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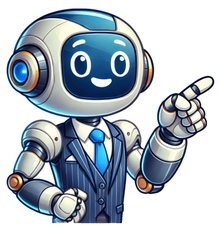

We need to be very careful when we are dealing with mathematically similar shapes and are asked to work out the length, area or volume. This is because the length scale factor, area scale factor and volume scale factor are all going to be different. The different scale factors all relate to one another, but they are all different. The table below shows the rules for the different scale factors. Let’s have an example to prove that this is the case. We have two cubes; a smaller cube and a larger cube. The smaller cube has sides of 2 cm and the larger cube has sides of 8 cm. Length Scale FactorLet’s first work out the length scale factor. We are going to do this by dividing a side in the larger shape by the corresponding side in the smaller shape (as this is a cube, all of the sides are going to be the same, so any side will be 2 cm in the smaller shape and 8 cm in the larger shape). The length scale factor is 4. Area Scale Factor According to the rule, the area scale factor will be the length scale factor squared. This means that the area scale factor should be 16 (42 = 4 x 4 = 16). Let’s just check that this is true by working out the surface area for the smaller and larger cube. A cube has 6 faces and the area of each of these faces are the same. The smaller cube has sides of length 2 cm, which means that the area of one of the faces is 4 cm2 (2 x 2). As there are 6 faces with the same area, we must multiply this value by 6, which tells us that the surface area of the smaller cube is 24 cm2. The larger cube has sides of length of 8 cm. This means that the area of one of the faces is 64 cm2 (8 x 8). To obtain the overall surface area, we multiply the area of one face by 6 and this gives us a total surface area of 384 cm2 (6 x 64). We now have both surface areas which means that we can work out the area scale factor. We do this by dividing the surface area of the larger cube by the surface area of the smaller cube (the larger cube has a surface are of 384 cm2 and the smaller cube has a surface area of 24 cm2). This is exactly the same value as the rule stated that we should obtain. Volume Scale Factor According to the rule, the volume scale factor should be the length scale factor cubed. Earlier we found that the length scale factor was 4, which means that the volume scale factor should be 64 (43 = 4 x 4 x 4). Let’s check that it is 64 by working out the volumes of the cubes that we were given. We work out the volume of a cube by cubing one of the sides. The sides of the smaller cube are 2 cm, which means that the smaller shape has a volume of 8 cm3 (23 = 2 x 2 x 2). The larger cube has sides of 8 cm, which means that the volume of the larger cube is 512 cm3 (83 = 8 x 8 x 8). We can find the volume scale factor by dividing the volume of the larger cube by the volume of the smaller cube. The volume of the larger cube is 512 cm3 and the volume of the smaller cube is 8 cm3. This gives us exactly the same value as the rule stated. Therefore, we can see that all of the rules that were given in the table for the three different scale factors work. It is probably worth writing these rules on a revision card. All Together The LSF, ASF and VSF for this example are shown in the table below. Therefore, we can see that all of the rules that were given in the table for the three different scale factors work. It is probably worth writing these rules on a revision card. In this section we look at what happens to the area of shapes and the volume of solids when the lengths in those shapes or solids are enlarged by a particular scale factor. The examples below will explain further. Example 1 Consider a rectangle 5cm by 2cm. The area of the rectangle is 5cm × 2cm = 10cm², but what happens if the rectangle is enlarged? We will start by multiplying the lengths by scale factor 2. The rectangle is now 10cm by 4cm and the area is 40 cm². The lengths were multiplied by 2, but the area has been multiplied by a scale factor of 4. Now we will multiply the lengths in the original rectangle by scale factor 3. The rectangle is now 15cm by 6cm and the area is 90 cm². The lengths were multiplied by 3, but the area has been multiplied by a scale factor of 9. Finally, we will try multiplying the lengths by scale factor 5. The rectangle is now 25cm by 10cm and the area is 250 cm². The lengths were multiplied by 5, but the area has been multiplied by a scale factor of 25. You should see a pattern! When all the lengths are multiplied by k, the areas are multiplied by k². Example 2 Consider a cuboid with sides of length 3cm, 4cm and 5cm. The volume of the cuboid is 3cm × 4cm × 5cm = 60cm³, but what happens if the cuboid is enlarged? We will start by multiplying the lengths by scale factor 2. The rectangle is now 6cm by 8cm by 10cm and the volume is 480 cm³. The lengths were multiplied by 2, but the volume has been multiplied by a scale factor of 8. Now we will multiply the lengths in the original cuboid by scale factor 3. The rectangle is now 9cm by 12cm by 15cm and the volume is 1620 cm³. The lengths were multiplied by 3, but the volume has been multiplied by a scale factor of 27. Finally, we will try multiplying the lengths by scale factor 10. The rectangle is now 30cm by 40cm by 50cm and the volume is 60000 cm³. The lengths were multiplied by 10, but the volume has been multiplied by a scale