Year 13 Physics: Roller Coaster

The radius of the loop is 11.2m and the mass of each car is 750kg. There are also 2 passengers with a combined mass of 160kg.

1. Calculate the support force supplied by the track if the car is moving at 85km per hour at the bottom of the loop.
2. Assume there is no energy loss due to friction. Use conservation of energy to show that the speed at the top of the loop is 11ms-1
3. Calculate the centripetal force at the top of the loop.
4. Calculate the support force at the top of the loop.
5. Calculate the slowest possible speed the car could have at the top of the loop.
6. Explain why passengers would feel completely “weightless” in the situation described in question 5.
7. Explain **in terms of circular motion** why the car would not make it around the loop at speeds less than that calculated in 5.

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Year 13 Physics: Gravity

The seasons are a result of two things: the fact that the earth is tilted by 23° on its rotational axis, combined with its orbit around the sun. This orbit is elliptical, but nearly circular. Let’s assume for now it is completely circular.

1. On the above diagram, draw 2 arrows to show the velocity of the earth and the force acting on the earth.
2. This force comes from **the gravitational attraction of the sun.** Newton’s law of gravitation states that **any** two objects of masses m1 and m2 will feel an attractive force toward each other given by:

F = $\frac{Gm\_{1}m\_{2} }{r^{2}}$

Where m1 and m2 are the masses, r is the distance between them and G is the Gravitational constant, **G = 6.67384 × 10-11 m3 kg-1 s-2.**

1. Light takes 8 minutes to reach the earth from the sun. The speed of light is 3 × 108 ms-1. What is the distance between the earth and the sun?
2. The mass of the earth is 5.972 × 1024  kg
The mass of the sun is 1.989 × 1030 kg
What is the gravitational force of the sun on the earth?
3. This force is what provides the centripetal force so the earth can orbit in a circle. Can you verify this? (Hint: how could you work out the earth’s velocity?). Are the values close? Why are they not exact?
4. Calculate the force of attraction between a 7g pen and a 2g paperclip separated by 3cm.
5. Calculate the force of attraction between the earth and a human on the earth’s surface, using 6371km for the radium of the earth and 80kg for the human’s mass.
6. Use Newton’s second law to show that for a human, and in fact any object, the acceleration that object experiences due to gravity is 9.8ms-1.

**Gravity homework:** what would happen if one day on earth was only 80 minutes? (Hint: what would be the centripetal acceleration of a person standing on the earth’s surface at the equator?) Write a short report on your findings. Look up any required values.