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Uniform circular motion is an important phenomenon that is essential for our day-to-day life. This is a type of circular motion, describing the motion of many natural things. Whenever a body moves or travels on a curved or circular path, then the motion of that body is called circular motion.For example, as shown in the main diagram above the bike is moving in a curved or circular path.We know that when a body is moving then it will have a velocity. And in a circular path, the body changes its direction at every instant, and because of that the direction of the velocity of the body also changes. But the magnitude of the velocity defines the types of circular motion.There are two types of circular motion1. Non-uniform circular motion2. Uniform circular motionNon-uniform and Uniform circular motionIf the speed (Magnitude of velocity) of the particle or body in a horizontal circular motion changes with respect to time, then its motion is said to be non-uniform circular motion.The tangent at that point of circumference where the object is present represents the direction of velocity.By this definition, velocity is changing continuously, and because of different velocities, the path covered by the particle is also different for the same time interval.ExampleHere, the Velocity of the object at point P is v and at point Q is v2. v1 v2so this motion is a non-uniform circular motion.On the other hand, if the body/particle is moving on a circular path with constant speed, then its motion is considered a uniform circular motion. Here we are learning about it deeply.Defining Uniform circular motionLet us consider, a ball rotating around point O on a circular path. The radius of the circular path is r.Here, at every point of the circular path, the magnitude of velocity is constant and that is v, and the direction is changing at every moment.Because of the same speed at every moment, the distance covered by the particle is the same for the same time interval.As shown in the diagram, the distance from point P to Q is the same as the distance from point Q to R in 2 seconds time intervals in both cases.So the definition will beWhen an object covers the same distance along the circumference of the circular path in the same time interval is called uniform circular motion. We can also define it asIf the particle/object moves in the circle with a uniform speed, we call it a uniform circular motion.Here, the change in speed is zero, which meansWhere v is speed and it is constant.Examples of Uniform circular motion1. The motion of Earth around the sunEarth revolves around the sun continuously and completes one round every year, and to complete it, the earth moves the same distance (1 revolution)If we compare this situation to the definition of uniform circular motion, we will find that the motion of the earth around the sun is uniform circular motion.2. The motion of the tip of the second hand of watches and clocksEvery day we see many types of watches: wristwatches, hand watches, wall clocks, etc. We can see there the tip of the second hand of these watches covers the same distance every second and their velocity is the same for every second,This phenomenon is the uniform circular motion of the tip of the second hand of watches.Acceleration in Uniform circular motionAs we know, acceleration appears when there is a change in velocity.In the case of uniform circular motion, acceleration occurs only due to a change in the direction of velocity, and this acceleration in uniform circular motion is called Centripetal acceleration.These are the important points that we learn from itThe direction of this centripetalacceleration is toward the center of the circular path along the radius of the circle.It is also called radial acceleration because its direction is along the radius of that circular path.This acceleration is perpendicular to the velocity vector, so it is also called normal acceleration (a)FormulaWhere v is the magnitude of the linear velocity of the particle and r is the radius of the circle.As we know that v = r (= angular velocity of the particle at point P). So, the formula becomesTo determine the direction of centripetal acceleration, let us consider an exampleIn this figure, a particle is moving along a circular path of radius r and point O is the center of the circle.When it is at point P on the circumference, it is making angle from X-axis,The radial vector r will be Some examples to build a better understandingExample 1.An object moves at constant speed along a circular path in a horizontal XY plane, with the center at the origin. When the object is at x = 2 m, its velocity is (4 m/s). Find the objects (a) velocity and (b) acceleration at y = 2 m.Solution:Here radius of the circle is r = 2mand velocity at x = 2m is v = 4m/s.It is mentioned in the question, object moves at a constant speedThat means it is a uniform circular motionso (a) velocity will remain constant for y = 2 and that isv = 4m/s(b) the object is doing a uniform circular motionThat means it will have only centripetal acceleration and it is existing because of changes in the direction of velocityThen at y = 2m, centripetal acceleration will be(The direction of the acceleration at y = 2m will be jExample 2.Find the acceleration of the moon with respect to the earth from the following data: Distance between the earth and the moon = 3.85 10 km and the time taken by the moon to complete one revolution around the earth = 27.3 days.Solution:The moon revolves around the earth by doing uniform circular motion cause it moves with constant speed and revolves in the same period continuouslyGiven in the questionDistance between earth and moon = 3.85 10 km or 3.85 10 mAnd the time taken to complete the one revolution is 27.3 days or 39,372 seconds(27.3246060) sThe formula of centripetal acceleration isExample 3.A woman rides a carnival Ferris wheel at a radius of 15 m, completing five turns about its horizontal axis every minute. What are (a) the period of the motion, (b) the magnitude, (c) the direction of her centripetal acceleration at the highest point, and (d) the magnitude and (e) the direction of her centripetal acceleration at the lowest point?Solution:Let the speed of the Carnival is v and the radius be rr = 15m (given)(a) it is given that the carnival is rotating 5 turns per minute,As we know consumed time for 1 rotation is called the period of the motionSo, 5 rotations = 60 secondsT = 1 rotation = 60/5 = 12 s(b) The magnitude of centripetal acceleration(c) when the woman is at top of the carnival the acceleration will direct towards the center of the carnival and it will be downwards(d) Magnitude of centripetal a creation remains constant in a whole uniform circular motion,That means the centripetal accelerationat the lowest point of the carnival will be the same as the highest point of the carnivals centripetal accelerationAnd it will beac = 4.11 m/s(e) at the lowest point of the carnival, centripetal acceleration on the woman will direct toward the center of the carnival, and that is upward,So the direction of centripetal acceleration at the lowest point will be upward.Example 4.A particle of mass m is observed from an inertial frame of reference and is found to move in a circle of radius r with a uniform speed v. The centripetal force on it is Solution:Inertial frame of reference means when the particle/object is observed from the ground, then the frame is called an inertial frame of reference. And in this situation, the force acts on a particle/object is called centripetal force and it directs toward the center of the circleWe know thatCentripetal acceleration for a particle moving on a circular pathExample 5.After a good meal at a party, you wash your hands and find that you have forgotten to bring your handkerchief. You shake your hands vigorously to remove the water as much as you can. Why is water removed in this process?Solution:When we try to wipe our hands with a handkerchief, we make a curved path for water particles to remove by applying tangential force on the surface of water particles,Through this process, water particles get some linear velocity on that curved path and because of it centripetal force appears over water particles and they remove from the handkerchief.Q&A 1. What is uniform circular motion?Ans. When a particle or object moves along a circular path with constant speed and covers the same distance for the same time interval, then the motion of that particle/object is called uniform circular motion.Moon revolving around the earth and earth revolving around the sun are real-life examples of uniform circular motion.2. When is an object moves in a uniform circular motion?Ans. When there is no external force other than the centripetal force on the object to accelerate the object moving on a circular path, then the object will not move with variable speed, so at this time, the object will move in a uniform circular motion.That means there are two conditionsThere should be no external force on the object.Net acceleration should be equal to centripetal acceleration.3. Is acceleration constant in uniform circular motion? Ans. Yes.4. Is velocity constant in uniform circular motion?Ans.No it is not constant, because it changes its direction continuously, and because of it acceleration also appears.5. A particle in uniform circular motion requires a net force acting in what direction?Ans. It requires a net force acting toward the center of that circular path, and this force is called centripetal force.The magnitude of this force remains constant in a whole circular motion but the direction changes with the change in direction of the centripetal acceleration.It can also be written as the above equationWhere ac is centripetal acceleration and m is the mass of the particle.6. In a uniform circular motion, which of the following quantities are constant?