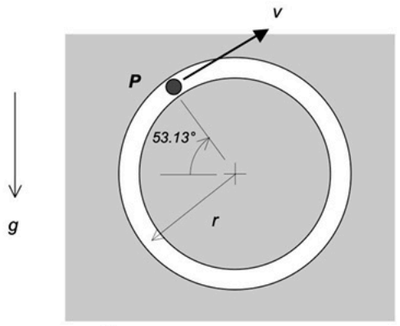
Question Q1

Particle P of mass m travels within a vertical plane along a smooth, circular slot having a radius of $r = 0.8\ m$. For the position shown, speed of P is $v = 5\ m/s$. For this position:

a. P is in contact with the inner surface of the slot.
b. P is in contact with the outer surface of the slot.
c. P is in contact with neither surface of the slot.
d. More information is needed to answer this question.

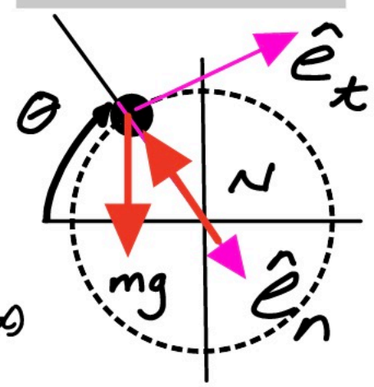


$\Sigma F_n = -N + mg\sin\theta = m\frac{v^2}{r}$

$N = m\left(g\sin\theta - \frac{v^2}{r}\right)$

$= m\left[(9.80)\left(\frac{4}{5}\right) - \frac{5^2}{0.8}\right]$

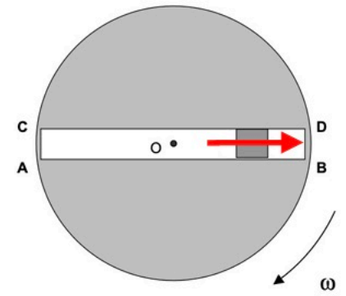
$= -23.4m$ ($<0 \Rightarrow N$ points inward)



Question Q2

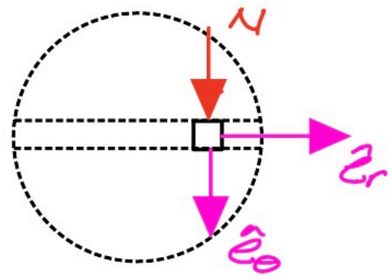
A disk rotates clockwise with a constant rate of ω about a vertical shaft which passes through the center O of the disk. A particle is known to be moving outward within the non-smooth radial slot away from O.

a. P is in contact with surface AB of the slot.
b. P is in contact with surface CD of the slot.
c. P is in contact with neither side of the slot.
d. More information is needed to answer this question.



$\Sigma F_\theta = N = m(r\ddot{\theta} + 2\dot{r}\dot{\theta}) < 0 \Rightarrow$ ($r\ddot{\theta} = 0$, $\dot{r} > 0$, $\dot{\theta} < 0$)

particle in contact with CD



Question Q3

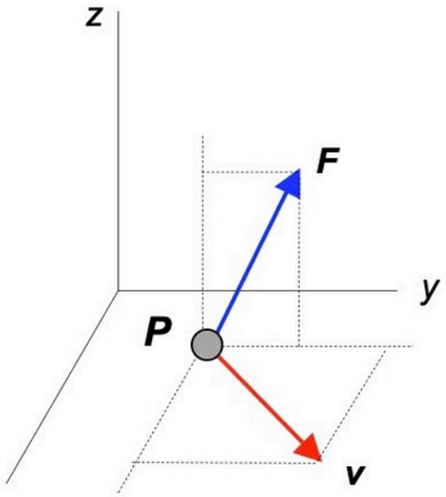
A single force of $\vec{F} = (-400\,\hat{j} + 300\,\hat{k})\ N$ acts on particle P that has a mass of m. At that instant, P has a velocity of $\vec{v} = (12\,\vec{i} + 16\,\vec{j})\ m/s$. At this instant:

a. P is moving with decreasing speed.
b. P is moving with increasing speed.
c. P is moving with constant speed.
d. More information is needed to answer this question.

$\dot{v} = \vec{a}\cdot\hat{e}_t = \left(\frac{\vec{F}}{m}\right)\cdot\frac{\vec{v}}{|\vec{v}|}$

$= \frac{(-400\hat{j} + 300\hat{k})}{m}\cdot\frac{(12\hat{i} + 16\hat{j})}{\sqrt{12^2+16^2}}$

$= \frac{(-400)(16)}{20m} < 0$

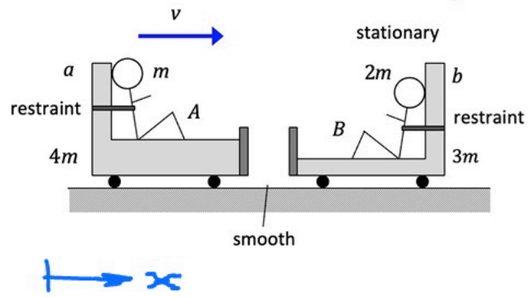


(generic figure showing the force and velocity vectors)

Question Q4

Cart "a" (of mass 4m) collides with stationary cart "b" (of mass 3m). Passengers "A" (of mass m) and "B" (of mass $2m$) are each held in place within the carts by inextensible restraints. Let F_A and F_B represent the restraint forces on passengers A and B, respectively, during the collision. Assume the carts to remain rigid during the collision.

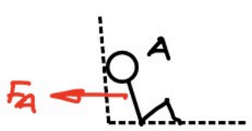
a. $F_A > F_B$
b. $F_A = F_B$
c. $F_A < F_B$
d. More information is needed to answer this question.



a+A: $\Sigma F_x = -F_{AB} = (4m+m)a_A$

b+B: $\Sigma F_x = F_{AB} = (3m+2m)a_B$

$\Rightarrow a_A = -a_B$



A: $\Sigma F_x = -F_A = ma_A$

B: $\Sigma F_x = F_B = 2ma_B$

$\Rightarrow -\frac{F_A}{F_B} = \frac{1}{2}\frac{a_A}{a_B}$

$\hookrightarrow \frac{F_A}{F_B} = \frac{1}{2}$