Q 04

A Saturn year is 29.5 times the earth year. How far is the Saturn from the sun if the earth is 1.50×10^8 km away from the sun?

Sol. Distance of the Earth from the Sun, re $= 1.5 \times 10^8 \text{km} = 1.5 \times 10^{11} \text{m}$

Time period of Saturn, $T_s = 29.5 T_e$

Distance of Saturn from the Sun $= r_s$

From Kepler's 3rd law of planetary motion $T^2 = r^3$

For the case of Saturn and Sun $\frac{T_s^2}{T_e^2} = \frac{r_s^3}{r_e^3}$

$$r_s = r_e \left(\frac{T_s}{T_e}\right)^{\frac{2}{3}} \quad \text{.................(1)}$$

put the value of r_e, T_e and T_s in equation (1)

$$r_s = 1.5 \times 10^{11} \left(\frac{29.5 T_e}{T_e}\right)^{\frac{2}{3}}$$

$$r_s = 1.5 \times 10^{11} (29.5)^{\frac{2}{3}} = 1.5 \times 10^{11} \times 9.55$$

$$r_s = 1.5 \times 10^{11} \times 9.55$$

$$r_s = 14.32 \times 10^{11} \text{m}$$

Hence, the distance between Saturn and the Sun is $1.43 \times 10^{12} \text{m}$.