SPFHS PHYSICS
PATERSON

SIX FLAGS GREAT ADVENTURE
ASSIGNMENT FOR
STUDENTS NOT AT THE PARK

Some of the rides featured in this packet may no longer be available at Six Flags Great Adventure.

We wish you were with us at the park today, however you still will not miss out on the physics fun! For each ride we have provided actual data from the park. Indicate the correct answer for each multiple choice question by darkening with a pencil the appropriate letter on the scantron. You must show all work for each multiple choice question on a separate paper that will be attached to the scantron. Answers to the open ended questions must be typed on a separate sheet of paper. (See the last page of this packet for specific instructions.) Be sure to put you name and period on each document.

THE CAROUSEL

Distance from outer ring of horses to center: 6 meters

Time for one revolution: 13 seconds

Mass of rider: 60 kilograms

1. What is the period of the merry go round in seconds?
   a) 0.077
   b) 0.77
   c) 1.3
   d) 13.0
   e) 0.217

2. What is the frequency of the merry go round in cycles per second?
   a) 0.077
   b) 0.77
   c) 1.3
   d) 13.0
   e) 0.217

3. What is your speed in meters per second if you are standing next to one of the horses in the outer ring?
   a) 2.90
   b) 1.45
   c) 0.45
   d) 1.45
   e) 0.15

4. What is the centripetal force in Newtons, acting on you if you are standing next to one of the horses in the outside ring?
   a) 840
   b) 29
   c) 84
   d) 14
   e) 0

5. What is the normal force in Newtons between the floor and you?
    a) 0
    b) 60
    c) 600
    d) 300
    e) 30

6. What must be the minimum coefficient of friction (μ) to prevent you from slipping off the ride?
    a) 1.00
    b) 0.00
    c) 1.40
    d) 0.14
    e) 0.28

You enjoyed the merry go round so much that you go on again. A 25 kg child is now standing next to another horse on the outer ring.

7. What is the centripetal force on the child in Newtons?
    a) 12.1
    b) 35.0
    c) 72.5
    d) 7.3
    e) 3.5

8. What is the normal force in Newtons between the child and the floor?
    a) 125
    b) 25
    c) 500
    d) 50
    e) 250

9. What is the minimum coefficient of friction that will keep the child from slipping off the ride?
    a) 0.42
    b) 0.28
    c) 0.07
    d) 0.14
    e) 0.56

OPEN ENDED QUESTIONS:

ACADEMIC: Compare and explain the answers to the values for μ for the child and you.

ACCELERATED: Prove mathematically that μ is independent of the mass of a rider at a fixed location from the center.

MOVIETOWN WATER EFFECT

Please refer to the sketch of the Movie Town Water Effect ride shown below in answers the following questions. Here is data for the ride:

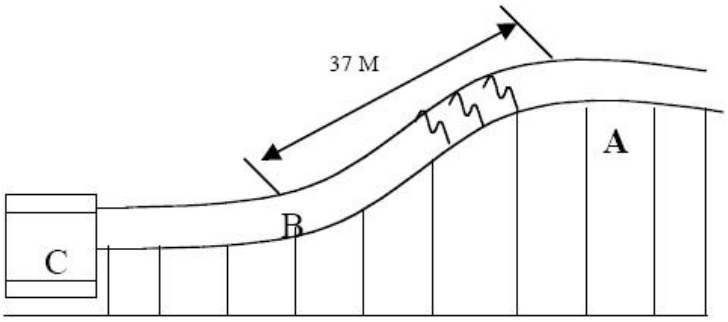
Length of each boat: 7.0 meters

Time for boat to pass point A (right before last drop): 1.9 sec

Time for boat to come down the slide (A to B): 2.8 seconds

Time for boat to pass point C: 3.5 seconds

Your Mass: 60 Kg



10. What is the velocity of the boat, in meters/second, at point A right before the last final drop?
    a) 7.0
    b) 9.8
    c) 10.0
    d) 3.7
    e) 7.4

11. What is the average velocity of the boat in meters per second as it goes down the slide?
    a) 37.0
    b) 10.0
    c) 13.2
    d) 10.6
    e) 26.4

12. What is the velocity of the boat at point B, if you assume constant acceleration? Remember the initial velocity of the boat is at point A
    a) 26.4
    b) 22.7
    c) 13.2
    d) 0
    e) 16.9

