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We've updated our Privacy Policy effective December 15. Please read our updated Privacy Policy and tap Formula About Rotational Kinetic Energy Calculator The Rotational Kinetic Energy Calculator is an essential tool in the field of physics that enables users to compute the amount of energy attained by a rotating object. It performs calculations based on specific parameters such as moment of inertia, angular velocity, and mass of the object. The calculator gives a quantified value representing the rotational kinetic energy of an object, which is a crucial aspect for understanding various mechanical systems and their performance. Rotational kinetic energy is a type of kinetic energy associated with the rotation of an object around an axis. It is essential to consider the distribution of mass within the object while determining this energy. Just as an object possesses translational kinetic energy when it moves linearly, an object with a spinning motion has rotational kinetic energy. There are three core principles to understand when using a rotational kinetic energy calculator: 1. Moment of Inertia: This term is a measure of an object's resistance to rotational motion about a given axis. It is a scalar value that considers the mass distribution around the axis and serves as the rotational analog of mass in linear motion. Objects with more mass distributed far from the axis have a larger moment of inertia, thereby requiring more torque to initiate or alter the object's rotational motion. 2. Angular Velocity: Angular velocity quantifies the speed at which an object rotates about an axis. It is defined as the angle covered by the object per unit time and is represented by the symbol '' (omega). This vector quantity is usually expressed in units of radians per second (rad/s), indicating the number of radians covered per second. 3. Mass and Radius: The mass (m) of an object and its distance from the axis of rotation (r) influence the moment of inertia. For example, in the case of a solid cylinder or disk, the moment of inertia is calculated as mr, wherein m is the mass, and r is the radius. In essence, more massive and farther objects from the axis possess higher inertia. The rotational kinetic energy calculator requires these parameters to determine the rotational kinetic energy. The formula for calculating it is given as: Rotational Kinetic Energy (K) = I Here, 'I' denotes the moment of inertia, and '' represents the angular velocity. Using this equation, one can quickly evaluate the amount of energy an object possesses because of its rotation in a mechanical system. This quantity can prove beneficial for designing various motor systems, evaluating the efficiency of power transmission in gears and flywheels, studying celestial bodies' motion, and analyzing the performance of mechanical devices such as centrifuges. To summarize, a Rotational Kinetic Energy Calculator is an essential facilitator in the realm of physics, helping users compute the rotational kinetic energy of an object based on its moment of inertia and angular velocity. By understanding these parameters and their influence on energy conservation and mechanical efficiency, scientists, engineers, and students can efficiently analyze the behavior of various spinning objects in different scenarios. These calculators make it possible to simplify complex calculations related to the rotational kinetic energy, paving the way for a deeper comprehension of rotational dynamics and their practical applications. Written By Saurav_C Last Modified 24-01-2023 How much energy do we need to rotate a wheel? How will different shapes of the object have different rotational kinetic energy? How does mass distribution affect the rotational kinetic energy? The only answer to all these questions is through the formula of rotational kinetic energy. Rotational kinetic energy describes the energy of motion of a rotating object. Rotational kinetic energy plays the same role in rotational motion as played by translational kinetic energy in translational motion. We know that the linear kinetic energy depends on the mass and speed of the body, in a similar way, the rotational kinetic energy depends on the moment of inertia (rotational mass) and angular velocity. In this article, we will provide detailed information on the rotational kinetic energy formula. Scroll down to learn more! The moment of inertia of a system is a measure of how difficult it is to cause an object to change its rotational motion about a specific axis. It is the measure of rotational inertia of a system. The moment of inertia for a rotating object depends on the mass of the object, and it also depends on how the mass is distributed about the axis of rotation. If the mass is distributed further away from the axis, then the moment of inertial will be more, then it will be harder to change its rotational motion. The values of the moment of inertia for different bodies are different. The value of the moment of inertia of some of the objects of mass \(M\)and radius \(R\)about the axis of rotation passing through their centre of mass is given below.I. MI of Circular Ring \(=\) MI of Hollow Cylinder \(= MR^2\)II. MI of Disc \(=\) MI of Solid Cylinder \(= \frac{1}{2} MR^2\)III. M.I Hollow Sphere \(= \frac{2}{3} MR^2\)IV. MI Solid sphere \(= \frac{2}{5} MR^2\)The SI unit of moment of inertia is given by \(\rm{kg}\;\rm{m}^2\) (which is consistent with our notion that it depends on mass and square of the distance from the rotational axis). The formula of rotational