Harmonic motion worksheet

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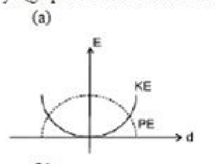
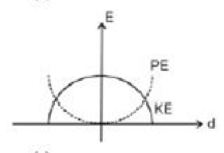
Q2. For a simple pendulum, a graph is plotted between its kinetic energy (KE) and potential energy (PE) against its displacement d. Which one of the following represents these correctly? (graphs are schematic and not drawn to scale)

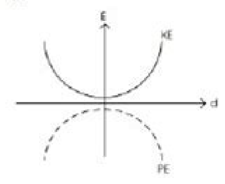
(a)



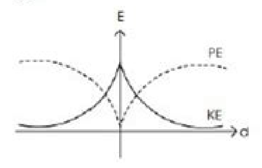
(b)



(c)



(d)



(IIT JEE Main 2015)

Sol.

Correct Option: (a)

Assume minimum potential energy at mean position to be zero.

Let A be the mean position and d be the displacement around the mean position.

$KE = \frac{1}{2}m\omega^2\left(A^2 - d^2\right)$

$PE = \frac{1}{2}m\omega^2 d^2$

Both the graphs are parabola.

At mean position ($d = 0$)

PE = 0, KE is max.

At extreme positions ($d = \pm A$)

KE = 0 and $PE = \frac{1}{2}m\omega^2 A^2$ = maximum

Simple Harmonic Motion

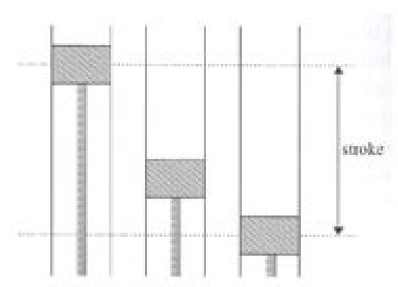
1. A ball goes back and forth along a horizontal floor bouncing off two vertical walls. Is the motion an example of an oscillation? If yes, is the oscillation simple harmonic?

2. The displacement of a particle executing SHM is given by $y = 5.0\cos(2t)$, where y is in millimeters and t is in seconds. Calculate:
   (a) The initial displacement of the particle
   (b) The displacement at t=1.2s
   (c) The time at which the displacement first becomes -2.0 mm
   (d) The displacement when the velocity of the particle is 6.0 mm s^{-1}

3. Write down an equation for the displacement of a particle undergoing SHM with an amplitude equal to 8.0 cm and frequency of 14 Hz, assuming that at t=0 the displacement is 8.0 cm and the particle is at rest.

4. A point on a guitar string oscillates in SHM with an amplitude of 5.0 mm and a frequency of 460 Hz. Determine the maximum velocity and acceleration of this point.

5. The piston (of mass 0.25 kg) of a car engine has a stroke (i.e. distance between extreme positions) of 9.0 cm and operates at 4500 rev min^{-1}, as shown.



   (a) Calculate the acceleration of the piston at maximum displacement.
   (b) Calculate the velocity as the piston moves past is equilibrium point.
   (c) What is the net force exerted on the piston at maximum displacement?

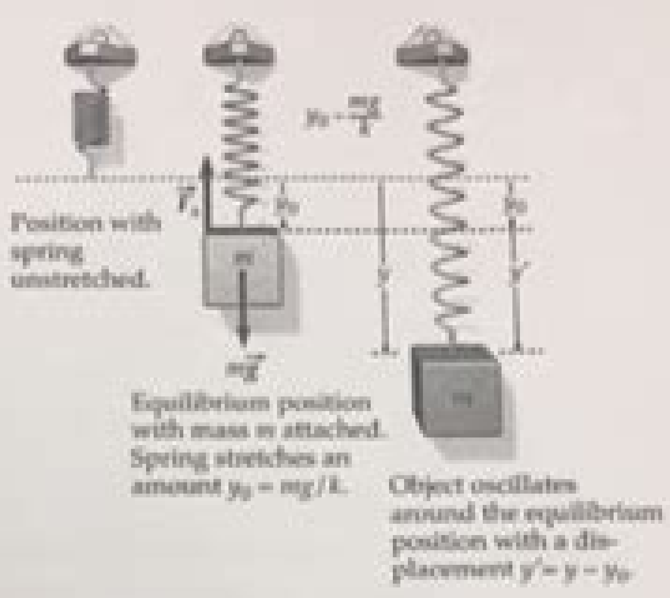
6. A particle undergoes SHM with angular frequency ω. The initial displacement is x_0 and the initial velocity is v_0. Deduce that an expression for the amplitude of this motion is

$$A = \sqrt{x_0^2 + \frac{v_0^2}{\omega^2}}$$

Simple Harmonic Motion Worksheet

Theory

Part A: Show relationship between derived equation from Hooke's law and the equation for a linear graph.



