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A Proof of Residency Letter (also known as a residency affidavit or verification of address letter) is a written statement that confirms where a person... A Parole Opposition Letter is a written statement submitted to a parole board by a victim, family member, or concerned citizen opposing the early release... A Housing Hardship Letter is a formal written statement provided by a tenant to a landlord, housing authority, or court explaining financial or personal difficulties... An Employment Verification Letter for Court is an official document written by an employer that confirms a current or past employee's job status. Courts often... A compassionate release letter is a formal request submitted to a federal judge, asking for the early release of an incarcerated individual due to extraordinary... A Victim Impact Statement is a powerful personal account delivered by a victim, or their loved ones, to a court at the time of sentencing... 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Writing an academic conference invitation letter is key to gathering a diverse and knowledgeable group of participants. This guide offers a free template for such... This lesson explores two new transformations, rotations and dilations. Rotations move shapes around a central point, while dilations either enlarge or shrink geometric figures without changing their shape. In the following applet, points A, B, C, and D, are movable. Arrange them as desired, then use the slider bar to rotate the points around the central point P. Use the measuring tool to fill in the following table with the distances between P and the image and preimage of each point. PA' PA' PB' PB' PC' PC' PD' PD' What conclusions can be drawn from the table? Repeat the process with different arrangements of points as needed to see a pattern. This time, use the slider bar to rotate triangle ABC about point P. Then, use the measuring tool to determine the angle measures of $\angle APA'$, $\angle BPB'$, and $\angle CPC'$. Change the triangle and perform the same procedure. What can be said about rotations? Does the conclusion depend on the position of P relative to the triangle? A rotation is a transformation in which a figure is turned about a fixed point P. The number of degrees the figure rotates α° is the angle of rotation. The fixed point P is called the center of rotation. Rotations map every point A in the plane to its image A' such that one of the following statements is satisfied. If A is the center of rotation, then A and A' are the same point. If A is not the center of rotation, then A and A' are equidistant from P, with $\angle APA'$ measuring α° . Rotations are usually performed counterclockwise unless stated otherwise. Since rotations preserve side lengths and angle measures, they are rigid motions. Rotations can be performed by hand with the help of a straightedge, a compass, and a protractor. To rotate point A about point P by an angle of 130° measured counterclockwise, follow these five steps. Place the center of the protractor on P and align it with PA. The protractor is placed as illustrated above when the rotation is counterclockwise. If the rotation has to be done clockwise, the protractor needs to be placed as follows. Locate the corresponding measure on the protractor and make a small mark. In this case, the mark will be made at 130° . Using the straightedge, draw a ray with starting point P that passes through the mark made in the previous step. Place the compass tip on P and open it to the distance between P and A. Without changing this setting and keeping the point of the compass at P, draw a small arc centered at P that intersects the ray drawn before. The intersection of the ray and the arc is the image A' after the give rotation. Notice that this method of construction has also confirmed that PA is congruent to PA'. Vincenzo and Zosia are two friends who love exploring the world of puzzles. Within the pages of a book discussing transformations, they find a circular disk with letters on it. They decide to call the disk a Cryptawheel. The Cryptawheel has a movable triangle with one vertex fixed at the center of the circular disk. To reveal its secrets, the friends need to rotate the triangle. Two vertices of the triangle show the letters N and E. These are the first two letters of a clue. Rotate the triangle 180° clockwise around its fixed vertex to find the other two letters. Zosia wants to perform this rotation using a protractor to be mathematically sure. Help her in this task. Start by rotating the vertices of the triangle. To do so, use a protractor to draw a 180° angle. Zosia's goal is to find the image of the triangle after a 180° clockwise rotation about its fixed vertex. Labeling the vertices of the triangle will make this rotation process simpler. The center of rotation is O and the angle of rotation is 180° . Perform the rotation by rotating one point at a time. To rotate N, place the center of the protractor on O and align it with NO. Use the protractor to draw a ray that starts from O and makes a 180° angle with NO. Then, mark a point N' on this ray so that ON' is the same length as ON. This is the image of N after the rotation. Since ON is the radius of the inner circle, N' should also be on that circle. Repeat the same process for the vertex E to find E'. Since O is the center of rotation, O will be in the same position as O. Finally connect N', E', and O' to draw the image of NEO after the 180° rotation. As shown, the image N' corresponds to P and E' corresponds to T. Therefore, the clue Vincenzo and Zosia is looking for is NEPT. Vincenzo, on the other hand, completes this rotation task by solely relying on his eyes, without the use of any extra tools. The applet shows how he rotated the triangle 180° about