Ex : A satellite in circular orbit at an altitude h of **230 km** above Earth's surface has a period T of **89 min**. What is the mass of the Earth from these data?

◦ Start with Kepler's law of periods.

$$T^2 = \left(\frac{4\pi^2}{GM}\right) r^3$$

◦ Solve this expression for M.

$$\begin{aligned} M &= \frac{4\pi^2 r^3}{GT^2} \\ &= \frac{4\pi^2 r^3}{(6.67 \times 10^{-11}\ \mathrm{N \cdot m^2/kg^2})(89\ \mathrm{min} \cdot 60\ \mathrm{s/min})^2} \\ M &= (20756\ \mathrm{kg/m^3}) \cdot r^3 \end{aligned}$$

◦ What is the value to employ for r?

$$\begin{aligned} r &= r_E + h = 6.37 \times 10^6\ \mathrm{m} + (230\ \mathrm{km} \cdot 1000\ \mathrm{m/km}) \\ &= 6.6 \times 10^6\ \mathrm{m} \end{aligned}$$

$$\Rightarrow \quad M = 6 \times 10^{24}\ \mathrm{kg}.$$