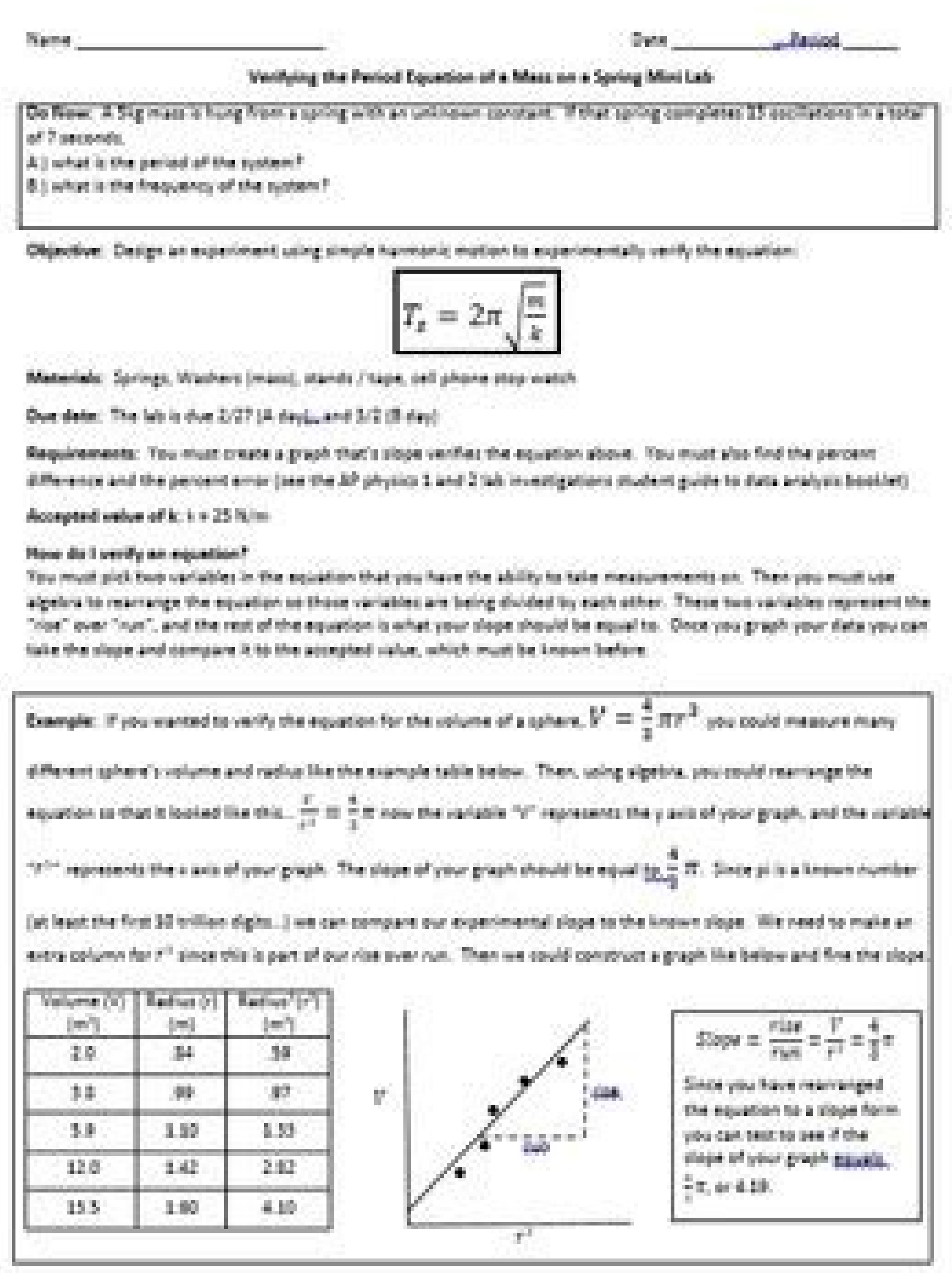
y = mx + b

x = g/k m

slope = g/k

k = g/slope

Part B: Show the relationship between $T^2 = (4\pi^2/k)m + (4\pi^2/k)fm_{sp}$ and the equation for a linear graph



Name ______________________ Date ____________ Period ______

Verifying the Period Equation of a Mass on a Spring Mini Lab

Do Now: A 5kg mass is hung from a spring with an unknown constant. If that spring completes 15 oscillations in a total of 7 seconds,
A.) what is the period of the system?
B.) what is the frequency of the system?