its fixed vertex. Notice that a 180° clockwise rotation and a 180° counterclockwise rotation produce the same image. Therefore, there is no need to specify direction when rotating a figure by 180° . Rotate triangle ABC around the red point on the specified angle and direction. Use the measuring tool to determine where the vertices of the triangle will end up after the rotation. In the coordinate plane, when a point is rotated counterclockwise around the origin at certain angles, its coordinates change in a specific way. This occurs when the angle of rotation is 90° , 180° , or 270° . Try to figure these patterns out using the following applet. From the diagram, the following rules can be set. Counterclockwise Rotations Around the Origin Angle of Rotation Rule 90° (x,y) \rightarrow (-y,x) 180° (x,y) \rightarrow (-x,-y) 270° (x,y) \rightarrow (y,-x) The clue Vincenzo and Zosia found reminded them of the word Neptune. Vincenzo had previously heard stories about this magical place. He had even heard about three ordinary students who had found a door into a mystical library. Could this be another doorway to that place? As they got closer, a puzzle appeared between the columns of the gate. Graph the figure and its image after a 90° counterclockwise rotation about the origin on the same coordinate plane. When a point with coordinates (x,y) is rotated 90° counterclockwise about the origin, its image becomes (-y,x). Zosia and Vincenzo want to rotate the figure 90° counterclockwise around the origin. This can be achieved by rotating each point of the original figure. In this case, four points will be sufficient to determine the position of the image. When a counterclockwise rotation is performed about the origin, the coordinates of the image can be written in relation to the coordinates of the preimage. Counterclockwise Rotations About the Origin 90° Rotation 180° Rotation 270° Rotation Preimage(x,y) \rightarrow Image(y,-x) Preimage(x,y) \rightarrow Image(-x,-y) Preimage(x,y) \rightarrow Image(-y,x) Use the coordinate changes shown in the table that correspond to a 90° counterclockwise rotation about the origin to determine the coordinates of the image of each point. Preimage(x,y)A(5,-1)B(-2,-3)C(5,-5)D(4,-3)Image(x,y)A'(1,-5)B'(3,-2)C'(5,-5)D'(3,-4) Now plot the image points and connect them. The final figure will be the image of the given figure after the rotation! The applet shows how the figure is rotated 90° counterclockwise about the origin. Notice that this rotation maps quadrilateral ABCD onto quadrilateral A'B'C'D'. The gate swings open as the figure rotates into place. Zosia takes the first step through the gate, while Vincenzo hesitantly waits to see what happens. Use the sliders to see how Zosia's size changes as she passes through the gate and down the hall. As he watches Zosia's size change with amazement, Vincenzo notices that her image changes relative to a fixed point. How can this point be identified? Feeling braver, Vincenzo steps through the gate as well. Inside, her and Zosia find an old notebook with a big red dot on one page. Zosia draws a figure on the page and watches as it changes size. The friends are excited about the magical discovery and eager to comprehend the logic behind it. What other surprises lie ahead? As they explore the magical realm, Vincenzo and Zosia come across Dilatius the Dimension Shifter, a wizard who can change the size of objects using dilations. They realize that the notebook they found belongs to the wizard and excitedly ask him to teach them about dilation. Dilatius thrilled to share his knowledge with them. A dilation is a transformation that changes the size of a figure while keeping its shape the same. This transformation involves enlarging or reducing the figure by a certain length scale factor k from a fixed point O called the center of dilation. For example, the image of every point on a leaf lies on the ray that starts at the center of the dilation and passes through its preimage. As shown in the diagram, O is the center of the dilation, k is the scale factor, A is the preimage, and A' is the image point. By definition, the scale factor k can also be defined as the ratio of a length in the image to the corresponding length in the preimage. When the scale factor is greater than 1, the dilation is called an enlargement because the image is larger than the preimage. When the scale factor is between 0 and 1, the dilation is called a reduction because the image is smaller than the preimage. When a point is dilated using a scale factor of k and a center of dilation at the origin, the coordinates of its image are found by multiplying the coordinates of the preimage by k. The diagram shows how the image changes as the preimage and the scale factor change. Dilatius is impressed by Vincenzo and Zosia's eagerness to learn. They seem to have picked up the dilation spell using the coordinate rule quickly, so he challenges them to dilate the following triangle. Draw the image of the triangle after a dilation with center (0,0) and a scale factor of 3. To find the image of a vertex after a dilation with scale factor k, multiply its coordinates by k. Zosia and Vincenzo need to dilate the triangle using a scale factor of 3 with respect to the origin. Start by identifying the vertices of the triangle. When the center of dilation is the origin, each coordinate of the preimage is multiplied by the scale factor k to find the coordinates of the image. Preimage(x,y) \rightarrow Image(kx,ky) Find the coordinates of the vertices of $\triangle ABC$ after a dilation with a scale factor k=3. Dilation With Scale Factor k=3 Preimage Multiply by k Image A(0,2) (3*0,3*2) A'(0,6) B(3,1) (3*3,3*1) B'(9,3) C(2,-1) (3*2,3*(-1)) C'(6,-3) Finally, plot the image points and connect them with segments. The new triangle will be the image of