Virtual Learning

Physics

Newton's Law of Gravitation

May 8, 2020

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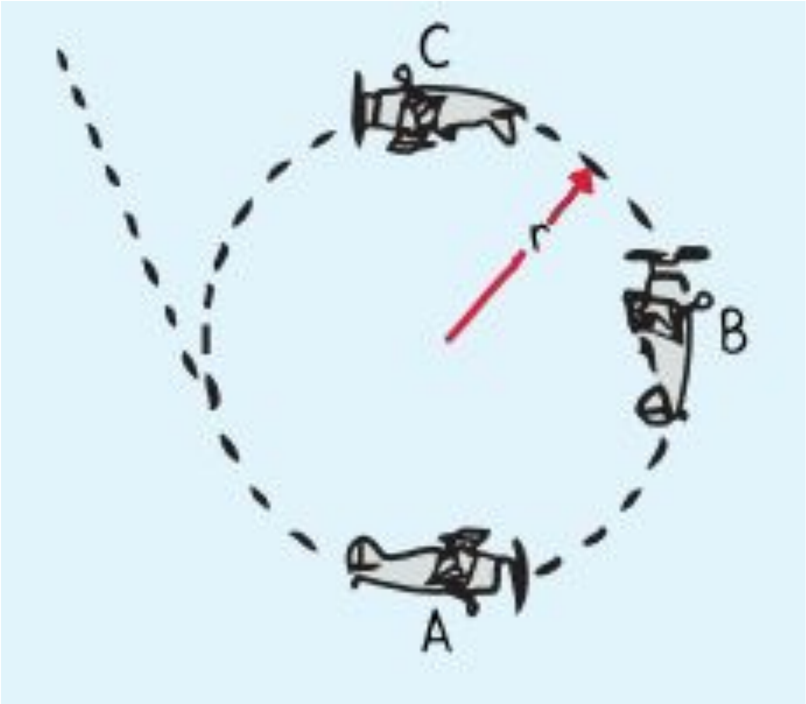
Newton;'s Law of Gravitation: May 8,2020

Objective/Learning Target:
Students will examine the concept of Gravity and use Newton's Law of Gravitation to solve some basic problems.

Quick Review #1

Paula flies a loop-the-loop maneuver at constant speed. Two forces act on Paula, the force due to gravity and the normal force of the seat pressing on her (which provides the sensation of weight). Rank from largest to smallest the normal forces on Paula at points A, B, and C.

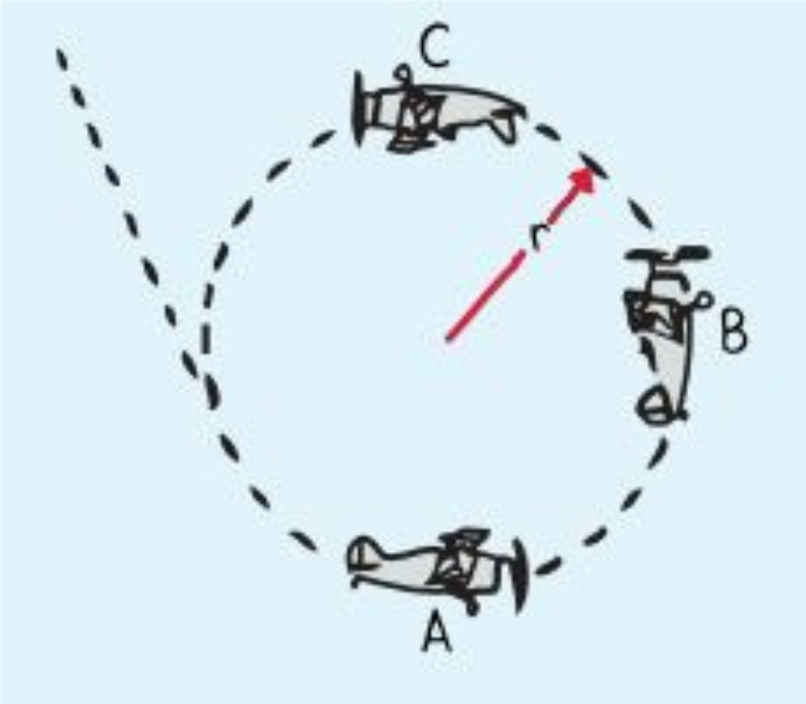


Quick Review #1Answer

The Normal force would be equal to how hard she pushes into the chair. So..

