PHY 211 Lecture 11

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Job opportunity

- If you are looking for a job, the experimental high energy physics group is looking for undergraduates to help with testing fabricated detector pieces
- It's not glamorous work, but it is paid
- Would schedule about 10 hours per week
- Let me know if you would like to know more

Plan for today

- Focus on breaking down force problems, primarily involving circular motion
- Remember that circular motion is just a special case of our general force problems where we know the magnitude and direction of the acceleration
- Add gravitation as another way to find the acceleration
- Should have time for some HW/recitation review

Pre-lecture 1

■ If a roller coaster is going around the inside of a loop, at which point is the normal force greatest?

A At the top

B At the side

C At the bottom

D All of these have the same normal force

Pre-lecture 2

When a ball on a string is spinning around a vertical pole, the string angles down towards the ground instead of being perfectly horizontal. Which way does the acceleration of the ball point?

- **A** Along the string
- **B** Horizontal towards the pole
- **C** Towards the ground
- **D** Horizontal away from the pole

Plumb bob

A plumb bob is hanging inside a train car. This train is travelling at a constant speed of 90 km/h around a curve in the track with a radius of 300 m. At what angle with respect to the vertical will the plumb bob hang?
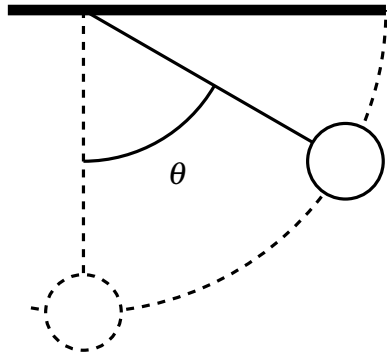
Assume that the length of the chain holding the tray is 1 m. If I hold the tray at $45°$ and spin around once per second, what is the minimum coefficient of static friction needed to keep the glass on the tray?

Question

Which way should I draw friction?

- **A** Along the tray, into the turn
- **B** Along the tray, out of the turn
- **C** Some other direction

Gravitation

- All mass in the universe exerts a pull on all other masses in the universe
- It gets weaker the smaller the masses and the farther apart they are.

Magnitude of gravitational force

$$F_g = \frac{GMm}{r^2}$$

- Both masses are pulled by this force (Newton's third law!)
- $G = 6.673 \times 10^{-11}\,\mathrm{N\,m^2/kg^2}$ is a fundamental constant of nature (not derived)

How massive is the Earth?

- The Earth's radius is 6371 km. We measured how much we accelerate in free-fall (g). How massive is the Earth?

Question

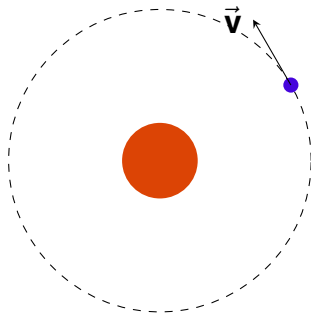Does it matter that the Earth is spinning?

A Yes

B No

How much do you accelerate the Earth?

Orbits

- Many orbits are very close to circular
- In this case, gravitation is the force that causes the centripetal acceleration

How massive is the Sun?

- The Earth is 147.88×10^6 km from the sun, and travels in an almost circular orbit. How massive is the sun?

Homework review