

# Circular Motion

## IB Physics Content Guide

### Big Ideas

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- Objects moving in a circle are experiencing acceleration since the direction of the velocity is constantly changing
- Centripetal acceleration and centripetal force are always directed toward the center of the circle
- The net force for a body in circular motion is equal to the centripetal force
- It is useful to draw a free body diagram to determine what forces are present at a given position

### Content Objectives

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#### 1 – Defining Circular Motion

|   |  |  |  |
|---|--|--|--|
| I can convert between angular displacement in revolutions and radians                         |  |  |  |
| I can describe and calculate the properties of period and frequency                           |  |  |  |
| I can calculate angular velocity  |  |  |  |
| I can describe and calculate tangential velocity based on the angular velocity and radius     |  |  |  |
| I can determine the direction and magnitude of centripetal acceleration and centripetal force |  |  |  |

#### 2 – Vertical Circular Motion

|  |  |  |  |
|--|--|--|--|
| I can draw correctly proportioned free body diagrams for horizontal and vertical circular motion     |  |  |  |
| I can compare the forces on an object at different positions in vertical circular motion             |  |  |  |
| I can identify the combination of forces that make up the net force that results in circular motion. |  |  |  |
| I can determine the magnitude and direction of the forces needed to move in a vertical circle        |  |  |  |

#### 3 – Circular Motion, Friction, and Angles

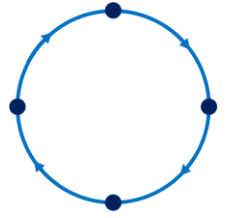
|   |  |  |  |
|---|--|--|--|
| I can draw a free body diagram when circular motion is produced by a reaction or friction force |  |  |  |
| I can solve problems that involve friction to create circular motion                            |  |  |  |
| I can solve circular motion problems that incorporate components of an angled force             |  |  |  |

# Circular Motion

## Shelving Guide

|                          | Variable Symbol | Unit |
|--------------------------|-----------------|------|
| Distance                 |                 |      |
| Angular Distance         |                 |      |
| Angular Velocity         |                 |      |
| Linear Velocity          |                 |      |
| Centripetal Acceleration |                 |      |
| Centripetal Force        |                 |      |

Draw in vectors for  $v$ ,  $a_c$ , and  $F_c \rightarrow$



Data Booklet Equations:

$$v = \omega r$$

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

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

## Defining Circular Motion

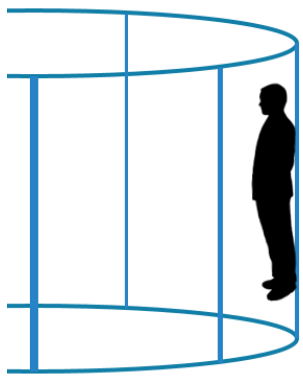

|  |        |  |  |                  |  |  |
|--|--------|--|--|------------------|--|--|
|  | Period |  |  | Angular Velocity |  |  |
|  |        |  |  |                  |  |  |

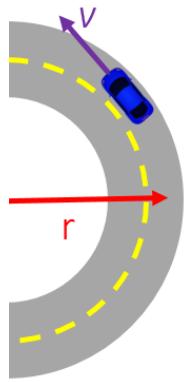

## Vertical Circular Motion

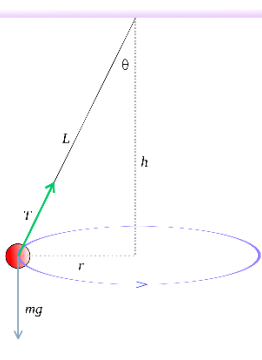

|  |                   |                   |
|--|-------------------|-------------------|
|  | Top:              | Bottom:           |
|  |                   |                   |
|  | $F_{net} = F_c =$ | $F_{net} = F_c =$ |

|                   |                   |
|-------------------|-------------------|
| Top:              | Bottom:           |
|                   |                   |
|                   |                   |
| $F_{net} = F_c =$ | $F_{net} = F_c =$ |

# Circular Motion with Friction and Angles

|  |  |                                  |
|--|--|----------------------------------|
|  A diagram showing a person standing on the inner surface of a rotating cylindrical structure. The structure is represented by a blue wireframe cylinder. |  A diagram of a blue square with a small blue dot in its center, representing a point mass or a specific location on a rotating object. | Relationships between variables: |
|--|--|----------------------------------|

|   |  |                                  |
|---|--|----------------------------------|
|  A diagram of a car on a curved road. A purple arrow labeled $v$ indicates the car's velocity. A red arrow labeled $r$ indicates the radius of the curve. The road is shown as a grey arc with a dashed yellow center line. |  A diagram showing the rear view of a grey car on a horizontal surface. | Relationships between variables: |
|---|--|----------------------------------|

|  |  |                                  |
|--|--|----------------------------------|
|  A diagram of a conical pendulum. A red ball is suspended by a string of length $L$ from a horizontal pink line. The string makes an angle $\theta$ with a vertical dashed line. The vertical height from the pivot to the ball is $h$ . The radius of the circular path is $r$ . The weight force $mg$ is shown acting vertically downwards from the ball. |  A diagram of a blue circle with a small blue dot in its center, representing a point mass or a specific location on a rotating object. | Relationships between variables: |
|--|--|----------------------------------|