13. What is your momentum at point B in kg m/s?
    a) 0
    b) 600
    c) 1360
    d) 1200
    e) 790

14. What is your speed in m/s after the splash as the boat passes point C?
    a) 3.5
    b) 7.0
    c) 1.75
    d) 2.00
    e) 4.00

15. What is your momentum in kg m/s at point C?
    a) 60.0
    b) 600.0
    c) 120.0
    d) 60.0
    e) 180.0

16. What is your difference in momentum between points B and C in kg (meters/second)?
    a) 0
    b) cannot be calculated
    c) 620
    d) 1242
    e) 2480

17. If the time required to go between points B and C was 1.5 seconds (duration of the final splash), calculate the force in Newtons on your body that you experienced.
    a) 1000
    b) 828
    c) 636
    d) 352
    e) 212

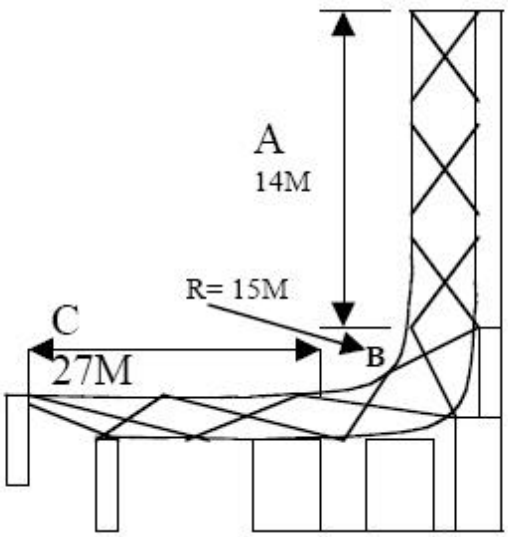
18. What was the force factor that your body experienced during the splash?
    a) 6.0
    b) 3.0
    c) 2.8
    d) 1.4
    e) 0.7

OPEN ENDED QUESTIONS:

ACADEMIC: Why is there water on the slide portion of the ride and not just at the bottom?

ACCELERATED: Calculate the time required to slide down the 37 meter section so as to produce a force factor of 4.0 on a 60 kg mass at point C

STUNTMAN'S FREE FALL



Length of vertical fall: 14 meters

Time to fall: 1.9 seconds

Height of drop platform from ground: 30 meters

Height of braking track from ground: 5 meters

Your mass: 60 kg

19. What is your actual acceleration in meters/sec^2 when falling?
    a) 9.8
    b) 3.9
    c) 14.7
    d) 7.8
    e) 10.0

20. What was your velocity in meters/second at the end of the free fall section?
    a) 9.8
    b) 14.7
    c) 4.9
    d) 7.3
    e) 28.0

21. What is the time it should take for the free fall drop of 14 meters if the track where frictionless?
    a) 1.69
    b) 1.19
    c) 1.42
    d) 2.86
    e) .84

22. The change in height from the drop to the start of the braking track is 25 meters. Calculate the speed in meters/second at the start of the braking track if all the potential energy is converted to kinetic energy.
    a) 11.0
    b) 2.0
    c) 34.3
    d) 22.3
    e) 9.8

23. Calculate your momentum in kg (meters/sec) as you enter the stopping track.
    a) 600
    b) 6600
    c) 2060
    d) 1340
    e) 2660

24. Your momentum after stopping is 0. The average time to stop the car is 1.25 seconds. Use the concepts of impulse and momentum to find the average braking force in Newtons on you while stopping.
    a) 1075
    b) 530
    c) 265
    d) 600
    e) 2120

25. What is the approximate force factor you experience during the braking process?
    a) 1.0
    b) 2.0
    c) 3.0
    d) 4.0
    e) 5.0

