

Circular Motion and Universal Gravitation - Expectations

1. Students should understand the different velocities, accelerations, and forces involved in circular motion and be able to represent them with vectors and be able to solve problems using these quantities.
2. Students should understand the difference between angular and tangential speed. They should be able to use these ideas in solving problems.
3. Students should be able to identify the source of the centripetal force in any circular motion situation.
4. Students should understand how and why things stay in orbit (e.g. what is necessary for them to remain in a stable orbit, also, what happens if one of those variables changes)
5. Students should understand the form and reasoning behind the inverse square law.
6. Students should understand the relationship which defines Universal Gravitational Attraction. They should be able to use this relationship
7. Students should understand the effect of acceleration on your apparent weight. They should be able to come up with a few situations where this idea applies, and calculate apparent weight.
8. Students should have a basic understanding of how the tides are created,
9. HONORS: students should be able to combine the concepts learned in circular and gravitational motion with all the other concepts we have covered this year to solve complex multi-step problems. (these problems may or may not include actual numbers... ie. Practice your _____ skills)

Practice problems:

1. Draw a diagram showing all forces, accelerations, and velocities of a horizontally rotating object.
2. Imagine the “round up” ride where you are spun around and then tilted so the circle becomes completely vertical.
 - a. What provides the force necessary for you to stay in place?
 - b. What is the minimum centripetal acceleration necessary for you to stay in your seat?
 - c. If the ride has a radius of 7m, what is the minimum speed necessary so no one dies?
 - d. If you are going with the minimum speed necessary for you to not fall out of your seat, how much will your apparent weight be at the top of the ride? How much at the bottom?
3. A .3kg piece of clay is spun around in a horizontal circle on a string with length 70cm. You count that it makes 10 revolutions in 6.6 seconds.
 - a. What is the period of the clay?
 - b. What is the tangential speed of the clay?
 - c. What is the acceleration of the clay? In what direction?
 - d. If the clay can withstand a force of 56N before the string cuts through it, how fast (tangential velocity) can it be spun without flying off?
 - e. A bug holding onto the string half way between the hand and the clay will feel how many g's?
4. A hummer and a tank are parked 50 m apart in the parking lot. The tank has a mass of 50,000 kg. The force of gravitational attraction between the two automobiles is .0667. Find the mass of the hummer.
5. Suppose a lemon at the top of a tree is pulled by earth's gravity with a force of 1 N. if the tree was twice as tall, would the force of gravity on the lemon be only $\frac{1}{4}$ as strong? Explain your answer.
6. Describe as many particular situations as you can think of when you could feel weightless. For each situation, say why you feel weightless.
7. What would happen to the orbit of the earth if the sun collapsed into a black hole?
8. Which has a stronger pull on the earth, the sun or the moon? Why?
9. Which has a greater effect on the tides, the sun or the moon? Why?
10. Which is a better way of defining weight: the force of gravity acting on you, or the normal force acting on you? Why?
11. The planet Zenok has 3 times the mass of earth, but only half the radius.
 - a. What is the acceleration due to gravity on Zenok?
 - b. How much would a .5kg apple weigh on Zenok?
 - c. What is the ratio of its weight on Zenok to its weight on Earth?
12. Honors: A spaceship is orbiting mars (radius r) at a distance from the surface equal to r . If the planet has mass m , how fast does the ship need to be moving in order to stay in a stable circular orbit?