

Homework B

Instructions: Write up your answers neatly showing all of your work and explaining the process. I encourage you to work together but you must write up your solutions independently.

1. Sarah's one-speed cruiser bike has a gear with 44 teeth in front (attached to the pedal) and a gear with 28 teeth in back (attached to the rear wheel). The back wheel is 26.3" in diameter (including the tire). How far will Sarah travel every full turn of the pedals?
2. Jacob is launching his own personal communications satellite built out of old Ford truck parts. He wants it to always be directly overhead and has discovered on Wikipedia that a geosynchronous orbit (from the Greek *geo* "earth" + *syn* "together" + *khronos* "time") is an orbit at just the right altitude that the speed of the satellite exactly matches the rotation of the Earth. Perfect! Only now he needs to figure out how high to launch his satellite. He finds Kepler's 3rd Law using Google:

$$P^2 \propto R^3$$

Where P is the period of an orbit and R is the radius of the orbit. He also finds on Wikipedia that the Moon orbits at a radius of 384,399 km. Amber also reminds Jacob that the period of the moon's orbit is 27.3 days and that the Earth rotates once every 24 hours. What is the orbital radius Jacob needs for his satellite?

3. One of Benny's specialty cats has escaped from his pet store and is wandering perilously close to the race track, where unfortunately, Morgan is driving at a very high speed! Morgan's angular velocity is 1.3 radians per minute on the 5-mile circular track. The cat pulls out the slide rule that Benny gave her in case of emergencies just like this, and computes Morgan's exact speed. How fast was Morgan driving?
4. Dr. Culbertson blew up his lab due to an error he made in a computation for creating his secret potions. Brittany diplomatically points out the he should have put the potion in a centrifuge to concentrate the secret ingredients rather than trying to boil off water from the volatile solution! She explains that an acceleration equivalent to twice that produced by the earth's gravity should be perfect. Dr. Culbertson knows of course that the acceleration due to earth's gravity is 9.8 m/s^2 and that the acceleration for an object rotating at a velocity v and radius r is

$$a = \frac{v^2}{r}.$$

To what angular speed (in revolutions per minute) should Dr. Culbertson set his centrifuge if it's radius of revolution is 10 cm?

5. Kellen decided to come up with a formula for Dr. Culbertson that would allow him to compute the number of g 's (multiples of earth's gravitational force) that would result from a centrifuge of radius r cm set to spin at N revolutions per minute (rpm). What formula should Kellen get?