Objective: Design an experiment using simple harmonic motion to experimentally verify the equation:

$$T_s = 2\pi\sqrt{\frac{m}{k}}$$

Materials: Springs, Washers (mass), stands / tape, cell phone stop watch

Due date: The lab is due 2/27 (A day) and 3/2 (B day)

Requirements: You must create a graph that's slope verifies the equation above. You must also find the percent difference and the percent error (see the AP physics 1 and 2 lab investigations student guide to data analysis booklet)

Accepted value of k: k = 25 N/m

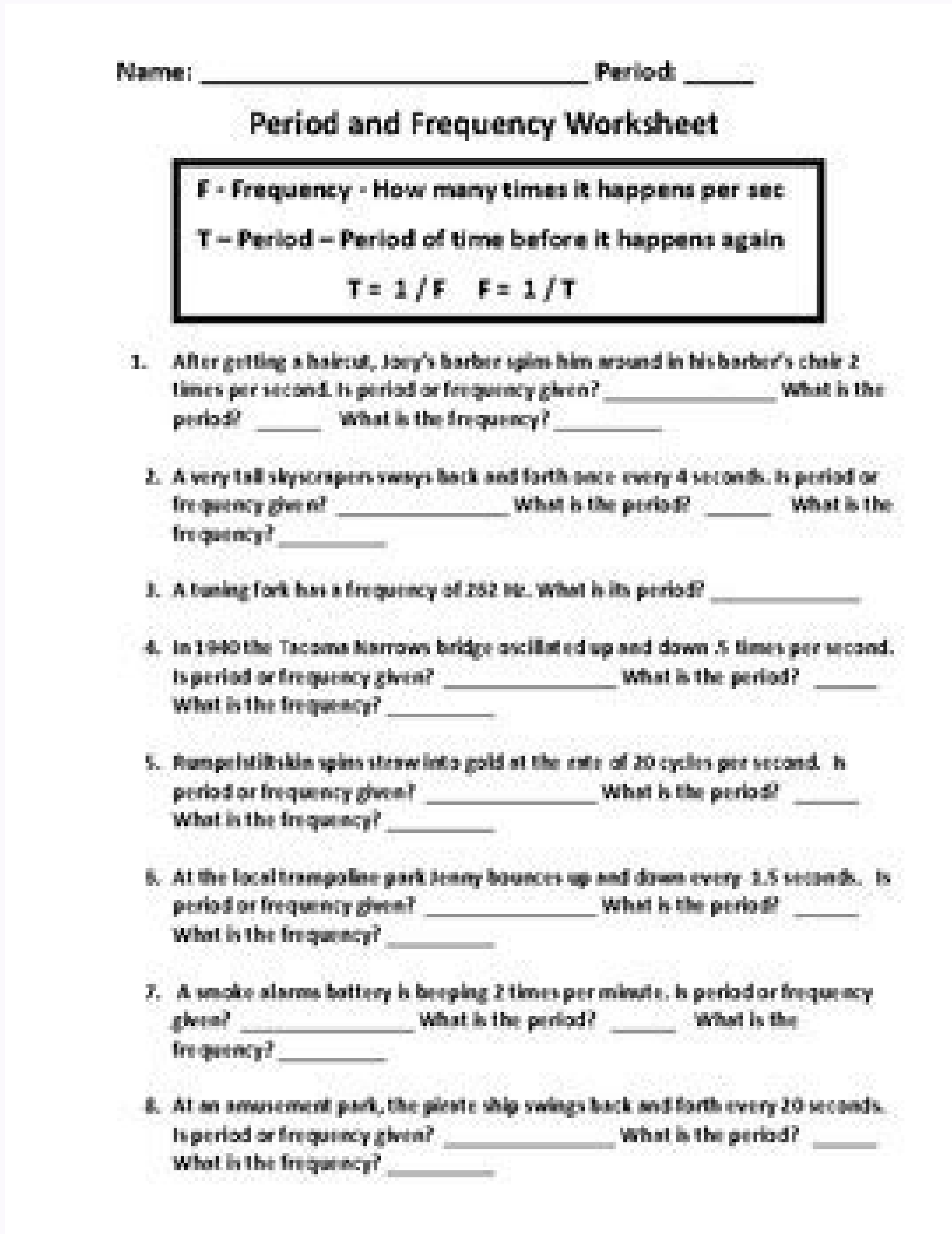
How do I verify an equation?
You must pick two variables in the equation that you have the ability to take measurements on. Then you must use algebra to rearrange the equation so those variables are being divided by each other. These two variables represent the "rise" over "run", and the rest of the equation is what your slope should be equal to. Once you graph your data you can take the slope and compare it to the accepted value, which must be known before.