factor of 1000. You should see a pattern again – when all the lengths are multiplied by k, the volumes are multiplied by k³. General Rule If the lengths in a shape or solid are all multiplied by a scalefactor of k, then the areas will be multiplied by a scale factor of k² and the volumes will be multiplied by a scale factor of k³. For example, if the lengths are enlarged with scale factor 4, then the areas will be enlarged with scale factor 16 and the volumes will be enlarged with scale factor 64. Practice Questions Work out the answer to each of these questions then click on the button marked to see whether you are correct. Practice Question 1 A hexagon has area 60 cm². What will the area of the hexagon be, if it is enlarged with scale factor 3? Practice Question 2 A cube has all sides of length 2cm. What are the surface area and volume of the cuboid? The same cube is enlarged with scale factor 5. What are the new surface area and volume? Exercises Work out the answers to the questions below and fill in the boxes. Click on the button to find out whether you have answered correctly. If you are right then will appear and you should move on to the next question. If appears then your answer is wrong. Click on to clear your original answer and have another go. If you can't work out the right answer then click on to see the answer. You have now completed Unit 19 Section 3 Return to the Y8 Tutorials Menu Produced by A.J. Reynolds August 2008 Solid A and solid B are mathematically similar. The volume of solid A is 32 cm3.The volume of solid B is 108 cm3.The height of solid A is 10 cm.Find the height of solid B.Calculate , the scale factor of enlargement for the volumes, using: Or Find the length scale factor by taking the cube root of the volume scale factor Substitute the value for into formula for the heights of the similar shapes:Height of B = 15 cmPage 2Exam code: 4MA12 hours38 questions13 marksA company makes monsters.The company makes small monsters with a height of 20 cm.A small monster has a surface area of 300 cm2.The company also makes large monsters with a height of 120 cm.A small monster and a large monster are mathematically similar.Work out the surface area of a large monster.Did this page help you?2a2 marksThe diagram shows two similar solids, and .Solid A has a volume of 80 cm3.Work out the volume of solid B.2b2 marksSolid B has a total surface area of 160 cm2.Work out the total surface area of solid .Did this page help you?3a2 marks and are two similar vases.Vase has height 24 . Vase has height 36 . Vase has a surface area of 960 Work out the surface area of vase .....3b2 marksVase has a volume of Find in terms of , an expression for the volume, in , of vase .....Did this page help you?43 marks andare two similar solids. has a volume of 1836 cm3 has a volume of 4352 cm3 has a total surface area of 1120 cm2 Work out the total surface area of ..... cm2 Did this page help you?53 marksand are two similar solid shapes.Shape has surface area and volume Shape has surface area Work out the volume of shape ..... Did this page help you?63 marksMathematically similar wooden blocks are made in a workshop.There are small blocks and there are large blocks.The volume of each small block is 300cm3Given that the surface area of each small block : the surface area of each large block = 25 : 36work out the volume of each large block..... cm3 Did this page help you?73 marksThe diagram shows two mathematically similar vases, and has a volume of has a volume of has a surface area of Work out the surface area of Did this page help you?83 marksThe diagram shows two similar bottles, and .Bottle has surface area Bottle has surface area 540 and volume Work out the volume of bottle .....Did this page help you?92 marksA and B are similar solid cylinders.base area of A : base area of B = 9 : 25Complete these ratios.curved surface area of A : curved surface area of B =..... : .....height of A : height of B =..... : .....Did this page help you?101 markA and B are similar cuboids.surface area of A : surface area of B = 16 : 25Work out volume of A : volume of B Circle your answer.4 : 516 : 2564 : 125256 : 625Did this page help you?113 marksSolids and are similar. has volume 64 cm3 has volume 343 cm3The surface area of is 176 cm2 Work out the surface area of .....cm2Did this page help you?122 marksSimon cuts the corners off a square piece of card to leave the regular octagon shown below.Simon makes a table top using the card as a model. The sides of the table top are 8 times as long as the sides of the card model.Find the ratio of the area of Simon’s table top to the area of the card model.Did this page help you?134 marksIn the diagram, AED and ABC are straight lines and BE is parallel to CD.The ratio of length AB to length BC is 2 : 3. Triangle ABE has an area of 8cm2 . Work out the area of triangle ACD..... cm2 Did this page help you?143 marksA transport lorry consists of a cab and a trailer. The trailer has a volume of 90m3. Alfie makes a model of this lorry using a scale of 1 : 72.Work out the volume of the trailer in Alfie’s model, giving your answer in cm3..... cm3 Did this page help you?154 marksToy building bricks are available in two sizes, small and large.The small and large bricks are mathematically similar.A small brick has volume 8cm3 and width 2.1cm.A large brick has volume 15.625 cm3.Calculate the width of a large brick..... cm Did this page help you?12 