

# 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

Your feeling of weight involves a real force

- ◊ Results from internal stresses as parts of you support one another

Your feeling of acceleration does not involve a real force

- ◊ Results from internal stresses as parts of you accelerate one another
- ◊ It is a sensation caused by your body's inertia
- ◊ It is directed opposite your acceleration
- ◊ It is proportional to that acceleration

You feel an overall apparent weight

- ◊ that is your feeling of weight plus your feeling of acceleration

## The Feeling of Weight

When you are at equilibrium,

- ◊ a upward support force balances your downward weight
- ◊ That upward support force acts on your lower surface
- ◊ Your downward weight is spread throughout your body

You feel internal supporting stresses

You identify these internal stresses as weight

## The Feeling of Acceleration

When you are accelerating forward,

- ◊ a forward support force causes your forward acceleration
- ◊ That forward support force acts on your back surface,
- ◊ while your mass is spread throughout your body

You feel internal supporting stresses

You misidentify these internal stresses as weight

## Question 2

Q: Why do you feel flung outward on a carousel?

A: You are accelerating inward on the carousel

Carousel riders undergo uniform circular motion

- ◊ They follow a circular path at a constant speed
- ◊ They are always accelerating toward the circle's center
- ◊ This acceleration depends on speed and circle size

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

## Carousels and Centripetal Acceleration

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 and back

## Question 4

Q: Why do you feel heavy as a roller coaster turns?

A: You are accelerating rapidly toward the center of the turn

As you turn at high speed,

- ◊ your acceleration is large and inward (toward the center of the turn)
- ◊ your feeling of acceleration is large and outward (away from center)
- ◊ your apparent weight is strong and points out and 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 large and downward (toward center of the loop)
- ◊ your feeling of acceleration is large and upward
- ◊ your apparent weight points upward!

## Choosing a Seat

As your car goes over the edge of the first hill and begins to dive,

- ◊ your acceleration is downward
- ◊ your 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 – you feel slightly weightless

Last car dives quickly – you feel almost completely weightless!

## 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!