Example: If you wanted to verify the equation for the volume of a sphere, $V = \frac{4}{3}\pi r^3$ you could measure many different sphere's volume and radius like the example table below. Then, using algebra, you could rearrange the equation so that it looked like this... $\frac{V}{r^3} = \frac{4}{3}\pi$ now the variable "V" represents the y axis of your graph, and the variable "r^3" represents the x axis of your graph. The slope of your graph should be equal to $\frac{4}{3}\pi$. Since pi is a known number (at least the first 10 trillion digits...) we can compare our experimental slope to the known slope. We need to make an extra column for r^3 since this is part of our rise over run. Then we could construct a graph like below and find the slope.

Volume (V) (m^3)	Radius (r) (m)	Radius^3 (r^3) (m^3)
2.0	.84	.59
3.8	.99	.97
5.8	1.10	1.33
12.0	1.42	2.82
15.5	1.60	4.10

$Slope = \frac{rise}{run} = \frac{V}{r^3} = \frac{4}{3}\pi$

Since you have rearranged the equation to a slope form you can test to see if the slope of your graph equals $\frac{4}{3}\pi$, or 4.19.



Name: ___________________________ Period: _____

Period and Frequency Worksheet

F - Frequency - How many times it happens per sec

T – Period – Period of time before it happens again

T = 1 / F   F = 1 / T

1. After getting a haircut, Joey's barber spins him around in his barber's chair 2 times per second. Is period or frequency given? _____________ What is the period? _____ What is the frequency? _________
2. A very tall skyscrapers sways back and forth once every 4 seconds. Is period or frequency given? _____________ What is the period? _____ What is the frequency? _________
3. A tuning fork has a frequency of 262 Hz. What is its period? ___________
4. In 1940 the Tacoma Narrows bridge oscillated up and down .5 times per second. Is period or frequency given? _____________ What is the period? _____ What is the frequency? _________
5. Rumpelstiltskin spins straw into gold at the rate of 20 cycles per second. Is period or frequency given? _____________ What is the period? _____ What is the frequency? _________
6. At the local trampoline park Jenny bounces up and down every 1.5 seconds. Is period or frequency given? _____________ What is the period? _____ What is the frequency? _________
7. A smoke alarms battery is beeping 2 times per minute. Is period or frequency given? _____________ What is the period? _____ What is the frequency? _________
8. At an amusement park, the pirate ship swings back and forth every 20 seconds. Is period or frequency given? _____________ What is the period? _____ What is the frequency? _________

Precalculus harmonic motion worksheet with answers. Simple harmonic motion worksheet. Harmonic motion graphs worksheet answers. Measuring simple harmonic motion worksheet answers. Simple harmonic motion worksheet pdf. Harmonic motion basics worksheet answers. Simple harmonic motion worksheet answers. Simple harmonic motion problems worksheet pdf.

