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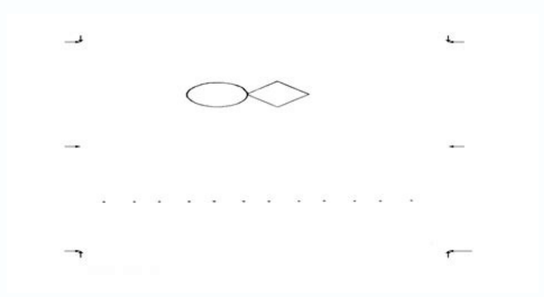

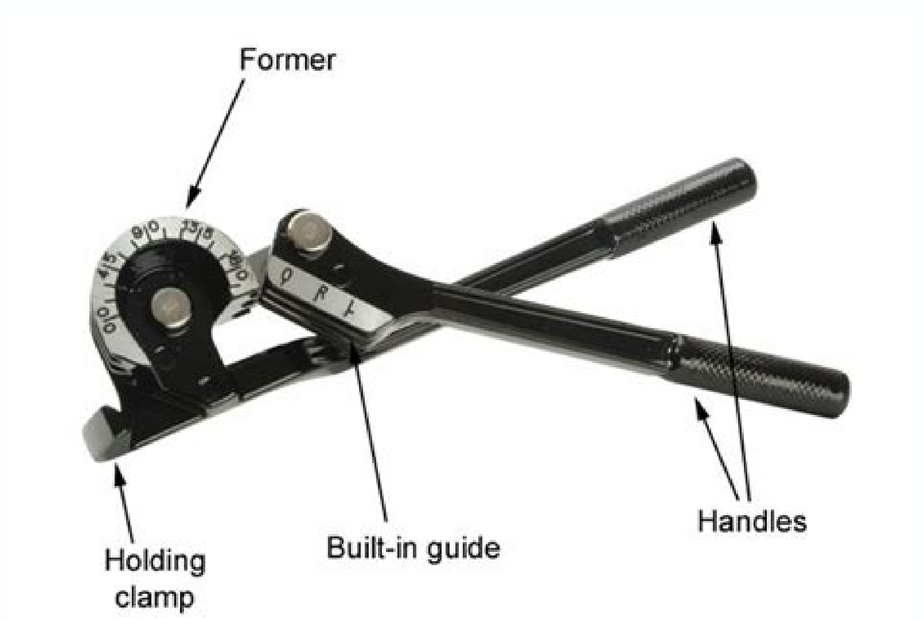

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Dan has been a licensed journey-level electrician for 17 years. He has extensive experience in most areas of the electrical trade.Guide to formulas and multipliersCanvaHelpful Formulas for Bending Electrical ConduitVery few beginning electricians are taught anything beyond the most basic instructions for bending electrical conduit pipe (EMT, electrical metallic tubing). As a result, they can have enormous difficulty when trying to bend larger conduit (greater than 1”). Even more experienced journey-level electricians seldom have any idea of the wide range of possibilities available. Nevertheless, learning how to bend conduit to very nearly any angle you want is not difficult.The math and formulas that make up a simple conduit-bending guide are actually quite simple and easily learned. The only tools you need for more complex bends are an angle finder and a cheap scientific-type hand calculator or, in today's world, a smartphone with a calculator.Any electrician bending large conduit should already have an angle finder as without a hand bender to tell the angle being bent an angle finder is necessary. If you don't, there are some examples at the end of this article. And now that we have smartphones, the calculator isn't just cheap; it's free. Recommended for Android phones is the RealCalc scientific calculator app, available from the Google Play store at no charge. Simply search the store for RealCalc and download it.Math Used for Bending ConduitThe math of conduit-bending that we will discuss here comes from two sources. Some of the math is already built into a common hand bender device, and the rest of it involves the geometry of a triangle.Note that making concentric bends requires using some additional math not discussed in this article. Math From Hand Benders Deducts, bend radiuses, and multipliers Lots of math is built into the hand bender device. Only a few numbers and math operations need to be memorized to make offsets, saddles and 90 degree bends. Even the “multiplier” and “deduct” figures are usually stamped onto the bender device.For more information on using a hand bender, see my comprehensive guide to bending conduit.Radius and Deduct Figures for ConduitSize of ConduitRadius of BendDeduct for 90 degrees1/2"4"5"3/4"4 1/2"6"1"5 3/4"8"Multipliers for Conduit OffsetsDegree of BendMultiplier10 degrees6.022 degrees2.630 degrees2.045 degrees1.460 degrees1.2 Math From Triangles The geometry of a triangle provides formulas useful for many conduit bends. Most conduit bends, in addition to a simple 90-degree bend, can be understood and calculated using the geometry of a right triangle.Using a Triangle to Understand an OffsetOffsetWildernessThe pipe above is bent into an offset. In the diagram below, the heavy black line represents the bent piece of conduit; the green triangle shows some useful lengths and angles.OffsetThe angle "d" is the angle at which the conduit is bent. One of the remaining angles of the triangle is always 90 degrees, while the third angle always depends on the first, being 90 degrees minus angle d. The sides of the triangle are labeled A, B and C; these letters represent the length of each side. From the angle, using formulas below, you can get the relationships between these lengths.In real life, of course, conduit is not a one-dimensional line, but rather a three-dimensional object with curved, not sharp, corners. But these considerations only affect the measurements you use in a very minor way; in everyday work, you can ignore them.Using Triangles to Understand SaddlesSaddles are used to route conduit around an obstruction. Look at the photos below to see how you would use the triangle concept for a three-point saddle (by placing a second triangle back-to-back with the first one) and a four-point saddle (by placing a second triangle separated from the first one by a length of straight conduit).Three-point saddleDan HarmonThree-point saddleFour-point saddleDan HarmonFour-point saddleMath Formulas From TrianglesThe math formulas we will be using are sine, cosine, and tangent. These are just the relationships between the sides of a right triangle; they depend on the angle (“d”) of the triangle. The formulas are listed below, with algebraic equivalents in each case. Each set of formulas—sine, cosine, and tangent—are just the same formula expressed three different ways.Calculations Using the SineSine(d) = A/C That is, the sine of angle d is the length of side A divided by the length of side C.A = sine(d) * C The length of side A is sine (d) times the length of side C.C = A/sine(d)The length of side C is the length of side A divided by sine (d).Calculations Using the CosineCos(d) = B/CThe cosine of angle (d) is the length of side B divided by the length of side C.B = cos(d) * CThe length of side B is the cosine of angle (d) multiplied by the length of side C.C = B/cos(d)The length of side C is the length of side B divided by the cosine of angle (d).Calculations Using the TangentTan(d) = A/BThe tangent of angle (d) is side A divided by the length of side B.A = tan(d) * BThe length of side A is the tangent of angle (d) times the length of side B.B = A/tan(d)The length of side B is the length of side A divided by the tangent of angle (d).Your calculator will give you the sine, cosine, and tangent of any angle. Because different calculators want you to press the keys in different sequences to get your results, you will have to read and understand the instructions for your particular calculator to use the trigonometric functions in it. In particular, you will have to know how to get inverse functions on your calculator; these functions convert a sine, cosine, or tangent figure into an angle, into the degrees of bend you need.And make sure that your calculator is set to describe angles in degrees, not in radians; radians are useless for the electrician.Examples Using Math to Bend ConduitAssume that we need a 2" offset in 3 1/2" conduit. Normally, this would be impossible using a 10º bend, as two bends cannot be made that close together (12”) in a conduit that large. Using the sine formulas above, let's try a 2º bend. We know side A is 2". The calculator shows that the sine of a 2-degree angle is .0349. Two inches divided by .0349 = 57". That's a little far apart for our bends, so let's try again using a 5º bend. The sine of 5 degrees is .087, and 2 / .087 = 22.98, or about 23". That's a more reasonable length for an offset in 3 1/2" pipe, so it can be used where a 10º offset cannot. As an exercise, consider an offset of 12" using two 22º bends. Again, C = A / sine(22º). Note that this can also be written as C = A * (1 / sine(22º)). The sine of 22º = .3846, and 1 / .3846 = 2.6, which is the familiar multiplier for a 22º offset. This kind of math is where those multipliers come from! Assume we need a 4" offset, and that it must take place in exactly 15". What is the angle to be used? We know that A = 4 and B = 15. We also know that tan(d) = 4 / 15, or .2666. The calculator tells us that the inverse tangent of .2666 = 15º. At the same time, we can find the multiplier of a 15º bend by dividing one by the sine of 15º; the answer comes back that the multiplier for 15º is 3.86. Assume we need a 4" 3-point saddle, and that we will use 45º as the center bend with 22.5º angle bends on each end. What is the conduit shrinkage—that is, the amount by which the center of the bend will be closer to the end of the conduit than the measured length of pipe? We know that A = 4" and angle d = 22.5º. What are B and C? Side C = 4” / sine(22.4º), or 10.45". Side B = 4" / tan(22.5º) or 9.65". The difference between B and C is our shrinkage; the center of our three-point saddle will move just under 1". Most electricians forget about or ignore this shrinkage on three-point saddles, and as a result, the center of their bend is not centered over the obstruction they are crossing. Bend Any Angle You WantUsing these formulas will enable the electrician to bend very nearly any angle he or she wants to. As an electrician myself, I have often found myself attempting to bend large conduit into odd angles and dimensions to match the demands of a building or get the appearance people want. Bending 3" or 4" conduit into odd angles by trial and error gets very expensive very quickly.Memorizing these simple formulas can make the bending of large conduit much easier. My own memory aid is this:Sine(d) = opposite / hypotenuse Cosine(d) = adjacent / hypotenuse Tangent(d) = opposite / adjacent where the “hypotenuse” is the longest side, the “opposite” is the side opposite the angle, and the “adjacent” is the side that touches the angle but is not the hypotenuse.“SOH-CAH-TOA” is the acronym you may hear for this memory aid.Or simply tape the formulas to the back of your calculator; believe it or not I grew up before there were calculators and I had to memorize.A final note: This article is but one of several written by an electrician, for electricians. If you don't find what you are looking for among my other articles, leave a comment and I’ll consider addressing your question in future articles; the whole series is a work in progress.Electricians and TrigonometryAngle Finders on AmazonTwo examples of angle finders from Amazon are shown below. One is considerably cheaper, but the other more accurate and easier to use. Either will work, just make sure that any one you choose has a magnet on at least one side to hold it to the pipe.This article is accurate and true to the best of the author’s knowledge. Content is for informational or entertainment purposes only and does not substitute for personal counsel or professional advice in business, financial, legal, or technical matters.Questions & AnswersQuestion: How do I figure out how to match 90 degree bends with different size pipe?Answer: The only way to do it is with "concentric bends" where the bends are equal, not concentric. The problem is that the radius of the bend varies with the size of pipe so instead of using the bender to determine the radius it must be matched to that of the largest conduit.Question: What is the Formula for 2 45 = 90? How do I measure and layout bend marks for this?Answer: Instructions can be found here: What the exact measurements of triangle bent of conduit pipes?Answer: If you are asking what the angles are, they can be anything that adds up to 180 degrees. Keep in mind that those are INTERIOR angles.Question: Is there a formula for concentric conduit bending?Answer: Not in the sense of the formulas given here. But an article on concentric bending does show the math used in the calculations: Emt Electrical Conduit Pipe Bending Instructions for Making Concentric Bends.Question: I have a 10' piece of 3/4" aluminum electrical conduit. I need to have 80" in the middle, with a 90° on each end. What is the length loss of a 90° bend?Answer: Assuming your brand of bender uses the minimum radius of bends (most do) the NEC indicates that that figure is 4.5" for 3/4 pipe. The "length" of the bend is then 4.5", but the length of pipe used to make that bend is 3.14*4.5/2, or 7". The "loss" is then 7-4.5, or 2.5". This is all assuming that the pipe is a pencil line, not a 3-dimensional object, which we know is not true. You would have to check in practice, but I suspect that the NEC figure is to the inside of the bend, meaning that the loss will be 3/4" less than what is calculated: the length of the completed bend will be 3/4" more than the minimum radius. Why not just use the star on the bender rather than the arrow?Question: I'm trying to bend a 10’ stick of 4” EMT in the centerline of the conduit so I can get equal lengths on both ends. Is there a formula for that?Answer: There is no real formula, but it can be calculated with a fair degree of precision. Multiply the radius of the bend you want to make by 6.28, then by degrees, bend and divide by 360. Divide once more by two, measure from the center of the pipe that far then set that mark at the front edge of the bending shoe. The center of the bend should be very close to the center of the pipe. If you use the NEC codebook to find the minimum radius of your bend, be aware that the figure given there is to the center of the pipe, not the edge, and correct accordingly.Question: What’s the formula to indicate when to start your kick on a 90 and loss?Answer: Given that the 90 is already bent, the same calculations as for an offset will give a pretty close answer. Referring to the diagrams in the article, the length of C will be the length of A divided by the sine of angle D. Measurements will be taken from the back of the 90. The figures will not be exact because of the difference in pipe thickness but will be quite close Shrinkage can be calculated as C - B, with B = cosine d * C. But that is all figured with the 90 already bent. I suspect you are asking where to put that 90 as well, and that becomes a very different proposition as different pipes will have a different radius of bend. The best you could realistically do is figure where the 90 should be bent as if there would be no kick, then add the shrinkage value to that number. Once bent, treat it as if it were an offset using the same multipliers as you would for bending an offset. Again, it will not be exact, but might be close enough for practical application in the field. Question: how do i figure out the development for a 15 degree saddle bend if the center line radius is 25"? I need to know how to figure it out.Answer: I'm not positive what you mean by a center line radius of 25", but here's a link to an article on bending both 3 and 4 point saddles: How do I determine set and bend permissible radial length for bending conduit or electrical pipe?Answer: Minimums are a function of the bender being used and cannot be reduced. Maximums are as high as you wish. I once made a 180-degree bend that was nearly 100 yards across. It was more a straight line than a bend!© 2010 Dan HarmonDan Harmon (author) from Boise, Idaho on May 18, 2020:@Andrew:Sorry, there is no link to provide a hard copy. But you can block it in and print it that way.Okonkwo Andrew on May 17, 2020:This is great and wow... Love it so much very educating.Okonkwo Andrew on May 17, 2020:I am so pleased and happy when I came across this site with or sincerity, I was glad.Please sir, could you do me a favour by giving a link where I can print and have your lessons in a hard copy. I want to study more so as to know more.ThanksAndrewWoody nyc lu 3 on December 15, 2019:Great info going to tell lots of apprentices to do it get on your site tough teaching the young guysNate on May 04, 2019:Who needs memory when you have Dan Harmon at dengarden lol. I kid. Im a 3rd yr electrician and this web site has been my go to for bending my whole apprenticeship. Most everything has been converted to memory. But i still find myself coming back. Thanks for this easy to understand site. Its helped me progress in my career making me more valuable and succesfull in my life.Dan Harmon (author) from Boise, Idaho on July 15, 2018:@ninmmkmfdmNot sure I understand the question. Measure the conduit and make the same bends. You can even measure the bends with a protractor.ninmmkmfdm@aol.com on July 15, 2018:How do i figure out the bends and degrees for an existing conduit to match without removing the emt or rigid?Otis Mullins on June 17, 2018:Great info. So glad I found this hub. Thank you.Your hub is my friend! on July 30, 2017:Great! Stuff. I'm starting a new job tomorrow where there will be lots of piping. I don't have a ton of experience with this under my belt, so feeding off of your hub has been very nourishing. I'm grateful to you and your work, from here in Canada. I now feel more confident that I will be more competent in my work. The information provided here is gold to any