Name:________________________ Student ID:________________________

PHYS1001 Tutorial 1 - Section A4

1. An ant crawls along a path defined by: $\mathbf{p} = \left(\overset{x}{-5t + 2t^2}, \overset{y}{\sin\left(\frac{2\pi}{5}t\right)}, \overset{z}{0}\right)$ mm

   (a) Does it ever stop moving completely?

   (b) i. If so, what position is it at when this occurs?

   ii. If not, what is the ant's velocity when its turns around in the x-direction?

a)

$x(t) = -5t + 2t^2$ mm

$y(t) = \sin\left(\frac{2\pi}{5}t\right)$ mm ✓

$z(t) = 0$ mm

does x or y velocity ever become 0? z can be ignored because it is motionless.

$\frac{dx}{dt} = (-5 + 4t)$ mm/s ✓

$\frac{dy}{dt} = \frac{2\pi}{5}\left(\cos\left(\frac{2\pi}{5}t\right)\right)$ mm/s

6/10

Let $V_x = 0$ mm/s and solve for time

$0\text{ mm/s} = -5 + 4t \text{ mm} \Rightarrow t = \frac{5}{4}$ s ✓

put $\frac{5}{4}$s into V_y since it is the only time that the V_x is 0 ✓

$V_y = \frac{2\pi}{5}\boxed{\cos\left(\frac{2\pi}{5}\left(\frac{5}{4}s\right)\right)\text{mm}} = 1.256$ m/s

$\left(\frac{2\pi}{5}\right)\left(\frac{5}{4}\right)$

$\cos\left(\frac{\pi}{2}\right) = 0$

$\therefore$ Stops moving @ $t = \frac{5}{4}$s

Therefore the ant dosen't stop crawling. ✗

b) ii) Let $x = 0$ and solve for t

$0\text{ mm/s} = -5 + 4t \text{ mm} \Rightarrow t = \frac{5}{4}$s ✗

$V_y = \frac{2\pi}{5}\cos\left(\frac{2\pi}{5}\left(\frac{5}{4}s\right)\right)$ mm $= 1.256$ m/s in y direction

The ant's ~~travels~~ velocity is 1.256 m/s in the y direction. ✗

↳ the ant stopped so you needed to find its position

7.5/10

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PHYS1001 Tutorial 2 - Section A4

The acceleration of a particle is given by $a(t) = A + Bt$ where $A = -4.00m/s^2$, and $B = 6.00m/s^3$. At time $t = 0$ the particle starts its motion at the origin.

1. Find the initial velocity $v_0 = v(0)$ such that the particle will have the same x coordinate at $t = 2.00s$ as it had at $t = 0s$.

2. What will be the velocity at $t = 2.00s$?

(1) $v(t) = \int_0^t (A + Bt')\,dt' + v(0)$

$= \left[\int_0^t A\,dt' + \int_0^t Bt'\,dt'\right] + v(0)$

$= At'\big|_0^t + \frac{Bt'^2}{2}\big|_0^t + v(0)$

$= A(t-0) + \frac{B(t-0)^2}{2} + v(0) = At + \frac{Bt^2}{2} + v(0)$

$v(t) = -4.00\,m/s^2\,t + 3.00\,m/s^3\,t^2 + v(0)$

So $x(t) = -2.00\,m/s^2\,t^2 + 1.00\,m/s^3\,t^3 + v(0)t$

$x_F - x_i = \int_0^t v(t)\,dt$

$0 = -2.00\,m/s^2\,t^2 + 1.00\,m/s^3\,t^3 + v(0)t$

$2.00\,m/s^2\,t^2 = 1.00\,m/s^3\,t^3$

$2.00\,m/s^2 = \frac{1.00\,m/s^3\,t^3}{t^2} = 1.00\,m/s^3\,t$

$t = 2.00s$ Therefore the initial velocity is 0 m/s

true but you haven't shown it

4.5/7

(2) $v(2s) = -4.00\,m/s^2(2s) + 3.00\,m/s^3(2s)^2 = 4.00\,m/s$

Therefore the velocity at $t = 2.00s$ is 4.00 m/s

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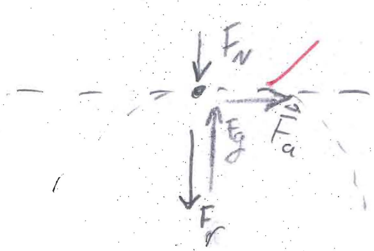
PHYS1001 Tutorial 3 - Section A4

In a 1901 circus performance, Allo "Dare Devil" Diavolo introduced the stunt of riding a bicycle in a loop-the-loop. Assuming the loop is a circle with radius $R = 3.7m$, what is the least speed v Diavolo could have at the top of the loop to *just* remain in contact with it there?



$\vec{F}_{net} = m\vec{a}$ ✓

$-\vec{F}_N + \vec{F}_g - \cancel{\vec{F}_a} = m\vec{a}$?