(a) Angular velocity (b) Velocity (c) Speed (d) Angular accelerationAns. (C). speedBecause the magnitude of the velocity is called speed and it doesnt change in a circular motion. In this direction of velocity changes rigorously but the magnitude of velocity remains constant, therefore speed remains constant.Written by: Amber SoniReferencesFundamentals of physics, Halliday and Resnick, 10th edition, Jeal walker, page no. 76-77.Concepts of physics 1, H.C.Verma, Bharti Bhawan publishers & distributors, page no. 102&112 Imagine watching a Ferris wheel spinning smoothly against the night sky. This mesmerizing sight is a perfect example of uniform circular motion in action. But what exactly does that mean? Uniform circular motion occurs when an object moves along a circular path at a constant speed, maintaining equal distances over equal time intervals.Uniform circular motion describes an object traveling in a circular path at a constant speed. Here, the objects velocity remains unchanged in magnitude, but its direction continuously varies. This change in direction indicates that theres acceleration present, even when the speed seems steady.In uniform circular motion:The distance covered is equal for each time interval.The motion occurs along a circular path, demonstrating consistent curvature.The centripetal force acts towards the center of the circle, maintaining this path.Consider how satellites orbit Earth. They move with uniform circular motion while consistently facing our planet. The gravitational pull provides the necessary centripetal force to keep them on their paths.Another example includes cars navigating around a circular track. The tires exert force against the road surface, and friction helps maintain this curved trajectory without changing speeds.These instances illustrate that uniform circular motion plays a crucial role in various real-world contexts.Uniform circular motion has distinct features that define its behavior. Understanding these characteristics provides insight into various real-world examples.In uniform circular motion, an object maintains a constant speed throughout its journey. This means it covers equal distances in equal time intervals, regardless of the changing direction. For instance, a car driving on a circular track travels at the same speed while making turns. The consistent pace ensures stability and predictability for objects following this path.The movement occurs along a circular path, which is crucial to defining uniform circular motion. Whether its satellites orbiting Earth or amusement park rides, the trajectory remains circular. This specific shape keeps the object in constant rotation around a central point. Without this defined path, such as when an object moves straight or follows an irregular route, it wouldnt exhibit uniform circular motion.Uniform circular motion appears in numerous everyday scenarios. Understanding these examples can enhance your grasp of this fundamental concept.Planets orbiting the Sun demonstrate uniform circular motion. Each planet travels along a curved path while maintaining a consistent speed. For instance, Earths orbit takes about 365 days to complete one revolution, moving at an average distance of approximately 93 million miles from the Sun. This constant motion is crucial for maintaining stable climates and seasons on Earth.Satellites in orbit exhibit uniform circular motion as well. These artificial objects, like the International Space Station (ISS), revolve around Earth at high speeds. The ISS orbits at roughly 17,500 miles per hour and completes one full revolution approximately every 90 minutes. This swift movement keeps satellites from falling back to Earth due to gravitational pull.Amusement park rides often incorporate uniform circular motion. Take a Ferris wheel; it rotates steadily, allowing passengers to experience equal distances within equal time intervals. Each rotation provides thrilling views while ensuring safety through centripetal force that pulls riders toward the center of the ride.Rounding a curve in a car illustrates uniform circular motion in action. When you navigate a turn, your vehicle maintains speed while changing direction along the curved path. Proper handling allows you to experience smooth transitions without losing control or skidding off course. Remember that friction between tires and road surfaces plays an essential role in enabling this type of movement safely.Uniform circular motion plays a crucial role in various fields of science and engineering. It provides essential insights for understanding complex systems, ensuring safety and efficiency.In rotational dynamics, uniform circular motion is fundamental. Objects like spinning discs or gears exhibit this type of motion when rotating at a constant speed. The study of these motions helps engineers design machines that operate smoothly. Consider how centrifugal pumps rely on uniform circular motion to move fluids efficiently. They operate by creating a consistent flow through the circular movement of blades, maximizing performance.Navigational systems also utilize uniform circular motion principles. For instance, satellites in orbit maintain their paths due to this type of motion. They travel around Earth at constant speeds while being pulled toward it by gravity. This interaction ensures stable orbits, allowing for reliable communication and weather forecasting services. Similarly, aircraft use navigational systems that depend on these principles for accurate flight paths during turns and approaches.ApplicationExampleImportanceRotational DynamicsCentrifugal pumpsFluid movement efficiencyNavigational SystemsSatellites in orbitReliable communicationAircraft navigationAccurate flight path managementUnderstanding these applications helps you appreciate the significance of uniform circular motion in technology today. Uniform circular motion describes the movement of an object traveling in a circular path with a constant speed. Although the speed remains constant, the object experiences acceleration due to the continuous change in its direction. This page will explore the basics of uniform circular motion. Curved roads are a key example of uniform circular motion in everyday life. In uniform circular motion, an object moves in a circular path with a constant speed. This means that the magnitude of its velocity remains unchanged. However, since the objects direction is continuously changing, its velocity vector changes resulting in a non-zero acceleration. This acceleration is always directed towards the center of the circular path and is called the centripetal acceleration. Centripetal acceleration is responsible for keeping the object moving in a circular path. It is calculated using the following formula: where is the objects linear speed (calculated simply as distance over time), and is the radius of the circular path. Since there is acceleration involved, a force is also acting on the object, known as the centripetal force . According to Newtons second law of motion, the centripetal force can be calculated as: where is the mass of the object. It is essential to note that centripetal force is not a separate force but rather a result of other forces acting on the object, such as tension, gravitational force, or friction, which keep the object in circular motion. Period : The time taken for the object to complete one full revolution around the circular path.Frequency : The number of complete revolutions the object makes in one second. Frequency is the reciprocal of the period, i.e., .Angular Velocity : The rate at which the object moves around the circle, measured in radians per second. It can be calculated using the formula: . Planetary motion: The planets orbiting the Sun move in approximately circular paths with nearly uniform motion. A car driving around a roundabout: The car maintains a constant speed while traveling around the roundabout, resulting in uniform circular motion. A spinning wheel: Each point on the wheel moves in a circular path with a constant speed. Example: You swing a rope above your head. The rope is 24 centimeters long. On one end is a ball of mass 2 kilograms. The ball makes 50 revolutions in 28 seconds. What is the average velocity of the ball? What is the centripetal acceleration? Finally, what is the cetripetal force? Lets start by determining the average velocity of the ball. One revolution means one full trip around the circle. Thus, a revolution starts and ends in the same place. Doing that fifty times doesnt change anything. You still start and end in the same place. The displacement of the ball is 0 meters as shown below. In order to solve for the centripetal acceleration, we need the average speed of the ball. The distance traveled in one revolution is just the circumference of the circle. . Thus the distance is equal to because the ball goes around the circle fifty times. Divide this number by the total time recorded (28 seconds) and you have solved for the speed. Now just plug in and solve for using the equation . From here, it is simple to solve for . Simply plug in your values to the equation from earlier: . And thus you have your final answers. This course uses Canvas for homework assignments, quizzes, and exams. These assignments are open to everyone. Anyone is allowed to enroll in the Canvas course. In fact, this is highly encouraged as it will help you track your progress as you go through the course. Graded feedback will help you get an idea for what your grade would actually be in a Physics 1 college course. Use this link to enroll in the Canvas course. Continue to Chapter 13: Friction Back to Chapter 11: Projectile Motion Are you enjoying this content? Read more from our Physics 1 course here! Do you prefer video lectures over reading a webpage? Follow on YouTube to stay updated with the latest video content!Circular motion or circulatory motion is the movement of objects along a circular path. A circular path is a path whose every boundary point is equidistant from a fixed point, i.e., from the centre. Hence, in other words, the motion of an object equidistant from a central point is known as circular motion. For example, the movement of planets around the sun, giant wheel, merry-go-round, etc. Examples of Circular Motion1. Ceiling fanA ceiling fans blades rotate around a hub in a circular motion. 