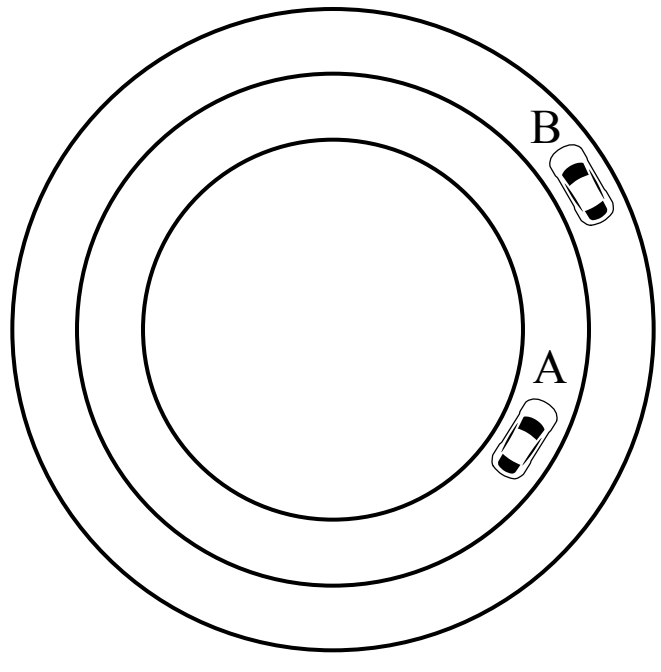
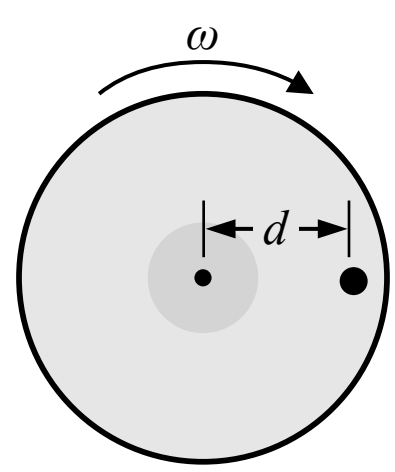
CONNECTING CIRCULAR AND ROTATIONAL MOTION



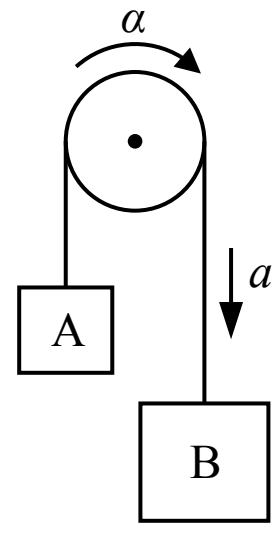
1. Car A and car B are driving around concentric circular tracks as shown in the figure above. Car B is on a track with a larger radius than the track car A is driving on. If both cars have the same speed, which car completes one full lap around its track in less time?

(A) Car A
(B) Car B
(C) Both cars complete one lap in the same amount of time
(D) Cannot be determined without knowing the radius of each track



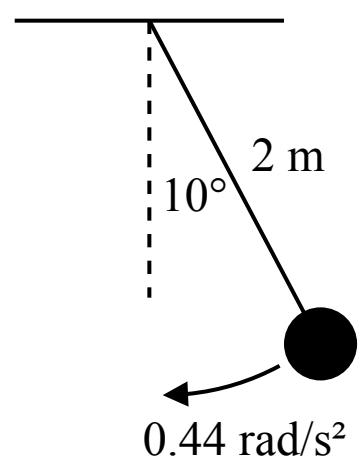
2. A fly is sitting near the edge of a spinning vinyl record, represented as a dot in the figure above. If the fly is a distance d from the center of the record, the speed of the fly is

(A) d/ω
(B) $d\omega^2$
(C) ω
(D) $d\omega$



3. Two blocks are connected by a cable that is wrapped around a pulley as shown in the figure above. Block B has a greater mass than block A so the blocks accelerate and the pulley experiences an angular acceleration (the cable turns the pulley without slipping). If the diameter of the pulley is 0.2 m and the angular acceleration of the pulley is 15 rad/s², the magnitude of the acceleration of the blocks is most nearly

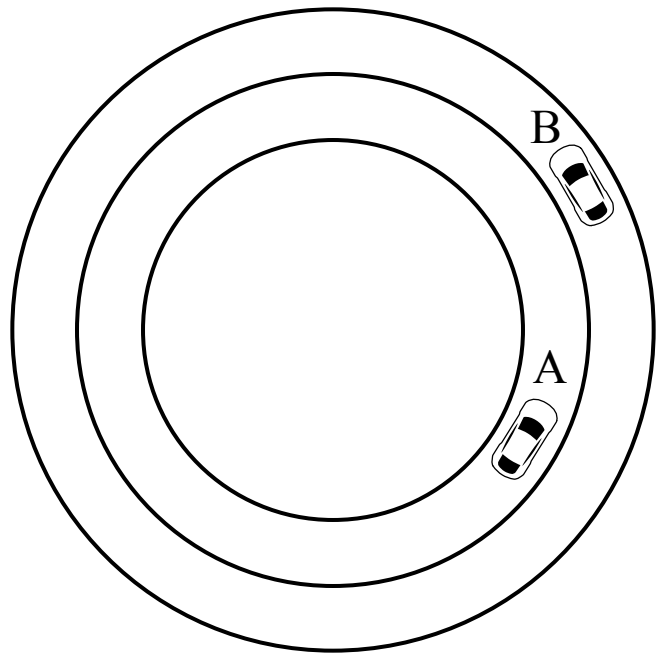
(A) 0.75 m/s²
(B) 150 m/s²
(C) 1.5 m/s²
(D) 3.0 m/s²



