Homework 5

Due Wednesday, 6 March

1. A heavy ball with mass 10 kg is hung from the ceiling of Stolkin Auditorium on a rope of length 4.5 m. It is pulled to one side and released, swinging like a pendulum; at its lowest point, it reaches a speed of 6 m/s. What is the tension in the rope at that point?

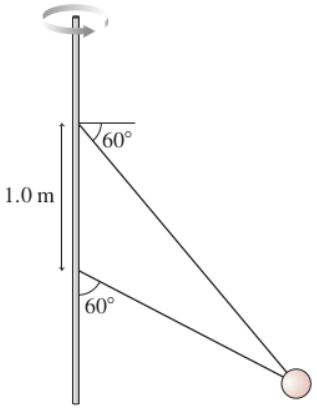
2. Astrologers claim that the positions of the planets can influence events on Earth. In this problem, you'll calculate whether this is plausible or not.

   (a) Which planet's gravity do you think would have the greatest effect on Earth? Venus' orbit is closest, but Jupiter is largest.

   (b) Look up astronomical parameters for Earth and your chosen planet. What is the closest they ever are to each other? You may approximate their orbits as circles, and can find all the information you need on Wikipedia. Show how you estimate their distance of closest approach.

   (c) What acceleration does your chosen planet impart to objects on Earth? Is this acceleration relevant to anything?

3. Two wires are tied to the sphere of mass 3 kg shown here. The sphere revolves around the pole in a horizontal circle at constant speed. *(Hint: Usually high school geometry isn't that helpful, but here it is. You will need to be a bit clever to find the radius of the circle that the ball travels in. As a first step, try finding the interior angles of the triangle formed by the two wires and the pole.)*



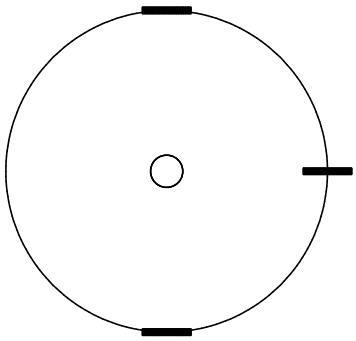
   (a) For what speed is the tension the same in both wires?

   (b) What is that tension?

4. A ball is attached to the end of a string hanging from the roof of a subway car. The train goes around a curve, turning to the left. You know that the car is traveling at 60 km/hr.

   - Which way will the ball appear to swing? Why?
   - If the ball swings at an angle of 15°, what is the radius of curvature of the curve in the tracks?

5. A carnival ride consists of a vertical wheel of radius r rotating at angular velocity ω around a horizontal axis. There is a horizontal platform attached to it; a person stands on the platform. (This platform stays horizontal, and does not rotate; the person remains upright during the whole ride.) This person has mass m, and stands on a scale. The coefficient of static friction between their feet and the scale is $\mu_s = 0.5$.



   (a) Draw force diagrams for the person at the top of the circle, the bottom of the circle, and the position at the same height as the middle of the circle. (You will need to think carefully about the third one of these.)

   (b) How does the scale reading relate to the forces that act on the person standing on the platform?

   (c) In terms of m, g, r, μ_s, and ω, what is the scale reading at the top? (Your answer may not depend on all of these.)

   (d) In terms of m, g, r, μ_s, and ω, what is the scale reading at the bottom? (Your answer may not depend on all of these.)

   (e) Suppose that the angular frequency ω is increased gradually until the person falls off of the platform. Where will they fall off? Find the maximum angular frequency ω before this happens in terms of m, g, r, μ_s, and ω. (Hint: Your answer here *does* depend on all of these.)

6. The film *Apollo 13* tells the story of three astronauts trying to survive aboard a crippled spacecraft in space between the Earth and the Moon. It involves scenes where the actors appear to be "weightless", mimicking the experience of the astronauts. Since going to space was prohibitively expensive, the producers shot those scenes in a set inside an aircraft. The aircraft flew in parabolas with an acceleration of precisely g downward; during this time, the astronauts appeared to float inside the set, as the aircraft climbed and then dove toward the ground.

   (a) The astronauts were able to experience "weightlessness" for about 25 seconds at a time. How far did the aircraft have to climb and then dive in order to do this?

   (b) Consider three forms of "weightlessness":

      - The experience of the actors and crew of the film *Apollo 13* in this aircraft

- The experience of astronauts in the Space Station, in orbit around Earth at a low altitude
- The experience of the astronauts in a real deep space mission like *Apollo 13*, in which the astronauts flew 400,000 km from Earth (which has a radius of around 6000 km).

What are the similarities between the dynamics of "weightlessness" in these situations? What are the differences?

7. We discussed "cherry-picking" in class as an example of misleading science. This is the practice of considering only a carefully-chosen subset of data or doing only a limited set of experiments in considering whether a scientific explanation or model agrees with observations (usually choosing observations that support the model), rather than including *all* available data and conducting experiments that are designed to possibly refute the proposal.

   Think of an example in the modern era (since 1875, more or less) where "cherry-picked" data have resulted in incorrect scientific claims. (It doesn't matter whether these claims were made by scientists themselves, or by other people like politiicans or businessfolk, etc.)

   In a brief discussion of around 250 words, describe the situation, answering questions like:

   - What happened? What incorrect claims were made, and how were they supported by incomplete data?
   - Were the people making these claims acting maliciously (intentionally using cherry-picked data to make claims they knew were untrue), or was their use of limited data a result of an honest mistake?
   - If you were reading their claims at the time, could you have recognized them as misleading?