kinetic energy is analogous to linear kinetic energy. We know that the linear kinetic energy of a mass \(m\) moving with speed \(v\) is given by \(\frac{1}{2}\;\rm{mv}^2\). We can assume the rigid body is made up of an infinite number of point masses. At any instant of time, each point mass will be moving with a linear velocity equal to the tangential velocity of that point. The magnitude of tangential velocity at any point at distance \(r\) from the rotating axis of a rigid body rotating with angular velocity \(\) is given by, \(v = r\)For any point mass \(m_1\) of a rigid body, the kinetic energy will be given by, \(K{E_1} = \frac{1}{2}{m_1}v_1^2\)Total kinetic energy, \(K{E_R} = \sum {_1^\infty } \frac{1}{2}{m_i}v_i^2\) \(= \sum {_1^\infty } \frac{1}{2}{m_i}r\omega _i^2\) \(= \sum {_1^\infty } \frac{1}{2}{m_i}r_i^2{\omega ^2}\) \(= \frac{1}{2}{\omega ^2}\sum {_1^\infty } {m_i}r_i^2\) \(= \frac{1}{2}I{\omega ^2}\) So, the rotational kinetic energy, \(KE_R = \frac{1}{2} I^2\). Here \(I\) is the rotational mass or moment of inertia of a rotating object, and \(\) is the angular speed. Below we have provided the units of rotational kinetic energy in SI and MKS system: SI unit systemJoules(J)MKS unit systemkg.m2.s-2 We know that rotational kinetic energy is written as, \(KE = \frac{1}{2} I^2.\) The moment of inertia of any object of mass \(m\) has the dimensions of \(mr^2\). Now the dimensional formula of the moment of inertia is given by, \(\left[I \right] = {M^1}{L^2}{T^0}.\)Also, the dimensional formula of angular velocity, \(\left[\omega \right] = {M^0}{L^0}{T^{ 1}}\)By plugging the dimensional formula of the moment of inertia and angular velocity, we get:Dimensional formula of rotational kinetic energy, \(\left[{KE} \right] = {M^1}{L^2}{T^{ 2}}\), which is the same as that of energy (as it should be). Kinetic Energy of a Rigid Body in Combined Rotational and Transitional Motion When the body has both rotational and translational motion, it has both translational kinetic energy and rotational kinetic energy.The translational kinetic energy is given by, \(KE_T = \frac{1}{2} mv_{\rm{COM}}^2\). Here \(v_{\rm{COM}}\) is the translational velocity of the centre of mass of the body. Also, the rotational kinetic energy is given by, \(KE_R = \frac{1}{2} I_{\rm{COM}} \omega^2\). Here \(I_{\rm{COM}}\) is the moment of inertia of the rigid body about the rotating axis of the rigid body.Thus, the total kinetic energy of the rigid body will be,\(KE = \frac{1}{2}mv_{{\text{COM}}}^2 + \frac{1}{2}{I_{{\text{COM}}}}\omega^2\) We know that the angular momentum of the rigid body having a moment of inertia \(I\) rotating with angular speed \(\) is given by, \(L = I\).Also, the rotational kinetic energy of the rigid body is given by,\(K{E_R} = \frac{1}{2}I\omega ^2\)By multiplying the numerator and denominator of the above equation with \(I\), we will get,\(K{E_R} = \frac{1}{2}\frac{{{I^2}\omega ^2}}{I}\)\(K{E_R} = \frac{L^2}{2I}\)As \(K{E_R} = \frac{L^2}{2I}\) i.e. \(K{E_R} \propto {L^2}\)It can be represented with \(y = Kx^2\). If angular momentum is the same for two objects, then kinetic energy will be inversely proportional to the moment of inertia. So, we can say that kinetic energy will be greater for a smaller moment of inertia (If angular momentum will be the same). We know that the moment of inertia of a solid sphere about an axis passing through its centre is given by,\(I = \frac{2}{5}MR^2\) Where \(R\) is the radius of the solid sphere, and \(M\) is the mass of the solid sphere.The rotational kinetic energy of the sphere is given by,\(KE_R = \frac{1}{2} I^2\)\(= \frac{1}{2} \times \frac {2}{5} MR^2 ^2\)\(= \frac{1}{5} MR^2 ^2\) Thus the rotational kinetic energy of a solid sphere rotating about a fixed axis passing through the centre of mass will be equal to, \(KE_R = \frac{1}{5} MR^2 ^2\). Moment of inertia of solid cylinder about an axis passing through its cylinder axis is given by, \(I = \frac{1}{2} MR^2\) where \(R\) is the radius of the solid cylinder, and \(M\) is the mass of the solid cylinder.The rotational kinetic energy of the solid cylinder will be,\(KE_R = \frac{1}{2} I^2\)\(= \frac{1}{4} MR^2 ^2\) Moment of inertia of disc about an axis passing through its centre is given by \(I = \frac{1}{2} MR^2\) where \(R\) is the radius of the disc, and \(M\) is the mass of the disc.The rotational kinetic energy of the disc is given by,\(KE_R = \frac{1}{2} I^2\)\(= \frac{1}{4} MR^2 ^2\) We can observe that the moment of inertia of a solid cylinder and disc of the same mass and same angular velocity are equal. Q.1. Earth spins about its axis approximately once every \(24\) hours. Lets assume that it has a uniform density. What is its rotational kinetic energy? (we know that the radius of the Earth is \(6.37 106\,\rm{m}\), and its mass is \(5.97 1024\;\rm{kg}\).)Ans: Given,Mass of the Earth, \(m = 5.97 1024\;\rm{kg}\),The radius of the Earth, \(r = 6.37 106\;\rm{m}\).First, we must find the moment of inertia to find the rotational energy. By approximating Earth as a solid sphere, we get:Moment of inertia, \(I = \frac{2}{5} mr^2\)\(= \frac{2}{5} (5.97 1024\;\rm{kg}) (6.37 106\;\rm{m})^2 = 9.69 1037\;\rm{kg}\;\rm{m}^2\)Now the angular velocity of the Earth is \(2\;\rm{radians}\;\rm{day}^{-1}\). Converting this to \(\rm{rad}\;\rm{s}^{-1}\) gives:\(2\pi \;\frac{{{\text{radians}}}}{{{\text{day}}}} \times \frac{{1\;{\text{day}}}}{{86400\;{\text{seconds}}}} = 7.27 \times {10^{ 5}}\;{\text{rad}}{{\text{s}}^{ 1}}\)So, the rotational \(KE\) of the Earth will be:\(KE_R = \frac{1}{2} I^2\)\(= \frac{1}{2}\left({9.69 \times {{10}^{37}}\;{\text{kg}}\;{{\text{m}}^2}} \right) \times {\left({7.27 \times {{10}^{ 5}}\;{\text{rad}}\;{{\text{s}}^{ 1}}} \right)^2}\)\(= 2.56 102^9\;\rm{J}\) Q.2. A uniform solid cylinder of mass \(0.75\;\rm{kg}\) and radius \(0.1\;\rm{m}\) rolls across the floor at a constant speed of \(4\;\rm{m}\;\rm{s}^{-1}\). What is its kinetic energy?Ans: Given,Mass of the solid cylinder, \(m = 0.75\;\rm{kg}\)Radius of the cylinder, \(r = 0.1\;\rm{m}\)Linear velocity, \(v = 4\;\rm{m}\;\rm{s}^{-1}\)The total kinetic energy is given by:\(KE_{\rm{tot}} = \frac{1}{2} I + \frac{1}{2} mv\)For a uniform solid cylinder, moment of inertia is given by, \(I = \frac{1}{2} mr^2\).Now for pure rotation without slipping, \(= \frac {v}{r}\).Simplifying the expression for total kinetic energy and putting the all the given values, we will get:\(K{E_{tot}} = \frac{1}{2}\left({\frac{1}{2}m{r^2}} \right){\left({\frac{v}{r}} \right)^2} + \frac{1}{2}m{v^2}\)\(= \frac{1}{4}m{v^2} + \frac{1}{2}m{v^2} = \frac{3}{4}m{v^2}\)\(= \frac{3}{4} \times 0.75 \times {4^2}\)\(K{E_{{\text{tot}}}} = 3 \times 0.75 \times 4 = 9\;{\text{J}}\) The kinetic energy of a rotating object is analogous to linear kinetic energy. It is given by, \(KE_R = \frac{1}{2} I^2\). Here \(I\) is the rotational mass or moment of inertia of a rotating object, and \(\) is the angular speed. The SI unit of kinetic energy is \(\rm{J}\). Its dimensional formula is \(M^1 L^2 T^{-2}\). It can also be expressed in terms of the moment of inertia and angular velocity. The rotational kinetic energy in terms of the moment of inertia and angular velocity is given by, \(KE_R = \frac{L^2}{2I}\).The kinetic energy of the rigid body a rigid body in combined rotational and transitional motion is given by, \(KE = \frac{1}{2} mv_{\rm{COM}}^2 + \frac{1}{2} I_{\rm{COM}} \). Here, rotational kinetic energy is, \(KE_R = \frac{1}{2} I\), and transitional kinetic energy is, \(K_T = \frac{1}{2} mv_{\rm{COM}}^2\). Q.1. What are the units of rotational kinetic energy?Ans: Unit of the rotational kinetic energy in SI and MKS system are given below:SI unit system: Joules \((\rm{J})\)MKS unit system: \(\rm{kg}\;\rm{m}^2\;\rm{s}^2\) Q.2. What effect does rotation have on the total kinetic energy of a moving body?Ans: When the body will start rotating during linear motion, its kinetic energy will increase. The total kinetic energy will be the sum of rotational kinetic energy and translational kinetic energy. Q.3. How does rotational kinetic energy relate to linear kinetic energy?Ans: Rotational kinetic energy is analogous to linear kinetic energy. It is given by,\(K{E_R} = \frac{1}{2}I{\omega ^2}.\) In the case of combined rotation and translation, The kinetic energy of the rigid body a rigid body is given by, \(KE = \frac{1}{2}mv_{{\text{COM}}}^2 + \frac{1}{2}{I_{{\text{COM}}}}{\omega ^2}.\) Q.4. Write the formula for rotational kinetic energy?Ans: We know that rotational kinetic energy is given as \({K_{\text{R}}} = \frac{1}{2}I{\omega ^2}.\) Here \(I\) is the rotational mass or moment of inertia of a rotating object, and \(\omega\)is the angular speed. Q.5. How is rotational kinetic energy related to angular momentum?Ans: Rotational kinetic energy is given by, \({K_{\text{R}}} = \frac{{{L^2}}}{{2I}}\)where \(I\) is the moment of inertia, and \(L\) is the angular momentum. Q.6. What is the SI unit of Rotational Kinetic Energy?Ans: Joules(J) is the SI unit of rotational kinetic energy. Q.7. Define Moment of Inertia.Ans: The moment of inertia of a system is defined as a measure of how difficult it is to cause an object to change its rotational motion about a specific axis. Learn Newtons Law Of Motion We hope this detailed article on Rotational Kinetic Energy Formula has helped you in clearing your doubts. If you have any doubts do let us know about it in the comments section below and we will get back to you soon. (Last Updated On: 2024-10-18) Unleash the potential of rotational motion with Newtum's Rotational Kinetic Energy Calculator. This innovative tool helps you effortlessly calculate kinetic energy for any rotating body, sparking your curiosity to explore deeper into the mechanics of rotation. Understanding the Mechanics of Our Calculating Tool The Rotational Kinetic Energy Calculator is a sophisticated tool that allows users to compute the energy stored in a rotating object. This energy, known as rotational kinetic energy, is crucial in various physics applications, providing insights into rotational motion dynamics. Deciphering the Rotational Kinetic Energy Formula Grasp the significance of the rotational kinetic energy formula, a key component in understanding the energy mechanics of rotating bodies. It's vital for analyzing and predicting the behavior of rotating systems. Define the moment of inertia (I) of the rotating object. Determine the angular velocity () in radians per second. Apply the formula KE_rot = 1/2 * I * ^2 to calculate the rotational kinetic energy. Step-by-Step Guide to Using Our Rotational Kinetic Energy Tool Our Rotational Kinetic Energy Calculator is incredibly user-friendly. Just follow the simple instructions below, and you'll have your calculations in no time, ensuring a smooth user experience. Enter the moment of inertia for the rotating object. Input the angular velocity in the designated field. Click 'Calculate' to receive the rotational kinetic energy. Review your results displayed instantly. Outstanding Features of Our Rotational Kinetic Energy Calculator User-Friendly Interface: Designed for simplicity and ease of use. Instant Results: Get your calculations immediately. Data