electrician. I'll recommend this to any electrician on site who is seeking to either learn, or just improving on their skill and efficiency.Jim on April 07, 2017:Learn'd more in 3 days studying your post than 3 weeks in multiple books.100% THANKS!Scott on February 26, 2017:Amazing. Thank you! Brought back memories from trig. There is a use for it!!!Dan Harmon (author) from Boise, Idaho on November 15, 2016:Thank you, Jeffery. It's always nice to hear that my writing has been of value.Jeffery K Murray on November 14, 2016:I enjoyed your article, particularly the comments. I am a EC in Cook and DuPage Counties in Illinois. All wiring must be in metallic raceways, so bending conduit is one of the first things every apprentice learns. My undergraduate degree is in applied mathematics and I often make the mistake of assuming that my new hires are equally versed in trigonometry. I found your explanations of the calculations easy to follow and I have sent links to your articles to all of my employees. I am certain they will find them helpful.Dan Harmon (author) from Boise, Idaho on April 08, 2016:If you are wanting an offset of 2 1/8" at 22 degrees, the distance between marks is 4 1/4" (2 1/8 X 2). There is no deduct except when doing 90 degrees on a hand bender. There will be some "shrinkage", which can be found by the math formula of Shrink=4.25-4.25*cos(22) = .31" in your case.Adam Mygrants on April 08, 2016:Point me to how we deturmine the deduct for a bend. I figured a 5 1/8" to drop with 22° bends 2 1/8"... if that is right, didn't write it down when doing it... but I'm not sure what to add to account for the loss in the bend. (3/4 conduit). Well, it's my first non-90 bend, and I'll be "winging it" in a second here. I'd eye off the 90 right, but I need a banger at starting height.Ralph Schwartz from Idaho Falls, Idaho on March 31, 2016:Excellent / even us amateurs can gain some knowledge from it.SPARKY on March 04, 2016:By the time you re done reading this, you WILL be a better Electrician. GREAT WRITE UP!!!Asher Socrates from Los Angeles, CA on February 21, 2016:This is a very detailed and superb write up! I always wondered how some of those pipes were bent in such a precise way. It was a formula this entire time. You learn something new everyday! Thank youJD Curtin from Brighton, Colorado on December 02, 2015:Wow this is great! My husband is an electrician and he has tried to show me how he calculates all of this but it has just been beyond me. Your easy to follow explanations, pictures and images really helped it make sense. Thank you :o)Dan Harmon (author) from Boise, Idaho on October 14, 2015:Good for you, Jane. Hope the information has been of some help to you. Thanks for the comment - it's nice to know I was able to be of assistance.Jane on October 14, 2015:Thank you! I have been taught this in class and doubted I would ever have to approach conduit bending with trigonometry but after having some difficulty bending large conduit today here I am!argin on July 14, 2015:How can i know the different take off of degree of pipe using tangentDan Harmon (author) from Boise, Idaho on April 13, 2015:LOL - that's the way it goes, John. I've never had to build odd offsets into a cable tray, but have done plenty of big pipe and have more than a few come back later and ask if I could teach them how to avoid costly mistakes. Yes, the very word ("math") scares a lot of people off, but it really isn't hard.John A. Joslin on April 13, 2015:Interesting & extremely valuable info here !! I often use the trig functions to design pipe work & am pretty lost otherwise .In contrast, a few months ago my partner 'cautioned' me that he definitely wasn't going to have anything to to with the cable tray offset we were about to build if I was going to use any "math" along the way. Well then, sez I,... If you want to design the thing & tell me what to do ... have at it. Seems like you have a different/ better way to proceed than me. I'm ready to learn something new. A long pause followed. And it got a little longer...He finally decided to weather the awful process of my 'math' usage, and sunnuva'gun if he didn't ask me later if I would go over some of the fine points with him , etc.Of course it was all about the basic trig which many learned to be afraid of way back when in some classroom or other. - Joslin (Detroit)Dan Harmon (author) from Boise, Idaho on February 02, 2015:Well, it made sense to me, too. And thanks for the compliment; if you're happy with the hub it must be of some use to you. That's always good to hear.Don on February 02, 2015:Thanks for the explanation, that makes sense. And, yes it's an example in ugly's from the 2011 edition pg. 160 (they also reference the wrong page which brings you to hand signals, ha,ha). I'm glad I found your blog!!Dan Harmon (author) from Boise, Idaho on February 02, 2015:Are you referring to an example in Ugly's? I can only guess here, but strongly suspect that it is because a pipe is three dimensional, not two dimensional. This means that 1.25 inches is pretty close to half the OD of a 2" pipe; they are probably measuring the minimum radius at the center of the pipe rather than choosing either the inside or outside of it. While this is not usually important in smaller conduit, it most definitely comes into play in the bigger