marksFred is making two rectangular flower beds.The dimensions of the larger rectangle will be three times the dimensions of the smaller rectangle.There is going to be the same depth of soil in each flower bed. Fred needs 180 kg of soil for the smaller flower bed.Work out how much soil Fred needs for the larger flower bed.Did this page help you?24 marks and are two triangular prisms that are mathematically similar.Prism has triangle as its cross section. Prism has triangle as its cross section. = 6 cm = 12 cmThe area of the cross section of prism is 10 cm2. The length of prism is 15 cm.Work out the volume of prism .Did this page help you?3a2 marks and are mathematically similar trapeziums.Work out the length of .3b3 marksTrapezium has an area of 36 cm2.Work out the area of the shaded region.Did this page help you?43 marksHere are two similar solid shapes.surface area of shape A : surface area of shape B = 3:4The volume of shape B is 10 cm3Work out the volume of shape A. Give your answer correct to 3 significant figures.Did this page help you?53 marksSolid A and solid B are mathematically similar. The ratio of the surface area of solid A to the surface area of solid B is 4: 9The volume of solid B is 405 cm3.Show that the volume of solid A is 120cm3.Did this page help you?63 marksMark has made a clay model. He will now make a clay statue that is mathematically similar to the clay model.The model has a base area of 6cm2 The statue will have a base area of 253.5 cm2Mark used 2kg of clay to make the model.Clay is sold in 10kg bags. Mark has to buy all the clay he needs to make the statue.How many bags of clay will Mark need to buy?Did this page help you?73 marksCone A and cone B are mathematically similar. The ratio of the volume of cone A to the volume of cone B is 27:8The surface area of cone A is 297 cm2Show that the surface area of cone B is 132 cm2Did this page help you?8a2 marksThe circumference of circle B is 90% of the circumference of circle A.Find the ratio of the area of circle A to the area of circle B.8b2 marksSquare E has sides of length cm. Square F has sides of length cm.The area of square E is 44% greater than the area of square F.Work out the ratio Did this page help you?94 marksThe three solids and C are similar such thatthe surface area of the surface area of andthe volume of the volume of Work out the ratiothe height of the height of Give your ratio in its simplest form.Did this page help you?103 marks and are regular hexagons each with centre . is an enlargement of , with centre and scale factor 2The triangle has an area of 5 cm2Calculate the area of the shaded region..... cm2 Did this page help you?113 marks and are regular pentagons. and are straight lines. The area of is Calculate the area of the shaded region.....Did this page help you?12a1 markHere are three similar cuboids, A, B and C.A has length 5 cm, width 2 cm and height 3 cm B has length 10 cm C has length cmThe total surface area of A is 62 cm2Tim wants to work out the total surface area of B. Here is his working.Make one criticism of Tim’s method.12b3 marksVolume of Volume of CWork out the value of .Did this page help you?134 marksA pattern is made from two similar trapeziums.Show that the shaded area is 294 cm2Did this page help you?144 marksThe diagram consists of three mathematically similar shapes. The heights of the shapes are in the ratio 1 : 4 : 5.Find the ratiototal shaded area : total unshaded area.Give your answer in its simplest form.total shaded area : total unshaded area ..... : .....Did this page help you?154 marksPrism P and prism Q are similar. The ratio of the surface area of prism P to the surface area of prism Q is 1 : 3.i) Jay saysThe height of prism P is one third of the height of prism Q.Explain why he is wrong.[1]ii) The volume of prism Q is 86 cm3.Calculate the volume of prism P..... cm3 [3]Did this page help you?14 marks is a right-angled triangle.Angle = 90° is parallel to .The area of triangle is 8 cm2 The area of triangle is 16 cm2Work out the area of triangle .Did this page help you?24 marks andare two similar vases.Vase has height 10 cm. Vase has height 15 cm. The difference between the volume of vase and the volume of vase is 1197 cm3 Calculate the volume of vase ..... cm3 Did this page help you?34 marksThe diagram shows two similar vases, and .The height of vase is 9cm and the height of vase is 13 cm.Given thatsurface area of vase + surface area of vase = 1800calculate the surface area of vase .....Did this page help you?44 marksThe total surface area of a solid hemisphere is equal to the curved surface area of a cylinder.The radius of the hemisphere is cm. The radius of the cylinder is twice the radius of the hemisphere.Given thatfind the value of .Did this page help you?54 marksA frustum is made by removing a small cone from a large cone. The cones are mathematically similar.The large cone has base radius cm and height cm. Given thatfind an expression, in terms of , for the height of the frustum..... cm Did this page help you?64 marksA standard tin and a large tin are mathematically similar. The volume of the large tin is 50% more than the volume of the standard tin. Both tins are cylinders.The radius of the standard tin is 10cm.Calculate the radius of the large tin..... cm Did this page help you?72 marksThe area of pentagon A is . The area of pentagon B is .Find the ratio perimeter of pentagon A : perimeter of pentagon B in its