Carousels and Roller Coasters

The Feeling of Weight

When you are at equilibrium, a support force balances your weight.

Your weight is spread throughout your body.

The floor pushes up on your feet – it must support your entire weight.

You also feel supporting forces within your body.
   Your legs must support your torso.
   Your neck must support your head.

The internal supporting forces decrease with height.

Support forces allow you to feel your weight.
The Feeling of Acceleration

You are standing on a rocket in outer space (far from any planet), which is accelerating upward.

Your mass is spread throughout your body.

The floor pushes up on your feet – it must accelerate your entire mass.

You also feel supporting forces within your body.
   Your legs must accelerate your torso.
   Your neck must accelerate your head.

The internal supporting forces decrease with height.

Support forces allow you to feel your acceleration.

Acceleration and Weight

Acceleration and weight produce the same feelings – they require the same internal supporting forces.

When you are standing at equilibrium on earth you feel your weight pushing down.

When you accelerate in the rocket it feels like something is pushing down on you.

This is not a real force – it is caused by your body’s inertia. You feel an “apparent weight” – how hard the surface pushes up on you.
Carousels

Riders undergo uniform circular motion.

They move at constant (uniform) speed along a circular path. The direction of their velocity continuously changes. The change in direction is toward the center of the circle. They are accelerating toward the circle’s center. This center-directed acceleration is called centripetal acceleration. This centripetal acceleration is caused by a center-directed or centripetal force.

Centripetal acceleration depends on speed and circle size.

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\text{centripetal acceleration} = \frac{\text{velocity}^2}{\text{radius}}
\]

Question

A rider in a “barrel of fun” finds herself stuck with her back to the wall. Which diagram correctly shows the forces acting on her?
Question

A dropped ball accelerates downward at the acceleration due to gravity. If you push downward on the ball with your open palm, it will accelerate downward

(1) at the acceleration due to gravity.
(2) faster than the acceleration due to gravity.
(3) slower than the acceleration due to gravity.

Loop-the-Loop

During the downhill dive,
   Acceleration is downhill
   Feeling of acceleration is uphill
   Apparent weight is smaller than real weight

At the dip at the bottom of the hill
   velocity changes from forward and down to forward and up
   Acceleration is upward
   Feeling of acceleration is downward
   Apparent weight is large and downward

At the top of the loop
   Acceleration is downward
   Feeling of acceleration is upward
   Apparent weight is upward
Problem
A child swings on a playground swing. On the diagram below draw arrows indicating the direction of acceleration of the child at positions P (the highest point in the swing) and Q (the lowest point in the swing). Also draw arrows indicating the net force at these two positions.

Question
A tennis ball is attached to a string. When the ball is swung in a vertical circle, is the string most likely to break

(4) at the top of the loop?
(5) at the bottom of the loop?
(6) on the way up?
(7) on the way down?
Question
A cart on a roller coaster rolls down the track shown below. As the cart rolls beyond the point shown, what happens to its speed and acceleration in the direction of motion?

1. Both decrease.
2. The speed decreases, but the acceleration increases.
3. Both remain constant.
4. The speed increases, but acceleration decreases.
5. Both increase.