Answer on Question # 71042, Physics / Mechanics | Relativity

Question

Consider earth as a sphere of radius 6400km and time period of rotation 24 hour, estimate the centripetal acceleration on a person at

1. The equator

2. At a latitude Ø from the earths centre

Solution. The magnitude of centripetal acceleration a_c is calculated using the equation

$$a_c = r\omega^2$$

where ω is the angular velocity and r is the radius of the circular path. Since

$$\omega = \frac{2\pi}{T}$$

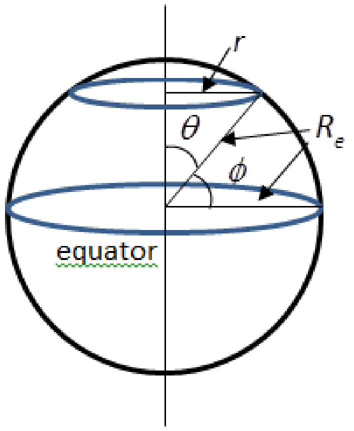
where T is the period of rotation, the centripetal acceleration can also be written as

$$a_c = \frac{4\pi^2 r}{T^2}$$

1. Estimate the centripetal acceleration on a person at the equator. In this case, the radius r is the radius of the Earth that is $r = R_e = 6{,}400 km$, or 6,400,000 m. The period of rotation is 24 hours or $24 \cdot 60 \cdot 60 = 86400$ s. Plugging this numbers into the equation for centripetal acceleration we get

$$a_c = \frac{4\pi^2 (6400000\ m)}{(86400\ s)^2} = 0.0328\ \frac{m}{s^2}$$

2. Estimate the centripetal acceleration on a person at a latitude Ø from the earths centre. As can be seen from the figure at latitude Ø the radius is



$$r = R_e \sin\theta = R_e \sin\left(\frac{\pi}{2} - \emptyset\right) = R_e \cos\emptyset$$

Plugging $r = R_e \cos\emptyset$ into the equation for centripetal acceleration we get

$$a_c = \frac{4\pi^2 R_e \cos\emptyset}{T^2} = \frac{4\pi^2 R_e}{T^2}\cos\emptyset = 0.0328 \cdot \cos\emptyset\ \frac{m}{s^2}$$

Answer:

1. The centripetal acceleration on a person at the equator is $a_c = 0.0328\ \frac{m}{s^2}$.

2. The centripetal acceleration on a person at a latitude Ø from the earths centre is $a_c = \frac{4\pi^2 R_e \cos\emptyset}{T^2} = \frac{4\pi^2 R_e}{T^2}\cos\emptyset = 0.0328 \cdot \cos\emptyset\ \frac{m}{s^2}$.