Complete the table on the first page of worksheet-compare.pdf. Fill each grid space with an appropriately concise answer. Sample responses are on the second page of worksheet-compare.pdf. Page 1: The questions Page 2: The answers worksheet-transform.pdfThe graph below shows velocity as a function of time for some unknown object. What can we say about the motion of this object? Plot the corresponding graph of acceleration as a function of time. Plot the corresponding graph of displacement as a function of time. The problem presents us with a velocity-time graph. Do not read it as if it was showing you position. You can't immediately determine where the object is from this graph. You can say what direction it's moving, how fast it's going, and whether or not it's accelerating, however. The motion of this object is described for several segments in the graph below. Acceleration is the rate of change of displacement with time. To find acceleration, calculate the slope in each interval. Plot these values as a function of time. Since the acceleration is constant within each interval, the new graph should be made entirely of linked horizontal segments. Displacement is the product of velocity and time. To find displacement, calculate the area under each interval. Find the cumulative areas starting from the origin (given an initial displacement of zero) 00 s → 0 = 0 m 04 s → 0 + 8 = +8 m 08 s → 0 + 8 − 8 = 0 m 12 s → 0 + 8 − 8 − 16 = −16 m 16 s → 0 + 8 − 8 − 16 − 8 = −24 m 20 s → 0 + 8 − 8 − 16 − 8 + 0 = −24 m 24 s → 0 + 8 − 8 − 16 − 8 + 0 + 8 = −16 m 30 s → 0 + 8 − 8 − 16 − 8 + 0 + 8 + 24 = +8 m Plot these values as a function of time. Pay attention to the shape of each segment. When the object is accelerating, the line should be curved. Sketch the displacement-time, velocity-time, and acceleration-time graphs for… an object moving with constant velocity. (Let the initial displacement be zero.) an object moving with constant acceleration. (Let the initial displacement and velocity be zero.) Since the velocity is constant, the displacement-time graph will always be straight, the velocity-time graph will always be horizontal, and the acceleration-time graph will always lie on the horizontal axis. When velocity is positive, the displacement-time graph should have a positive slope. When velocity is negative, the displacement-time graph should have a negative slope. When velocity is zero, the displacement-time graph should be horizontal. Since the acceleration is constant, the displacement-time graph will always be a parabola, the velocity-time graph will always be straight, and the acceleration-time graph will always be horizontal. When acceleration is positive, the velocity-time graph should have a positive slope and the displacement-time graph should bend upward. When acceleration is negative, the velocity-time graph should have a negative slope and the displacement-time graph should bend downward. When acceleration is zero, all three graphs should lie on the horizontal axis. The graph below shows the altitude of a skydiver initially at rest as a function of time. After 7 s of free fall the skydiver's chute deployed completely, which changed the motion abruptly. Determine the velocity at the instant… just before the parachute opened just after the parachute opened What was the skydiver's acceleration… from the beginning of the jump to the time just before the parachute opened? from the time just after the parachute opened to the time when the skydiver landed? Sketch the corresponding graphs of… velocity-time acceleration-time Questions about velocity. There are at least two ways to determine the velocity just before the parachute opened. One would be to use the fact stated in the stem of the problem — that the skydiver was in free fall. We could use the first equation of motion for an object with a constant acceleration. Up is positive on this graph, so gravity will have to be negative. v = v0 + atv = (0 m/s) + (−9.8 m/s2)(7 s)v = −69 m/s We could also use the graph itself (instead of the description of the graph) to solve this part of the problem. In the last half second, from 6.5 to 7.0 seconds, the graph looks very nearly straight and the skydiver appears to drop from 90 to 60 meters. Slope is velocity on a displacement-time graph. Compute it. v = v = 60 m − 90 m 7.0 s − 6.5 s v = −60 m/s So which answer is correct? Well neither. Free fall in an atmosphere is technically impossible, which means the first answer is only true in an idealized world. The second answer is definitely a mathematical approximation. We don't really know the slope of the tangent to the left side of 7 seconds. I said it sort of looks straight in the last half second, but sort of doesn't cut it. I think it's more likely that the skydiver was almost in free fall than the curve was almost straight in the last half second before the chute opened. If I were to ask this question of my students, however, I would accept both answers as reasonable and award full credit — as long as there were no other errors like missing units. From 7 to 17 seconds, the graph is straight. Straight lines on a displacement-time graph indicate constant velocity. Velocity is slope on this kind of graph. Compute it. v = v = v = −6.0 m/s This is the answer to this part of the problem. On this there can be no debate. Questions about acceleration. There appear to be 4 valid ways to determine the acceleration in the first 7 seconds. The first is to just agree with what the text description says. The skydiver is in free fall. Free fall acceleration on Earth is just a number — a number that you should memorize if you have a professional reason for learning physics. a = −9.8 m/s2 The second method uses the graph and an equation of motion. Since we're given a displacement-time graph, use the displacement-time relationship, a.k.a. the second equation of motion. After 7 seconds, the skydiver has fallen from rest a distance of 240 meters. Δs = v0t + ½at2a = 2Δs/t2a = 2(−240 m)/(7 s)2a = −9.8 m/s2 The third and fourth methods use the other two equations of motion. Since these rely on our choices for the final velocity, multiple valid answers are possible. Let's say we use the velocity calculated from the slope of a "tangent" with a value of −60 m/s and and the velocity-time relationship, a.k.a. the first equation of motion. Then… v = v0 + ata = v/ta = (−60 m/s)/(7 s)a = −8.8 