simplest form. ..... : ..... Did this page help you?8a5 marksThe diagram shows a company logo made from a rectangle and a major sector of a circle. The circle has centre O and radius OA. OA = OD = 0.5 cm and AB = 1.5 cm. E is a point on OC such that OE = 0.25 cm and angle OED = 90°.Calculate the perimeter of the logo. ..... cm 8b3 marksCalculate the area of the logo. ..... cm2 8c3 marksA mathematically similar logo is drawn. The area of this logo is 77.44 cm2.Calculate the radius of the major sector in this logo. ..... cm Did this page help you?Page 3Set Notation & Venn DiagramsSet Notation & Venn DiagramsCompound Interest & DepreciationCompound Interest, DepreciationSimplifying Surds, Rationalising DenominatorsUsing a CalculatorRatios & FDP, Multiple RatiosExchange Rates & Best BuysExchange Rates, Best BuysAlgebraic Roots & IndicesAlgebraic Roots & IndicesCompleting the SquareAlgebraic ProofSolving Linear EquationsFinding Gradients of TangentsArea & Volume of Similar ShapesSimilar Areas & Volumes3D Pythagoras & Trigonometry3D Pythagoras & TrigonometryDiscrete & Continuous Data, Mean, Median & Mode, Calculations with the Mean, Averages from Tables, Averages from Grouped Data, Range & Interquartile Range, Comparing Data Sets, Bar Charts & Pictograms, Two-Way Tables, Pie Charts, Reading & Interpreting Statistical Diagrams, Comparing Statistical DiagramsPage 4Exam code: 4MA1Tools designed specifically for the Edexcel IGCSE Maths A: Higher syllabus, to help you ace your exams, including: past papers, revision notes, and exam-style questions, created by our expert team of teachers and examinersExam specification aligned Personalised feedback on exam answersWritten by teachers and examinersExaminer tips and tricksExam practice with solutionsPDF downloadsStep-by-step mark schemesPage 5 In this lesson, similar figures will be compared in terms of their surface areas and volumes. On a trip to Egypt, Emily is visiting the Great Egyptian Museum. She sees two models of Pyramids, Khafra and Menkaure, on display. She decides to buy the model of Menkaure, but now as she exits the gift shop, she has become even more curious about the volume of Khafra. Suppose that the models of the pyramids are similar. If the scale factor of the corresponding side lengths is 1:2 and the volume of the smaller pyramid is 20 cubic centimeters, what is the volume of the larger model? If two figures are similar, then the ratio of their areas is equal to the square of the ratio of their corresponding side lengths. Let KLMN and PQRS be similar figures, and A1 and A2 be their respective areas. The length scale factor between corresponding side lengths is ba. Here, the following conditional statement holds true. The statement will be proven for similar rectangles, but this proof can be adapted for other similar figures. The area of a rectangle is the product of its length and its width. Area of KLMN Area of PQRS A1=KL·LM A2=PQ·QR By the definition of similar polygons, the corresponding side lengths are proportional and equal to the scale factor ba. ⎩⎪⎪⎪⎨⎪⎪⎪⎧PQKL=baQRLM=ba⇒⎩⎪⎪⎪⎨⎪⎪⎪⎧KL=PQ·baLM=QR·ba The next step is to substitute the expressions for KL and LM into the formula for A1, which represents the area of KLMN. Notice that the expression on the right-hand side is (ba)2 times the area of PQRS, or A2. This proof has shown that the ratio of the areas of the similar rectangles is equal to the square of the ratio of their corresponding side lengths. This ratio is also called the area scale factor. Scale Factorba⇒Area Scale FactorA2A1=(ba)2 The length scale factor of two similar figures can be used to find the area of one of the two figures when the area of one of the figures is known. Dominika is making a flyer for a concert and wants to compare the areas of the two pieces of paper. The widths of A4 and A2 papers are 21 and 42 centimeters, respectively. If these two pieces of paper are similar and the area of A4 paper is about 624 square centimeters, find the area of the A2 paper. Round the answer to the nearest integer. If the scale factor of two similar figures is ba, then the ratio of their areas is b2a2. The two pieces of paper are similar and two corresponding sides measure 21 centimeters and 42 centimeters. Therefore, the scale factor is the ratio of these corresponding sides. Using this information, the ratio of the areas, or area scale factor, can be calculated by the theorem about the areas of similar figures. Scale Factor21⇒Area Scale Factor2212=41 Now, let A2 be the area of the piece of A2 paper. Then, a proportion can be written using the area scale factor and the area of the A4 paper, which is 624 square centimeters. The area of the A2 paper is 2496 square centimeters. Dominika figures that is just the right amount of area to promote the rock band Twenty-One Scale Breakers. It was just learned that if the length scale factor of two similar figures and one of the areas of the figures are known, then the unknown area can be found. Next, consider if both areas but only the side length of one figure are known. It will be possible to solve for the other similar figure's corresponding side length. The diagram shows two similar figures. Figure A has an area of 9 square inches, and Figure B has an area of 25 square inches. If a side length of Figure B is 2.5 inches, find the length of the corresponding side in the other shape. If the scale factor of two similar figures is ba, then the