

Wednesday, October 7, 2020

Example Winds and surface speed of Saturn

Question #1: How long would it take to circumnavigate Saturn at the equator in a balloon?

Wind speed at equator = 500 m/s

$$\begin{aligned}
 \text{Equatorial circumference} &= 2\pi R_{\text{Saturn}} \\
 &= 2(3.1415)(60.3 \times 10^6 \text{ m}) \\
 &= 3.79 \times 10^8 \text{ m} \\
 &= 3.79 \times 10^5 \text{ km} \\
 &= 379,000 \text{ km}
 \end{aligned}
 \left| \begin{array}{l} R_{\text{Saturn}} \\ = 60.3 \times 10^3 \text{ km} \\ = 60.3 \times 10^6 \text{ m} \end{array} \right.$$

$$\text{Circumnavigation time} = \frac{\text{distance (m)}}{\text{velocity (m/s)}}$$

$$\begin{aligned}
 &= \frac{3.79 \times 10^8 \text{ m}}{500 \text{ m/s}} = 757.8 \times 10^3 \text{ s} \\
 &= 210.5 \text{ hours} \quad \swarrow \text{divide by } 3600 \\
 &= 8.77 \text{ days} \quad \swarrow \text{divide by } 24 \approx \underline{9 \text{ days}}
 \end{aligned}$$

It would take $\Delta T = 8.77 \text{ days}$ to circumnavigate

Saturn in a balloon.

Question #2: What is the absolute velocity of the velocity of the balloon? (relative to planetary core)

Velocity of Saturn's surface

$$= \frac{\text{distance}}{\text{time}} = \frac{\text{Equatorial circumference}}{\text{rotation time of planet}}$$

$$= \frac{3.79 \times 10^8 \text{ m}}{38018 \text{ s}}$$

$$= 9965.7 \text{ m/s}$$

$$\approx 9.966 \text{ km/s}$$

$$\approx 9.97 \text{ km/s}$$

T_{rotation}
Saturn

$$= 10 \text{ h } 33 \text{ minutes } 38 \text{ s}$$

$$= 38018 \text{ s}$$

Total velocity of balloon = planetary surface velocity + wind velocity

$$= 9965.7 + 500$$

$$= 10465.7 \text{ m/s}$$

$$\approx 10470 \text{ m/s}$$

$$\approx 10.47 \text{ km/s}$$

The absolute velocity of the balloon is $v = 10.47 \text{ km/s}$

note: wind is 5% of surface velocity.