Any object moving in a circle is accelerating, even if its speed remains the same. This might seem counterintuitive because how can you have acceleration without a change in speed? In fact, because acceleration is the rate of change of velocity, and velocity includes speed and the direction of motion, it's impossible to have circular motion without acceleration. By Newton's second law, any acceleration (a) is linked to a force (F) by F = ma, and in the case of circular motion, the force in question is called the centripetal force. Working this out is a simple process, but you might have to think about the situation in different ways depending on the information you have. Find the centripetal force using the formula:_F_ = _mv_2 / _r Here, _F_ references the force, _m_ is the mass of the object, _v_ is the tangential speed of the object, and _r_ is the radius of the circle it travels in. If you know the source of the centripetal force (gravity, for example), you can find the centripetal force using the equation for that force. Centripetal force isn't a force in the same way as gravitational force or frictional force. Centripetal force exists because centripetal acceleration exists, but the physical cause of this force can vary depending on the specific situation.Consider the Earth's motion around the sun. Even though the speed of its orbit is constant, it changes direction continuously and therefore has acceleration directed toward the sun. This acceleration must be caused by a force, according to Newton's first and second laws of motion. In the case of the Earth's orbit, the force causing the acceleration is gravity.However, if you swing a ball on a string in a circle at a constant speed, the force causing the acceleration is different. In this case, the force is from the tension in the string. Another example is a car maintaining a constant speed but turning in a circle. In this case, the friction between the car's wheels and the road is the source of the force.In other words, centripetal forces exist, but the physical cause of them depends on the situation. Centripetal acceleration is the name for the acceleration directly toward the center of the circle in circular motion. This is defined by:\(a=\frac{v^2}{r}\)Where v is the speed of the object in the line tangential to the circle, and r is the radius of the circle it is moving in. Think about what would happen if you were swinging a ball connected to a string in a circle, but the string broke. The ball would fly off in a straight line from its position on the circle at the time the string broke, and this gives you an idea what v means in the above equation.Because Newton's second law states that force = mass acceleration, and we have an equation for acceleration above, the centripetal force must be:\(F=\frac{mv^2}{r}\)In this equation, m refers to mass.So, to find the centripetal force, you need to know the mass of the object, the radius of the circle it's traveling in and its tangential speed. Use the equation above to find the force based on these factors. Square the speed, multiply it by the mass and then divide the result by the radius of the circle. **Angular Velocities:** You can also use the angular velocity ____ of the object if you know it; it is the rate of change of the object's angular position with time. This changes the centripetal acceleration equation to:_a_ = __2_r_The centripetal force equation becomes:_F_ = _m_2_r_ If you don't have all the information you need for the equation above, it might seem like finding the centripetal force is impossible. However, if you think about the situation, you can often work out what the force might be.For example, if you're trying to find the centripetal force acting on a planet orbiting a star or a moon orbiting a planet, you know that the centripetal force comes from gravity. This means you can find the centripetal force without the tangential velocity by using the ordinary equation for gravitational force:\(F=\frac{Gm_1m_2}{r^2}\)Where m1 and m2 are the masses, G is the gravitational constant, and r is the separation between the two masses.To calculate centripetal force without a radius, you need either more information (the circumference of the circle related to radius by C = 2r, for example) or the value for the centripetal acceleration. If you know the centripetal acceleration, you can calculate the centripetal force directly using Newton's second law, F = ma. Johnson, Lee. "How To Find Centripetal Force" sciencing.com, . 2 November 2020. APA Johnson, Lee. (2020, November 2). How To Find Centripetal Force. sciencing.com. Retrieved from Chicago Johnson, Lee. How To Find Centripetal Force last modified August 30, 2022. Question: 245 15. An object of mass m is traveling at constant speed v in a circular path of radius r. How much work is done by the centripetal force during one-half of a revolution? A. mv2B. 0C. mv2rD. 2mv2r Correct Answer: B Explanation: BSince the centripetal force always points along a radius toward the center of the circle, and the velocity of the object is always tangent to the circle (and thus perpendicular to the radius), the work done by the centripetal force is zero. Alternatively, since the object's speed remains constant, the Work-Energy Theorem tells you that no work is being performed. Page 2 Question: 246 1. A block attached to an ideal spring undergoes simple harmonic motion. The acceleration of the block has its maximum magnitude at the point where A. the speed is the maximumB. the speed is the minimumC. the restoring force is the minimumD. the