ratio of their areas is b2a2. Recall that the ratio of areas of two similar figures is equal to the square of the ratio of their corresponding side lengths. Scale Factorba⇒Area Scale Factor(ba)2 Since the areas are given, the following proportion can be written. Now, take square roots of both sides of the equation to find the value of ba, the scale factor. Keep in mind that only the principal roots will be considered because only positive numbers make sense in this situation. The scale factor of the figures is 3:5. Finally, with the scale factor and knowing that the side length of Figure B is 2.5 inches, the length of the corresponding side in Figure A represented by x can be found. The corresponding length in Figure A is 1.5 inches. Determine the linear scale factor of the shape on the right to the shape on the left. For similar three-dimensional figures, the volume scale factor and the length scale factor are also related. If two figures are similar, then the ratio of their volumes is equal to the cube of the ratio of their corresponding side lengths. Let Solid A and Solid B be similar solids and V1 and V2 be their respective volumes. The length scale factor between corresponding linear measures is ba. Given these characteristics, the following conditional statement holds true. Solid A∼Solid B⇒V2V1=(ba)3 The statement will be proven for similar rectangular prisms, but this proof can be adapted to prove other similar solids. As shown in the diagram, let a1, a2, and a3 be the dimensions of Solid A and b1, b2, and b3 be the dimensions of Solid B. The volume of a rectangular prism is the product of its base area and its height. Volume of Solid A Volume of Solid B V1=a1·a2·a3 V2=b1·b2·b3 By the definition of similar solids, the side lengths are proportional and equal to the scale factor ba. ⎩⎪⎪⎪⎪⎪⎪⎪⎨⎪⎪⎪⎪⎪⎪⎪⎧b1a1=bab2a2=bab3a3=ba⇒⎩⎪⎪⎪⎪⎪⎪⎪⎨⎪⎪⎪⎪⎪⎪⎪⎧a1=b1·baa2=b2·baa3=b3·ba The next step is to substitute the expressions for a1, a2, and a3 into the formula for V1, the volume of Solid A. V1=(b1·ba)(b2·ba)(b3·ba) V1=b1·ba·b2·ba·b3·baV1=ba·ba·ba·b1·b2·b3 Notice that the expression on the right-hand side is (ba)3 times the volume of Solid B. As shown, the ratio of the volumes of the similar prisms is equal to the cube of the ratio of their corresponding linear measures. This ratio is also called the volume scale factor. Scale Factorba⇒Volume Scale FactorV2V1=(ba)3 The scale factor of two similar figures can be used to find the volume of one of the figures when the volume of the other figure is known. The suitcase company Case-O-La produces snazzy suitcases of various sizes. When a large-sized suitcase is bought, the company offers its cabin-sized version at a discounted price to the same customer. The large-sized suitcase has a height of 27 inches and a volume of 90 liters. If the cabin-sized suitcase has a height of 18 inches, determine its volume. Round the answer to one decimal place. If the scale factor of two similar figures is ba, then the ratio of their volumes is (ba)3. The suitcases can be considered as two similar rectangular prisms with heights 27 and 18 inches. Similar solids have the same shape and all of their corresponding sides are proportional. The ratio of the corresponding linear dimensions of the similar solids is the scale factor. Height of big suitcaseHeight of small suitcase=2718 If the scale factor of two similar solids is a:b, then the ratio of their corresponding volumes is a3:b3. Now, raise the scale factor to the third power to obtain the ratio of the volumes. The ratio of the volumes is 8:27. Now, let V1 be the volume of the small suitcase. Since the volume of the big suitcase is 90 liters, the ratio of V1 to 90 is 8:27. The volume of the small suitcase is about 26.7 liters. After reading a physics magazine, Mark feels confident in estimating the radius of the Sun. To do so, he will use the volumes of the Sun and Earth, which are 1.41×1018 and 1.08×1012 cubic kilometers, respectively. If the radius of the Earth is about 6300 kilometers, help Mark find the radius of the Sun. Sun and Earth can be regarded as two similar spheres. Therefore, the volume scale factor can be used to find the radius of the Sun. The Sun and Earth are two similar spheres. Consequently, the ratio of their volumes is equal to the cube of the ratio of their corresponding linear measures, which in this case is the ratio of their radii. Let r and R be the radii of the Earth and Sun, respectively. Scale FactorRr⇒Ratio of the Volumes(Rr)3 Given that the volumes are known, the volume scale factor can be used to find the scale factor of the Earth to the Sun. (Rr)3=1.41×10181.08×1012 Next, take the cube roots of both sides of the equation to find the value of Rr, the length scale factor. (Rr)3=1.41×10181.08×1012 (Rr)3=(1.411.08)(10181012)Write in scientific notation Finally, with the scale factor and knowing that the radius of the Earth is about 6300 kilometers, the radius of the Sun R can be found. The ratio of 6300 to R is equal to the scale factor. Write in scientific notation The radius of Sun is about 6.92×105, or 692000, kilometers. The applet shows the volumes of two similar solids. Determine the scale factor of the blue solid to the orange solid. The corresponding faces of two similar three-dimensional figures are also similar. Subsequently, the ratio of the areas of the corresponding faces is proportional to the square of the length scale factor of the