2. Giant WheelA giant wheel or a Ferris wheel is an amusement ride that is one of the major attractions of a carnival or a fair. The cabins attached to the rim of a giant wheel tend to move along a fixed circular path. Hence, the circulatory motion of the cabins can be observed easily by observing the movement of the giant wheel.3. Satellites Orbiting Around PlanetsThe movement of a satellite around a planet is exhibited in a fixed orbit that is usually circular in nature. Hence, the motion of the satellites along the circular orbit is yet another example of circulatory motion in everyday life.4. Stone Tied to a StringWhen a string attached to a stone at one end is supplied with a force to swirl it in the air, the stone rises in height and traces a circular path. Hence, the existence of circular motion can be seen clearly. A special kind of force known as the centripetal force acts on the stone that helps to maintain its circulatory motion.5. Stirring BatterTo stir a cake batter or while stirring tea, the mixing spoon tends to follow a circular path that is equidistant from a central point. Hence, the motion of the spoon represents circular motion. A number of mechanical equipment have also been invented to serve the purpose of mixing or whisking. The blades of such mixing devices tend to exhibit circulatory motion in a similar manner but at a rapid rate for better performance.6. Running on a Circular TrackWhen an athlete runs along a circular racing track, he/she tends to exhibit a circulatory motion because the movement of the athlete at every instant is equidistant from the central point of the track.7. Merry-Go-RoundA merry-go-round is one of the most common rides present in a carnival or a park. The children standing at the edge of a merry-go-round are likely to experience a force that pulls them outwards. This force is known as the centrifugal force that arises as a result of circular motion exhibited by a body.8. Movement of Electrons Around the NucleusThe electrons of an element revolve around the nucleus in their respective orbits. The orbit is the path followed by the electron to move around the nucleus. The nucleus here acts as the central point, and the orbit is circular in nature. Hence, the motion of the electrons is circulatory motion. 9. Twirling a LassoThe lasso trick performed by a person is a classic example of circulatory motion. To perform the lasso trick, a person tends to move his hand in circulatory motion. This makes the rope completely taut, and it builds a considerable amount of tension force in it. The continuous motion of the hand in a circular direction helps to maintain the motion of the rope and prohibits it to fall down on the ground.10. Wall of DeathWall of death is one of the most common stunts performed at a carnival. It is also known as motordrome. It consists of a rigid wooden cylinder. The stuntman or the rider tends to drive a car or ride a bike along the boundary of the wooden cylinder, thereby tracing a circular path and displaying circulatory motion in real life. Circular motion refers to the movement of an object along the circumference of a circle or a circular path. In this type of motion, the objects distance from a fixed central point remains constant while it travels around this point. The velocity of the object changes direction continuously, even if its speed remains constant, due to the centripetal force acting towards the center of the circle. This force is essential to maintain the circular trajectory, counteracting the objects natural tendency to move in a straight line due to inertia. Circular motion is commonly observed in planetary orbits, the motion of a car around a curved track, and the rotation of a fan blade. Circular motion is the movement of an object along the circumference of a circle or a circular path. This motion involves a continuous change in direction, leading to centripetal acceleration towards the center of the circle, essential in understanding rotational dynamics. F = / Where: = Centripetal Force (N) = Mass of the object (kg)= Tangential velocity (m/s)= Radius of the circular path (m) a = v/r Where: a= Centripetal Acceleration (m/s)v = Tangential velocity (m/s)r = Radius of the circular path (m) v = r Where: v = Tangential velocity (m/s) = Angular velocity (rad/s) r = Radius of the circular path (m) = / t Where: = Angular velocity (rad/s) = Angular displacement (rad) t = Time (s) T = 2r/ v Where: T = Period of revolution (s) r = Radius of the circular path (m) v = Tangential velocity (m/s) f= 1/ T=v / 2r Where: f = Frequency of revolution (Hz) T = Period of revolution (s) v = Tangential velocity (m/s) r = Radius of the circular path (m) Understanding these formulas is crucial for analyzing various real-world scenarios involving circular motion, such as: Planetary Orbits: Calculating the centripetal force keeping planets in orbit around the sun. Car Turning on a Curved Path: Determining the necessary frictional force to prevent skidding. Rotational Machinery: Evaluating the forces in rotating parts to ensure mechanical stability. Spinning Wheels: The wheels of bicycles and cars rotate in circular motion. Ceiling Fans: Blades of ceiling fans rotate around a central hub. Clock Hands: The hands of analog clocks move in a circular path. CDs and DVDs: When played, they spin around their center. Merry-Go-Rounds: Seats move in a circle around a central axis. Figure Skating Spins: Skaters spin in circles during routines. Gymnasts on Rings: Gymnasts rotate their bodies around the rings. Basketball Spinning: The ball spins in circular motion during a free throw. Hammer Throw: Athletes spin the hammer in a circular path before releasing it. Hula Hooping: The hoop moves in a circular motion around the waist. Planetary Orbits: Planets move in elliptical orbits around the sun. Moons Orbit: The moon revolves around Earth. Water in a Drain: Water spirals down a drain in a circular motion. Whirlpools and Tornadoes: Water and air rotate around a central vortex. Electron Orbits: Electrons move in circular orbits around the nucleus of an atom. Electric Motors: Rotors inside electric motors spin to create movement. Hard Disk Drives: The platters inside spin at high speeds. Washing Machines: The drum rotates during the spin cycle. Wind Turbines: The blades rotate to generate electricity. Rotary Blades: Blades in helicopters rotate to provide lift.Tires on a Moving Car: As a car moves, its tires rotate in a circular motion. Washing Machine Drum: During the spin cycle, the drum of a washing machine spins in a circular path. Yo-Yo: When you spin a yo-yo, it moves up and down in a circular motion. Rotating Sprinkler: Garden sprinklers often rotate in a circular pattern to distribute water evenly. Wind Turbines: The blades of wind turbines rotate in a circular motion to generate electricity. Gyroscope: Gyroscopes maintain orientation by spinning in a circular motion. Crankshafts in Engines: The crankshaft in an internal combustion engine rotates in a circular motion. Rotary Tools: Tools like drills and dremels rotate in circular motion to perform tasks. Helicopter Rotors: The main rotor blades of a helicopter spin in a circular path to provide lift. Potters Wheel: A potters wheel rotates in a circular motion to shape clay. Circular Saws: The blade of a circular saw spins to cut through materials. Wheels of a Skateboard: The wheels of a skateboard turn in a circular motion as it moves. Amusement Park Rotors: Rotor rides in amusement parks spin in a circular path. Rotating Beacons: Emergency vehicle lights often rotate in a circular pattern to signal their presence. Spinning Frisbee: When you throw a frisbee, it spins in a circular motion through the air. Drone Propellers: The propellers of drones rotate in circular paths to provide lift and control. Earths Rotation: The Earth itself rotates in a circular motion around its axis. Vortex in Fluids: When water drains, it creates a circular vortex. Roller Bearings: The rollers in bearings move in circular paths to reduce friction. Pulleys in Machinery: Pulleys rotate in a circular motion to lift or move loads. Circular motion is a fundamental concept in physics, describing the motion of an object along the circumference of a circle. This motion can be categorized based on several criteria. Below are the primary types of circular motion: Occurs when an object moves in a circle with a constant speed. Constant speed: The magnitude of the velocity remains constant. Changing velocity: The direction of the velocity changes continuously, resulting in acceleration. Centripetal force: This inward force is necessary to keep the object moving in a circle and is directed towards the center of the circle. Examples: A car turning around a circular track at a constant speed. The motion of a satellite orbiting Earth in a circular path.Occurs when an object moves in a circle with a varying speed. Variable speed: The speed of the object changes over time. Changing velocity and acceleration: Both the magnitude and direction of the velocity change, leading to variable acceleration. Centripetal and tangential forces: The object experiences both centripetal force (directed towards the center) and tangential force (acting along the tangent to the path). Examples: A car accelerating or decelerating while turning around a circular track. A roller coaster moving through a circular loop with varying speed.Refers to the motion of an object moving in a circular path in a horizontal plane. Constant height: The object remains at the same height above the ground. Centripetal force: Provided by friction, tension, or other horizontal forces. Examples: A car turning on a flat, circular track. A ball tied to a string and swung in a horizontal circle.Describes the motion of an object moving in a circular path in a vertical plane. Variable speed: Speed changes due to the influence of gravity. Centripetal force: Combination of tension (or normal force) and gravitational force. Critical points: Speed and tension vary significantly at the top and bottom of the path. Examples: A roller coaster performing a vertical loop. A bucket of water swung in a vertical circle.Occurs when an object spins around an internal axis. Fixed axis: The object rotates around a fixed point or axis within itself. Angular displacement: Measured in radians, describing how far the object has rotated. Examples: The spinning of a top. The rotation of the Earth on its axis. AspectUniform