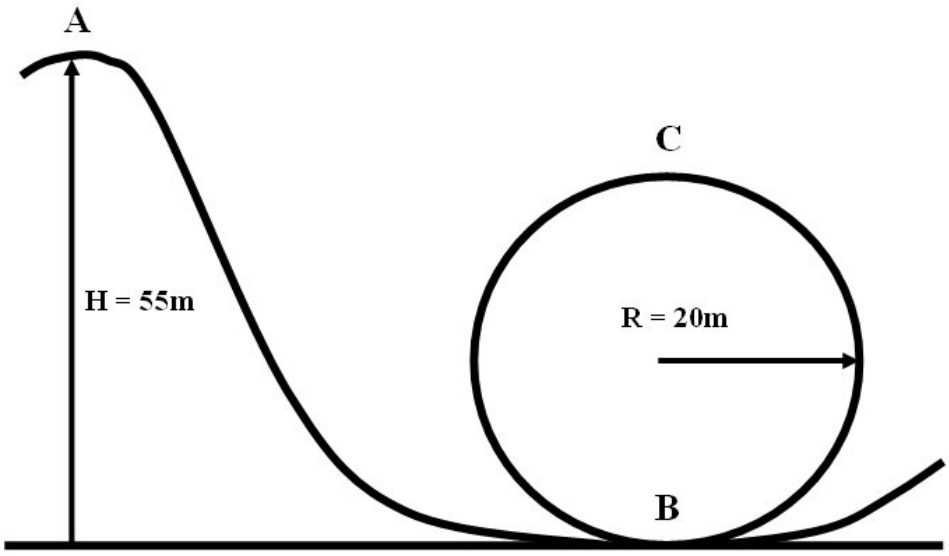
OPEN ENDED QUESTIONS:

ACADEMIC: An elevator takes you to the top of the ride (a height of 30 meters). In order to detemine the correct horsepower of the motor on the elevator what other information did the park engineers need in addition to the height the riders where being lifted?

ACCELERATED: If you were designing a new free fall ride where you wanted to reduce the wait time, what attributes of the existing ride would you change?

GENERAL ROLLER COASTER DESIGN

Refer to the drawing below of a proposed roller coaster design. Consider the 3 points - A, B, and C. The velocity of the roller coaster car at point A is 0 meters per second. Point A is 55 m above the ground, Point B is on the ground, and Point C is 40 meters above the ground. Assume the mass of the passenger is 60 kg.



26. What is the potential energy in joules of the passenger at point A?
    a) 13,200
    b) 33,000
    c) 60,000
    d) 30,000
    e) 0

27. What is the potential energy in joules of the car at point B?
    a) 11,000
    b) 27,500
    c) 50,000
    d) 25,000
    e) 0

28. What is the kinetic energy in joules of the car at point C?
    a) 9,000
    b) 13,800
    c) 30,000
    d) 20,000
    e) 0

29. What is the velocity of the car in meters per second at point B?
    a) 66
    b) 33
    c) 23
    d) 0
    e) 10

30. What is the velocity of the car in meters per second at point C?
    a) 17
    b) 34
    c) 66
    d) 12
    e) 15

31. What is the Centripetal Force (on you) in Newtons at point C?
    a) 900
    b) 750
    c) 675
    d) 432
    e) 340

32. What is the Centripetal Force (on you) in Newtons at point B?
    a) 27,500
    b) 8,250
    c) 4,375
    d) 3,270
    e) 2,750

33. What is the force exerted on the passenger's seat (F_{seat}) at point B?
    a) 9,250
    b) 7,250
    c) 5,500
    d) 3,875
    e) 0

34. What is the force exerted on the passenger's seat (F_{seat}) at point C?
    a) 300
    b) 500
    c) 750
    d) 1,000
    e) 0

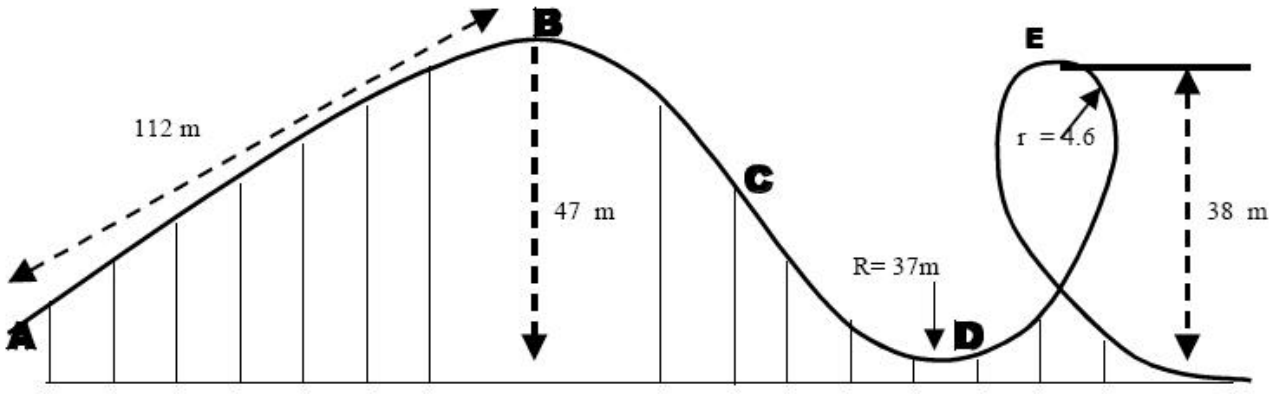
35. What is the force factor experienced by the passenger at point B?
    a) 2.5
    b) 3.5
    c) 4.5
    d) 5.5
    e) 6.5