figures. Dylan has a golden retriever and a chihuahua. He buys two similar doghouses, whose corresponding side lengths are proportional. When he is about to finish painting the doghouses, he realizes that there is not enough paint for the front face of the small doghouse! Dylan knows the volumes of each doghouse. They are about 63500 and 34500 cubic inches. He also knows that the front face of the big doghouse has an area of 650 square inches. Help Dylan determine the area of the front face of the small doghouse. This will help him determine how much more paint to buy. Round the answer to the nearest integer. The length scale factor will be found first. To do so, the cube root of the volume scale factor will be calculated. Recall that the ratio of volumes of two similar solids is equal to the cube of the ratio of their corresponding side lengths. Scale Factorba⇒Volume Scale Factor(ba)3 A proportion can be written using the ratio of the volumes. Now, take cube roots of both sides of the equation to find the value of ba, the length scale factor. The area scale factor can be found by squaring the scale factor for length. Scale Factor0.82⇒Area Scale Factor0.822 Finally, knowing that the larger doghouse's front face area is about 650 square inches, the corresponding area in the other one can be calculated. Let A1 be that area. Then, 0.822 should be equal to the ratio of A1 to 650. The smaller doghouse has a front face with an area about 437 square inches. He can now go shopping for more paint to appease his cool chihuahua. Since the corresponding faces of two similar three-dimensional figures are similar, it can be concluded that the ratio of the surface areas is the square of the scale factor. A three-dimensional figure is called a composite solid if it is the combination of two or more solids. Like similar solids, if the corresponding linear measures of two composite solids are proportional, the composite solids are said to be similar. Therefore, their length scale factor can be determined and used to find certain characteristics of the shapes. The amount of material used to construct the larger silo is three times that of the smaller one. That is, the surface area of the larger silo is three times as large as the surface area of the smaller silo. These two silos can be considered to be similar solids. Furthermore, each silo is composed of a cone and a cylinder as shown. If the volume of the larger silo is 6750 cubic meters, find the volume of the smaller silo. Round the answer to the nearest integer. The given silos are similar composite solids. Since they are similar, their corresponding linear measures are proportional. Therefore, each silo can be considered as a whole. To find the volume of the smaller silo, these steps will be followed. The ratio of their surface areas will be used to determine the length scale factor. The length scale factor will be used to determine the volume scale factor. Finally, the volume scale factor will be used to determine the volume of the smaller silo. It is given that the surface area of the larger silo is three times as large as the surface area of the smaller silo. To find the length scale factor, consider its relationship to the surface areas. Recall that for areas of similar figures, the ratio of their areas is equal to the square of the ratio of their corresponding side lengths. Refer to the smaller silo's side length as a and the larger silo's side length as b. Length Scale Factorba⇒Area Scale Factor(ba)2 Since the surface area of the larger silo is three times the surface area of the smaller silo, the ratio of the surface area, small to large, is 1:3. With that information, the following equation can be expressed. Next, this equation can be simplified to solve for the length scale factor. Begin by taking the square root of both sides of the equation. Now, the length scale factor can be used to find the volume scale factor. To do so, the length scale factor needs to be raised to the third power. Length Scale Factorba=31⇒Volume Scale Factor(ba)3=(31)3 Finally, knowing that the volume of the larger silo is about 6750 cubic meters, the volume of the smaller silo Vs can be calculated. Similar to the areas, the ratio of the volumes should be equal to the volume scale factor. The capacity of the smaller silo is about 1299 cubic meters. The similarity makes it possible to solve for certain characteristics of a wide range of shapes, like prisms, spheres, composite solids, and pyramids. In this course, the relationships between the length scale factor, area scale factor and volume scale factor have been discussed. If the scale factor between two similar figures is ba, then the ratio for their areas and volumes can be expressed as the table shows. Length Scale Factor Area Scale Factor Volume Scale Factor ba (ba)2 (ba)3 Considering these expressions, the challenge presented at the beginning can be solved with more confidence. Emily knows that the models in the museum are similar pyramids and the scale factor between the corresponding side lengths is 1:2. If the volume of the smaller model is 20 cubic centimeters, find the volume of the larger model. If the scale factor of two similar figures is ba, then the ratio of their volumes is (ba)3. To find the volume of the larger model, first, find the volume scale factor. Note that the volume scale factor is equal to the cube of the length scale factor. The length scale factor is