Circular MotionNon-Uniform Circular MotionSpeedConstantVariableAccelerationCentripetal acceleration onlyBoth centripetal and tangential accelerationsVelocityConstant magnitude, changing directionChanging magnitude and directionForceConstant magnitude, directed towards the centerVariable magnitude and directionExamplesEarth orbiting the SunCar accelerating/decelerating in a circular trackAngular VelocityConstantVariable Circular motion plays a vital role in various natural phenomena and technological advancements. Here are some significant applications: Communication: Satellites enable global communication, broadcasting signals for television, radio, and internet services. Weather Forecasting: Meteorological satellites monitor weather patterns and predict natural disasters. GPS: Global Positioning System satellites provide accurate location data for navigation.Orbiting Planets: Planets revolve around the Sun in nearly circular orbits due to the gravitational force acting as the centripetal force.Ferris Wheel: Passengers move in a vertical circle, experiencing varying forces at different points. Roller Coaster: Combines circular and projectile motion to create thrilling experiences. Merry-Go-Round: Rotates around a central axis, providing circular motion for riders.Medical Laboratories: Used to separate blood components or purify samples. Industrial Applications: Employed to separate liquids and solids in chemical processes.Turning and Maneuvering: Tires undergo circular motion when a car turns, with friction providing the necessary centripetal force.Energy Storage: Flywheels store rotational energy through circular motion, maintaining consistent engine speed and smooth power delivery.Electric Generators: Convert mechanical energy into electrical energy through rotational motion. Electric Motors: Convert electrical energy into mechanical energy using principles of circular motion.Spin Cycle: Uses circular motion to remove water from clothes by spinning them at high speeds. A car of mass 1,000 kg is traveling at a speed of 20 m/s around a circular track with a radius of 50 meters. Calculate the centripetal force acting on the car. Solution: Given:Mass (m) = 1,000 kg Speed (v) = 20 m/s Radius (r) = 50 m Formula: F = / Substitute values in above formula Answer: The centripetal force acting on the car is 8,000 N. A wheel rotates 360 degrees (or 2 radians) in 4 seconds. Calculate its angular velocity. Solution: Given:Angular displacement () =2 radiansTime (t) = 4 secondsFormula: = / tSubstitute values in above formula Answer: The angular velocity of the wheel is /2 rad/s. Centripetal force is the inward force that keeps an object moving in a circular path, directed towards the circles center. Centripetal force can be caused by gravity, tension, friction, or other forces acting towards the center of the circle. Centrifugal force is the apparent outward force felt by an object moving in a circular path, due to inertia. Angular velocity is the rate of change of an objects angle as it moves along a circular path, usually measured in radians per second. Centripetal acceleration is given by a = v/r wherev is the linear velocity andr is the radius of the circle. Mass directly affects centripetal force, as the force is given by F = / Frequency is the number of revolutions per unit time and is the reciprocal of the period, Friction provides the necessary centripetal force for circular motion in cases like cars turning on a road. If the radius is doubled, the centripetal force is halved, assuming constant mass and speed. Astronauts experience weightlessness because they are in free fall, constantly falling towards Earth but moving forward fast enough to miss it. Add Tone Friendly Formal Casual Instructive Professional Empathetic Humorous Serious Optimistic Neutral 10 Examples of Public speaking 20 Examples of Gas lighting What is the centripetal force in circular motion? Choose the correct answer The force that acts outward from the center of the circle The force that acts tangent to the circle The force that acts towards the center of the circle The force that opposes gravity Which quantity remains constant for an object moving in uniform circular motion? Choose the correct answer What is the direction of the acceleration vector in circular motion? Choose the correct answer Perpendicular to the plane of the circle If the radius of a circular path is doubled while keeping the speed constant, what happens to the centripetal force? Choose the correct answer What happens to the period of an object in circular motion if the frequency is increased? Choose the correct answer The period remains the same In circular motion, which force is responsible for keeping the object moving along the curved path? Choose the correct answer If the speed of an object in circular motion is doubled, how does the centripetal force change? Choose the correct answer What does the term "angular velocity" refer to in circular motion? Choose the correct answer The rate at which an object moves through the circle The rate at which the angle changes The speed of the object in the circle The force acting on the object Which of the following factors affects the centripetal force? Choose the correct answer What would be the effect of increasing the radius of the circular path while keeping the speed constant? Choose the correct answer The centripetal force increases The centripetal force decreases The centripetal force remains the same The speed of the object increases Imagine youre at an amusement park, feeling the thrill as a roller coaster spins around in perfect circles. This exhilarating experience is a prime example of uniform circular motion, where objects move along a circular path at constant speed. But its not just rides that showcase this fascinating concept; everyday life is filled with instances of uniform circular motion.In this article, youll discover various examples of uniform circular motion that illustrate how this principle operates in different contextsfrom planets orbiting the sun to cars navigating roundabouts. Have you ever wondered how satellites maintain their paths or why your washing machine spins clothes so efficiently? Join us as we explore these captivating examples and uncover the science behind them. Each instance will deepen your understanding and appreciation for the dynamics of motion all around you.Uniform circular motion describes the movement of an object traveling in a circular path at a constant speed. This type of motion is crucial in understanding various phenomena in physics and real-world applications.Uniform circular motion refers to the motion of an object moving along a circular trajectory with consistent speed. The direction, however, continuously changes. This change means that even though the speed remains constant, there is acceleration due to the change in velocitys direction. Its important to remember that this acceleration points toward the center of the circle, known as centripetal acceleration.Understanding uniform circular motion involves recognizing its distinct characteristics:Constant Speed: The objects speed remains unchanged throughout its journey.Centripetal Force: A force acts towards the center, maintaining the objects curved path.Acceleration Direction: Acceleration always points inward, despite no increase in speed.Period and Frequency: The time taken for one complete revolution defines its period; frequency measures revolutions per unit time.These aspects highlight how uniform circular motion operates fundamentally and provide insight into various examples from daily life.Uniform circular motion appears in various aspects of daily life, showcasing how objects move along a circular path at a constant speed. Understanding these examples reinforces the concept and highlights its significance.You encounter uniform circular motion regularly. Consider the following examples:Cars on Roundabouts: Cars navigating roundabouts maintain a steady speed while changing direction, demonstrating uniform circular motion.Planets Orbiting the Sun: Planets travel around the sun in elliptical orbits but exhibit uniform circular motion when considering average distances and speeds.Washing Machines: The spin cycle of washing machines involves clothes moving in circles at consistent speeds, enhancing water extraction efficiency.These instances illustrate how common this type of motion is, affecting your day-to-day activities.Uniform circular motion significantly influences sports and recreational activities. Think about these scenarios:Cyclists on Velodromes: Cyclists race around banked tracks at constant speeds, allowing for high-speed turns without losing control.Merry-Go-Rounds: Children experience uniform circular motion while playing on merry-go-rounds, spinning consistently as they enjoy their ride.Skaters on Ice Rinks: Ice skaters performing spins maintain their velocity while rotating around a central point, exemplifying this principle beautifully.These examples highlight how understanding uniform circular motion can enhance appreciation for various sports and recreational activities you engage in.Uniform circular motion appears in various fields, showcasing its importance. Understanding these applications helps you grasp how this principle affects daily life.In physics and engineering, uniform circular motion plays a crucial role. For example:Centrifuges: Devices that spin samples to separate substances based on density.Roller Coasters: Designs use uniform circular motion principles for safety and thrill.Vehicles on Curves: Engineers consider centripetal force when designing roads and tracks.These examples demonstrate how uniform circular motion is essential for creating efficient systems in technology and transportation.Astronomy showcases uniform circular motion on a grand scale. Consider the following instances:Planetary Orbits: Planets orbiting the sun maintain nearly circular paths due to gravitational forces.Satellites: Artificial satellites circle Earth at specific altitudes, relying on consistent speed for stability.Galaxies: Stars within galaxies revolve around their centers, illustrating large-scale uniform circular motion.Such examples underline the significance of this concept