AP® Physics B
1999 Sample Student Responses

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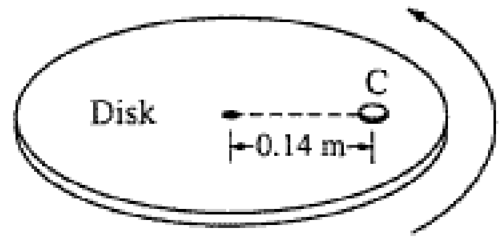
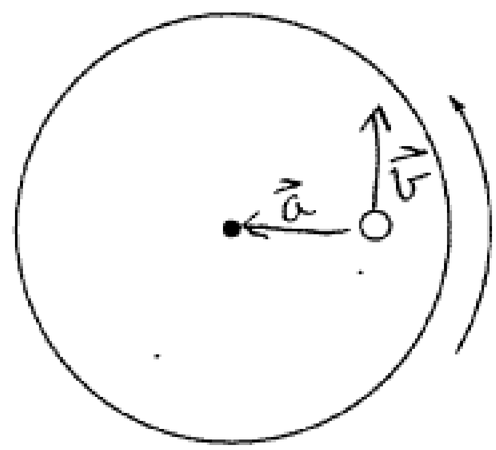


5. (10 points)
A coin C of mass 0.0050 kg is placed on a horizontal disk at a distance of 0.14 m from the center, as shown above. The disk rotates at a constant rate in a counterclockwise direction as seen from above. The coin does not slip, and the time it takes for the coin to make a complete revolution is 1.5 s.

(a) The figure below shows the disk and coin as viewed from above. Draw and label vectors on the figure below to show the instantaneous acceleration and linear velocity vectors for the coin when it is at the position shown.



(b) Determine the linear speed of the coin.

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

$\vec{v} = \frac{2\pi(0.14 m)}{1.5 s} = 0.59 \frac{m}{s}$

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(c) The rate of rotation of the disk is gradually increased. The coefficient of static friction between the coin and the disk is 0.50. Determine the linear speed of the coin when it just begins to slip.

$\mu = 0.50$

$\vec{F}_c = \vec{F}$

$\frac{m\vec{v}^2}{R} = \mu \vec{N}$

$\frac{m\vec{v}^2}{R} = \mu m g$

$\frac{\vec{v}^2}{R} = \mu g$

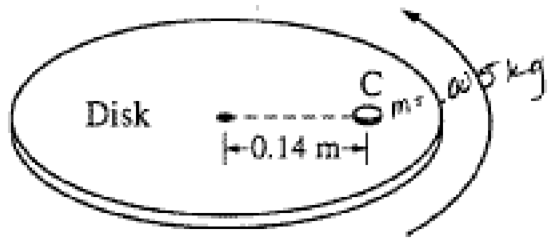
$\vec{v} = \sqrt{\mu g R}$

$\vec{v} = \sqrt{(0.50)(9.8\frac{m}{s^2})(0.14m)}$

$\vec{v} = 0.83 \frac{m}{s}$

(d) If the experiment in part (c) were repeated with a second, identical coin glued to the top of the first coin, how would this affect the answer to part (c) ? Explain your reasoning.

It would not affect part c because the velocity is independent of the mass. the mass is canceled when centripetal force is set equal to the force of friction.



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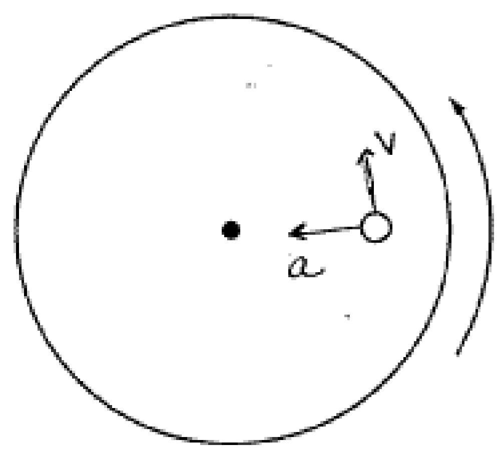

(b) Determine the linear speed of the coin.

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

$V = \frac{2\pi(.14\text{ m})}{1.5\text{ s}}$

$V = .59 \frac{m}{s}$

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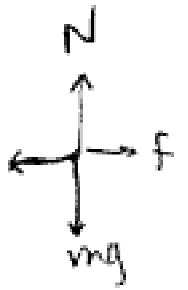
(c) The rate of rotation of the disk is gradually increased. The coefficient of static friction between the coin and the disk is 0.50. Determine the linear speed of the coin when it just begins to slip.

$v = ?$

$f = \mu N$

$f = .5(.049\,N)$

$f = .0245\,N$



$\Sigma F_y = ma^{0}$

$0 = N - mg$

$N = mg$

$N = (.005\,kg)(9.8\,\frac{m}{s^2})$

$N = .049\,N$

$\Sigma F_x = ma = F_c - f$

$\frac{mv^2}{R} = f$

$v = \sqrt{\frac{fR}{m}}$

$v = \sqrt{\frac{.0245(.14\,m)}{.005\,kg}}$

$v = .83\,\frac{m}{s}$

(d) If the experiment in part (c) were repeated with a second, identical coin glued to the top of the first coin, how would this affect the answer to part (c) ? Explain your reasoning.

The velocity would be slower because of the additional weight.

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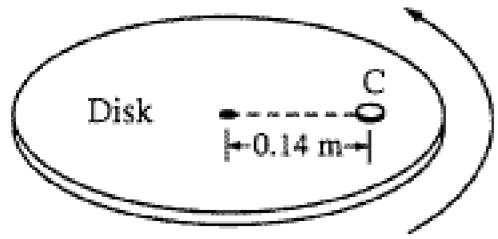

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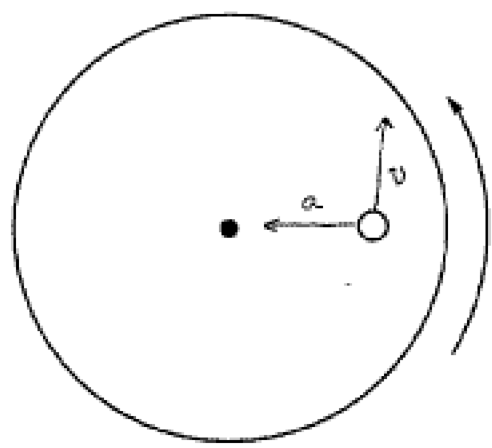
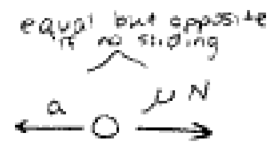


(b) Determine the linear speed of the coin.

$v = \frac{2\pi r}{T}$ $\quad v = \frac{2\pi(.14)}{1.5} = \boxed{.59\ m/s}$ or $.1867\pi$

(c) The rate of rotation of the disk is gradually increased. The coefficient of static friction between the coin and the disk is 0.50. Determine the linear speed of the coin when it just begins to slip.



$F \le \mu N \qquad N = mg$

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

$\frac{v^2}{r} > \mu mg$ (start slipping)

$\frac{v^2}{.14} > (.5)(.005)(9.8)$

$v > 5.86 \times 10^{-2}$ m/s

(d) If the experiment in part (c) were repeated with a second, identical coin glued to the top of the first coin, how would this affect the answer to part (c) ? Explain your reasoning.

The mass would double increasing the speed at which the coin would slip because the friction force vector would be twice as great: $F_{fric} = \mu N$, the normals magnitude is determined by the mass of the object (which is being doubled).