given as 1:2, or 21. Length Scale Factor21⇒Volume Scale Factor(21)3=81 An equation can now be written using the known volume scale factor and the ratio of the model's volumes. Recall that it is given that the volume of the smaller model is 20 cubic centimeters. Substitute that value into the equation to solve for the volume of the larger model. The volume of the larger model is 160 cubic centimeters. We need to be very careful when we are dealing with mathematically similar shapes and are asked to work out the length, area or volume. This is because the length scale factor, area scale factor and volume scale factor are all going to be different. The different scale factors all relate to one another, but they are all different. The table below shows the rules for the different scale factors. Let’s have an example to prove that this is the case. We have two cubes; a smaller cube and a larger cube. The smaller cube has sides of 2 cm and the larger cube has sides of 8 cm. Length Scale FactorLet’s first work out the length scale factor. We are going to do this by dividing a side in the larger shape by the corresponding side in the smaller shape (as this is a cube, all of the sides are going to be the same, so any side will be 2 cm in the smaller shape and 8 cm in the larger shape). The length scale factor is 4. Area Scale Factor According to the rule, the area scale factor will be the length scale factor squared. This means that the area scale factor should be 16 (42 = 4 x 4 = 16). Let’s just check that this is true by working out the surface area for the smaller and larger cube. A cube has 6 faces and the area of each of these faces are the same. The smaller cube has sides of length 2 cm, which means that the area of one of the faces is 4 cm2 (2 x 2). As there are 6 faces with the same area, we must multiply this value by 6, which tells us that the surface area of the smaller cube is 24 cm2. The larger cube has sides of length of 8 cm. This means that the area of one of the faces is 64 cm2 (8 x 8). To obtain the overall surface area, we multiply the area of one face by 6 and this gives us a total surface area of 384 cm2 (6 x 64). We now have both surface areas which means that we can work out the area scale factor. We do this by dividing the surface area of the larger cube by the surface area of the smaller cube (the larger cube has a surface are of 384 cm2 and the smaller cube has a surface area of 24 cm2). This is exactly the same value as the rule stated that we should obtain. Volume Scale Factor According to the rule, the volume scale factor should be the length scale factor cubed. Earlier we found that the length scale factor was 4, which means that the volume scale factor should be 64 (43 = 4 x 4 x 4). Let’s check that it is 64 by working out the volumes of the cubes that we were given. We work out the volume of a cube by cubing one of the sides. The sides of the smaller cube are 2 cm, which means that the smaller shape has a volume of 8 cm3 (23 = 2 x 2 x 2). The larger cube has sides of 8 cm, which means that the volume of the larger cube is 512 cm3 (83 = 8 x 8 x 8). We can find the volume scale factor by dividing the volume of the larger cube by the volume of the smaller cube. The volume of the larger cube is 512 cm3 and the volume of the smaller cube is 8 cm3. This gives us exactly the same value as the rule stated. Therefore, we can see that all of the rules that were given in the table for the three different scale factors work. It is probably worth writing these rules on a revision card. All Together The LSF, ASF and VSF for this example are shown in the table below. Therefore, we can see that all of the rules that were given in the table for the three different scale factors work. It is probably worth writing these rules on a revision card. ← Back to Library Scale Factor of Length The scale factor is the ratio of the lengths of corresponding sides in two similar shapes. If the scale factor of length is k, each dimension in the new shape is k times larger than the corresponding dimension in the original shape. When scaling down, the scale factor will be between 0 and 1. When scaling up, the value of k will be greater than 1. Scale Factor of Surface Area The scale factor of surface area is the scale factor of length squared. If the scale factor of length is k, the surface area of the new shape is k² times larger than the surface area of the original shape. This stems from the fact that area is a 2-dimensional measurement, hence the scale factor must be squared. Scale Factor of Volume The scale factor of volume is the scale factor of length cubed. If the scale factor of length is k, the volume of the new shape is k³ times larger than the volume of the original shape. This is because volume is a 3-dimensional measurement, thus the scale factor must be cubed. Practical Applications Understanding scale factors can be particularly useful in a range of real-world scenarios, including map reading, architectural designing, model building, and more. Applying correct scale factors ensures that all aspects of an item keep the same proportions, preserving the authenticity of the original item in the scaled version. Ensure that you comprehend these fundamental principles and regularly practice problems related to scale factors to cement your understanding. In particular, remember to square the scale factor when dealing with area, and cube it when working