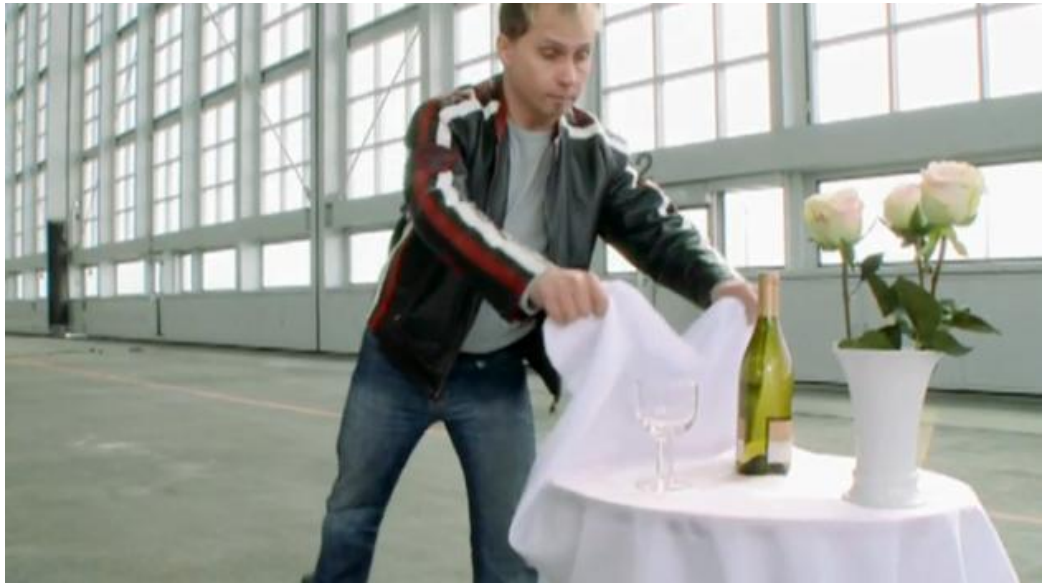
Centripetal Force and Acceleration

IB PHYSICS | CIRCULAR MOTION

Remember Newton's 1st?

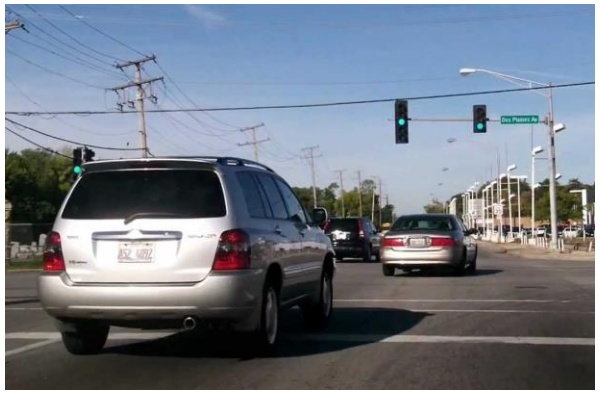
A body will remain at rest or moving with constant velocity unless acted upon by an unbalanced force

"Law of Inertia"



Remember back…

There are 3 ways that an object can be experiencing acceleration?