$-\vec{F}_N + \vec{F}_g - \cancel{\frac{v^2}{R}} = m\vec{a}$ $\frac{v^2}{R}$

$\vec{F}_a = m a$

$m = \frac{F_a}{a}$

Since the bike is about to lose the ramp $F_N = 0$ F_g $F_g \neq 0$

$\frac{5}{10}$

$-\frac{v^2}{R} = ma$

Since

$\frac{-v^2}{R} = ma$

Si

$V = \sqrt{-maR}$

but since $a = 0\,m/s^2$

$V = 0\,m/s$ ✗

Therefore the minimum velocity is 0m/s.

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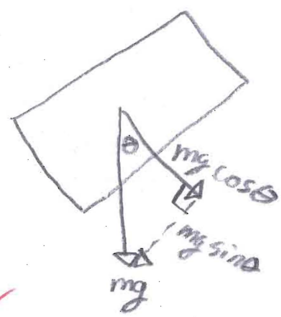
PHYS1001 Tutorial 4 - Section A9

$\frac{9}{10}$

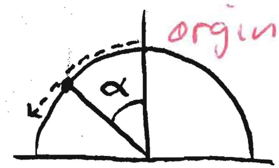
A mass starts at the top of a large frictionless sphere with negligible initial speed and slides down the side. Taking angle α as the angle from the centre of the sphere between a vertical and a line to the mass, at what angle α does the mass lose contact with the sphere?

(Hint 1: the mass loses contact when the normal force exerted by the sphere on the mass drops to zero.)

(Hint 2: all forces are conservative, so you can use conservation of total energy in this problem.)



axis? orgin?



$F = ma$

$$\frac{mv^2}{r} = mg\cos\theta \Rightarrow v^2 = rg\cos\theta$$

E_i

$$E_f = \frac{1}{2}mv^2 + mgh = \frac{1}{2}m(rg\cos\theta) + mg(r\sin(90-\theta)) = mgr$$

try and be clear.

$$mgr = mgr\left(\frac{1}{2}\cos\theta + \sin(90-\theta)\right)$$

$$1 = \frac{1}{2}\cos\theta + \sin(90-\theta)$$

$$1 = \frac{1}{2}\cos\theta + \sin 90\cos\theta - \sin\theta\cos 90$$

$$1 = \frac{1}{2}\cos\theta + \cos\theta = \frac{3}{2}\cos\theta$$

$$\frac{2}{3} = \cos\theta \Rightarrow \theta = \cos^{-1}\left(\frac{2}{3}\right) \approx 48.2^\circ$$

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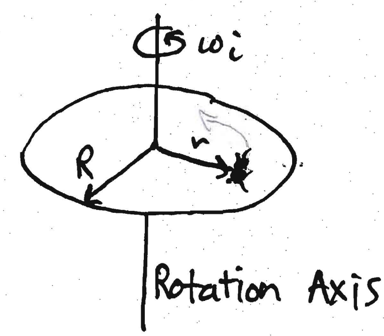
PHYS1001 Tutorial 5 - Section A4

A cockroach with mass m rides on a disk of mass $6.00 \cdot m$ and radius R. The disk rotates like a merry-go-round around its central axis at angular speed $\omega_i = 1.50 rad/s$. The cockroach is intially at the radius $r = 0.800 \cdot R$, but then it crawls out to the rim of the disk. Treat the cockroach as a particle. What then is the angular speed of the disc + cockroach in the final state.
Note: The disc and cockroach experience NO external torques or forces. The cockroach sticks to the disc.

$I_{disc} = \frac{1}{2}MR^2$, $I_{particle} = mr^2$.

~~$m_{Disk} = 6.00 \cdot m$~~



we know $L = I\omega$ and $L_i = L_f$, so:

$\omega_r = \omega_D$

$$I_{roach_i} \omega_{roach_i} + I_{Disk_i} \omega_{Disk_i} = (I_{roach_f} + I_{Disk})_f \omega_f$$

$$\left[(6.00 \cdot m)(0.800 \cdot R)^2\right] \cdot \left[\omega_{Disk_i} \cdot (0.800)\right] + \left(\frac{1}{2} m R^2\right)\omega_i = \left(\left[(6.00 \cdot m)R^2\right] + \left(\frac{1}{2} m R^2\right)\right)\omega_f$$

since the cockroach is $0.8 \cdot R$ on the disk it would be traveling at 0.8 of the angular speed of the disk.

$$\omega_f = \frac{\left[(6.00 \cdot m)(0.800 \cdot R^2)\right]\left[\omega_{Disk_i} \cdot (0.800)\right] + \left(\frac{1}{2} m R^2\right)\omega_{Disk_i}}{\left[(6.00 \cdot m)R^2 + \frac{1}{2} m R^2\right]}$$

$$= \frac{(4.8\, mR^2)(1.2\ rad/s) + (0.75\, mR^2)\, rad/s}{(6.00 \cdot m)R^2 + \frac{1}{2} m R^2} = \frac{\left[(5.76\, \cancel{mR^2}) + (0.75\, \cancel{mR^2})\right] rad/s}{6.00\, \cancel{mR^2} + \frac{1}{2}\cancel{mR^2}}$$

$$= \frac{(5.76 + 0.75)\ rad/s}{(6.00 + 0.5)} = \cancel{1.00}\ rad/s$$

1.37 rad/s

Therefore the final angular speed is 1.00 ~~rad/s~~

sorry about the confusion.

$\frac{8.5}{10}$