Security: No data is sent to the server, ensuring your information stays on your device. Accessibility Across Devices: Use the calculator on any device with a web browser. No Installation Needed: Access the tool directly online without any downloads. Examples for Clarity: Provides examples to help you understand the calculations. Transparent Process: Clear and straightforward calculation method. Educational Resource: Useful for learning and teaching purposes. Responsive Customer Support: Assistance is just a message away. Regular Updates: Benefit from the latest features and improvements. Privacy Assurance: Your data remains confidential. Efficient Retrieval: Quick and accurate energy computations. Language Accessibility: Available in multiple languages. Engaging Content: Makes learning fun and interactive. Shareable Results: Easily share your findings with others. Responsive Design: Adapts to your screen size for optimal viewing. Educational Platform Integration: Can be used alongside other learning resources. Comprehensive Documentation: Detailed guidance for using the calculator. Exploring the Applications and Usage of the Rotational Kinetic Energy Calculator Examine the rotational kinetic energy for educational purposes. Apply in engineering projects requiring rotational dynamics analysis. Utilize in physics research to study rotational motion. Integrate into mechanical system designs to optimize energy efficiency. Assess the performance of rotating machinery and components. Practical Examples to Demonstrate the Rotational Kinetic Energy Formula Example 1: Suppose a wheel with a moment of inertia (I) of 5 kg*m^2 is rotating at an angular velocity () of 10 rad/s. Using the Rotational Kinetic Energy Calculator, the kinetic energy (KE_rot) would be calculated as 1/2 * 5 * 10^2, resulting in 250 joules. Example 2: For a disc with a moment of inertia (I) of 3 kg*m^2 and an angular velocity () of 15 rad/s, the energy stored would be 1/2 * 3 * 15^2, equating to 337.5 joules of rotational kinetic energy. Ensuring Your Data Security with Our Rotational Kinetic Energy Calculator Our Rotational Kinetic Energy Calculator is not only a robust tool for understanding and calculating energy in rotating bodies, but it is also a bastion of data security. By running entirely in your browser with JavaScript and HTML, your data never leaves your device, ensuring complete privacy. Whether you're a student, educator, or professional, you can use this calculator with the confidence that your sensitive information remains secure and unexposed to any server processing. This tool stands out as a secure and reliable resource for all your rotational kinetic energy calculation needs. Frequently Asked Questions About Rotational Kinetic Energy What is rotational kinetic energy and how is it calculated? Can the Rotational Kinetic Energy Calculator be used for any rotating object? Is there a cost associated with using the Rotational Kinetic Energy Calculator? How does the calculator ensure the accuracy of the results? What makes this calculator secure compared to other online tools? With our rotational kinetic energy calculator, you can use the rotational energy formula without going into the tedious process of computation or unit change. To estimate the energy, you need to provide two physical quantities:Angular velocity - check out our other calculator to learn how to find angular velocity.Moment of inertia - the equivalent of the mass for kinetic energy. You can compute this value using the mass moment of inertia calculator.The calculator will show the result automatically after receiving the inputs. You don't need to know how to calculate rotational kinetic energy at all!The article below explains the rotational kinetic energy formula and how to find the rotational kinetic energy for a rotating ball as an example.The equation for rotational kinetic energy is the following:E=12I2E = \frac{1}{2} \times I \times \omega^2E=21I2where:EEE - The rotational kinetic energy, usually expressed in joules;III - The moment of inertia, expressed in kgm2\text{kg}\cdot\text{m}^2kgm2; and\omega - The angular velocity in radians per second.That's basically it! You now know how to find rotational kinetic energy by hand. Check the torque calculator to learn about another physical quantity related to rotational motion, or read about its units and how to convert convert Nm to ft lbs and vice-versa.Let's solve the rotational energy formula for the case of a rotating ball with the rotational kinetic energy calculator:Enter the angular velocity of the ball. We assume it's rotating with 60revolutionsperminute(RPM)60 \text{ revolutions per minute (RPM)}60revolutionsperminute(RPM) or 6.283rad/s6.283 \text{ rad/s}6.283rad/s. You can use the unit switcher in our tool if you want to use other units.Find the ball's moment of inertia using the equation I=25mr2I = \frac{2}{5}\times m \times r^2I=52mr2, where mmm is the mass and rrr the radius of the ball. In our case, we estimated it as I=1.25kgm2I = 1.25\text{ kg}\cdot\text{m}^2I=1.25kgm2.The calculator will automatically use the equation for rotational kinetic energy and present the result of 24.674J24.674 \text{ J}24.674J.Good job! You just solved the problem of how to calculate rotational kinetic energy. Enter the values of Mass of Moment of Inertia I(kg) & Angular Velocity w(radians/sec) to determine the value of Rotational Kinetic Energy E(J). Rotational Kinetic Energy Formula:The Rotational Kinetic Energy E(J) in Joules is Equal to the 0.5 into Multiply the Mass of Moment of Inertia I(kg) in kilogram and is Multiply