{Ryugu}} / t_{\text{Ryugu}} = 2.513.2 / (7.6\text{h} \times 60\text{min} \times 60\text{s}) = 0,9186 \text{ m/s}$$

*Centrifugal force:*

$$F_c = m \times v^2 / r$$

$$F_{c_{\text{Ryugu}}} = 1 \text{ kg} \times 0,9186^2 / 400\text{m} = 0,0021094 \text{ N}$$

$$F_{c_{\text{Ryugu}}} = 0,0021094 \text{ N/kg}$$

*Comparison gravitational & centrifugal force:*

$$F_{g_{\text{Ryugu}}} = 0,0003396 \text{ N/kg}$$

$$F_{c_{\text{Ryugu}}} = 0,0021094 \text{ N/kg}$$

**GRAVITATIONAL vs. CENTRIFUGAL FORCE:**

**0.16 : 1 ('Zero gravity')**

***Ryugu as an octaeder with a diagonal of 800m:***

*Volume of Ryugu as a octaeder with diagonal 800m:*

$$L_c^2 = 800^2 \text{ m} = L_a^2 + L_b^2 \text{ (Pythagoras)}$$

$$L_a = L_b = 565.7\text{m}$$

$$T = L_a/b^3$$

$$T_{\text{Ryugu}} = 565.7^3 \text{ m} = 181,019,336 \text{ m}^3$$

*Mass of Ryugu as a an octaeder (e.g. Granite 2,700 kg / m<sup>3</sup>):*

$$M = V \times D$$

$$M_{\text{Ryugu}} = 1.8102 \cdot 10^8 \text{ m}^3 \times 2,700 = 4.888 \cdot 10^{11} \text{ kg}$$

*Gravitational force with Ryugu as an octaeder*

$$F_g = G \times M_1 \times M_2 / r^2$$

$$F_{g_{\text{Ryugu}}} = 6.672 \times 10^{-11} \times 1 \text{ kg} \times 4.888 \cdot 10^{11} \text{ kg} / (400\text{m})^2 = 0,0002038 \text{ N/kg}$$

$$F_{g_{\text{Ryugu}}} = 0,0002038 \text{ N/kg}$$

$$\text{Gravity on Ryugu} = 0.0002038 \text{ m/s}^2 = 0.0002038 \text{ N/kg}$$

Ratio to earth: 48,121 : 1

*Centrifugal force:*

$$F_c = m \times v^2 / r$$

$$F_{c_{\text{Ryugu}}} = 1 \text{ kg} \times 0,9186^2 / 400\text{m} = 0,0021094 \text{ N}$$

$$F_{c_{\text{Ryugu}}} = 0,0021094 \text{ N/kg}$$

*Comparison gravitational & centrifugal force:*

$$F_{g_{\text{Ryugu}}} = 0,0002038 \text{ N/kg}$$

$$F_{c_{\text{Ryugu}}} = 0,0021094 \text{ N/kg}$$

**GRAVITATIONAL vs. CENTRIFUGAL FORCE:**

**0.10 : 1 ('Zero gravity')**