stuff.Or, if the radius is considered at the center, adding that 1.25 will result in a measurement to the outside. If you're making another pipe to fit onto a rack next to the 2" pipe, it will have to have a radius of that figure plus the distance between pipes (plus half it's own diameter, of course).Don on February 02, 2015:Hey Dan,I'm curious as to why you would add 1.25" to determine the minimum radius of a 2" conduit (as used in ugly's multi-shot:90 degree bending exampleDan Harmon (author) from Boise, Idaho on January 30, 2015:Thank you, Steven. Somehow I missed this comment but you filled in nicely.Steven on January 30, 2015:Mack,What you're referring to is called a parallel offset. You'd make a mark on your first pipe of where the off set starts. The mark on your second pipe will be moved based on the distance between your pipes and the diameter of your second pipe. The formula is (distance between pipe + diameter of pipe) x tan(half the offset angle). For example, if you had from left to right, 1/2" pipe and a 3/4" pipe, the offset on your 1/2" starting at 24" and you were bending 30 degree bends for a 6" offset, and you wanted 1" between your pipes, you'd make the following marks, measuring from bottom up. 1/2" pipe Mark 1 at 24", Mark 2 at 36" (offset height, which is 6" x offset multiplier, which is the cosecant of bending angle, which is csc(30), which is 2, therefor 12" between marks) Now, for the 3/4" pipe, we take the O.D of the pipe, which we'll say is an inch and an eighth, and we add it to the distance we want between pipes, which is 1". This gives us 2.125". Now we multiply this 2.125" by the tangent of half the offset angle, which happens to be 30 degrees, so half will be 15 degrees. So, we have 2.125" x tan(15), or 2.125" x .268, which gives us .5695. To covert this to inches, we multiply by 16, which gives us 9.122, so we now know .5695 is real close to 9/16". Finally, we subtract this 9/16" from 24" to yield 23 and 7/16". This is our first mark for the 3/4" pipe. Our second mark will be 12" away at 35 and 7/16". This is a lot easier to understand if you draw your pipes first so you can visualize how your marks will be moving on each subsequent pipe. The joys of being able to draw on the unfinished drywall.metoo on October 02, 2014:shrink = hypotenuse(offset bend marks) - cos of angle X hypotenuseDan Harmon (author) from Boise, Idaho on September 15, 2014:That depends on what you are doing. The shrinkage if a 3 point saddle is given in the section on examples. Shrinkage of an offset is the difference between "b" and "c" in the first diagram.Jose on September 15, 2014:How do I find shrinkDan Harmon (author) from Boise, Idaho on September 10, 2014:1 divided by the sine of the angle.Jose on September 10, 2014:How do I find the multiplier of a degreeDan Harmon (author) from Boise, Idaho on February 25, 2014:That would depend on the desired angle of rise and what angle the center bend is to be bent at. See ... for complete instructions for saddles.Michael bryant on February 25, 2014:When bending a 3 bend saddle , my mark A is 30 inches and im crossing a 3 inch object then what are my measurements for mark B and CDan Harmon (author) from Boise, Idaho on February 23, 2014:10 degrees rise per inch = .08". 60 degree rise per inch = .57"1/(sin(10))-1/(tan(10))=.08The fourth example shows this.Kelly on February 23, 2014:What is the shrink per inch of rise for 10 and 60 degree bends ?Dan Harmon (author) from Boise, Idaho on December 14, 2013:Not bad, although a few of additions need to be made. The 2.5" per inch of rise applies only to a 22/45 saddle, not a 10/22 or a 30/60 degree saddle. The "B" bend is not at the same point on the bender, but at the center of the chosen degree for the center bend. The A and C bends must be made with the bender reversed. And if the order of bend is A,B,C the bender should be reversed after the first bend - normally I will bend B,A,C and reverse the bender after the A bend.This is also covered in the article McKee on December 14, 2013:Shrinkage per inch of rise :22 degrees - 3/16"30 degrees - 1/4"45 degrees - 3/8"3 point saddle :Mark center line "A" after adding shrinkage- first bendThen mark line "B" after adding 2.5" per inch of rise from center line.Then mark line "C" using same measurement as line "B" above but mark on opposite side of center Line "A".Tnen bend conduit in order A, B, C.Multipliers :10 degrees - 6.022 degrees - 2.630 degrees - 2.045 degrees - 1.460 degrees - 1.2Dan Harmon (author) from Boise, Idaho on October 14, 2013:Thanks Ron. I have done a lot of large EMT (seldom rigid) and that's what prompted this article. Mistakes do get very expensive very quickly when you're dealing with 4" conduit, whether rigid or EMT. That's not the time to be making guesses and experimenting.Ron Stewart from Knoxville, Tennessee on October 13, 2013:I been doing electrical work for about 35 years. Started out wiring house's, then on to schools, hospitals, grocery stores and now work as a lineman at a utility company in substations. I really enjoy the information you have shared here and find it not only usefull, but necessary to do a professional job. When working with large rigid conduit a wrong bend is not a easy fix, and also expensive.Dan Harmon (author) from Boise, Idaho on September 23, 2013:Knowing electric