the Angular Velocity w(radians/sec) in radians per second is squared.The Equation of Rotational Kinetic Energy can be written as,E(J) = 0.5 * I(kg) * w2(radians/sec)Here,E(J) = Rotational Kinetic Energy in JoulesI(kg) = Mass of Moment of Inertia in kilogramw(radians/sec) = Angular Velocity in radians per secondRotational Kinetic Energy Calculation:1) Calculate the Rotational Kinetic Energy and given for the Mass of Moment of Inertia = 15kg , Angular Velocity = 10rad/sec.AnswerE = 0.5 * I * w2E = 0.5 * 15 * 102E = 750J.Learn More: Voltage Calculator, Formula, Voltage Calculation2) Calculate the Angular Velocity and given for the Mass of Moment of Inertia = 15kg , Rotational Kinetic Energy = 750J.AnswerE = 0.5 * I * w2750 = 0.5 * 15 * w2w = 10rad/sec. Rotational energy is the component of kinetic energy that comes from a bodys rotation. It results when any form of matter revolves around a center of rotation. It can be converted into other forms of energy, most typically translational and heat energy. Many analogies exist between rotational kinetic energy and linear kinetic energy. There are some practical applications for rotational energy, such as the storage of energy in a spinning flywheel. The law of conservation of energy holds that the total amount of energy in an isolated system must remain constant over time. Energy losses of one type must result in energy gains of another type. Transfer of energy between types often occurs through the exchange of momentum between the atomic particles of matter. Examples of different forms of energy include chemical, potential, and thermal, in addition to rotational. Rotational energy, therefore, is one of many possible ways matter can hold energy. There are many analogies between rotational energy and linear kinetic energy. Instead of mass, rotational systems have a moment of inertia. The moment of inertia can be thought of as the resistance to angular accelerationit's similar to how mass is the resistance to linear acceleration. Moments of inertia increase when matter is further from the center of rotation. This is because it is more difficult to get a system spinning if its matter is located far from the center. Similarly, rotational systems have an angular velocity instead of a linear velocity. Angular velocity is measured in radians per second, which is equal to about 57.3 degrees per second. Both high moment of inertia and high angular velocity correspond to high rotational energy. According to the law of conservation of energy, the same amount of rotational energy can be obtained by reducing a systems moment of inertia while increasing the angular velocity. One practical application of rotational energy is the use of flywheel batteries. Just as a standard battery stores electrical energy, a flywheel battery stores rotational energy. In a train with a flywheel battery, the linear kinetic energy of the moving train can be transferred to the rotational energy of the onboard flywheel. The effect of this transfer will be a reduction in the trains velocity. If no energy is lost to heat, all the energy of the trains motion can be stored in the flywheel and later used to accelerate the train up to speed again. All The Science is dedicated to providing accurate and trustworthy information. We carefully select reputable sources and employ a rigorous fact-checking process to maintain the highest standards. To learn more about our commitment to accuracy, read our editorial process. Definition Formula Wheel example Flywheel example Calculator References Any object or body with an inertia and rotational (angular) speed has rotational kinetic energy. An object or body with zero rotational speed (which means that its stationary) will have zero rotational kinetic energy. Image: Rotational kinetic energy A spinning flywheel is a very good example of an object which possesses rotational kinetic energy. The kinetic energy of a rotating object is similar to the linear kinetic energy and can be calculated function of the moment of inertia and angular speed. Go back Formula To calculate rotational kinetic energy multiply the moment of inertia around the axis of rotation with the square value of the angular speed and divide the result to two. The equation to calculate rotational kinetic energy is [1]: where: Ek [J] rotational kinetic energy J [kgm2] moment of inertia around the axis of rotation [rad/s] angular (rotational) speed The unit of measurement of rotational kinetic energy is joule [J]. Go back Wheel example Calculate the rotational kinetic energy of a wheel with the moment of inertia of 0.015 kgm2, spinning with the rotational speed of 500 rpm. Step 1. Convert the rotational speed from [rpm] to [rad/s]: = (500) / 30 = 52.36 rad/s Step 2. Calculate the rotational kinetic energy Ek [J] of the wheel using equation (1): Ek = (J 2) / 2 = (0.015 52.362) / 2 = 20.562 J Go back Flywheel example A KERS has a flywheel with the moment of inertia of 1.03 kgm2, spinning at the speed of 10000 rpm. Calculate the rotational kinetic energy which can be stored by the flywheel [4]. Step 1. Convert the rotational speed from [rpm] to [rad/s]: = (10000) / 30 = 1047.2 rad/s Step 2. Calculate the rotational kinetic energy Ek [J] of the flywheel using equation (1): Ek = (J 2) / 2 = (1.03 1047.22) / 2 = 564763.3376 J Go back Calculator The rotational kinetic energy calculator allows you to calculate the rotational kinetic energy of a body or object with a given moment of inertia and rotational speed. You need to enter the moment of inertia and rotational speed parameters and choose the desired unit