in understanding celestial mechanics.Understanding uniform circular motion involves several key formulas and concepts. Youll find that these relate to the speed, acceleration, and forces acting on an object in circular motion.Centripetal Acceleration: This acceleration points toward the center of the circle. It can be calculated using the formula:[a_c = frac{v^{2}}{r}]Here, (v) represents linear speed, and (r) is the radius of the circle.Centripetal Force: The net force required to keep an object moving in a circular path also points inward. You can express it as:[F_c = m cdot a_c]where (m) is mass.Period (T): This refers to the time taken for one complete rotation around a circle. It relates to speed with:[T = frac{2pi r}{v}]Frequency (f): This indicates how many rotations occur per unit time, calculated as:[f = frac{1}{T}]These formulas help you analyze motion effectively in various scenarios involving uniform circular motion.Lets look at some practical problems to solidify your understanding:Example 1: A car traveling at 20 m/s enters a roundabout with a radius of 10 meters. Whats its centripetal acceleration?Using (a_c = frac{v^2}{r} = frac{(20)^2}{10} = 40,m/s^2).Example 2: A satellite orbits Earth at a radius of 6,371 km with an orbital speed of 7,900 m/s. Whats its period?Calculate using (T = frac{2pi r}{v} T = 5,300, s), which is about 88 minutes.By applying these examples directly related to real-world situations, you gain insight into the calculations involved in uniform circular motion.Uniform circular motion results when an object moves in a circle at a constant speed, which means that the object travels equal distances along the circular path in equal time intervals However, the object has a constantly changing direction.This article will explore the details of uniform circular motion: just what the differences in forces that permit circular motion are, and how velocity and acceleration work with respect to this kind of motion. This concept falls under the broader category of kinematics which is a crucial chapter in Class 11 physics. It is not only essential for board exams but also for competitive exams like the Joint Entrance Examination (JEE Main), National Eligibility Entrance Test (NEET), and other entrance exams such as SRMJEE, BITSAT, WBJEE, BCECE and more. Over the last ten years of the JEE Main exam (from 2013 to 2023), a total of nine questions have been asked on this concept. And for NEET five questions were asked from this concept.Circular Motion:Circular Motion Examples:Define Uniform Circular Motion :Characteristic of uniform circular motion:Examples of Uniform Circular motion:Angular AccelerationCentripetal Acceleration and Tangential accelerationSolved Example Besed On Uniform Circular MotionSummary Uniform Circular Motion - Definition, Examples, Diagram, Characteristic, Examples, FAQs Circular Motion:Circular Motion Definition: In physics, a body is said to be performing circular motion, if it moves only in a circular path. For example, If a boy is running on a circular track then, motion performed by the boy is said to be circular motion.Circular Motion Examples:Some of most common examples of circular motion in our everyday life are listed as:When athletes run in a circular track, the motion performed by athletes is circular motion.Planets revolving around the sun is also an example of circular motion.The blades of the ceiling fan move in circular motion.Also read -Circular motion diagram:When a body moves along a circular path of fixed radius, the circular motion diagram of the body can simply be shown as(Source: Self-Drawn using Geogebra)Related Topic Link - Projectile MotionDefine Uniform Circular Motion :Uniform circular motion definition: When a body moves in a circular path but with constant value of speed, the motion governed by the body is said to be uniform circular motion. But velocity of a body in uniform circular motion changes at every instant of the motion.Uniform circular motion diagram:Body moving with constant speed in a circular path having uniform circular motion can be shown as:(Source: Self-Drawn using Geogebra)Characteristic of uniform circular motion:Some of important points of uniform circular motion are listed as:The speed of a particle moving in uniform circular motions is always the same.The velocity of a particle performing uniform circular motion is in the direction of tangent at that point and velocity changes at every instant of motion.The force acting on a particle towards the centre of the circular path is called centripetal force.The acceleration of a particle performing uniform circular motion has only a radial component.The tangential component of acceleration of uniform circular motion is always zero.NEET Highest Scoring Chapters & TopicsThis ebook serves as a valuable study guide for NEET exams, specifically designed to assist students in light of recent changes and the removal of certain topics from the NEET exam. Download E-bookAcceleration of uniform circular motion:When a body performs a uniform circular motion, then only the radial acceleration acts on the body which is in the direction towards the centre. If a particle performing uniform circular motion in a circular path having radius of r and speed v then, acceleration acting on the particle is given by a=v2r.Characteristic of acceleration of uniform circular motion:Some of important points related to acceleration of a particle performing uniform circular motion are listed as:The direction of acceleration is always towards the centre of the circular path followed by the particle.The acceleration has a constant value as it performs uniform circular motion.Acceleration of uniform circular motion inversely proportional to radius of circular path.Acceleration of uniform circular motion directly proportional to the square of the speed of the particle.Acceleration directed towards the centre of the circular path following uniform circular motion is known as radial acceleration.There is no tangential component of acceleration of a particle performing uniform circular motion.Force acting on a particle performing Uniform circular motion:The force which acts on a particle performing uniform circular motion always acts in the direction towards the centre of the circular path and this force is known as Centripetal force.F=mv2r.Characteristic of Force in Uniform circular motion:Some of most common points to be noted of centripetal force are listed as:The Centripetal force has a constant magnitude in uniform circular motion.The direction of centripetal force in uniform circular motion is always towards the centre of the circular path.Centripetal force is directly proportional to acceleration of uniform circular motion and mass of the particle.Also Read:Time period of uniform circular motion:The time taken by a particle performing uniform circular motion in order to cover the total circumference of the circular path is known as the time period of uniform circular motion.If r, v be the radius of circular path, speed of a particle performing uniform circular motion then, circumference of the circular path is 2r and if T denoted for time period of uniform circular motion, then T=2rv.Characteristic of Time period of uniform circular motion:Some of important points of time period of a particle performing uniform circular motion are listed as:The value of the time period of uniform circular motion is always constant.Time period of uniform circular motion is directly proportional to the radius of the circular path followed by the particle.Time period of uniform circular motion is inversely proportional to the speed of the particle.Examples of Uniform Circular motion:Some of most common examples of a particle performing uniform circular motion are listed as:The motion of blades of a ceiling fan moving with constant speed is an example of uniform circular motion.The motion of atomic particles such as electrons moving around the nucleus in its fixed orbit is also an example of uniform circular motion.The motion of heavenly bodies in the universe rotating about each other due to gravitational force of attraction in fixed orbit is also an example of uniform circular motion.The artificial satellites which when released in their orbit around the earth also perform uniform circular motion.Any object which moves with constant speed and moves in a circular path will be considered as uniform circular motion.Let's understand this concept better from the solved example given below:Example :The angular velocity (in radian/sec) of a particle rotating in a circular orbit 100 times per minute is at=rat= tangential acceleration Where r= radius vector = angular acceleration 1) 10.52) 103) 40.34) 20.6Solution:Uniform circular motion -If an object moves in a circular path with a constant speed, then its motion is known as uniform circular motion.- wherein Fig shows Uniform circular of motion= Angle in radian time =1002(radian)60(sec)=103=10.47radian/sec Note: Relation between angular velocity and linear velocity : v=r Angular AccelerationThe rate of change of angular velocity with time is said to be Angular Acceleration.=tSI units- rad.