Note: Figure not drawn to scale

4. A pendulum consisting of a mass hanging from a 2 m long string is shown in the figure above. When the mass swings all the way to the right it momentarily comes to rest and the string forms a 10° angle with the vertical. If the pendulum experiences a constant angular acceleration of 0.44 rad/s² as it swings down, the speed of the mass when it reaches the lowest point (and the string is vertical) is most nearly

(A) 0.8 m/s
(B) 5.9 m/s
(C) 0.4 m/s
(D) 0.2 m/s



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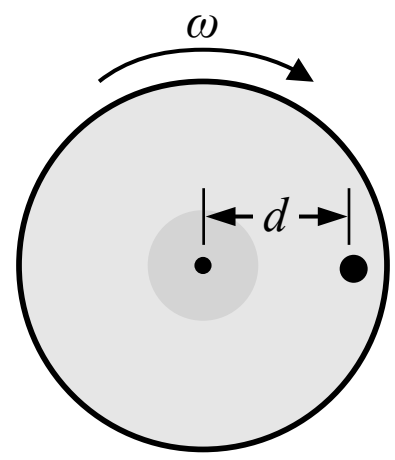
(A) Car A
(B) Car B
(C) Both cars complete one lap in the same amount of time
(D) Cannot be determined without knowing the radius of each track

A **Correct**
Car A is on a track with a smaller circumference (and has less distance to travel) than car B because the radius is smaller. If both cars have the same speed then car A will complete one lap (one circumference) in less time.

B Incorrect

C Incorrect

D Incorrect



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(A) d/ω

(B) $d\omega^2$

(C) ω

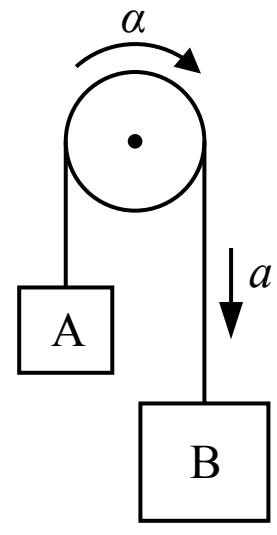
(D) $d\omega$

A Incorrect

B Incorrect

C Incorrect
This is the angular speed of the fly. The term “speed” by itself refers to the linear or tangential speed.

D Correct
The fly has the same angular speed as the record and travels one circumference (of its own circular path) in the time it takes the record to rotate one revolution. The linear or tangential speed is equal to the radius of the circular path multiplied by the angular speed.
$v = r\omega = d\omega$



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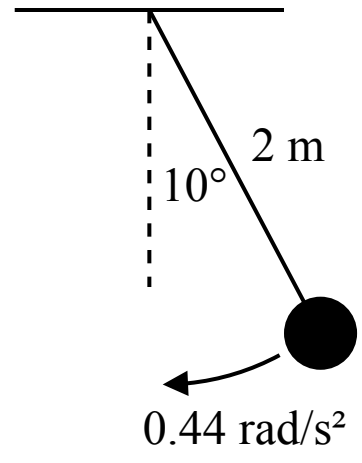
(A) 0.75 m/s²
(B) 150 m/s²
(C) 1.5 m/s²
(D) 3.0 m/s²

A Incorrect

B Incorrect
This answer incorrectly divides the angular acceleration by the radius instead of multiplying them.

C Correct
The cable is wrapped around the outer edge of the pulley so the linear or tangential acceleration of the cable and the blocks is equal to the radius of the pulley multiplied by the angular acceleration.
$a = r\alpha = (0.1\text{ m})(15\text{ rad/s}^2) = 1.5\text{ m/s}^2$

D Incorrect
This answer incorrectly uses 0.2 m as the radius of the pulley instead of 0.1 m.



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(D) 0.2 m/s

A Correct

This question can be solved using kinematics. The initial angular speed is zero and the angular speed of the pendulum after accelerating over an angular displacement of 10° can be found using a kinematic equation (after converting the degrees to radians). The angular speed can then be converted into the linear or tangential speed of the mass using the length of the string as the radius of the circular path.

$$\frac{10°}{} \times \frac{2\pi \text{ rad}}{360°} = \pi/18 \text{ rad}$$

$$\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta \qquad \omega_f^2 = (0 \text{ rad/s})^2 + 2(0.44 \text{ rad/s}^2)(\pi/18 \text{ rad}) \qquad \omega_f = 0.39 \text{ rad/s}$$

$$v = r\omega = (2 \text{ m})(0.39 \text{ rad/s}) = 0.8 \text{ m/s}$$

B Incorrect

This answer incorrectly uses 10 radians as the angular displacement.

C Incorrect

This answer is the angular speed of the pendulum at the lowest point (0.39 rad/s) with the unit of m/s.

D Incorrect