of measurement. The default unit of measurement for energy is Joule. If you want the result displayed in another unit, use the dropt down list to choose and click the CALCULATE button again. Go back References [1] David Halliday, Robert Resnick, Jearl Walker, Fundamentals of Physics, 7th edition, John Wiley & Sons, 2004. [2] Benjamin Crowell, Light and Matter Physics, 2007. [3] Raymond A. Serway and John W. Jr. Jewett, Physics for Scientists and Engineers, 6th edition, Brooks/Cole Publishing Co.,2004 [4] Jiansong Li, Jiyun Zhao, and Xiaochun Zhang, A Novel Energy Recovery System Integrating Flywheel and Flow Regeneration for a Hydraulic Excavator Boom System, Energies 2020. [5] Leo H. Holthuijsen, Waves in oceanic and coastal waters, Cambridge University Press, 2007. [6] Kira Grogg, Harvesting the Wind: The Physics of Wind Turbines, Carleton College, 2005. Dear user, Our website provides free and high quality content by displaying ads to our visitors. Please support us by disabling your Ad blocker for our site. Thank you! Definition Formula Wheel example Flywheel example Calculator References Any object or body with an inertia and rotational (angular) speed has rotational kinetic energy. An object or body with zero rotational speed (which means that its stationary) will have zero rotational kinetic energy. 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Bogna SzykDominik Czernia, PhDPhD, Institute of Nuclear Physics PANDominik Czernia, PhD, is a physicist at the Institute of Nuclear Physics in Krakw, specializing in condensed matter physics with a focus on molecular magnetism. He has led several national research projects, pioneering innovative approaches to novel materials for high technology. Passionate about making science accessible, Dominik has created various calculators, mostly in physics and math categories. In his free time, he enjoys family walks, city explorations, mountain hiking, and traveling everywhere by bike. See full profileCheck our editorial policy and Steven WoodingSteven Wooding is a physicist by training with a degree from the University of Surrey specializing in nuclear physics. He loves data analysis and computer programming. He has worked on exciting projects such as environmentally aware radar, using genetic algorithms to tune radar, and building the UK vaccine queue calculator. Steve is now the Editorial Quality Assurance Coordinator here at Omni Calculator, making sure every calculator meets the standards our users expect. In his spare time, he enjoys cycling, photography, wildlife watching, and long walks. See full profileCheck our editorial policy43 people find this calculator helpfulThis rotational kinetic energy calculator is a tool that lets you determine the energy of a rotating object, such as a spindle or a wheel, or a carousel.In this article, we will provide you with all information you will need to make your calculations, including the rotational kinetic energy formula.We will also show you how to calculate rotational kinetic energy, illustrating the guidelines with a step-by-step example.Rotational energy is a form of kinetic energy (see kinetic energy calculator). It describes the energy of an object in motion. While regular kinetic energy is related to objects moving along a straight line, rotational energy is linked with rotating objects. That is why, instead of a linear speed, we have to use angular velocity in our calculations.Remember that if an object is both in translation (moving along a straight line) and rotation (turning around its axis), it has both regular and rotational kinetic energy. Therefore, to find out its total energy, you must calculate and add both values.Just as potential energy can be calculated using the potential energy formula, rotational kinetic energy can be expressed with a straightforward equation. In this case:RE=0.5I2\small{\rm RE} = 0.5 I \omega^2RE=0.5I2where:RE\rm RERE Rotational kinetic energy, expressed in joules;III Moment of inertia of the object, expressed in kgm; and\omega Angular velocity of the body, expressed in radians per second, hertz (rotations per second), or RPM (revolutions per minute) after the appropriate unit conversion. If you're not sure how to calculate this value for a body in rotary motion, head straight to our centrifugal force calculator to find out.Let's analyze the following example together: a wheel of radius R=0.5mR = 0.5\ \rm{m}R=0.5m and mass M=1kgM = 1\ \rm{kg}M=1kg is rolling along a track, making 30 revolutions per minute. What is its rotational energy?First, we need to determine the wheel's angular velocity. We know that it is equal to 30 RPM, which is equivalent to about 3.1416 rad/s.Then, we need to calculate the wheel's moment of inertia. We already know its radius. As the wheel has the shape of a circle, we can express its moment of inertia with the equation:I=MR2=10.52=0.25kgm2\qquad \small\begin{align*}I &= MR^2\\&= 1 \times 0.5^2 = 0.25\ \rm{kg}\cdot\rm{m}^2\end{align*}I=MR2=10.52=0.25kgm2Once we know both the angular velocity and the moment of inertia, all we have to do is plug them into the rotational kinetic energy formula:RE=0.5I2=0.50.253.141621.2337J\qquad \small\begin{align*}{\rm RE} &= 0.5 \times I \times \omega^2\\&= 0.5 \times 0.25 \times 3.1416^2\\&\approx 1.2337\ \rm J\end{align*}RE=0.5I2=0.50.253.141621.2337JWe have found that the rotational kinetic energy of the rolling wheel equals about 1.2337 J.And if you'd like to learn about three-dimensional rotations, make sure to check Omni's quaternion calculator.Rotational kinetic energyDid we solve your problem today?Check