A space ship sitting on the surface of Saturn's moon Mimas experiences a gravitational pull from that moon of F_0 Newtons.

The space ship then lifts off from the surface and enters a circular orbit around Mimas a distance $2R$ above the surface (and thus $3R$ from the center of Mimas), where R is the radius of Mimas. What is the gravitational pull of Mimas acting on the space ship when it is in orbit?

1. $F_0/2$
2. $F_0/3$
3. $F_0/4$
4. $F_0/9$

Newton's Universal Law of Gravitation

In general:

$$F = G\,\frac{M_1 M_2}{d^2}$$

On the surface of Mimas, $d = R$:

$$F_0 = G\,\frac{M_1 M_2}{R^2}$$

In orbit around Mimas, $d = R + 2R = 3R$:

$$\begin{aligned} F_{\text{orbit}} &= G\,\frac{M_1 M_2}{(3R)^2} \\ &= G\,\frac{M_1 M_2}{9\,R^2} \\ &= \frac{1}{9}\,G\,\frac{M_1 M_2}{R^2} \\ &= \frac{1}{9}\,F_0 \end{aligned}$$