WJEC (Wales) Physics A-level

Topic 3.1: Circular Motion

Notes

Definitions

Period of Rotation

The period of rotation is the time it takes for an object to complete one rotation or oscillation. In a circular motion, this means it is the time it takes for the object to make **one whole revolution**.

Frequency

The **number of times an object completes a full rotation** or oscillation in a unit time is the frequency.

The Radian

The radian is a measure of angle. One radian is the angle within a sector when the **arc length of the sector is equal to the radius of the circle** from which the sector is formed.

To convert between radians and degrees, you should note that there are 2π radians in a circle (because the circumference is 2π times the radius) and so 2π radians is equal to $360°$.

From radians to degrees, divide by 2π and times by 360 i.e. multiply by $\frac{180}{\pi}$.

From degrees to radians, divide by 360 and times by 2π i.e. multiply by $\frac{\pi}{180}$.

Angular Velocity

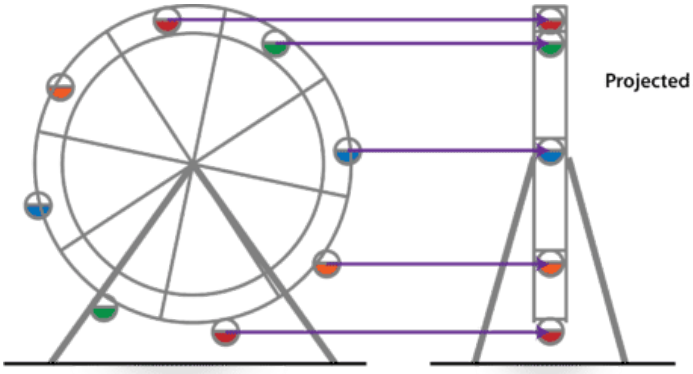
The **rate of change of angular displacement** is equal to the angular velocity. It is a vector quantity. In a circular motion, it can be positive or negative depending on which way you define the positive direction to be in (clockwise or anti-clockwise). It is given the symbol ω.

In simple harmonic motion, the angular velocity is representative of the frequency at which it oscillates at because $\frac{\omega}{2\pi} = f$. Also, if you were **to view circular motion side on,** you would notice that you see simple harmonic motion. This is why angular velocity is used in both situations. The diagram below shows that if you watch the ferris wheel from the side, the cars will undergo simple harmonic motion.

The equation linking velocity (the distance the object covers every second in a given direction) to the angular velocity is:

$$v = \omega r$$

This is because, using some basic geometry of circles, if the object covers ω radians per second, then every second, the arc length over which it travels is equal to that angle multiplied by the radius of the circle ωr.



https://www.ck12.org/user:ynjncmvuawvyqgdtywlslmnvbq../book/episd-physics/section/7.1/

Centripetal Force and Acceleration

Centripetal Force

Objects in circular motion require a force to maintain their motion. The centripetal force is the name given to the **resultant force on an object moving at constant speed in circular motion**. For the object to move in a circular motion the **centripetal force must be towards the centre of the circle and along the radius**. The centripetal force:

$$F = \frac{mv^2}{r} = mw^2r$$

Centripetal Acceleration

If there is a resultant force, then there must be some acceleration directly proportional to and in the same direction as the resultant force (Newton's second law). Therefore, there is an acceleration called the **centripetal acceleration which acts towards the centre of the circle and along the radius**. This acceleration causes the object to constantly change direction (but not speed) and keeps its path as a circle. The centripetal acceleration:

$$a = \frac{v^2}{r} = w^2r$$