the given figure after the dilation! To check the answer, draw rays from the origin through the vertices of the original figure. The vertices of the dilation should lie on those rays. Notice that OA' is 3 times as long as OA since 3 is the scale factor. This also applies to other side lengths. OA'=3*OA=3*OB=3*OC Dilatius teaches Vincenzo and Zosia to use *reducio* to make things smaller and *enlargio* to make them bigger. These phrases produce a reduction and an enlargement, respectively. He then quizzes them about the magic behind the drawings in his notebook. The green square is a dilation of the blue square. Determine whether the dilation is an enlargement or a reduction and the scale factor of the dilation. A.B.C.D.Type of DilationReductionEnlargementReductionEnlargementScale Factor2123323 The scale factor is the ratio of the sides lengths of the image to the corresponding side lengths of the original figure. There are two types of dilations. Enlargement: The image is larger than the original figure. An enlargement is the product of a scale factor greater than 1. Reduction: The image is smaller than the original figure. A reduction is the product of a scale factor between 0 and 1. In the given coordinate plane, it can be seen that the green square is smaller than the blue square. This means that the dilation is a reduction. Next, remember that the scale factor is the ratio of the sides lengths of the image to the corresponding side lengths of the preimage. Scale Factor=Preimage Side LengthImage Side Length In the graph, AB is 9 units long and the corresponding side A'B' is 6 units long. Substitute these values into the formula to find the scale factor. The scale factor is equal to $\frac{6}{9} = \frac{2}{3}$. Therefore, the green square is a reduction of the blue square with a scale factor of $\frac{2}{3}$. The answer is C. To check the answer, draw rays from the origin through the vertices of the original figure. The vertices of the dilation should lie on those rays. The square ABCD has a side length of 9 units, while the square A'B'C'D' has a side length of 6 units. Therefore, the scale factor is $\frac{6}{9}$, or $\frac{2}{3}$. Reflecting on their journey, Vincenzo and Zosia realized that both rotations and dilations preserve the original shape of an object. Consider, for example, a triangle. No matter how much it is rotated or dilated, its image is still a triangle. However, these transformations do still transform the preimage, almost like a magic trick. Rotations can change the orientation of a figure. Dilations reduce or enlarge a figure while preserving its original shape and angle measures. 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PDF Printable Algebra Worksheets PDF You can all these worksheets for different grades in the PDF form. All you need to do is download these worksheets in PDF format. Then you can print them and use them for practicing and improving your skills. PDF Template 1 PDF Template 2 PDF Template 3 PDF Template 4 PDF Template 5 A dilation is a type of transformation that changes the size of the image. The scale factor, sometimes called the scalar factor, measures how much larger or smaller the image is. Below is a picture of each type of dilation (one that gets larger and one that gets smaller). The picture below shows a dilation with a scale factor of 2. This means that the image, A', is twice as large as the pre-image A. Like other transformations, prime notation is used to distinguish the image from the pre-image. The image always has a prime after the letter such as A'. Dilations can also reduce the size of shape. The picture below demonstrates a dilation of $\frac{1}{2}$. Any time that the scale factor is a fraction, the image will get smaller. It's always easier to understand a concept by looking at specific examples with pictures, so I suggest looking at the dilation examples below first...before you try to internalize the general formula for dilating a point with coordinates of (2, 4) by a scale factor of $\frac{1}{2}$. Multiply both coordinates by scale factor $(\frac{1}{2} \cdot 2, \frac{1}{2} \cdot 4) \rightarrow (1, 2)$. 4) $(\frac{1}{2} \cdot 2, \frac{1}{2} \cdot 4) \rightarrow (1, 2)$ 2) Simplify (1, 2) 3) Graph (if required) Dilation Demonstration Dilation Demonstration Perform a Dilation of 3 on point A (2, 1) which you can see in the graph below. Multiply the coordinates of the original point (2, 1), called the image, by 3. Image's coordinates = (2 * 3, 1 * 3) to get the coordinates of the image (6, 3). Perform a Dilation of 4 on point A (2, 3) which you can see in the picture below. Multiply the coordinates of the original point (2, 3), called the image, by 4. Image's coordinates = (2 * 4, 3 * 4) to get the coordinates of the image (8, 12). Perform a Dilation of $\frac{1}{2}$ on point A (2, 4) which you can see in the picture below. Use the formula for dilations. 1) Multiply both coordinates by scale factor (2 * $\frac{1}{2}$, 4 * $\frac{1}{2}$) 2) Simplify (1, 2) 3) Graph (if required) see picture below Perform a Dilation of $\frac{1}{3}$ on point A (3, 6) which you can see in the picture below. Use the formula for dilations. 1) Multiply both coordinates by scale factor (3 * $\frac{1}{3}$, 6 * $\frac{1}{3}$) 2) Simplify (1, 2) 3) Graph (if required) see picture below What is the image of Triangle ABC graphed below after a dilation of $\frac{1}{2}$? Multiply each vertex by the scale factor of $\frac{1}{2}$! And plot the new coordinates. © 2025 TeacherTube. All Rights Reserved. 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Learn skills in a logical order and you'll be able to answer a range of question types - get ready to watch your confidence grow! We hope that our content will be enough to help you reach your goals. But if you need more support you can reach out to us at any time.