codes is huge. You may or may not need to know how to bend conduit, depending on your choice of fields. Wiring homes, for instances have little to no conduit bending. Learning to read blueprints and sometimes schematics will be important.Depending on the state you live in, you may be required to go to school to learn much of this, as well as working as an apprentice learning the trade. Check you your state and local laws on what it requires to be come an electrician.Eddie on September 22, 2013:I want to be an electrician. From my understanding I'm going to learn about electrician tools, wiring, how to wire up motors, PLC n controls, power distribution, electric codes, blueprints schematics, electronic component circuits, a little construction, and how to bend conduit. Is there anything else I should learn and which is the toughest thing to learn. I've heard ppl say that AC theory n conduit bending are a bitch.Dan Harmon (author) from Boise, Idaho on May 03, 2013:You're probably right that we use 22.5 degrees because it is 1/4 of a 90. Or 1/2 of a 45 (which in turn is half a 90), take your choice.Interesting that you use 60 divided by the angel, and it does work fairly well. Within an 1/8th of an inch is almost always good enough; if you need to be closer than that you'll probably have to tweak it some anyway.khaki ninja on May 03, 2013:@wilderness, the angle is 22.5 is because it is 1/4th of a 90. Making concentric bends easier. I also wanted to add, as a general rule, I find that,if you need to make an uncommonon degree offset (such as 17°), your multiplier is how many times the degrees goes into 60. So, 60\17 = 3.5. I applied this to bending rigid ocal, and it got me pretty darn close. Within an 1/8th.david on March 09, 2013:i believe what jerome meant by "take up" is the amount that you loose in your entire length of pipe when bending a 90. (not to be confused the shrinkage you get with offsets) it's useful to know if you want to cut and thread your pipe before bending it.Dan Harmon (author) from Boise, Idaho on November 19, 2012:@Mike: yes the multiplier of a 30 degree offset is 2, that's what is in the chart above. Have you picked up an error elsewhere in the article that I missed when proofreading?You're right in that 22 degree is about 2.4, but the mark on a hand bender is for a 22.5 degree (for some unknown reason), which makes the multiplier 2.6.mike on November 19, 2012:your multiplier of 6 is wrong if you are using a 30 degree angle your mutiplier is 2. 22 degree is around 2.4Dan Harmon (author) from Boise, Idaho on October 14, 2012:LOL There are probably about as many memory aids as there are people. I would have more trouble remembering Sohcahtoa than I would the formulas! A history buff might use it, though - thanks for the tip.ttx336 on October 13, 2012:for a memory aid: Chief Sohcahtoa... S= O/H C=A/H T=O/Aprobably works for me since I'm Cherokee ;-)Dan Harmon (author) from Boise, Idaho on June 05, 2012:Thanks, cablemanagements. That bending pipe is actually a practical use of trigonometry is not common knowledge. I simply got curious one day and put some of my college math to work - it's been useful ever since.Dan Harmon (author) from Boise, Idaho on May 09, 2012:You are more than welcome, and thanks for the comment. It's always appreciated.shiloh morgan on May 09, 2012:Very intense information. Will take days to understand and experience I'm sure. But thanks all the sameDan Harmon (author) from Boise, Idaho on May 01, 2012:That's my guess, as I said - you simply overbent it just a little. And your thought that it was in accounting for spring back is quite likely right - it's awfully easy to do, especially with the small degree bends.It sounds like you're doing fine. A little more experience is using that bender and you'll be a pro!Croakerchoker on May 01, 2012:Thanks a lot for the speedy response and lengthy information!I use the bender standing upright it has the stand and the little plate thing it slides along as its being bent. We have a little roofers' angle finder at our shop that I use for finding angles.I'm guessing I over bent the pipe when I was actually trying to compensate for the "spring effect" when being released.I think these benders should be made with more precision, like I said the thing that holds the pipe to the shoe and the shoe has too much play and ends up bending the pipe where u had not anticipated. I am going to keep trying to use these formulas and keep my calculator in my truck. We just got this bender about 6 months ago and I'm always the one running to the shop to bend pipe, If I can get it down to the science that I know it is, I would b happy :)I'm still having a little trouble understanding the calculations probably because when in high school I finished all my math early and opted against trig so I could talk to all the honeys in business math, now look where I'm at!! HahahahahDan Harmon (author) from Boise, Idaho on April 30, 2012:@ Brian: If you got a 6.5" offset with marks 28.75" apart you have a 13 degree bend. It doesn't matter what size pipe it is, nor what bender it is - the trig works for any and all pipe size or bender.6.5/28.75=.226 This is the sine.The inverse sine of .226 = 13 degreesThis isn't hard to

