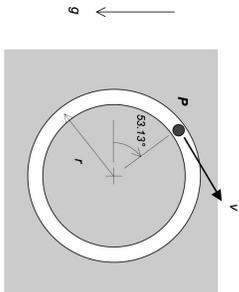


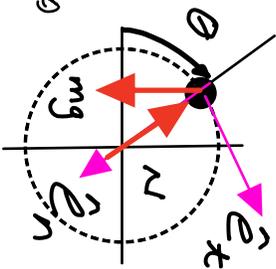
Question Q1

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



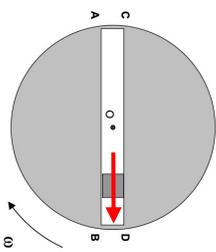
$$\begin{aligned} \Sigma F_n &= -N + mg \sin \theta = m \frac{v^2}{r} \\ N &= m \left(g \sin \theta - \frac{v^2}{r} \right) \\ &= m \left[(9.802) \left(\frac{4}{5} \right) - \frac{5^2}{0.8} \right] \\ &= -23.4 m \quad (< 0 \Rightarrow N \text{ points inward}) \end{aligned}$$



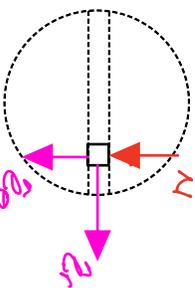
Question Q2

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.



$$\begin{aligned} \Sigma F_o &= N = m(r\ddot{\theta} + 2\dot{r}\dot{\theta}) < 0 \Rightarrow \\ &\text{particle in contact with CD} \end{aligned}$$

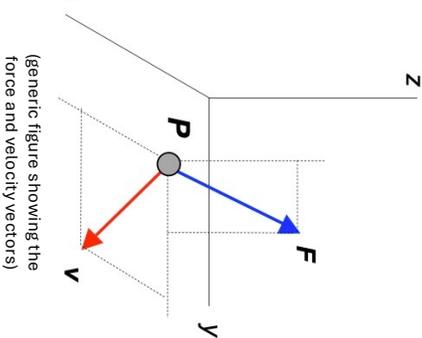


Question Q3

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

$$\begin{aligned} \dot{v} &= \vec{a} \cdot \hat{e}_v = \left(\frac{\vec{F}}{m} \right) \cdot \frac{\vec{v}}{|\vec{v}|} \\ &= \frac{(-400\hat{j} + 300\hat{k})}{m} \cdot \frac{(12\hat{i} + 16\hat{j})}{\sqrt{12^2 + 16^2}} \\ &= \frac{(-400)(16)}{20m} < 0 \end{aligned}$$

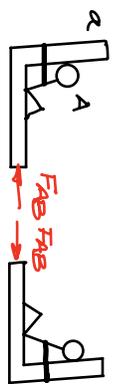
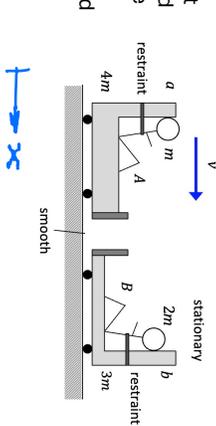


(generic figure showing the force and velocity vectors)

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.



$$\begin{aligned} \text{Q1A: } \Sigma F_x &= -F_{AB} = (4m + m)a_A \\ \text{Q1B: } \Sigma F_x &= F_{AB} = (3m + 2m)a_B \\ \text{A: } \Sigma F_x &= -F_A = ma_A \\ \text{B: } \Sigma F_x &= F_B = 2ma_B \end{aligned} \Rightarrow \begin{cases} a_A = a_B \\ -F_A = \frac{1}{2} \frac{Q_A}{a_B} \\ F_B = \frac{1}{2} \frac{F_A}{a_B} \end{cases} \Rightarrow \begin{cases} F_A = \frac{1}{2} Q_A \\ F_B = \frac{1}{2} Q_B \end{cases}$$