Question

Estimate the centripetal acceleration of

(a) an item of clothing in a tumble dryer;

(b) the rim of a car tyre going at 100kmh^{-1}

(c) the earth going around the sun (assume it has a circular orbit of radius $1.5 \times 10^{11}\text{m}$);

(d) a child on a roundabout.
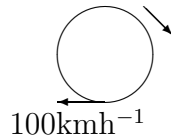
Make clear your assumptions

Answer

(a) Tumble dryer rotates about once per second, i.e. $\dot{\theta} = 2\pi$ rad s^{-1}

The radius of the drum ≈ 0.3m

Therefore the centripetal acceleration $= 0.3 \times (2\pi)^2 \approx 9.2\text{ms}^{-1}$

(b)

$$100\text{kmh}^{-1}$$

$$
\begin{aligned}
100\text{kmh}^{-1} &= \frac{10^5}{3.6 \times 10^3} = \frac{10^2}{3.6}\text{ms}^{-1} \\
\text{as } v &= r\dot{\theta} \quad r \approx 0.2\text{m} \\
\dot{\theta} &= \frac{10^2}{3.5 \times 0.2} \approx 138.9\text{rad s}^{-1}
\end{aligned}
$$

Centripetal acceleration $= r\dot{\theta}^2 = 0.2 \times 138.9^2 = 3658\text{ms}^{-1}$

(c)

$$
\begin{aligned}
\text{Angular velocity} &= \frac{2\pi}{365 \times 24 \times 3600} \\
&= 1.9 \times 10^{-7} \text{ rad s}^{-1}
\end{aligned}
$$

Centripetal acceleration $= 1.5 \times 10^{11} \times 1.9^2 \times 10^{-14} = 5.415 \times 10^{-3}\text{ms}^{-1}$

(d) Roundabout rotates $\approx$ once per second. Therefore angular velocity $\approx 2\pi \approx 6\text{rad s}^{-1}$

Radius $\approx$ 1m. Therefore centripetal acceleration is 36ms^{-1}