m/s2 We could also use the velocity-displacement relationship, a.k.a. the third equation of motion, with a final velocity of −60 m/s and a displacement of −240 m. That gives us… v2 = v02 + 2aΔsa = v2/2Δsa = (−60 m/s)2/2(−240 m)a = −7.5 m/s2 I don't like these last two answers, but I'd have to accept them if a student gave them to me. They are valid answers given what the graph shows. Given how much they disagree with the other answers means they're probably "wrong", but so what? They aren't wrong because of faulty reasoning. They're wrong because of the limitations of the graph. Welcome to the real world. After 7 seconds, life is easy. Look at the graph near the end. It's a straight line. Look at it again. Isn't it lovely? So straight. A straight line on a displacement time graph indicates constant velocity or zero acceleration. Let me compute it for you. Oh wait, there's nothing to compute. Draw a hole and add a unit to it. a = 0 m/s2 Questions about the graphs. Here's the original altitude-time, or displacement-time, or position-time or whatever-you-want-to-call-it graph. It's what I gave you to work with. Here's the velocity-time graph. All the signs are negative. The velocity became more and more negative until the chute opened, then it was a smaller (but constant) negative number afterwards. Here's the acceleration-time graph. The skydiver falls with a constant negative acceleration of −9.8 m/s2 for 7 seconds, then she has no acceleration. No means zero meters per second squared. Constant values are horizontal lines on this graph. By the end of this section, you will be able to do the following: Describe centripetal acceleration and relate it to linear acceleration Describe centripetal force and relate it to linear force Solve problems involving centripetal acceleration and centripetal force The learning objectives in this section will help your students master the following standards: (4) Science concepts. The student knows and applies the laws governing motion in a variety of situations. The student is expected to: (C) analyze and describe accelerated motion in two dimensions using equations, including projectile and circular examples. (D) calculate the effect of forces on objects, including the law of inertia, the relationship between force and acceleration, and the nature of force pairs between objects. In addition, the High School Physics Laboratory Manual addresses content in this section in the lab titled: Circular and Rotational Motion, as well as the following standards: (4) Science concepts. The student knows and applies the laws governing motion in a variety of situations. The student is expected to: (C) analyze and describe accelerated motion in two dimensions using equations, including projectile and circular examples. centrifugal force centripetal acceleration centripetal force uniform circular motion [BL][OL] Review uniform circular motion. Ask students to give examples of circular motion. Review linear acceleration. In the previous section, we defined circular motion. The simplest case of circular motion is uniform circular motion, where an object travels a circular path at a constant speed. Note that, unlike speed, the linear velocity of an object in circular motion is constantly changing because it is always changing direction. We know from kinematics that acceleration is a change in velocity, either in magnitude or in direction or both. Therefore, an object undergoing uniform circular motion is always accelerating, even though the magnitude of its velocity is constant. You experience this acceleration yourself every time you ride in a car while it turns a corner. If you hold the steering wheel steady during the turn and move at a constant speed, you are executing uniform circular motion. What you notice is a feeling of sliding (or being flung, depending on the speed) away from the center of the turn. This isn't an actual force that is acting on you—it only happens because your body wants to continue moving in a straight line (as per Newton's first law) whereas the car is turning off this straight-line path. Inside the car it appears as if you are forced away from the center of the turn. This fictitious force is known as the centrifugal force. The sharper the curve and the greater your speed, the more noticeable this effect becomes. [BL][OL][AL] Demonstrate circular motion by tying a weight to a string and twirling it around. Ask students what would happen if you suddenly cut the string? In which direction would the object travel? Why? What does this say about the direction of acceleration? Ask students to give examples of when they have come across centripetal acceleration. Figure 6.7 shows an object moving in a circular path at constant speed. The direction of the instantaneous tangential velocity is shown at two points along the path. Acceleration is in the direction of the change in velocity; in this case it points roughly toward the center of rotation. (The center of rotation is at the center of the circular path). If we imagine Δs Δs becoming smaller and smaller, then the acceleration would point exactly toward the center of rotation, but this case is hard to draw. We call the acceleration of an object moving in uniform circular motion the centripetal acceleration ac because centripetal means center seeking. Figure 6.7 The directions of the velocity of an object at two different points are shown, and the change in velocity Δv Δv is seen to point approximately toward the center of curvature (see small inset). For an extremely small value of Δs Δs , Δv Δv points exactly toward the center of the circle (but this is hard to draw). Because a c =Δv/Δt a c =Δv/Δt , the acceleration is also toward the center, so a c is called centripetal acceleration. Consider Figure 6.7. The figure shows an object moving in a circular path at constant speed and the direction of the instantaneous velocity of two points along the path. Acceleration is in the direction of the change in velocity and points toward the center of rotation. This is strictly true only as Δs Δs tends to zero. Now that we know that the direction of centripetal acceleration is toward the center of rotation, let's discuss the magnitude of centripetal acceleration. For an object traveling at speed v in a circular path with radius r, the magnitude of centripetal acceleration is a c = v 2 r . a c = v 2 r . Centripetal acceleration is greater at high speeds and in sharp curves (smaller radius), as you may have noticed when driving a car, because the car actually pushes you toward the center of the turn. But it is a bit surprising that ac is proportional to the speed squared. This means, for example, that the acceleration is four times greater when you take a curve at 100 km/h than at 50 km/h. We can also express ac in terms of the magnitude of angular velocity. Substituting v=rω v=rω into the equation above, we get a c = (rω) 2 r =r ω 2 a c = (rω) 2 r =r ω 2 . Therefore, the magnitude of centripetal acceleration in terms of the magnitude of angular velocity is a c =r ω 2 . a c =r ω 2 . 