do with large benders. I, too, use a Greenlee bender for larger pipe and it is always a hassle. Some thoughts here:I always use the bender upright, which requires someone to hold it from falling over. This leaves the pipe horizontal, with the end being bent upward. It is critical that the pipe be really horizontal, at 0 degrees; check with a level. I can't remember for 3" pipe, but often a different shoe works very well to set under the end of the conduit to level it. A protractor is then used to measure the bend being produced; I overbend about 2 degrees, relax the pressure and re-check.It is very important to get the two marks at exactly the same place on the bender, and it isn't always easy with big pipe. The "hook" that the pipe fits through sometimes doesn't want to come all the way back to the shoe, the bottom shoe may not be fully back, etc. and all of these things must be checked carefully.Finally, it is very easy to over or under bend pipe at ten degrees. A 3 degree variance from what you want is 30%, while if you are making a 30 degree bend and go over 3 degrees that's only 10%. Many protractors are very difficult to read exactly what you want, and 1 or 2 degrees off is very common.You're on the right track here, and your math is correct - you even caught that the multiplier for 10 degrees is not 6, but actually 5.75 (6 is just a usable figure that is easy to work with). I'm sure the problem is in the bending process - the wrong angle (are you using the bender on it's side and measuring with the rod that comes out to indicate bend?), marks a little off (although 10" off would be horrible!), an inaccurate or poorly placed protractor, etc.I hope the comments on the bender make sense; every job I've been on bending large pipe has been with a greenlee bender, but they have likely made improvements over the old models I've used.Brian on April 30, 2012:Sorry I left out a few words, may be confusing so..After I bent the first at 22, I then tried 10 degrees but it seems the multiplier (6) is too big. I then tried 5.75 spaced 28.75 apart and came out with a 6.5" offsetSo...Sine(10)=.1746.5/.174= 37I didn't space my bends at 37 like i said they were 28.75. My boss said there was no formula but I know there is.. Maybe greenlee has multipliers that are used for certain benders.I guess my almost perfect pipe will be getting outfitted with a nice new coupling lol :) at least it wasn't too small..Brian on April 30, 2012:I have tried using these calculations to recreate the results I had at work today. I needed a 5 to 5 1/2" offset in a 3 inch conduit. I tried 22 degrees as close together as possible, it was over 9 inches. I previously tried your multiplier of 6, and was unsuccessful, today I tried 5.75 with a spacing of 28.75. I resulted with a 6.5" offset. Please verify if my calculations are off or if I am missing something, I never took trig but my calculator did and I can recreate your results on paper with it but the multipliers don't seem to be working..Dan Harmon (author) from Boise, Idaho on March 06, 2012:?? I'm not sure what you refer to - the deduct numbers are different for each size of conduit. Although it is stamped on every bender I've ever seen, just as you say.john on March 06, 2012:deduct 6 inches for a 90. If your using a hand, dunno why you would cuz it will look like crap, but it will be stamped on the side.Dan Harmon (author) from Boise, Idaho on November 28, 2011:I'm not sure I'm understanding your question, but let me try.Bending offsets and such requires use of decimals to make the calculations (or at least it's much easier that way), but to then use the result on a tape measure requires the use of fractions. My solution was to memorize the decimal to fraction equivalents for each 1/8 of an inch. 1/8=.125, 2/8 (or 1/4)=.25, 3/8=.375 and so on. You can find these on a calculator by dividing 1 by 8 for instance, which is 1/8 or .125.When the calculated result doesn't match one of the memorized eighth inch numbers (and it very seldom does) I simply choose the nearest one. I've never found it necessary to measure closer than 1/8" in the field so it works fine there.I understand that in class that might not be close enough, and you could go the extra distance and memorize each 1/16" as well, but it won't usually match exactly, either. In the final analysis it will always be necessary to round off and simply choose the nearest fractional equivalent to the calculated decimal figure.If I have misunderstood or just didn't come with something you can use, please let me know and I'll try again.scott on November 28, 2011:going to school for conduit bending with union and learning about shrink and gain. I just passed ac theory and im having trouble with switching decimals and fractions. They keep saying it so close with my answers. but i know i wouldn't use them in the feild. I only bent conduit by eye and a tape measure.Could you give me some advice.Dan Harmon (author) from Boise, Idaho on October 03, 2011:I'm sorry, I'm not familiar with that term - it isn't used in my area. Do you refer to the "deduct" when making a 90? That would be dependent on the bender used. None of the multipliers used in offsets are conduit material dependent, nor do they depend on the size of the conduit.Sorry about this. Many local terms are just that - local, and aren't used country wide.jerome on October 03, 2011:hey what's the take up for rigid