Name & Number (if applicable): _____

1: _____/16 + _____ late

2: _____/12 + _____ late

Incorrect/incomplete: –_____

Scaled score: _____/20

Unit 6 Learning Goals – Circular Kinematics & Dynamics

Goal Set 1:

Students will be able to qualitatively and quantitatively analyze circular motion.

4.0	I can analyze complex scenarios and problems involving mechanical energy.
3.0	**I can qualitatively and quantitatively analyze circular motion.**
2.0	I can recognize, recall, and explain specific vocabulary and concepts including: • Circular motion, rotational motion, frequency, period, circumference, arc length, tangential velocity, centripetal acceleration, centripetal force, inertia I am able to… • Distinguish between circular motion and rotational motion by comparing and contrasting them. • Distinguish between frequency and period by comparing and contrasting them. • Describe circular motion in terms of frequency, period, circumference, arc length, tangential velocity, centripetal acceleration, centripetal force, and inertia. • Calculate the frequency, period, distance traveled, tangential velocity, centripetal acceleration, and centripetal force of an object traveling in a circle.
1.0	With help, partial success at 2.0 content

Check yourself:

Level 2.0

1.) _____ motion involves objects spinning around an internal axis, while _____ motion involves objects moving in a circular path around an external axis.

2.) For each of the following, identify whether the motion is circular or rotational:

a. A person going around a loop on the Corkscrew at Cedar Point C R

b. A person driving a car around a curve while getting on the highway C R

c. A figure skater spinning in place C R

3.) _____ is a measure of how long it takes for something to complete one cycle of motion. Its units are _____. _____ is a measure of how many cycles occur in a period of time. Its units are _____.

4.) Calculate the period and frequency for each of the following:
   a. An electromagnetic wave moves up and down 4.00×10^{14} times a second.[1]

      T = _____ f = _____

   b. A disk spins 250 times a second.

      T = _____ f = _____

   c. A gear turns once every 2×10^{-2} seconds.

      T = _____ f = _____

Level 3.0

A 920 kg car drives on a circular path around a track with a radius of 42 meters. The car takes 15 seconds each time it travels around the track.

1.) What are the frequency and period of the car's motion?

   T = _____ f = _____

2.) What is the car's tangential velocity?

3.) What is the car's centripetal acceleration?

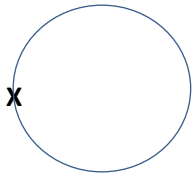
[1] This is red light. The number given (4.00×10^{14} is 400 THz (terahertz.) Think about how fast that wave is moving up and down!!! And when that light hits your eye, your eye interprets that frequency as "red." Amazing stuff if you really think about it)

4.) How much centripetal force is required to keep the car from sliding off the track?

5.) What provides the centripetal force to keep the car from sliding off the track?

6.) If the car sped up, what would happen to the amount of force required to keep the car from sliding off the track?

7.) If the car were to slide off the track, which way would it go? Draw it on the diagram below where the X represents the place where the car left the track. Assume the car was moving clockwise.



8.) If the car were to slide off the track, why would it do so?

Let's look at altering variables while others stay constant and see their effects.

9.) Let's keep radius constant and increase rate of rotation. As rate of rotation increases, what happens to…

   a. Period?
      Increases Decreases Is unaffected

   b. Circumference?
      Increases Decreases Is unaffected

   c. Tangential velocity?
      Increases Decreases Is unaffected

   d. Centripetal acceleration?
      Increases Decreases Is unaffected

   e. Centripetal force required to keep the object traveling in a circle?
      Increases Decreases Is unaffected

10.) Let's keep rate of rotation constant and change the radius by moving the object further from the axis of rotation. What happens to…

   a. Period?
      Increases Decreases Is unaffected

   b. Circumference?
      Increases Decreases Is unaffected

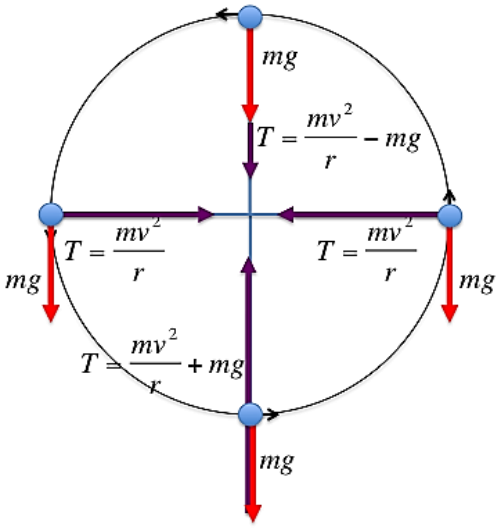
   c. Tangential velocity?
      Increases Decreases Is unaffected

   d. Centripetal acceleration?
      Increases Decreases Is unaffected

   e. Centripetal force required to keep the object traveling in a circle?
      Increases Decreases Is unaffected

Level 4.0

When an object moves in a vertical circle by being swung on a string, tension force in the string is combined with gravity to create the centripetal force. This relationship between centripetal force (Fc), tension (T), and weight (mg) varies depending on where the object is along the circular path. Analyze the diagram of an object being spun vertically on a string. Rank the tension in the string from greatest to least for the following positions: Top, Side, Bottom and justify your ranking semi-quantitatively (with variables.)