6.9 The equation expressed in the form ac = rω2 is useful for solving problems where you know the angular velocity rather than the tangential velocity. In this simulation, you experiment with the position, velocity, and acceleration of a ladybug in circular and elliptical motion. Switch the type of motion from linear to circular and observe the velocity and acceleration vectors. Next, try elliptical motion and notice how the velocity and acceleration vectors differ from those in circular motion. Click to view content In uniform circular motion, what is the angle between the acceleration and the velocity? What type of acceleration does a body experience in the uniform circular motion? The angle between acceleration and velocity is 0°, and the body experiences linear acceleration. The angle between acceleration and velocity is 0°, and the body experiences centripetal acceleration. The angle between acceleration and velocity is 90°, and the body experiences linear acceleration. The angle between acceleration and velocity is 90°, and the body experiences centripetal acceleration. [BL][OL][AL] Using the same demonstration as before, ask students to predict the relationships between the quantities of angular velocity, centripetal acceleration, mass, centripetal force. Invite students to experiment by using various lengths of string and different weights. Because an object in uniform circular motion undergoes constant acceleration (by changing direction), we know from Newton's second law of motion that there must be a constant net external force acting on the object. Any force or combination of forces can cause a centripetal acceleration. Just a few examples are the tension in the rope on a tether ball, the force of Earth's gravity on the Moon, the friction between a road and the tires of a car as it goes around a curve, or the normal force of a roller coaster track on the cart during a loop-the-loop. Any net force causing uniform circular motion is called a centripetal force. The direction of a centripetal force is toward the center of rotation, the same as for centripetal acceleration. According to Newton's second law of motion, a net force causes the acceleration of mass according to Fnet = ma. For uniform circular motion, the acceleration is centripetal acceleration: a = ac. Therefore, the magnitude of centripetal force, Fc, is F c =m a c F c =m a c .By using the two different forms of the equation for the magnitude of centripetal acceleration, a c = v 2 /r a c = v 2 /r and a c =r ω 2 a c =r ω 2 , we get two expressions involving the magnitude of the centripetal force Fc. The first expression is in terms of tangential speed, the second is in terms of angular speed: F c =m v 2 r F c =m v 2 r and F c =mr ω 2 F c =mr ω 2 .Both forms of the equation depend on mass, velocity, and the radius of the circular path. You may use whichever expression for centripetal force is more convenient. Newton's second law also states that the object will accelerate in the same direction as the net force. By definition, the centripetal force is directed towards the center of rotation, so the object will also accelerate towards the center. A straight line drawn from the circular path to the center of the circle will always be perpendicular to the tangential velocity. Note that, if you solve the first expression for r, you get r= m v 2 F c . r= m v 2 F c . From this expression, we see that, for a given mass and velocity, a large centripetal force causes a small radius of curvature—that is, a tight curve. Figure 6.8 In this figure, the frictional force f serves as the centripetal force Fc. Centripetal force is perpendicular to tangential velocity and causes uniform circular motion. The larger the centripetal force Fc, the smaller is the radius of curvature r and the sharper is the curve. The lower curve has the same velocity v, but a larger centripetal force Fc produces a smaller radius r ′ r ′ . This video explains why a centripetal force creates centripetal acceleration and uniform circular motion. It also covers the difference between speed and velocity and shows examples of uniform circular motion. Click to view content Some students might be confused between centripetal force and centrifugal force. Centrifugal force is not a real force but the result of an accelerating reference frame, such as a turning car or the spinning Earth. Centrifugal force refers to a fictional center fleeing force. Click to view content Imagine that you are swinging a yoyo in a vertical clockwise circle in front of you, perpendicular to the direction you are facing. If the string breaks just as the yoyo reaches its bottommost position, nearest the floor. What will happen to the yoyo after the string breaks? The yoyo will fly inward in the direction of the centripetal force. The yoyo will fly outward in the direction of the centripetal force. The yoyo will fly to the left in the direction of the tangential velocity. The yoyo will fly to the right in the direction of the tangential velocity. To get a feel for the typical magnitudes of centripetal acceleration, we'll do a lab estimating the centripetal acceleration of a tennis racket and then, in our first Worked Example, compare the centripetal acceleration of a car rounding a curve to gravitational acceleration. For the second Worked Example, we'll calculate the force required to make a car round a curve. In this activity, you will measure the swing of a golf club or tennis racket to estimate the centripetal acceleration of the end of the club or racket. You may choose to do this in slow motion. Recall that the equation for centripetal acceleration is a c = v 2 r a c = v 2 r or a c =r ω 2 a c =r ω 2 . One tennis racket or golf club One timer One