Carousels and Roller Coasters

Turn off all electronic devices

Observations about Carousels and Roller Coasters

- You can feel your motion with your eyes closed
- You feel pulled in unusual directions
- You sometimes feel weightless
- You can become inverted without feeling it

5 Questions about Carousels and Roller Coasters

1. What aspects of motion do you feel?
2. Why do you feel flung outward on a carousel?
3. Why do you feel light as a roller coaster dives?
4. Why do you feel heavy as a roller coaster turns?
5. How do you stay seated on a loop-the-loop?

Question 1

Q: What aspects of motion do you feel?

A: You feel acceleration, but not velocity

- This feeling of acceleration is not a real force
  - It's just a sensation caused by your body's inertia
  - It's directed opposite your acceleration
  - It's proportional to that acceleration
- You feel an overall apparent weight:
  - feeling of real weight plus feeling of acceleration

The Feeling of Weight

- When you are at equilibrium,
  - a support force balances your weight
  - and that support force acts on your lower surface,
  - while your weight is spread throughout your body
- You feel internal supporting stresses
- You identify these stresses as weight

The Feeling of Acceleration

- When you are accelerating,
  - a support force causes your acceleration
  - and that support force acts on your surface,
  - while your mass is spread throughout your body
- You feel internal supporting stresses
- You misidentify these stresses as weight

Question 2

Q: Why do you feel flung outward on a carousel?
A: You are accelerating inward on the carousel

- Riders undergo uniform circular motion
  - They follow a circular path at constant speed
  - They are accelerating toward the circle's center
  - This acceleration depends on speed and circle size

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

Carousels (Part 2)

- The acceleration of uniform circular motion is
  - a center-directed or centripetal acceleration
  - caused by a center-directed or centripetal force
- A centripetal acceleration
  - gives rise to a feeling of acceleration
  - that points away from the center of motion
  - and is a sensation due to inertia, not a real force
- This feeling is often called "centrifugal force"

Question 3

Q: Why do you feel light as a roller coaster dives?
A: Your feeling of acceleration is upward

- As you dive down a hill,
  - your acceleration is downhill
  - your feeling of acceleration is uphill
  - your apparent weight is weak and points down & back

Question 4

Q: Why do you feel heavy as a roller coaster turns?
A: Your feeling of acceleration is outward

- As you turn at high speed,
  - your acceleration is inward
  - your feeling of acceleration is outward
  - your apparent weight is strong and points out & down

Question 5

Q: How do you stay seated on a loop-the-loop?
A: You are accelerating downward very rapidly

- At you arc through the top of the loop-the-loop,
  - your acceleration is strongly downward
  - your feeling of acceleration is strongly upward
  - your apparent weight points upward!

Choosing a Seat

- As you go over cliff-shaped hills,
  - acceleration is downward
  - feeling of acceleration is upward
- The faster you dive over the first hill,
  - the greater the downward acceleration
  - the stronger the upward feeling of acceleration
- First car dives slowly – weak weightlessness
- Last car dives quickly – strong weightlessness!

Summary about Carousels and Roller Coasters

- You are often accelerating on these rides
- You experience feelings of acceleration
- Those feelings point opposite your acceleration
- Your apparent weight can
  - become larger or smaller than your real weight
  - point at any angle
  - can even point upward!