

# Speedy Beetle



## Introduction

This ride is a mini roller coaster. You will experience sharp rises and falls, quick turns in a carriage that can spin. You move along a figure 8 circuit.

Along the track there are motors that give the train of four carriages the energy to go up to the top.

The ride involves a series of energy transformations. Electrical energy is transformed by the motor into kinetic and gravitational potential energy. There is also a banked curve to investigate.

## Drawings

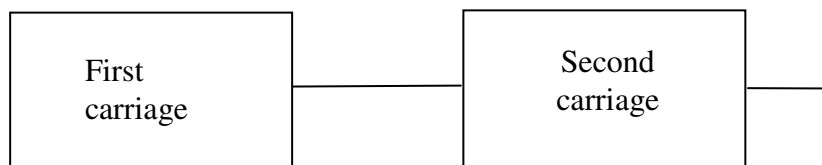
- 1) Draw the shape of the track and label the points on the track where you would experience:
  - The maximum speed (S)
  - The greatest acceleration (A)
  - The largest gravitational potential energy (G)
  - The most kinetic energy (K)



- 2) Draw a diagram of you sitting in a carriage as you go along the banked curve through the hoops. Draw in and label all the forces acting on you at this point.



- 3) On the drawing of the first two carriages, draw in the forces acting on the first carriage as the ride starts off.



**Supplied Data:**

Mass of a carriage: 620 kg

Length of train: 9.36 m

Length of track: 60 m

Radius of banked curve: 4.10 m

Angle of banked curve:  $14.4^\circ$

Height difference between highest and lowest points on the track: 2.83 m

**Measurements (equipment needed: stop watch):**

Time for one complete lap of the track: \_\_\_\_\_ s (A)

Time for train to pass through the opening at the top: \_\_\_\_\_ s (B)

Time for the train to pass a post near the start: \_\_\_\_\_ s (C)

**Calculations (include units)**

**Average speed**

1) Using your measurement of the time A above, calculate your average speed.

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**Energy conversion**

2) a) Use the measurement of the time B above, to calculate your speed at the top, your slowest speed,

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b) Use the measurement of the time C above, to calculate your speed at the bottom, your fastest speed.

\_\_\_\_\_

c) Use these two values of speed, calculate the gain in your kinetic energy from top to bottom

\_\_\_\_\_

d) Use the height difference to calculate the loss in your gravitational potential energy in moving from top to bottom.

\_\_\_\_\_

e) How does the loss in GPE compare with the gain in KE? Suggest reasons for any difference

\_\_\_\_\_

\_\_\_\_\_

**Momentum**

3) a) Count the maximum possible number of passengers and the number of carriages and estimate the mass of a full train and calculate the momentum of a full train as it completes a lap.

\_\_\_\_\_

\_\_\_\_\_

b) When the ride stops what happens to this momentum?

\_\_\_\_\_

**Centripetal Acceleration**

Half way down the sloping banked curve your speed should be about half way between your answers to 2a and 2b above

4) a) Use this value to calculate your centripetal acceleration.

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b) Draw and label vectors to represent the two forces acting on you: i) force by the earth and ii) force by the seat.

c) Draw a dotted arrow to show the direction of the acceleration.

d) You enter the banked curve slowly, but speed up as you go down. Do you experience any difference in your sideways movement in your seat? If so, what? and can you explain it?

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