out 22 similar rotational and periodic motion calculators The formula to calculate Rotational Energy is: $$ E_{rot} = \frac{\hbar^2 \times \beta}{2I} $$ Where: $\hbar$ (h-bar) is the reduced Planck constant (1.054571817 10 Js) The Rotational Energy (Erot) is the energy associated with the rotational levels in rotational spectroscopy of molecules. Beta () is a dimensionless parameter in the Schrdinger equation related to rotational energy levels. Moment of Inertia (I) is the measure of the resistance of a body to angular acceleration about a given axis. Let's assume the following values: Beta () = 7 Moment of Inertia (I) = 1.125 kgm Using the formula: $$ E_{rot} = \frac{(1.054571817 \times 10^{-34})^2 \times 7}{2 \times 1.125} \approx 3.4599 \times 10^{-68} \, \text{J} $$ The Rotational Energy is approximately 3.4599 10 J. Rotational energy is the kinetic energy associated with the rotation of an object and is part of its total kinetic energy. 2. Why is the energy value so small? The energy values are extremely small because the reduced Planck constant is very small (10 scale) and it appears squared in the numerator. 3. What is the physical significance of Beta? Beta () represents the rotational quantum number in the Schrdinger equation and determines the allowed rotational energy levels. 4. What units should I use for inputs? Beta is dimensionless, and Moment of Inertia should be in kgm. The calculator returns energy in Joules. 5. Can this be used for molecular systems? Yes, this calculation is particularly relevant for understanding rotational energy levels in diatomic and polyatomic molecules. Calculator - All Rights Reserved 2025 Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. 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Understanding the Mechanics of Our Calculating Tool The Rotational Kinetic Energy Calculator is a sophisticated tool that allows users to compute the energy stored in a rotating object. This energy, known as rotational kinetic energy, is crucial in various physics applications, providing insights into rotational motion dynamics. Deciphering the Rotational Kinetic Energy Formula Grasp the significance of the rotational kinetic energy formula, a key component in understanding the energy mechanics of rotating bodies. It's vital for analyzing and predicting the behavior of rotating systems. Define the moment of inertia (I) of the rotating object. Determine the angular velocity () in radians per second. Apply the formula KE_rot = 1/2 * I * ^2 to calculate the rotational kinetic energy. Step-by-Step Guide to Using Our Rotational Kinetic Energy Tool Our Rotational Kinetic Energy Calculator is incredibly user-friendly. Just follow the simple instructions below, and you'll have your calculations in no time, ensuring a smooth user experience. Enter the moment of inertia for the rotating object. Input the angular velocity in the designated field. Click 'Calculate' to receive the rotational kinetic energy. Review your results displayed instantly. Outstanding Features of Our Rotational Kinetic Energy Calculator User-Friendly Interface: Designed for simplicity and ease of use. Instant Results: Get your calculations immediately. Data Security: No data is sent to the server, ensuring your information stays on your device. Accessibility Across Devices: Use the calculator on any device with a web browser. No Installation Needed: Access the tool directly online without any downloads. Examples for Clarity: Provides examples to help you understand the calculations. Transparent Process: Clear and straightforward calculation method. Educational Resource: Useful for learning and teaching purposes. 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Assess the performance of rotating machinery and components. Practical Examples to Demonstrate the Rotational Kinetic Energy Formula Example 1: Suppose a wheel with a moment of inertia (I) of 5 kg*m^2 is rotating at an angular velocity () of 10 rad/s. Using the Rotational Kinetic Energy Calculator, the kinetic energy (KE_rot) would be calculated as 1/2 * 5 * 10^2, resulting in 250 joules. Example 2: For a disc with a moment of inertia (I) of 3 kg*m^2 and an angular velocity () of 15 rad/s, the energy stored would be 1/2 * 3 * 15^2, equating to 337.5 joules of rotational kinetic energy. Ensuring Your Data Security with Our Rotational Kinetic Energy Calculator Our Rotational Kinetic Energy Calculator is not only a robust tool for understanding and calculating energy in rotating bodies, but it is also a bastion of data security. By running entirely in your browser with JavaScript and HTML, your data never leaves your device, ensuring complete privacy. Whether you're a student, educator, or professional, you can use this calculator with the confidence that your sensitive information remains secure and unexposed to any server processing. This tool stands out as a secure and reliable resource for all your rotational kinetic energy calculation needs. Frequently Asked Questions About Rotational Kinetic Energy What is rotational kinetic energy and how is it calculated? Can the Rotational Kinetic Energy Calculator be used for any rotating object? Is there a cost associated with using the Rotational Kinetic Energy Calculator? How does the calculator ensure the accuracy of the results? What makes this calculator secure compared to other online tools? Definition Formula Wheel example Flywheel example Calculator References Any object or body with an inertia and rotational (angular) speed has rotational kinetic energy. An object or body with zero rotational speed (which means that its stationary) will have zero rotational kinetic energy. Image: Rotational kinetic energy A spinning flywheel is a very good example of an object which possesses rotational kinetic energy. The kinetic energy of a rotating object is similar to the linear kinetic energy and can be calculated function of the moment of inertia and angular speed. Go back Formula To calculate rotational kinetic energy multiply the moment of inertia around the axis of rotation with the square value of the angular speed and divide the result to two. The equation to calculate rotational kinetic energy is [1]: where: Ek [J] rotational kinetic energy J [kgm2] moment of inertia around the axis of rotation [rad/s] angular (rotational) speed The unit of measurement of rotational kinetic energy is joule [J]. Go back Wheel example Calculate the rotational kinetic energy of a wheel with the moment of inertia of 0.015 kgm2, spinning with the rotational speed of 500 rpm. Step 1. Convert the rotational speed from [rpm] to [rad/s]: = (500) / 30 = 52.36 rad/s Step 2. Calculate the rotational kinetic energy Ek [J] of the wheel using equation (1): Ek = (J 2) / 2 = (0.015 52.362) / 2 = 20.562 J Go back Flywheel example A KERS has a flywheel with the moment of inertia of 1.03 kgm2, spinning at the speed of 10000 rpm. Calculate the rotational kinetic energy which can be stored by the flywheel [4]. Step 1. Convert the rotational speed from [rpm] to [rad/s]: = (10000) / 30 = 1047.2 rad/s Step 2. Calculate the rotational kinetic energy Ek [J] of the flywheel using equation (1): Ek = (J 2) / 2 = (1.03 1047.22) / 2 = 564763.3376 J Go back Calculator The rotational kinetic energy calculator allows you to calculate the rotational kinetic energy of a body or object with a given moment of inertia and rotational speed. You need to enter the moment of inertia and rotational speed parameters and choose the desired unit of measurement. The default unit of measurement for energy is Joule. If you want the result displayed in another unit, use the dropt down list to choose and click the CALCULATE button again. Go back References [1] David Halliday, Robert Resnick, Jearl Walker, Fundamentals of Physics, 7th edition, John Wiley & Sons, 2004. [2] Benjamin Crowell, Light and Matter Physics, 2007. [3] Raymond A. Serway and John W. Jr. Jewett, Physics for Scientists and Engineers, 6th edition, Brooks/Cole Publishing Co.,2004 [4] Jiansong Li, Jiyun Zhao, and Xiaochun Zhang, A Novel Energy Recovery System Integrating Flywheel and Flow Regeneration for a Hydraulic Excavator Boom System, Energies 2020. [5] Leo H. Holthuijsen, Waves in oceanic and coastal waters, Cambridge University Press, 2007. [6] Kira Grogg, Harvesting the Wind: The Physics of Wind Turbines, Carleton College, 2005. Dear user, Our website provides free and high quality content by displaying ads to our visitors. Please support us by disabling your Ad blocker for our site. Thank you! The rotational kinetic energy calculator operates on the fundamental principle that any rotating object possesses energy due to its motion. This energy is determined by two crucial factors: the object's moment of inertia (I) and its angular velocity (). The mathematical relationship is expressed through the equation E_rot = I, where E_rot represents the rotational kinetic energy measured in Joules (J). The moment of inertia, measured in kilogram-square meters (kgm), represents how an object's mass is distributed around its axis of rotation. Think of it as the rotational equivalent of mass in linear motion. A larger moment of inertia means the object requires more energy to change its rotational speed. The angular velocity, measured in radians per second (rad/s), indicates how quickly the object rotates around its axis. Our calculator uses advanced JavaScript algorithms to instantly compute the rotational kinetic energy when you input these values. It also features an interactive graph that visualizes how energy changes with varying angular velocities, helping you understand the quadratic relationship between speed and energy. The real-time calculations ensure accuracy and save valuable time compared to manual computations. We are independent & ad-supported. We may earn a commission for purchases made through our links. Advertiser Disclosure Our website is an independent, advertising-supported platform. We provide our content free of charge to our readers, and to keep it that way, we rely on revenue generated through advertisements and affiliate partnerships. This means that when you click on certain links on our site and make a purchase, we may earn a commission. Learn more. How We Make Money We sustain our operations through affiliate commissions and advertising. If you click on an affiliate link and make a purchase, we may receive a commission from the merchant at no additional cost to you. 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Jr. Jewett, Physics for Scientists and Engineers, 6th edition, Brooks/Cole Publishing Co.,2004 [4] Jiansong Li, Jiyun Zhao, and Xiaochun Zhang, A Novel Energy Recovery System Integrating Flywheel and Flow Regeneration for a Hydraulic Excavator Boom System, Energies 2020. [5] Leo H. Holthuijsen, Waves in oceanic and coastal waters, Cambridge University Press, 2007. [6] Kira Grogg, Harvesting the Wind: The Physics of Wind Turbines, Carleton College, 2005. Dear user, Our website provides free and high quality content by displaying ads to our visitors. Please support us by disabling your Ad blocker for our site. Thank you!

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