Goal Set 2:

Students will be able to analyze the gravitational forces between two masses and apply this in conjunction with principles of circular motion in order to analyze planetary orbits.

4.0	I can analyze complex situations involving gravitation, circular motion, and/or planetary orbits.
3.0	**I can analyze the gravitational forces between two masses and apply this in conjunction with principles of circular motion in order to analyze planetary orbits.**
2.0	I can recognize, recall, and explain specific vocabulary and concepts including: • Mass, circular motion, tangential velocity, centripetal acceleration, centripetal force, inertia, projectiles, center of mass, gravity, Newton's law of universal gravitation I am able to… • Analyze circular motion qualitatively and quantitatively. • Analyze physical situations in terms of the inertia of objects. • Analyze projectile motion qualitatively. • Analyze the center of mass of an object or system qualitatively. • Calculate the gravitational force between to masses given the mass of each object and the distance between their centers of mass.
1.0	With help, partial success at 2.0 content

Check yourself:

Level 2.0

1.) Define the concept of center of mass as applied to an object.

2.) Define the concept of center of mass as applied to a system.

3.) If this is a binary star system, draw a dot at the point that you think the stars revolve around.

4.) Justify your choice of that location as the point around which the stars revolve.

5.) If the right-hand star from question 3 were really a tiny planet, how would your answer to question 3 change?

6.) What factors affect the gravitational force between two objects?

7.) When measuring radius for the gravitational force equation, where do you measure from?
   a. Distance between the surfaces of each object
   b. Distance between the center of mass of each object
   c. Distance between the center of mass of each object and the center of mass of the system

8.) The gravitational force equation is described as being an inverse-square relationship between force and radius. Describe what you think this means.

9.) Sun's mass is 1.989×10^{30} kg, and the mass of Mercury is 3.285×10^{23} kg. The average distance between them is 5.79×10^{7} km. What is the gravitational force between them?

Level 3.0

1.) Predict whether you think the gravitational force of the sun on Earth is greater or less than the gravitational force between the sun and Mercury. Justify your prediction based on the variables of mass and radius.

2.) Explain how gravitational force and centripetal force relate in planetary orbits.

3.) On the following drawing showing a planet approaching a star traveling from right-to-left…
   a. With a dashed line draw the trajectory of a planet that approaches a solar system with a tangential velocity that is too fast to allow the planet to orbit.
   b. With a dotted line draw the trajectory of a planet that approaches a solar system with a tangential velocity that is too slow to allow the planet to orbit.
   c. With a solid line draw the trajectory of a planet that approaches a solar system with a tangential velocity that allows the planet to orbit.

Level 4.0

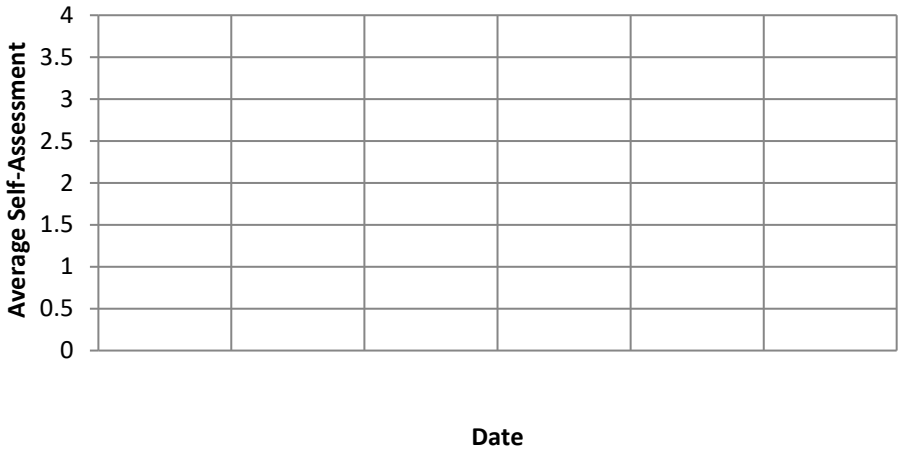
1.) Look back at level 3.0 question 2. Start with the formula for gravitation and set it equal to the formula for centripetal force. Then use substitution to derive the formula for the tangential velocity required for an object to orbit a planet at a given radius.

2.) Does the mass of the planet have any effect on the required orbital velocity? Justify your answer.

3.) Based on this, calculate the average orbital velocity of Earth. The mass of the sun is 1.989E30kg, the mass of Earth is 5.97E24kg, and the average orbital distance is 1.49E11m (which is 93,000,000 miles.)

Chart your Progress

Goal Set 1



Goal Set 2