Chapter 8 Supplemental Problems Rotational Motion Answers

Chapter 8 Supplemental Problems Rotational Motion Answers Chapter 8 Supplemental Problems Rotational Motion Answers This document provides detailed solutions to the supplemental problems presented in Chapter 8 of your textbook covering the fundamentals of rotational motion These problems are designed to challenge your understanding of concepts such as angular velocity angular acceleration torque moment of inertia and conservation of angular momentum By working through these problems you will gain a deeper understanding of the principles governing rotational motion and their application in various physical scenarios Rotational Motion Angular Velocity Angular Acceleration Torque Moment of Inertia Conservation of Angular Momentum Supplemental Problems Solutions This document provides comprehensive solutions to a set of supplemental problems designed to reinforce and enhance your understanding of rotational motion Each problem is carefully analyzed outlining the relevant concepts equations and steps involved in reaching the final answer The solutions are presented in a clear and concise manner utilizing diagrams and detailed explanations to facilitate comprehension Solutions Problem 1 The Spinning Disk A solid disk of mass M and radius R is rotating about an axis through its center with an angular velocity What is the kinetic energy of the disk Solution The kinetic energy of a rotating object is given by K 12I Where I is the moment of inertia of the object For a solid disk rotating about its center the moment of inertia is 2 I 12MR Substituting this into the kinetic energy equation we get K 1212MR 14MR Problem 2 The Rolling Cylinder A solid cylinder of mass M and radius R rolls without slipping down an incline of angle What is the linear acceleration of the cylinder Solution The linear acceleration of the cylinder can be found using the following steps 1 Draw a free body diagram The forces acting on the cylinder are gravity Mg the normal force N and friction f 2 Apply Newtons second law Fx Ma Mg sin f Fy 0 N Mg cos 3 Apply the rotational equivalent of Newtons second law torque I fR Where is the angular acceleration and I is the moment of inertia of the cylinder I 12MR 4 Relate linear and angular acceleration For rolling without slipping a R 5 Solve for the linear acceleration a Using the above equations we can solve for a to obtain a 23g sin Problem 3 The Rotating Rod A uniform rod of length L and mass M is pivoted at one end and allowed to swing freely What is the period of oscillation for small angles Solution The period of oscillation for a physical pendulum is given by T 2Imgd 3 Where I is the moment of inertia about the pivot point m is the mass and d is the distance from the pivot point to the center of mass For a rod pivoted at one end the moment of inertia about the pivot is I 13ML The distance from the pivot to the center of mass is L2 Substituting these values into the period equation we get T 213ML MgL2 22L3g Problem 4 The Conservation of Angular Momentum A figure skater is spinning with an

initial angular velocity i She then extends her arms increasing her moment of inertia from Ii to If What is her final angular velocity f Solution The principle of conservation of angular momentum states that in the absence of external torques the total angular momentum of a system remains constant Mathematically this can be expressed as Iii Iff Solving for f we get f IiIfi Since the figure skater increases her moment of inertia her final angular velocity will decrease Problem 5 The Rotating Platform A rotating platform is initially spinning with an angular velocity A person standing at the 4 edge of the platform throws a ball horizontally in the same direction as the platforms rotation Does the platforms angular velocity increase decrease or remain the same Solution The platforms angular velocity will decrease When the person throws the ball they are essentially transferring some of their angular momentum to the ball Since angular momentum is conserved the platform must lose angular momentum to compensate This results in a decrease in the platforms angular velocity Conclusion By working through these supplemental problems you have developed a deeper understanding of the key concepts governing rotational motion Youve explored how these concepts are applied in various physical scenarios from spinning disks to rolling cylinders to swinging rods Remember understanding rotational motion is crucial not only for understanding the physical world around us but also for countless engineering and scientific applications FAQs 1 What is the difference between linear and angular velocity Linear velocity describes the rate of change of an objects position in a straight line while angular velocity describes the rate of change of an objects angular position 2 How does the concept of torque relate to rotational motion Torque is the rotational equivalent of force It is a force applied at a distance from an axis of rotation causing the object to rotate 3 What is the significance of the moment of inertia in rotational motion The moment of inertia is a measure of an objects resistance to changes in its rotational motion It depends on the objects mass distribution and its shape 4 How does the conservation of angular momentum apply to realworld scenarios Conservation of angular momentum is a fundamental principle that applies to a wide range of phenomena from the spinning of planets to the angular momentum of atoms It is also important in engineering applications such as the design of spinning machines and spacecraft 5 What are some realworld examples of rotational motion Examples include spinning wheels rotating gears a spinning top a carousel and the rotation of the earth 5

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