Flipping Physics Lecture Notes:
AP Physics 1 - Unit 5a Review - Rotational Kinematics - Exam Prep
http://www.flippingphysics.com/rotational-kinematics-visualizations.html

This lecture is a free part of my AP Physics 1 Ultimate Review Packet. If you find this video useful, I suggest you invest in the rest of the packet.

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Each of the objects in the rigid system does not move relative to the other objects. Clockwise is defined as positive for this demonstration and the motion is comprised of 3 parts:

Part 1) Constant, positive angular acceleration.
Part 2) Constant, positive angular velocity.
Part 3) Constant, negative angular acceleration.
[Rough draft of the demos: https://youtu.be/prBTIpFhBZA]

All 5 objects go through the same angular displacement during the same change in time:

$$\Delta\vec{\theta} = \vec{\theta}_f - \vec{\theta}_i$$

- Therefore, all objects have the same average angular velocity: $\vec{\omega} = \frac{\Delta\vec{\theta}}{\Delta t}$
- And all objects have the same angular acceleraiton: $\vec{\alpha} = \frac{\Delta\vec{\omega}}{\Delta t}$

All 5 objects do not have the same radius of the path traced out by each object:

- The larger the radius of the object's path, the larger the arc length traced out by the object.

$$s = r\Delta\theta$$

- The larger the radius of the object's path, the larger the tangential speed of the object. $v_t = r\omega$
- The larger the radius of the object's path, the larger the tangential acceleration of the object. $a_t = r\alpha$

The direction of the tangential acceleration of each object is:

- The same as the direction of the tangential velocity when the magnitude of the tangential velocity is increasing.
- Opposite the direction of the tangential velocity when the magnitude of the tangential velocity is decreasing.
- And when the magnitude of the tangential velocity is constant, the object has no tangential acceleration.

For centripetal acceleration: $a_c = r\omega^2$

- Because each object has the same angular velocity, the larger the radius of the path traced out by each object, the larger the centripetal acceleration of the object.
- When an object is moving in a circular path, the object must have centripetal acceleration. This is because centripetal acceleration is the result of the change in the direction of the tangential velocity of the object.
    - Tangential acceleration is the result of the change in the magnitude of the tangential velocity of the object, so objects moving along circular paths do not have to have tangential acceleration.

Linear quantity directions when moving in circular motion:

- Tangential acceleration is always in a direction tangent to the circular path being traced out by the object and perpendicular to the radius.
- Centripetal acceleration is always in a direction perpendicular to the circular path being traced out by the object and in toward the center of the circle along the radius.
- Tangential velocity and centripetal acceleration are always perpendicular to one another.

When a rigid object is rotating, the terms angular displacement, angular velocity, and angular acceleration refer to the whole object, however, the terms arc length, tangential velocity, tangential acceleration, and centripetal acceleration refer to a point particle in a specific location on the object.