Carousels and Roller Coasters

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

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 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!