(sec)2Angular Acceleration is a vector quantity.The direction of Angular Acceleration a) If angular velocity is increasing then the direction of Angular Acceleration is in the direction of angular velocity. b) If angular velocity is decreasing then the direction of Angular Acceleration is in the direction which is opposite to the direction of angular velocity.Time is taken to complete one rotationFormula- T=2Where = angular velocity If N=no. of revolutions antotalal time then T=tN or (=2Nt) Frequency The total number of rotations in one second. Formula- =1TWe can write the relation between angular frequency and frequency as w=2Centripetal Acceleration and Tangential acceleration Centripetal acceleration: When a body is moving in a uniform circular motion, a force is responsible for changing the direction of its velocity. This force acts towards the centre of the circle and is called centripetal forceThe acceleration produced by this force is centripetal acceleration.Formula- ac=V2rWhere ac= Centripetal acceleration, V= linear velocity r= radius Figure Shows Centripetal acceleration at=dv dtRelation Between Angular Acceleration and Tangential Acceleration- at=r Where at= tangential acceleration r= radius vector = angular acceleration Total accelerationThe vector sum of Centripetal acceleration and tangential acceleration is called Total acceleration.Formula- an=ac2+at2 The angle between Net acceleration and tangential acceleration (θ)From the above diagram- tan=acatSolved Example Besed On Uniform Circular MotionExample 1: If a body moving in a circular path maintains a constant speed of 10 ms-1, then which of the following correctly describes the relation between acceleration and radius?1)2)3) 4)Solution:$a=\frac{v^2}{r}$Figure Shows Centripetal acceleration $\begin{aligned} & a=\frac{v^2}{r} \because|\vec{v}|=\text { constant } \\ & a \propto \frac{1}{r} \text { or } a r=\text { constant } \end{aligned}$Hence, the graph between a and r will be a hyperbola.Example 2: A Point P moves in a counter-clockwise direction on a circular path as shown in the figure. The movement of P is such that it sweeps out a length that is in metres and t is in seconds. The radius of the path is $\mathbf{2 0 ~ m}$, The acceleration (in $\mathrm{m} / \mathrm{s}^2$) of P When $t=2 s$ is nearly1) 142)133)124)7.2Solution:$ \begin{aligned} & \text { As } S=t^3+3 \\ & V=\frac{d s}{d t}=3 t^2+0 \\ & \Rightarrow v=3 t^2 \end{aligned} $ tangential acceleration $ \begin{aligned} & =a_t=\frac{d v}{d t}=\frac{d\left(3 t^2\right)}{d t} \\ & a_t=6 t \end{aligned} $At $t=2 \mathrm{sec}$ $ \begin{aligned} & v=3(2)^2=12 \mathrm{~ms}^{-1} \\ & a_t=6 \times 2=12 \mathrm{~ms}^{-2} \end{aligned} $ $ \begin{aligned} & \therefore \text { centripetal acceleration }=\vec{a}_c=\frac{v^2}{r}=\frac{(12)^2}{20}=\frac{144}{20} \\ & a_c=7.2 \mathrm{~ms}^{-2} \end{aligned} $$\therefore$ Net acceleration $ \begin{aligned} & a=\sqrt{a_c^2+a_t^2}=\sqrt{7.2^2+12^2} \\ & a_c \simeq 14 \mathrm{~ms}^{-2} \end{aligned} $Example 3: A particle is moving with speed varying as v = 2t, then the angle which resultant acceleration makes with radial direction (R=1m) at t = 2 is1)$\tan^{-1}\left(\frac{1}{2} \right)$2)$\tan^{-1}\left(\frac{1}{6} \right)$3)$\tan^{-1}\left(\frac{1}{8} \right)$4)$\tan^{-1}\left(\frac{1}{4} \right)$Solution:The angle between Total acceleration and centripetal acceleration is given by $ \tan \phi=\frac{a_t}{a_c}=\frac{r^2 \alpha}{V^2} $ where $\alpha=$ angular acceleration $V=$ velocity $r=$ radius of circle So From the below figure$\begin{aligned} & \tan \theta=\frac{a_t}{a_r} \\ & a_t=\frac{\mathrm{d} v}{\mathrm{~d} t}=2 \mathrm{~m} / \mathrm{s}^2 \\ & a_r=\frac{v^2}{R} \\ & a_r=\frac{4 t^2}{1}=4 \times 2^2=16 \\ & \therefore \tan \theta=\frac{2}{16}=\frac{1}{8} \\ & \therefore \theta=\tan ^{-1}\left(\frac{1}{8}\right) \end{aligned}$Example 4:A particle is moving with a constant speed of 8 m/s in a circular path of radius 1 m. What will be the displacement of the particle in 1 sec?1) 2 sin 802) 2 sin 403) 4 sin 804) 4 sin 40Solution:Displacement in Circular Motion -$ \Delta r=2 r \sin \frac{\theta}{2} $ $\Delta r=$ displacement $\theta=$ Angle between two vectors - wherein $ \text { If }\left|\overrightarrow{r_1}\right|=\left|\overrightarrow{r_2}\right|=r $Let the angular displacement of the particle from A to B will be $ 2 R \sin \frac{\Theta}{2} $Length of circular arc $A B=8 * 1=8 \mathrm{~m}$ $ \begin{aligned} & \text { Angle } \Theta=\frac{\text { arc length }}{\text { Radius }}=\frac{\Theta}{1}=8 \mathrm{rad} \\ & d=2 R \sin \frac{\Theta}{2}=2 * 1 * \sin \frac{8}{2} \\ & 2 \sin 4^0 \end{aligned} $Hence, the correct answer is option (2).SummaryCircular motion involves a particle moving along a circular path at a constant speed, with its velocity continuously changing due to the changing direction. A common example is a merry-go-round, where objects move in circles at a uniform speed. This concept also applies to natural phenomena like planets orbiting the sun. Understanding uniform circular motion helps us grasp how forces and motion work in circular paths, essential for both everyday experiences and comprehending larger cosmic movements. Circular Motion is defined as the movement of an object rotating along a circular path. Objects in a circular motion can be performing either uniform or non-uniform circular motion. Motion of a car on a bank road, the motion of a bike, the well of death, etc. are examples of circular motion.In this article, we will learn about circular motion and some related concepts, such as examples, equations, applications, etc.What is Circular Motion?When any object moves in a circular path, it is said to be in circular motion. For example, when a car moves around a circular track at some speed, when the hands of the analog clock are moving, or when you swing an object tied with a rope in a circular path. In all the examples of circular motion, you will generally encounter an object that will be moving at some speed (constant or varying) around a circular path. Generally, the objects tend to move in a straight motion when you apply some force. But for an object to move in a circular motion, there must be some force acting on the object continuously which will turn the object towards the center of the circular path so that the object changes its direction continuously and thus forms a circular motion. Circular Motion DefinitionIn physics, circular motion can be defined as the motion in which an object moves when it follows a circular path. In circular motion the object generally moves around a fixed point and the distance between the object and the fixed point is generally fixed. Circular Motion ExampleThere are many examples of circular motion which you have already encountered in your life.Example 1: When you watch the hands of the analog clock moving in a clockwise direction, you will find that the hands are already moving in circular motion. Although it might look like the hands are actually rotating but when you will trace the motion of the tip of the hands, you will find that they are in circular motion. (We will further discuss the difference between rotational motion and circular motion in this article.)Example 2: When you tie a stone with a rope and swung it in a circular motion (Kindly check your environment before doing this experiment as this may hurt someone). Example 3: You must have heard that the electrons orbits in a circular path around a fixed nucleus in Bohr's Atomic model. This also constitutes the example of circular motion as the electrons are going along a circular path (in Bohr's Atomic model).Circular Motion in Real LifeThere are also situations where you have encountered circular motion of an object in real life too.Example 1: When we go to some fair (carnival) and we want to ride the Ferris wheel. The pods of the Ferris wheel moves in a circular motion.Example 2: A car turning on a circular track is also an example of circular motion. Generally these curves are made at an angle known as banked road which helps to reduce the role of friction to the circular motion of the car (Don't worry if you are not able to visualize this contribution of friction, we will help you visualize this later in this article).Example 3: In your home when your mother bakes the cake, she used to make the batter for the cake first. For making the batter for the cake she stirs the spoon in a circular motion, where the mixing spoon is follows a circular path equidistant from a central point.These real life examples helps us visualize the circular motion and we tend to conceptualize the concepts even better.There are various new terms which comes into the picture when we talk about circular motion. These new terms generally arises from the fact that in circular motion there is angle involved so the terms, such as, angular displacement, angular velocity, or angular acceleration. The image added below shows the Angular Velocity and others in an object performing circular motion.Let's see these concepts one by one.Angular DisplacementAngular displacement can be defined as the measurement of the amount of rotation an object has gone through in a circular path. In circular motion, the object moves in a circular path, and angular displacement helps us observe the position of the object in a circular path. It can also be understood as the angle made by the position vector of the object between its final and initial position in the circular path. Angular displacement is a vector quantity. The SI unit of the angular displacement is radians. It is conventionally denoted as . The mathematical representation of angular displacement is,Angular Displacement() = Arc Length/RadiusTherefore, = S/Rwhere, S is Linear Displacement Done by Object on Circular PathR is Distance of Object from a Fixed Central Point (Called Radius)Angular VelocityAngular velocity can be defined as the rate of change of angular displacement. It is analogous to the linear velocity as it is the rate of change of linear displacement. Angular velocity can also be understood as the rate at which an object moves in a circular path. Angular velocity is a vector quantity. It is denoted by .SI unit of angular velocity is radian per second (rad s-1). Mathematically, angular velocity can be represented as,Angular Velocity () = d/dtWe know from above that, = S/RUsing Angular Displacement in above equation, = d/dt.(S/R)which gives, = 1/R.(dS/dt)Finally, = v/Rwhere,V is Linear Velocity and V = dS/dtR is Distance of Object from a Fixed Central PointAngular AccelerationAngular acceleration can be defined as the rate of change of angular velocity. It can be understood as the measurement of how fast or slow the angular velocity of an object is changing on the circular path. When any object starts from rest and acquires motion in circular path, it is said to have angular acceleration working on it. For example, when the Ferris wheel starts from the rest and acquires the speed, then the pods of the Ferris wheel gains angular acceleration. When the angular velocity increases, then the angular acceleration is positive. But when the angular velocity decreases, the angular acceleration is negative, i.e., angular deceleration.Angular acceleration is vector quantity. It is denoted by .SI unit of angular acceleration is radian per second squared (rad s-2). Angular acceleration can be represented as,Angular acceleration () = d/dtWe can substitute = v/R in above equation to get, = d/dt (v/R) = 1/R (dv/dt) = 1/R.