ruler or tape measure Work with a partner. Stand a safe distance away from your partner as he or she swings the golf club or tennis racket. Describe the motion of the swing—is this uniform circular motion? Why or why not? Try to get the swing as close to uniform circular motion as possible. What adjustments did your partner need to make? Measure the radius of curvature. What did you physically measure? By using the timer, find either the linear or angular velocity, depending on which equation you decide to use. What is the approximate centripetal acceleration based on these measurements? How accurate do you think they are? Why? How might you and your partner make these measurements more accurate? The swing of the golf club or racket can be made very close to uniform circular motion. For this, the person would have to move it at a constant speed, without bending their arm. The length of the arm plus the length of the club or racket is the radius of curvature. Accuracy of measurements of angular velocity and angular acceleration will depend on resolution of the timer used and human observational error. The swing of the golf club or racket can be made very close to uniform circular motion. For this, the person would have to move it at a constant speed, without bending their arm. The length of the arm plus the length of the club or racket is the radius of curvature. Accuracy of measurements of angular velocity and angular acceleration will depend on resolution of the timer used and human observational error. Was it more useful to use the equation a c = v 2 r a c = v 2 r or a c =r ω 2 a c =r ω 2 in this activity? Why? It should be simpler to use a c =r ω 2 a c =r ω 2 because measuring angular velocity through observation would be easier. It should be simpler to use a c = v 2 r a c = v 2 r because measuring tangential velocity through observation would be easier. It should be simpler to use a c =r ω 2 a c =r ω 2 because measuring angular velocity through observation would be difficult. It should be simpler to use a c = v 2 r a c = v 2 r because measuring tangential velocity through observation would be difficult. A car follows a curve of radius 500 m at a speed of 25.0 m/s (about 90 km/h). What is the magnitude of the car's centripetal acceleration? Compare the centripetal acceleration for this fairly gentle curve taken at highway speed with acceleration due to gravity (g). Because linear rather than angular speed is given, it is most convenient to use the expression a c = v 2 r a c = v 2 r to find the magnitude of the centripetal acceleration. Entering the given values of v = 25.0 m/s and r = 500 m into the expression for ac gives a c = v 2 r = (25.0m/s) 2 500m = 1.25 m/s 2 . a c = v 2 r = (25.0m/s) 2 500m = 1.25 m/s 2 . To compare this with the acceleration due to gravity (g = 9.80 m/s2), we take the ratio a c /g = (1.25 m/s 2)/ (9.80 m/s 2) =0.128 a c /g = (1.25 m/s 2)/ (9.80 m/s 2) =0.128 . Therefore, a c =0.128g a c =0.128g, which means that the centripetal acceleration is about one tenth the acceleration due to gravity. Calculate the centripetal force exerted on a 900 kg car that rounds a 600-m-radius curve on horizontal ground at 25.0 m/s. Static friction prevents the car from slipping. Find the magnitude of the frictional force between the tires and the road that allows the car to round the curve without sliding off in a straight line. We know that F c =m v 2 r F c =m v 2 r . Therefore, F c = m v 2 r = (900kg) (25.0m/s) 2 600m = 938N. F c = m v 2 r = (900kg) (25.0m/s) 2 600m = 938N. The image above shows the forces acting on the car while rounding the curve. In this diagram, the car is traveling into the page as shown and is turning to the left. Friction acts toward the left, accelerating the car toward the center of the curve. Because friction is the only horizontal force acting on the car, it provides all of the centripetal force in this case. Therefore, the force of friction is the centripetal force in this situation and points toward the center of the curve. f= F c =938N f= F c =938N Since we found the force of friction in part (b), we could also solve for the coefficient of friction, since f= μ s N= μ s mg f= μ s N= μ s mg . 9. What is the centripetal acceleration felt by the passengers of a car moving at 12 m/s along a curve with radius 2.0 m? 3 m/s2 6 m/s2 36 m/s2 72 m/s2 10. Calculate the centripetal acceleration of an object following a path with a radius of a curvature of 0.2 m and at an angular velocity of 5 rad/s. 1 m/s 5 m/s 1 m/s2 5 m/s2 11. What is uniform circular motion? Uniform circular motion is when an object accelerates on a circular path at a constantly increasing velocity. Uniform circular motion is when an object travels on a circular path at a variable acceleration. Uniform circular motion is when an object travels on a circular path at a constant speed. Uniform circular motion is when an object travels on a circular path at a variable speed. 12. What is centripetal acceleration? The acceleration of an object moving in a circular path and directed radially toward the center of the circular orbit The acceleration of an object moving in a circular path and directed tangentially along the circular path The acceleration of an object moving in a linear path and directed in the direction of motion of the object The acceleration of an object moving in a linear path and directed in the direction opposite to the motion of the object 13. Is there a net force acting on an object in uniform circular motion? Yes, the object is accelerating, so a net force must be acting on it. Yes, because there is no acceleration. No, because there is acceleration. No, because there is no acceleration. 14. Identify two examples of forces that can cause centripetal acceleration. The force of Earth's gravity on the moon and the normal force The force of Earth's gravity on the moon and the tension in the rope on an orbiting tetherball The normal force and the force of friction acting on a moving car The normal force and the tension in the rope on a tetherball Use the Check Your Understanding questions to assess whether students master the learning objectives of this section. If students are struggling with a specific objective, the formative assessment will help identify which objective is causing the problem and direct students to the relevant content.

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