

## Carousels and Roller Coasters

### Question:

When the wine glass was directly above my head, was there a force pushing up on the wine glass that kept the glass against the tray?

### The Experience of Weight

- When you are at equilibrium,
  - a support force balances your weight
  - support force acts on your lower surfaces
  - weight force acts throughout your body
- You feel internal stresses conveying support
- You identify these stresses as weight

### The Experience of Acceleration

- When you are accelerating,
  - a support force often causes acceleration
  - support force acts on your surfaces
  - inertia resists acceleration throughout your body
- You feel internal stresses conveying support
- You identify these stresses as weight

### Acceleration and Weight

- Fictitious “force”—felt while accelerating
  - Feeling caused by your body’s inertia
  - Points in the direction opposite the acceleration
  - Has a strength proportional to the acceleration
- “Apparent weight”—felt due to the combined effects of gravitational and fictitious forces

### Carousels

- Riders undergo “uniform circular motion”
  - Riders follow a circular path
  - Riders move at constant speed
- UCM involves centripetal acceleration
  - Acceleration is directed toward the circle’s center
  - Acceleration depends on speed and size of circle

$$\text{acceleration} = \frac{\text{velocity}^2}{\text{radius}}$$

## Carousels

- Centripetal acceleration needs centripetal force
  - Force is directed toward the circle's center
  - Any centrally directed force is a centripetal force
- Centripetal acceleration → “Centrifugal force”
  - Acceleration is inward (toward center)
  - Fictitious “force” is outward (away from center)
  - It is just an experience of inertia, not a real force

## Question:

When the wine glass was directly above my head, was there a real force pushing up on the wine glass that kept the glass against the tray?

## Roller Coasters - Hills

- During hill descent,
  - acceleration is downhill
  - fictitious “force” is uphill
  - apparent weight is weak and into the track
- At bottom of hill,
  - acceleration is approximately upward
  - fictitious “force” is approximately downward
  - apparent weight is very strong and downward

## Roller Coasters - Loops

- At top of loop-the-loop,
  - acceleration is strongly downward
  - fictitious “force” is strongly upward
  - apparent weight is weak but upward!

## Choosing a Seat

- As you go over cliff-shaped hills,
  - acceleration is downward
  - fictitious “force” is upward
  - higher speed → greater acceleration and “force”
- First car goes over cliff slowly
- Last car goes over cliff quickly
- Last car has best weightless feeling!