OPEN ENDED QUESTIONS:

ACADEMIC: Should this roller coaster design be approved – why or why not?

ACCELERATED: In consideration of the force factor at point C, what would be the psychological effects (if any) on the passenger after exiting the ride?

THE GREAT AMERICAN SCREAM MACHINE



Time for cars to pass point E: 1.5 seconds

Length of Cars: 18 meters

Height of first hill: 47 meters

Height at Point E: 38 meters

Radius at Point E: 4.6 meters

Your mass: 60 kg

36. Where does the coaster ride have the maximum potential energy?
    a) A
    b) B
    c) C
    d) D
    e) E

37. Where does the roller coaster have the maximum kinetic energy?
    a) A
    b) B
    c) C
    d) D
    e) E

38. Where does the roller coaster have the maximum velocity?
    a) A
    b) B
    c) C
    d) D
    e) E

39. If the reference for zero potential energy is the ground, what is your potential energy in joules at point B?
    a) 28,200
    b) 22,200
    c) 56,400
    d) 0
    e) 22,800

40. Calculate your potential energy in joules at the top of the loop E.
    a) 14,400
    b) 28,200
    c) 22,800
    d) 0
    e) 22,200

41. What is your kinetic energy in joules at the top of the loop E?
    a) 0
    b) 22,800
    c) 14,400
    d) 5,400
    e) 10,800

42. What is your calculated speed in meters per second at the top of the loop E?
    a) 13.4
    b) 180.0
    c) 9.5
    d) 104.0
    e) 26.8

43. Calculate the actual speed in meters per second of the coaster at point E by using the time it took for the entire train of cars to pass point E at the top of the loop.
    a) 18
    b) 9
    c) 12
    d) 36
    e) 20

44. Calculate the actual value of the total energy at Point E using the velocity determined in question 42. Note that you have the same potential energy as in Problem 40.
    a) 22,800
    b) 4,320
    c) 8.640
    d) 27,120
    e) 17,120

45. At point D, the potential energy of the ride is 0. What is your speed at point D in meters per second?
    a) 21.7
    b) 10.8
    c) 30.7
    d) 23.7
    e) 61.4

46. What is the centripetal force in Newtons at point D?
    a) 1498
    b) 1967
    c) 2000
    d) 1528
    e) 1917

47. What is the seat force that you experience at point D?
    a) 900
    b) 2100
    c) 1200
    d) 600
    e) 0

48. What is the force factor at point D?
    a) 1.5
    b) 2.5
    c) 3.5
    d) 4.5
    e) 5.5

49. Using the velocity determined in Problem 42, calculate the centripetal force at point E in Newtons.
    a) 1880
    b) 1560
    c) 156
    d) 0
    e) 8640

50. What is the force exerted by the seat in Newtons at point E?
    a) 2480
    b) 1560
    c) 1880
    d) 1280
    e) 0

OPEN ENDED QUESTIONS:

ACADEMIC: Explain why the successive hills in a roller coaster become successively smaller and can never be higher than the first hill.

ACCELERATED: If the loop radius at point E was made larger but the height remained the same would the speed at E be any different. Explain in terms of energy considerations.

OPEN ENDED QUESTIONS:

Type your answers to these questions on a separate sheet of paper. Label each question with its appropriate ride. Students in Academic Level Physics are to complete the Open Ended Questions marked "Academic" only. Accelerated Level Physics students are to answer ALL Open Ended Questions .

The space below is for you to make notes or calculations for these questions but it should not be turned in and will not be graded. Only your typed answers will be graded.

THE CAROUSEL

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