kinetic energy is the maximum Correct Answer: B Explanation: BThe acceleration of the block has its maximum magnitude at the points where its displacement from equilibrium has the maximum magnitude (since a = F/m = kx/m). At the endpoints of the oscillation region, the potential energy is maximized and the kinetic energy (and hence the speed) is zero. Page 3 Question: 247 2. A block attached to an ideal spring undergoes simple harmonic motion about its equilibrium position (x = 0) with amplitude A. What fraction of the total energy is in the form of kinetic energy when the block is at position x = A ? A. B. C. D. Correct Answer: D Explanation: DBy Conservation of Mechanical Energy, K + US is a constant for the motion of the block. At the endpoints of the oscillation region, the block's displacement, x, is equal to A. Since K = 0 here, all the energy is in the form of potential energy of the spring, kA2. Because kA2 gives the total energy at these positions, it also gives the total energy at any other position.Using the equation US(x) = kx2, find that, at x = A.Therefore, Page 4 Question: 248 3. A student measures the maximum speed of a block undergoing simple harmonic oscillations of amplitude A on the end of an ideal spring. If the block is replaced by one with twice its mass but the amplitude of its oscillations remains the same, then the maximum speed of the block will A. decrease by a factor of 4B. decrease by a factor of 2C. decrease by a factor of D. increase by a factor of 2 Correct Answer: C Explanation: CThe maximum speed of the block is given by the equation vmax = . Therefore, vmax is inversely proportional to . If m is increased by a factor of 2, then vmax will decrease by a factor of . Page 5 Question: 249 4. A spring-block simple harmonic oscillator is set up so that the oscillations are vertical. The period of the motion is T. If the spring and block are taken to the surface of the Moon, where the gravitational acceleration is 1/6 of its value here, then the vertical oscillations will have a period of A. B. C. D. T Correct Answer: D Explanation: DThe period of a spring-block simple harmonic oscillator is independent of the value of g. (Recall that T =) Therefore, the period will remain the same. Page 6 Question: 250 5. A linear spring of force constant k is used in a physics lab experiment. A block of mass m is attached to the spring and the resulting frequency, f, of the simple harmonic oscillations is measured. Blocks of various masses are used in different trials, and in each case, the corresponding frequency is measured and recorded. If f2 is plotted versus 1/m, the graph will be a straight line with slope A. B. C. 42kD. Correct Answer: D Explanation: DThe frequency of a spring-block simple harmonic oscillator is given by the equation f = . Squaring both sides of this equation, you get f2 = . Therefore, if f2 is plotted versus (1/m), then the graph will be a straight line with slope k/42. (Note: The slope of the line whose equation is y = ax is a.) Page 7 Question: 251 6. A simple pendulum swings about the vertical equilibrium position with a maximum angular displacement of 5 and period T. If the same pendulum is given a maximum angular displacement of 10, then which of the following best gives the period of the oscillations? A. B. C. TD. 2T Correct Answer: C Explanation: CFor small angular displacements, the period of a simple pendulum is essentially independent of amplitude. Page 8 Question: 252 7. A block with a mass of 20 kg is attached to a spring with a force constant k = 50 N/m. What is the magnitude of the acceleration of the block when the spring is stretched 4 m from its equilibrium position? A. 4 m/s2B. 6 m/s2C. 8 m/s2D. 10 m/s2 Correct Answer: D Explanation: DCombining Hooke's Law with Newton's Second Law, you get Page 9 Question: 253 8. A block with a mass of 10 kg connected to a spring oscillates back and forth with an amplitude of 2 m. What is the approximate period of the block if it has a speed of 4 m/s when it passes through its equilibrium point? A. 1 sB. 3 sC. 6 sD. 12 s Correct Answer: B Explanation: BBy Conservation of Mechanical Energy, the energy of the block is the same throughout the motion. At the amplitude, the block has potential energy and zero kinetic energy. At the equilibrium position, the block has kinetic energy and zero potential energy. Applying the Conservation of Mechanical Energy to these two points in the motion yieldsThe period of the block can then be calculated using the following equation: Page 10 Question: 254 9. A block with a mass of 4 kg is attached to a spring on the wall that oscillates back and forth with a frequency of 4 Hz and an amplitude of 3 m. What would the frequency be if the block were replaced by one with one-fourth the mass and the amplitude of the block is increased to 9 m ? A. 4 HzB. 8 HzC. 12 HzD. 24 Hz Correct Answer: B Explanation: BThe frequency of a spring-block simple harmonic oscillator is independent of the amplitude. The equation for the frequency of a spring-block simple harmonic oscillator is . The frequency is inversely proportional to the square root of the mass, so decreasing the mass of the block by a factor of 4 would increase the frequency by a factor of 2. Page 11 Question: 255 1. What is the wavelength of a 5 Hz wave that travels with a speed of 10 m/s ? A. 0.25 mB. 0.5 mC. 2 mD. 50 m Correct Answer: C Explanation: CFrom the equation f = v, find that Chapter 18: Centripetal Forces Key18.2 Centripetal Force & Roller Coasters1.v >> 11 m/s2.No they need more speed (ac= 2.2 m/s2