Roller Coaster Design Interactive

The Roller Coaster Design Interactive explores the physics principles behind the design of a roller coaster. The wealth of decisions that must be made to enrich a rider's experience while providing a safe ride are discussed. Design data depicting the effect of a variety of design parameters upon the rider experience are displayed. The Interactive is accompanied by a collection of questions that target a student's ability to reason scientifically. The questions are shown here.

1. For any given location, the accelerations are greatest when the speed …
   a. and the radius of curvature are greatest
   b. and the radius of curvature are smallest
   c. is greatest and the radius of curvature is smallest
   d. is smallest and the radius of curvature is greatest
   e. …nonsense! The pattern is different for different locations.

2. Which one of the following variables does **not** affect the acceleration of a roller coaster rider at the bottom of the loop (**C**)?
   a. The height of the first drop.
   b. The height of the loop (height at B).
   c. The speed of the rider at the bottom of the loop.
   d. The radius of curvature of the bottom of the loop.

3. Consider a first drop height of 80 meters. If starting from this location, how will the speed of a rider compare at the top of a 40-meter high loop compared to the top of a 40-meter high hill?
   a. The rider moves faster at the top of the loop.
   b. The rider moves faster at the top of the hill.
   c. The rider speed is the same on the top of the loop and of the hill.
   d. Nonsense! There is insufficient information to make such a decision.

4. Which set of listed parameters would result in the smallest acceleration at the top of a loop (location **B**)?
   a. Height at **A** = 50.0 m, Height at **B** = 25.0 m, Radius at **B** = 10.0 m
   b. Height at **A** = 60.0 m, Height at **B** = 40.0 m, Radius at **B** = 15.0 m
   c. Height at **A** = 70.0 m, Height at **B** = 40.0 m, Radius at **B** = 25.0 m
   d. Height at **A** = 80.0 m, Height at **B** = 65.0 m, Radius at **B** = 25.0 m

5. Which set of listed parameters would result in the greatest number of Gs at the bottom of a loop (location **C**)?
   a. Height at **A** = 50.0 m, Height at **B** = 30.0 m, Radius at **C** = 20.0 m
   b. Height at **A** = 60.0 m, Height at **B** = 45.0 m, Radius at **C** = 20.0 m
   c. Height at **A** = 60.0 m, Height at **B** = 35.0 m, Radius at **C** = 25.0 m
   d. Height at **A** = 80.0 m, Height at **B** = 60.0 m, Radius at **C** = 50.0 m

6. A designer has designed a loop that results in riders experiencing 1.5 Gs of force at the topmost location (**B**). The designer wishes to reduce this to 0.5 Gs of force. Which one of the following changes would be effective in lowering the number of Gs?
   a. Increase the height of the top of the loop.
   b. Decrease the radius of curvature of the top of the loop.
   c. Increase the radius of curvature of the bottom of the loop.
   d. Raise the first drop height without making any changes in the height and radius at location B.

7. Which variable will be most useful in predicting the speed of a rider at the top of a loop?
   a. The height of the first drop.
   b. The height of the top of the loop.
   c. The radius of the top of the loop.
   d. The change in height from the first drop to the top of the loop.

8. A designer has designed a loop in which riders reach a free-fall state at the topmost location (**B**). Which one of the following design changes would eliminate this hazard?
   a. Increase the height of the top of the loop.
   b. Decrease the radius of curvature of the top of the loop.
   c. Increase the radius of curvature of the bottom of the loop.
   d. Lower the first drop height without making any changes in the height and radius at location B.

9. Based on the provided data, which set of parameters would result in a rider having a completely weightless sensation at the top of a hill?
   a. Height at **A** = 50.0 m, height at **D** = 25.0 m, radius at **D** = 25.0 m
   b. Height at **A** = 50.0 m, height at **D** = 25.0 m, radius at **D** = 50.0 m
   c. Height at **A** = 70.0 m, height at **D** = 40.0 m, radius at **D** = 70.0 m
   d. Height at **A** = 80.0 m, height at **D** = 40.0 m, radius at **D** = 40.0 m

10. Which set of conditions is most likely to result in the largest amount of negative Gs at the top of a hill (**D**)?
    a. Low first drop height (**A**), Low height at **D**, Small radius of curvature at **D**.
    b. Low first drop height (**A**), High height at **D**, Large radius of curvature at **D**.
    c. High first drop height (**A**), Low height at **D**, Small radius of curvature at **D**.
    d. High first drop height (**A**), Low height at **D**, Large radius of curvature at **D**.

11. Which variable seems to be the only variable that affects the speed of a rider at the bottom of a roller coaster hill?
    a. The height of the first drop.
    b. The height at the top of the hill.
    c. The radius of curvature at the top of the hill.
    d. The radius of curvature at the bottom of the hill.

12. Based on the provided data for an 80-meter first drop, which set of parameters results in the greatest number of Gs at the bottom of a hill (**E**) without being *brutal* or *fatal*?
    a. height at **D** = 20.0 m, R = 40.0 m
    b. height at **D** = 30.0 m, R = 45.0 m
    c. height at **D** = 45.0 m, R = 50.0 m
    d. height at **D** = 50.0 m, R = 25.0 m

13. If the track at the bottom of a hill (**E**) is designed to be sharply turned, then riders are most likely to experience a _____.
    a. smaller acceleration, a greater number of Gs, and a less thrilling ride
    a. larger acceleration, a smaller number of Gs, and a more thrilling ride
    a. larger acceleration, a greater number of Gs, and a more thrilling ride
    a. larger acceleration, a greater number of Gs, and a less thrilling ride

14. Which one of the following variables affects the speed and acceleration of riders at locations **B**, **C**, **D**, and **E**?
    a. The height of the initial drop.
    b. The height of the top of the loop.
    c. The radius at the top of the loop.
    d. The total length of the track.
    e. None of these variables affects the speed and accelerations at all other locations.

15. Consider a 70.0-meter high first drop. Extrapolate from the provided data to estimate the # of Gs experienced at the bottom of a hill (**E**) if the radius of curvature at this location is 80.0 m.
    a. # of Gs = 1.9
    b. # of Gs = 2.8
    c. # of Gs = 3.3
    d. # of Gs = 7.6

16. Consider an 80.0-meter high first drop. Interpolate from the provided data to estimate the # of Gs experienced at the top of a 40.0-meter high hill (**D**) with a radius of curvature of 55.0 m.
    a. # of Gs = 0.2
    b. # of Gs = 0.0
    c. # of Gs = -0.2
    d. # of Gs = -0.4