(a)Since, rate of change of linear velocity is called linear acceleration, therefore, above equation can be written as, = a/Rwhere, a is Linear Acceleration of ObjectR is Distance of Object from a Fixed Central PointEquations for Circular MotionAcceleration which an object faces in circular motion generally has two components:-Tangential Acceleration (aT)Radial Acceleration (aR)When the object moves in a circular path, it experiences two different acceleration which works for two different purposes. One acceleration provides the magnitude of acceleration to the object while the other one is responsible for its direction. The acceleration which is responsible for the magnitude is called as tangential acceleration or linear acceleration. The acceleration which is responsible for the direction of the object moving in a circular path is called radial acceleration or centripetal acceleration. Both the tangential and the centripetal acceleration are perpendicular to each other.Centripetal acceleration acts towards the centre of the circle and keeps the object in a circular path. This centripetal acceleration is further responsible for the Centripetal force. The normal reaction of this force is Centrifugal force which is equal in magnitude and opposite in direction to the centripetal force.As we know the centripetal acceleration is given as, ac = V2/R. Since this acceleration is responsible for the centripetal force , therefore the centripetal force is given by,F = mac = mV2/RWe also know from above that = V/RPutting the value of V from above in centripetal force, we get,F = mR2Since the object is moving in a circular path, the object must have taken some time to complete one full revolution. As we know that the time taken by the object to complete one full revolution is defined as its time period. It is denoted by T. A similar but slight different concept is frequency, which is the number of revolution made by the object in one second. Frequency is denoted by . = 1/TIn a complete revolution, the object will move a distance of S = 2R. Therefore, we will have V = 2R/TIn terms of frequency we can write V = 2R. The angular velocity can be written as, =2. The centripetal acceleration can be written as, ac = 422RCentripetal ForceCentripetal force is the force which causes any object to undergo in the circular motion. This force is actually responsible for the motion of the object in the circular path. Centripetal force acts inward towards the center of the circular path. If the centripetal force would be absent, the object will continue to move in the straight path. For example, when we swing a ball tied to string, the ball will start moving in the circular motion.Centripetal force will be acting (along the string) on the ball will keep the ball in the circular path. The moment you will release the string, the ball will loose its centripetal component and then it will follow a straight path.Centripetal force FC is given by, FC = mV2/R, where m is the mass of the object having linear velocity V and moving along a circular path of radius R. When the time period of the object to complete one revolution is T, then the linear velocity V is given by, V = 2R/T.Centripetal force in terms of time period T is given by, FC = 4m2R/T2.Centrifugal ForceNow lets talk about Centrifugal force. Have you been in a car when it is moving on a curve or circular path. You must have feel an outward sensation when the car moves in circular motion. While the car is moving in the circular path due to the centripetal force, what you were experiencing was actually the centrifugal force. Centrifugal force is actually a pseudo force (not a real force) which is experienced by the object when it is moving in a circular motion. It acts in the outward direction of the circular motion. Centrifugal force is observed in the non-inertial frame of reference. The magnitude of the centrifugal force is equal and opposite in direction to the centripetal force. That's why it is considered as the normal reaction of the the centripetal force.Centrifugal force in terms of terms of linear velocity is given by, FC = mV2/Rwhere, m is Mass of ObjectR is Radius of Circular PathV is Linear Velocity of Object Moving in Circular MotionApplications of Centripetal Force and Centrifugal ForceApplications of centripetal force and centrifugal force are observed in our daily lives are,Centripetal ForceCar Turnings: When the car turns on a curved circular path, the frictional force between the road and the tyre of the car provides sufficient centripetal force to keep the car in the circular path.Satellites Orbiting the Planet: Gravitational pull of the planet helps providing the centripetal force which is required by the satellite to keep orbiting in a circular stable path. Particle Accelerator: Due to the magnetic field, the charged particles experiences the centripetal force which keeps them in the circular path.Amusement Ride: Rotation of the amusement ride such as merry-go-round provides the necessary centripetal force which keeps the rides in circular motion.Washing Machine Spin Cycle: The clothes in the washing machine are cleaned using the centripetal force which is provided by the rotating drum inside the washing machine.Centripetal Force ExamplesCentrifugal ForceCar Turning: When the car turns on a circular path, the passengers sitting inside the car feels an outward push which is known as centrifugal force experienced by the passengers.Artificial Gravity Simulator: Artificial gravity simulator rotates simulating an artificial gravity like situation for the rider due to the centrifugal force experience by the rider in the outward direction.Cloth Dryers: Rotating motion of the dryer forces the cloth to move in circular motion providing centrifugal force to the wet clothes, and forcing the water droplets to move outward from the wet clothes and thus helping the clothes to dry.Child on a Merry-Go-Round Ride: Child experiences the outward force in a merry-go-round ride, which acts due to the centrifugal force acting on the child due to rotating motion of the ride.Equatorial Bulge of Earth: You may heard that the Earth is bulged at the equator and flattened at the poles. This is due to the centrifugal force acting on the Earth due its rotation which creates an outward force at the equator.Types of Circular MotionCircular motion can be classified into various types based on various factors. In context of physics and mechanics the object can be in circular motion in many different situations. Some common types includes:-Uniform Circular MotionNon-Uniform Circular MotionPlanetary MotionRotational MotionBut here we will learn only about, two types of circular motion, i.e., uniform circular motion and non-uniform circular motion.Uniform Circular MotionWhen any object moves in a circular path at some constant speed then we say that the object is in uniform circular motion. Their is no change in the speed of the object and hence there is no acceleration produced. However, it is to be noted that the object is moving in a circular direction and the direction of the object is changing at every point of the path. Hence the centripetal acceleration is applying on the object at every point. This acceleration is inward in direction. But the tangential or linear acceleration is zero as the linear velocity is same.Let's look at some examples now.Uniform Circular Motion ExamplesUniform circular motion has many examples which can be seen around us in everyday life. In these examples the speed is constant which results in stable angular velocity. Such examples are discussed below:Motion of Planets: The planets are revolving around the Sun shows nearly uniform motion. Although the orbital motion are slightly elliptical in nature, they can be considered to be a circular motion.Ceiling Fan Blades: The blades of the ceiling fan when in full speed shows uniform circular motion, where the blades are moving at a constant speed in the circular path.Clock Hands: The hands of the clock moves at a contact speed in a particular circular direction. All the three different hands of the clock, i.e., the second hand, the minute hand, and the hour hand moves at constant speed, respectively.Ferris Ball: The pods of the Ferris wheel when moving at a constant speed, shows a uniform circular motion.Merry-Go-Round: The merry-go-round is a classic example of uniform circular motion. When the ride starts moving at a constant speed, the carts or the horses of the merry-go-round displays uniform circular motion as it moves along with the circular platform on which it is mounted.Acceleration in Uniform Circular MotionCentripetal Acceleration can be written in terms of linear velocity of the object and the radius of the circular path, and is given by,ac = V2/Rwhere,ac is Centripetal AccelerationV is Magnitude of Linear Velocity of ObjectR is Radius of Circular PathCentripetal acceleration is inversely proportional to the radius of the circular path, which means as the radius of the path decreases the centripetal acceleration increases and vice versa. Non-Uniform Circular MotionWhen the object moves in the circular path along a fixed central point at changing speed, more specifically when the magnitude of the velocity changes over a particular period of time, then the object is said to be in non-uniform circular motion. The change in velocity can have implication on radius in non-uniform circular motion as change in velocity can bring the change in the radius of the system of the circular path on which the object is moving.Let's look at some examples now.Examples of Non-Uniform Circular MotionExamples of non-uniform circular motion shows change in speed, and angular velocity which results in varied motion of the object along the circular path. These examples show changing velocity over time, either increasing or decreasing. Such examples include,Roller Coster: Suppose a roller coster makes a loop like ride which is circular in motion. Then the roller coster will approach the loop with a particular speed and then in the middle of the loop the speed will