From greatest to least:

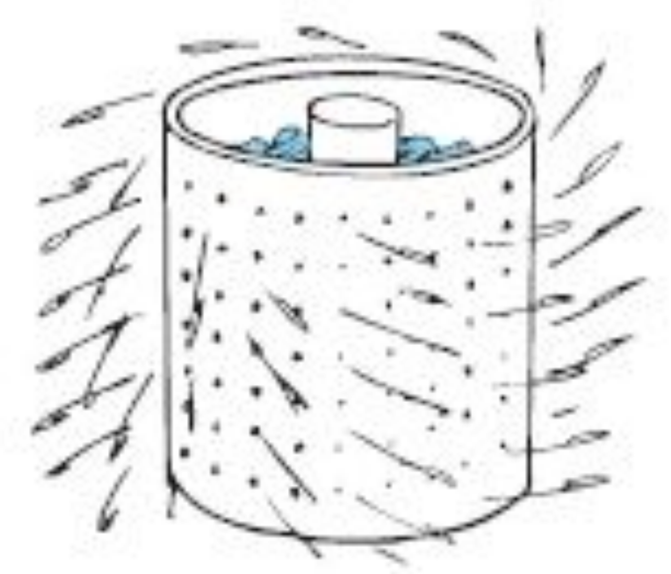
A, B, C



Quick Review #2

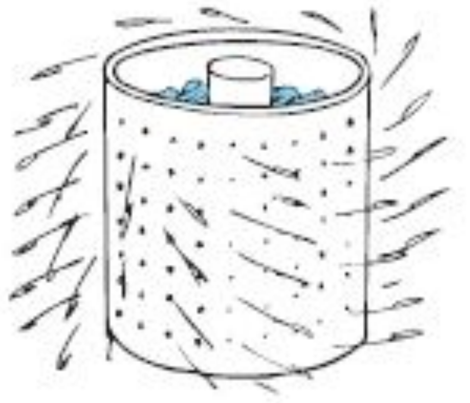
A familiar household example of centripetal force is the spinning tub in an automatic washing machine.

Describe in “physics terms” how this device works.



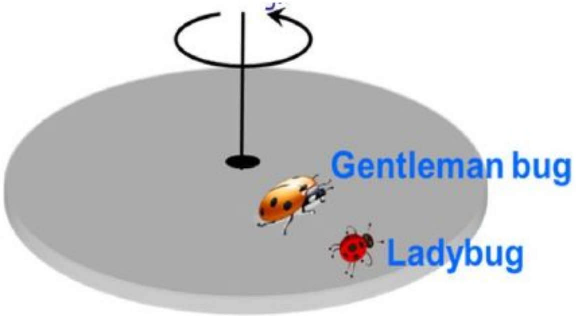
Quick Review #2

In its spin cycle, the tub rotates at high speed and produces a centripetal force on the clothes, which are forced into a circular path by the inner wall of the tub. The tub exerts a large force on the clothes, but the holes in the tub prevent the exertion of the same force on the water in the clothes. The water escapes tangentially out the holes.



Strictly speaking, the clothes are forced away from the water; the water is not forced away from the clothes. Think about that.

Newton’s Universal Law of Gravitation



Link: [Newton's Universal Law of Gravitation]

Directions:

- Read through Newton’s Universal Law of Gravitation..
- Work through any examples on a separate piece of paper before you scroll down to the solution.
- On a separate piece of paper complete the practice problems on the following slides.
- Check your answers.
- For additional practice check out the conceptual questions and the problems and exercises in the table of contents for the online text linked above.

Practice Problem #1

a. If you stood atop a ladder that was so tall that you doubled your distance from Earth’s center, how would your weight compare with its present value?

b. Suppose you stood atop a ladder that was so tall that you were three Earth radii from Earth’s center, how would your weight compare with its present value?

Practice Problem #1 Answer

a. $F = G \dfrac{mM}{r^2}$

So…

$F = G \dfrac{mM}{(2r)^2}$ F would be ¼ as much

b. $F = G \dfrac{mM}{(3r)^2}$ F would be 1/9 as much

Practice Problem #2

Calculate the force of gravity a newborn baby (mass 3.0 kg) and the planet Mars (mass 6.4 x 10^{23} kg) exert on each other when Mars is at its closest to Earth (distance 5.6 x 10^{10} m).

Practice Problem #2 Answer

$$F = G\frac{mM}{r^2}$$

$$= (6.67 \times 10^{-11} Nm^2/kg^2) \times \frac{4kg \times 6.4 \times 10^{23}kg}{(5.6 \times 10^{10}\ m)^2}$$

$$= 5.44 \times 10^{-8}\ N$$

Practice Problem #3

Calculate the force of gravity a newborn baby of mass 3.0 kg and the obstetrician of mass 100.0 kg exert on each other when the distance between them is 0.5 m.

Practice Problem #3

$$F = G\frac{mM}{r^2}$$

$$= (6.67 \times 10^{-11} Nm^2/kg^2) \times \frac{4kg \times 100kg}{(0.5m)^2}$$

$$=1.06 \times 10^{-7} N$$

Practice Problem #4

Which exerts more gravitational force on the baby: Mars or the obstetrician? By how much?

VS.

Practice Problem #4

There is more gravitational force between the obstetrician and the baby than between the baby and Mars.

$$1.06 \times 10^{-7}\ \text{N} \div 5.44 \times 10^{-8}\ \text{N} = 1.95$$

About twice

Additional Practice

For additional practice check out the conceptual questions and the problems and exercises in the table of contents from the online text linked above.