with volume. Scale factor is a number by which the size of any geometrical figure or shape can be changed with respect to its original size. It is used to draw the enlarged or reduced shape of any given figure and to find the missing length, area, or volume of an enlarged or reduced figure. It should be noted that the scale factor helps in changing the size of the figure and not its shape. What is a Scale Factor? Scale factor is defined as the number or the conversion factor which is used to change the size of a figure without changing its shape. It is used to increase or decrease the size of an object. The scale factor can be calculated if the dimensions of the original figure and the dimensions of the dilated (increased or decreased) figure are known. For example, a rectangle has a length of 5 units and a width of 2 units. Now, if we increase the size of this rectangle by a scale factor of 2, the sides will become 10 units and 4 units, respectively. Hence, we can use the scale factor to get the dimensions of the changed figures. Observe the following figure which shows how the scale factor can change the original figure to its larger and smaller versions. In the following figure, the original rectangle has the dimensions given as 3 units and 2 units. To create an enlarged figure, the dimensions are multiplied by the scale factor of 3 using the formula: Dimensions of the new shape = Dimensions of the original shape × Scale factor. This gives the new dimensions as 9 units and 6 units respectively. Similarly, to create a reduced figure, we multiply the original dimensions with the scale factor of 1/2. This gives the reduced dimensions as 1.5 units and 1 unit. Scale Factor Formula The basic formula to find the scale factor of a figure is expressed as, Scale factor = Dimensions of the new shape ÷ Dimensions of the original shape. This formula can also be used to calculate the dimensions of the new figure or the original figure by simply substituting the values in the formula. How to Find the Scale Factor? The scale factor can be calculated when the new dimensions and the original dimensions are given. However, there are two terms that need to be understood when using the scale factor. When the size of a figure is increased, we say that it has been scaled up and when it is decreased, we say that it has scaled down. Scale Up Scaling up means that a smaller figure is enlarged to a bigger one. In this case, the scale factor can be calculated by a formula, which is another version of the basic formula given in the previous section. Scale factor = Larger figure dimensions ÷ Smaller figure dimensions The scale factor for scaling up is always greater than 1. For example, if the dimension of the larger figure is 15 and that of the smaller one is 5, let us place this in the formula which makes it: 15 ÷ 5 = 3. Thus, we can see that the scale factor is greater than 1. Scale Down Scaling down means that a larger figure is reduced to a smaller one. Even in this case, the scale factor can be calculated by a formula, which is another version of the basic formula. Scale factor = Smaller figure dimensions ÷ Larger figure dimensions The scale factor for scaling down is always less than 1. For example, if the dimension of the smaller figure is 8 and that of the larger one is 24, let us place this in the formula which makes it: 8 ÷ 24 = 1/3. Thus, we can see that the scale factor is less than 1. Observe the following triangles which explain the concept of a scaled-up figure and a scaled-down figure. Important Notes The following points should be remembered while studying about the scale factor: The scale factor of a dilated figure is denoted by 'r' or 'k'. If the scale factor is more than 1 (k > 1), the image is enlarged. If the scale factor is less than 1 (0< k 1). This means the image is scaled up. The scale factor formula = Larger figure dimensions ÷ Smaller figure dimensions b) If the image needs to be reduced, the scale factor is less than 1 (0 1), it means that the given figure needs to be enlarged. What Does a Scale Factor of 0.5 Mean? A scale factor of 0.5 means that the changed image will be scaled down. For example, the original figure of a square has one of its sides as 6 units. Now, let us use the scale factor of 0.5, to change its size. We will use the formula: Dimensions of the new shape = Dimensions of the original shape × Scale factor. Substituting the values in the formula: the dimensions of the new square will be = 6 × 0.5 = 3 units. This shows that a scale factor of 0.5 changed the figure to a smaller one. How do you Find the Scale Factor? The scale factor can be calculated when the new dimensions and the original dimensions are given. The basic formula to find the scale factor of a figure is: Scale factor = Dimension of the new shape ÷ Dimension of the original shape. For example, if the side length of a square is 6 units and if the size of the square has been increased such that the side length of the square becomes 18 units, let us find the scale factor. We will use the formula, Scale factor = Dimension of the new shape ÷ Dimension of the original shape. After substituting the given values we get, Scale factor = 18 ÷ 6 = 3. Therefore, the scale factor that is used to increase the size of the square is 3. What Happens if the Scale Factor is Less Than 1? If the scale factor is less than 1 (0< k

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