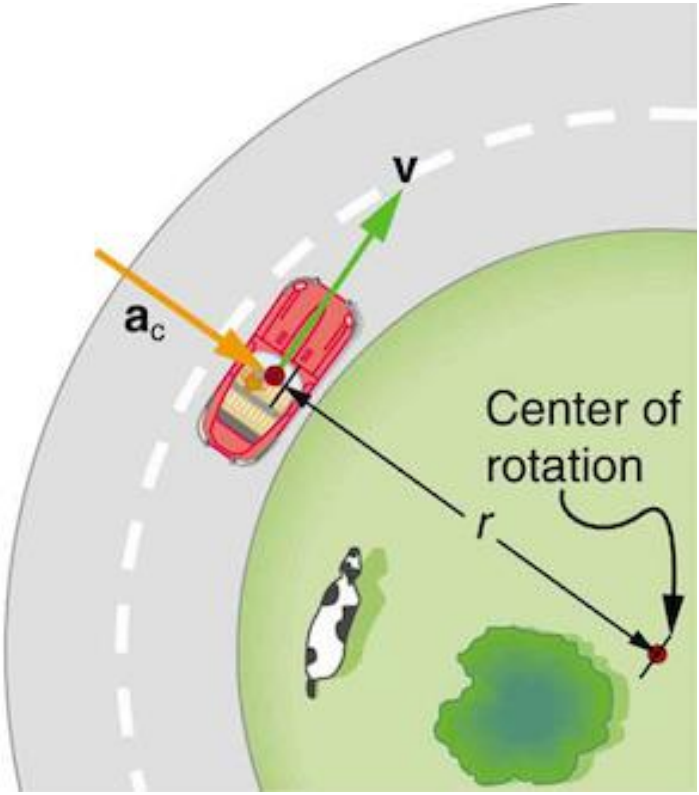
Speeding Up

Slowing Down

Changing Direction

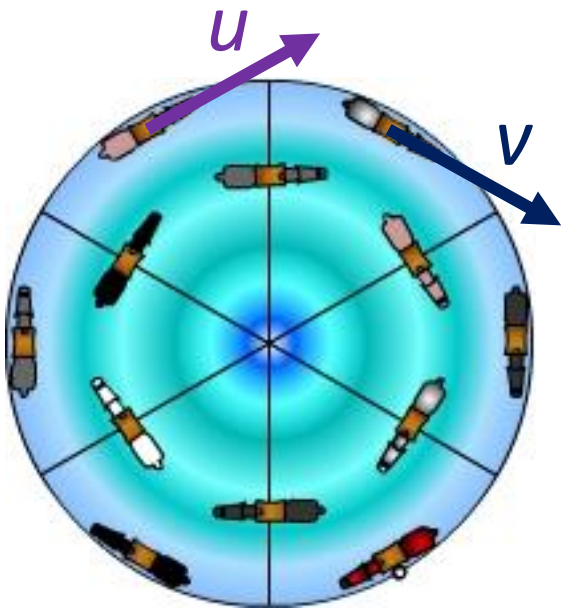
Centripetal Acceleration

Centripetal acceleration represents the rate of change of velocity and its direction



Centripetal Acceleration

Centripetal acceleration can be seen when finding the change between velocity vectors



Centripetal acceleration will always point to the

center

Calculating Centripetal Acceleration

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

$$v = \omega r$$

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

$$v = \frac{2\pi r}{T}$$

IB Physics Data Booklet

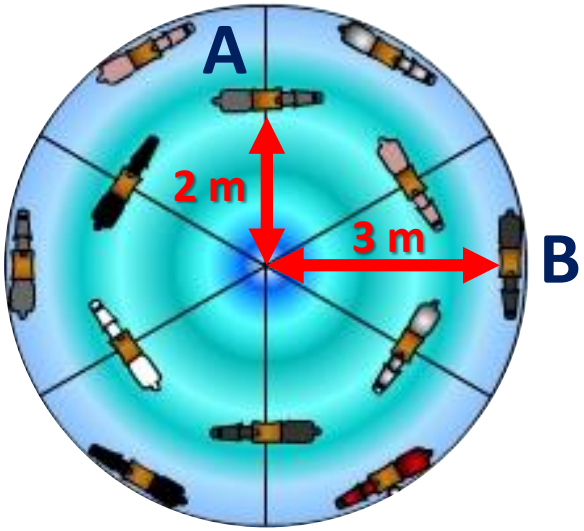
Sub-topic 6.1 – Circular motion

$$v = \omega r$$

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

$$F = \frac{mv^2}{r} = m\omega^2 r$$

Try this....



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

If the carousel spins at 1 complete rotation every 10 seconds, what is the centripetal acceleration for each row?

A	$\omega = 0.63$ rad s^{-1} | $v = 1.3$ m s^{-1}
B	$\omega = 0.63$ rad s^{-1} | $v = 1.9$ m s^{-1}

Wait… Where's the Force?

We know from Newton's 2nd Law that every time that we have acceleration, there must be a force causing that change in velocity

$$F = ma$$

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

Calculating Centripetal Force

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

$$v = \omega r$$

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Try This…

A **3 kg** rock swings in a circle of radius **5 m**. If its constant speed is **8 m s^{-1}**, what is the centripetal acceleration and force?

$$v = \omega r$$

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

$$F = \frac{mv^2}{r} = m\omega^2 r$$

Try This…

A pilot is flying a small plane at 30.0 m s^{-1} with a radius of 100.0 m. If a force of 635 N is needed to maintain the pilot's circular motion, what is the pilot's mass?

$$v = \omega r$$

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

$$F = \frac{mv^2}{r} = m\omega^2 r$$

Equation Summary

Sub-topic 6.1 – Circular motion

$$v = \omega r$$

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

$$F = \frac{mv^2}{r} = m\omega^2 r$$

Velocity

Linear
$v \rightarrow$ m s^{-1}

Angular
$\omega \rightarrow$ rad s^{-1}

Centripetal Acceleration
changes direction toward center

$a_c \rightarrow$ m s^{-2}

Centripetal Force
directed toward center

$F = ma$

See derived equations

Lesson Takeaways

- ❑ I can determine the direction and magnitude of centripetal acceleration and centripetal force
- ❑ I can identify circular motion properties in a description and choose an appropriate equation to relate them