decrease but as soon as the coster will approach the end of the loop its speed will increase. Thus showing varying speed profile and therefore, can be an example of non-uniform circular motion.Car on curved road: In practical life, the car making a turn at a curved road usually lower its speed and thus resulting in change in speed further resulting in negative acceleration, i.e., deceleration. This is also an example of non-uniform circular motion.Amusement Ride: Small Ferris wheel in amusement park or fair is usually moved with the help of a human, which moves the Ferris wheel at varying speed. Thus the speed of the pods of the Ferris wheel experiences non-uniform circular motion.Acceleration in Non-Uniform Circular MotionIn non-uniform circular motion, as the speed or the angular velocity of the object changes, it experiences both the acceleration. Therefore, the acceleration in non-uniform circular motion has two components, i.e., the tangential acceleration as well as the centripetal acceleration.Tangential Acceleration: This component of acceleration acts along the tangent to the circular path. Tangential acceleration generally changes the magnitude of the linear velocity. Tangential acceleration is given by,at = dV/dtwhere at is Tangential AccelerationdV is Change in VelocitydT is Change in TimeCentripetal Acceleration: This component of acceleration acts towards the centre of the circular path. It is directed inward towards the centre of the circular path. It is also called the radial acceleration. Centripetal acceleration is given by,ac = V2/Rwhere at is Centripetal AccelerationV is VelocityR is Radius of Circular PathApplication of Circular MotionApplication of circular motion can be found in our everyday life as well as in practical situations. Various application includes,Turning of Vehicles at Banked RoadAs we know that the centripetal force which is directed towards the centre of a vehicle moving at a circular road is given by, FC = mV2/R. This force is provided by the force of friction which is between the tyre of the vehicle and the surface of the road. Note that it is the static friction which provides the centripetal force. Suppose the static frictional coefficient is S and R is the radius of the circular road. Then the maximum speed at which the vehicle can drive at the circular flat road is given by,Vmax = (SRg)As the velocity of the vehicle is dependent on the s and R, and the radius is generally not changeable. We can reduce the contribution of the static friction on the vehicle in a circular motion if we can make the road banked at an angle.Let the angle at which the road is banked be .As the vertical component has no acceleration part, its net force must be zero, therefore,N cos = mg + FsinHorizontal component is solely responsible for the centripetal force acting on the vehicle, therefore,Nsin + Fcos = mv2/RSince F is less than sN. Therefore, in order to have the maximum velocity, we have to put,FS = sNTherefore, the equation of the vertical components will become,N cos = mg + sNsinAnd Horizontal component will become,Nsin + sNcos = mv2/RFrom vertical component, we can get the value of N to be,N = \frac{mg}{cos\theta-\mu_ssin\theta} Putting this value of N in horizontal component, we get,\frac{mg(sin\theta+\mu_scos\theta)}{cos\theta-\mu_ssin\theta} = \frac{mV_{max}^2}{R} Rearranging the term and dividing the left hand side of the equation with cos, we get Vmax to be,V_{max} = \sqrt{\frac{Rg(\mu_s+tan\theta)}{1-\mu_stan\theta}} Comparing this maximum speed with the maximum speed of the vehicle at the flat road, we can clearly see that this term has some other part in the equation which increases the maximum speed with which the vehicle can move at a banked road in a circular motion.Differences Between Uniform and Non-Uniform Circular MotionBelow is listed a table to differentiate between uniform circular motion and non-uniform circular motion.Uniform Circular Motion Vs Non-Uniform Circular MotionCharacteristicsUniform Circular MotionNon-uniform Circular MotionLinear VelocityConstant magnitudeVarying magnitude (increase or decrease)Angular VelocityConstant over timeCan increase, decrease or remain constant over timeAngular AccelerationRemains Zero as there is no change in angular velocityCan have varying value as there is change in angular velocityCentripetal AccelerationConstant magnitudeMagnitude can change (increase or decrease)Tangential AccelerationZero as the linear velocity is not changingNon-zero as there is change in linear velocity over time.Time PeriodConstant Can be constant or changingFrequencyConstantCan be constant or changingExampleMotion of Planets around Sun in the orbitCar turning on the circular path with varying speedCircular Motion and Rotational MotionBelow table highlights the difference between the circular motion and the rotational motion.Difference Between Circular Motion and Rotational MotionCharacteristicsCircular MotionRotational MotionDefinitionMotion of object when it moves in circular pathMotion of object when it rotates around an axisDefined Path of movementCircular as the object moves along the circular pathCircular but the object rotates along a fixed axis of rotationAxis of RotationOutside the bodyInside the bodyReference PointCentre of the circular pathAxis of the rotationAngular DisplacementAngle through which the object has moved along the circular pathAngle through which the object has rotated along the axis of rotationAngular VelocityRate of change of angular displacement with respect to timeRate of change of rotational speed with respect to timeAngular AccelerationRate of change of angular velocity with respect to timeRate of change of rotational speed with respect to timeExampleEarth revolving around the Sun in an orbit causing seasonal changesEarth rotating on its own axis of rotation in the orbit causing day and nightCircular Motion FormulasCircular Motion formulas are added in the table below,Physical QuantityDenoted byFormulaAngular Displacement = S/RAngular Velocity = V/RAngular Acceleration (Tangential) = a/RCentripetal Accelerationacac = V2/RCentripetal Force (in terms of V)FcFc = mV2/RCentripetal Force (in terms of)FcFc = mR2Frequency (in terms of Time period) = 1/TLinear velocity (in terms of Frequency)VV = 2RAngular velocity (in terms of Frequency) = 2Centripetal Acceleration (in terms of)acac = 422RLearn More,Distance and DisplacementVelocityAccelerationCircular Motion - Solved ExamplesExample 1: Find the angular velocity of the boy who is riding the bicycle at a speed of 10 ms-1 on a circular path of radius 25 m.Solution: We have given,Linear speed of the boy as he is riding the bicycle, V = 10 ms-1Radius of the circular path, R = 25 mWe know that, the angular velocity of the boy riding the bicycle on a circular path can be obtained by using the given formula,\omega = \frac{V}{R} Substituting the value of V and R in the formula of angular velocity, we get,\omega = \frac{10\,ms^{-1}}{25\,m} \omega = 0.4\,rad\,s^{-1} Therefore, the angular velocity () of the boy who is riding the bicycle at a speed of 10 ms-1 on a circular path of radius 25 m is 0.4 rad s-1 .Example 2: In the above problem, if the mass of the boy is 35 kg then calculate the centripetal acceleration of the boy and also find the centrifugal force acting on the boy.Solution: We know that centripetal acceleration is given by, a_c = \frac{V^2}{R} Substituting the value of V and R in above formula, we get,a_c = \frac{{(10\,ms^{-1})}^2}{25\,m} ac = 4 ms-2Now, the centrifugal force can be given by the,F_c = \frac{mV^2}{R} As the mass of the boy is given to be m = 35 kg, therefore,F_c = \frac{35\,kg.{(10ms^{-1})}^2}{25\,m} Fc = 140 NTherefore, centripetal acceleration of the boy is 4 ms-2 and the centrifugal force experienced by the boy is 140 N. Example 3: Suppose a motorcyclist is making a turn at a speed of 10 ms-2. How will the force acting towards the centre will change if he doubles its speed?Solution: As we know, the centripetal force is given by,F_c = \frac{mV^2}{R} Since, the centripetal force is directly proportional to the square of the speed, i.e.,F_c \propto V^2 Therefore, when the speed will get doubles, the centripetal force acting on the motorcyclist will increase to 4 times.Example 4: A car is going in a non-uniform motion on curve of circular path, and its tangential acceleration is given as 3 ms-2, while its centripetal acceleration is given as 4 ms-2. Calculate its total acceleration.Solution: Given,Tangential Acceleration (at) = 3 ms-2Centripetal Acceleration (ac) = 4 ms-2We know that the total acceleration is given by,a = \sqrt{a_t^2\,+\,a_c^2} Substituting values, we get,a = \sqrt{{(3\,ms^{-2})}^2\,+\,{(4\,ms^{-2})}^2} a = \sqrt{9\,+\,16} = \sqrt{25} = 5\,ms^{-2} Therefore the total acceleration is 5 ms-2.Example 5: An insect is trapped in a circular groove of radius 10 cm moves along the groove steadily and completes 5 revolutions in 100 seconds. What is the angular speed and linear speed of the motion?Solution:Given,Radius, R = 10 cmTotal revolution made = 2\pi \times5 Time taken, T = 100 sTherefore angular speed, is given by, \omega = \frac{Total\,revolution\,made}{Time\,taken} \omega = \frac{2\pi\times5}{100\,s} \omega = 0.31\,rad\,s^{-1} The linear speed, V is given by,V = RV = 0.31\,s^{-1}\,\times\,10\,cm = 3.1\,cm\,s^{-1} Therefore, the angular speed is 0.31\,rad\,s^{-1} and the linear speed is 3.1\,cm\,s^{-1} .Circular Motion - NumericalsQ1: A boy with a mass of 25 kg is rides his cycle in a circular path at a speed of 2.5 ms-1. If the radius of the circular path is 2.5 m, then calculate the centripetal acceleration of the boy.Q2: A boy is riding a merry-go-round. If he completes 10 revolutions in 20 seconds. Calculate its angular velocity.Q3: A car of mass 500 kg is moving on a circular path of radius 150 m. The car is moving at a constant speed of 50 ms-1. How much force is required to keep the car in circular motion?

What are the examples of uniform circular motion. Give one example of uniform circular motion observed in daily life. Uniform circular motion in everyday life. Uniform circular motion in daily life. Give an example of uniform circular motion observed in daily life. Example of uniform circular motion in real life.