conduit 3/4, 1'' 1 1/2, 2'' and 3'' asap need info fast rigid pipe not imcDan Harmon (author) from Boise, Idaho on December 31, 2010:The rolling offset is indeed one of the more useful bends and can save additional bends when done properly. Difficult to describe, but easily mastered with the largest problem being just how to measure the needed offset.And yes, math and its associated items (reading a tape measure perhaps) is very important and for someone that has no training in math at all even simple addition or subtraction of fractional figures can be difficult. As you say, start simple and go from there and the math in this hub is not where to start. Learn how to use the deduct of a 90 and worry about the trigonometry of large conduit offsets later.Michael Willis from Arkansas on December 31, 2010:One of the hardest things to teach to "newbies" can be conduit bending if they do not understand math sometimes.I always start with the basic bends first. After they master these, I will then show them more bending techniques and formulas.One I use all the time is the "rolling offset."Dan Harmon (author) from Boise, Idaho on November 03, 2010:You are most welcome. I actually do enjoy sharing my knowledge and work tips with others. I'm glad you found it useful.ABANG RAYMOND OJONG on November 03, 2010:thanks for sharing knowledge and teaching othersDan Harmon (author) from Boise, Idaho on October 14, 2010:You are more than welcome. It is a pleasure to share what I have learned over the years, and I'm always glad when someone finds it useful.How do you? on October 13, 2010:Thank you so very much for sharing your knowledge. It's much appreciated.Dan Harmon (author) from Boise, Idaho on October 05, 2010:Indeed it is, although few electricians realize it or use it. Most of the time the math is built into the tools we use, but as I'm sure you realize, math is behind many things we take for granted. You're right - this might help students realize how important it is to learn and understand math - it really does have uses in everyday life.Julie Burke from Alaska on October 04, 2010:I didn't even realize that trig would be pertinent to bending conduit! I'll use this new knowledge when teaching my reluctant math students.Dan Harmon (author) from Boise, Idaho on August 21, 2010:Thanks for the comment and compliment. I'm glad you liked it - it's information few electricians know anything about, but can certainly learn.SEOshortcuts from San Francisco CA on August 21, 2010:Holy moly - you are an artist with this hub! Great in-content links, very relevant to the review, and as a former electrician, good information to boot!

15/03/2021 · For example, you can bend EMT using a conduit bender. BUT, using pre-bent conduit and fittings will greatly simplify your work. So, find parts to complete your conduit run like a puzzle. Do the least amount of self-bending to avoid possible conduit damage. #7 Cutting and reaming conduits. You can cut EMT using a hacksaw. IDEAL Electrical 74-031 Aluminum Bender Head – Conduit Metal Pipe Bender w/handle for 1/2 in. EMT Pipes, Benders. This is the title, one would assume if it says w/handle it would come with a handle. The bender head seems to be good quality. 30/09/2019 · Our materials included 1/2-in. EMT conduit (10 ft. long), 4 x 4 x 1-1/2 in. metal boxes (which hold two receptacles; Photo 2), 4-in. square raised covers, one 1/2-in. offset setscrew connector for each conduit/box connection (Photo 2), plus 1/2-in. couplings (to join two pieces of conduit in longer runs), electric conduit straps, a 15-amp switch, receptacles and 14-gauge ... 11/02/2020 · Work with a bender. A bender is an essential for any conduit bending project. The tool should fit the correct sized conduit tube that you need to use. Before you start the bending process, locate any instructions on the conduit bender that may describe how much conduit should remain past the bend to the end of the bending shoe. Reverse tube in bender and adjust so that X is lined up with inch-mark on bender corresponding to depth of offset desired. Line up guide-line with opposite arrow and make second 45° bend. A true offset, in the same plane, will result between X and Y. 21/08/2010 · Learn how to bend conduit to any configuration desired, not merely the common bends on a conduit bender. ... For more information on using a hand bender, see my comprehensive guide to bending conduit. Radius and Deduct Figures for Conduit. Size of Conduit Radius of Bend Deduct for 90 degrees; 1/2" 4" 5" 3/4" 4 1/2" 6" 1" 5 3/4" 8" 19/02/2021 · Electrical metallic tubing can be bent with a special conduit bender tool to accommodate a variety of electrical applications. Measure the installation area to determine the angle and length of conduit you need. You'll also need to calculate the necessary deduct length or takeup, which is the amount of extra length that'll be lost in the bend. "Conduit" is the fourth episode of the first season of the American science fiction television series The X-Files. It premiered on the Fox network on October 1, 1993. It was written by Alex Gansa and Howard Gordon, directed by Daniel Sackheim, and featured a guest appearance by Carrie Snodgress as the mother of an abducted teenager.. The show centers on FBI special agents ...

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