Quadratic function standard form vertex

Curved antennas, such as those shown in the figure \\PageIndex{1}\), are commonly used to focus microwaves and radio waves for the transmission of television and telephone signals, as well as satellite and space communications. The cross section of the antenna has the shape of a parable, which can be described by a square function. Figure \(\PageIndex{1}\): A series of satellite dishes. (credit: Matthew Colvin de Valle, Flickr) Working with square functions can be less complicated than working with higher-grade functions, so they provide a good opportunity for a detailed study of function behavior. The chart of a square function is a U-shaped curve called a parable. An important feature of the chart is that it has an extreme point, called the top. If the parable opens, the top represents the lowest point in the chart or the minimum value of the square function. If the parable opens down, the top represents the highest point in the chart or the maximum value. In both cases, the top is a turning point in the chart. The chart is also symmetrical with a vertical line drawn through the top, called the symmetry axis. These features are illustrated in the \(\PageIndex{2}\) schema. Figure \(\PageIndex{2}\): A chart of a parable showing where the \(x\) and \(y\) intercepts are located, top, and axis of symmetry. The y-intersection point is the point at which the parable crosses the \(y\) axis. X-box points are the points at which the parable crosses the \(x\) axis. If any, x-funds represent the zeros or roots of the square function, the \(x\) values in which \(y=0\). Example \\PageIndex{1}\): Determine the characteristics of a Parabola Specify the top, axis of symmetry, zeros, and y-heading of the parable shown in the \((\PageIndex{3}\{3}). We can see that the top is in \(((3,1)\). , the symmetry axis is \(x=3\). This parable does not cross the x-axis, so it has no zeros. Crosses the \(y\) axis in \(((0.7)\), so this is the intersection point y. The general format of a square function shows the function as \[f(x)=ax^2+bx+c\] where \(a\), \(b\) and \(c\) are real numbers and \(a{eq}0\). If \(a>0\), the parable opens up. If \(a<0\), the parable opens Down. We can use the general form of a parable to find the equation for the axis of symmetry. The symmetry axis is defined by \(x=−\frac{b}{2a}\). If we use the square formula, \(x=\frac{−b{\pm}\sqrt{b^2−4ac}}{2a}\) to solve \(ax^2+bx+c=0\) for x-faces or zeros, we find \(x\) \(x\) \(x\) between them is always \(x=−\frac{b}{2a}\), the equation for the symmetry axis. The shape \(\PageIndex{4}\) represents the chart of the square function written in general format as \(y=x^2+4x+3\). In this form, \(a=1\), \(b=4\) and \(c=3\). Because \(a>0\), the parable opens up. The symmetry axis is \(x=−\frac{4}{2(1)}=−2\). This also makes sense because we can see from the chart that the vertical line \(x=−2\) divides the chart in half. The top always appears along the axis of symmetry. For a parable that opens up, the top appears at the lowest point of the chart, in this case\ \((−2,−1)\). those points where the parable crosses the x-axis appear in the units \((−3.0)\) and \((−1.0)\{4}). The standard format of a square function shows the function as \[f(x)=a(x−h)^2+k\] where \(h, k)\) is the top. , the parable opens up and the top is minimal. If <0\), the= parabola= opens= down,= and= the= vertex= is= a= maximum.= figure= \(\pageindex{5}\)= represents= the= graph= of= the= quadratic= function= written= in= standard= form= as= \(y=−3(x+2)^2+4\). since= \(x–h=x+2\) in= this= example,= \(h=–2\). in= this= form,= \(a=−3\), \(h=−2\), and= \(k=4\). because=></0\),> <0\), the= parabola= opens= downward.= the= vertex= is= at= \((−2,= 4)\).= figure= \(\pageindex{5}\):= graph= of= a= parabola= showing= where= the= \(x\)= and= \(y\)= intercepts,= vertex,= and= axis= of= symmetry= are= for= the= function= \(y=-3(x+2)^2+4\). the= standard= form= is= useful= for= determining= how= the= graph= is= transformed= from= the= graph= of= \(y=x^2\). figure= \(\pageindex{6}\)= is= the= graph= of= this= basic= function.= figure= \(\pageindex{6}\):= graph= of= \(y=x^2\). if= \(k=>\(0\), the chart shifts up, while if \(k<0\), the=graph= shifts= downward.= in= figure= \(\pageindex{5}\),= \(k=>0\) so that the chart shifts 4 points upwards. If \(h>0\), the chart shifts to the right, and if \(h <0\), the=graph= shifts= to= the= left.= in= figure= \(\pageindex{5}\),=></0\),> <0\), so= the= graph= is= shifted= 2= units= to= the= left.= the= magnetude= of= \(a\)= indicates= the= stretch = of= the= graph.= if= \(|a|=>1\), the point associated with a specific x value moves further away from the x-axis so that the chart looks narrower and there is a vertical extension. αν \(|a|<1\), the= point= associated= with= a= particular= x-value= shifts= closer= to= the= x-axis,= so= the= graph= appears= to= become= wider,= but= in= fact= there= is= a= vertical= compression.= in= figure= \(\pageindex{5}\),= \(|a|=> 1\), έτσι ώστε το γράφημα γίνεται στενότερο. Το τυποποιημένο έντυπο και το γενικό έντυπο είναι ισοδύναμες μέθοδοι περιγραφής</1\),> </0\),> </0\),> </0\),> </0\),> Function. We can see this by broadening the overall form and setting it equal to the standard form. \[\begin{align*} a(x−h)^2+k &= ax^2+bx+c \\[4pt] ax^2−2ahx+(ah^2+k)&=ax^2+bx+c \end aligned{*} \] \[–2ah=b \text{, so } h=−\dfrac{b}{2a}. onumber\] This is the axis of symmetry that we defined earlier. Set fixed terms equal: \[\begin{align*} ah^2+k&=c\\k&=c−ah^2 \\&=c−a−\Big(\dfrac{b}{2a}\Big)^2 \\\\dfrac{b^2}{4a} \end{align*}\] In practice, however, it is usually easier to remember that \(k\) is the output value of the function when the input is \(h\), so \(f(h)=k\). Definitions: Square function formats A square function is a function of grade two. The chart of a square function is a parable. The general format of a square function is \(f(x)=ax^2+bx+c\) where \(a\), \(b\) and \(c\) are real numbers and \(a{eq}0\). The standard format of a square function is \(f(x)=a(x−h)^2+k\). The top \((h,k)\) is at \[h=–\dfrac{b}{2a},\;k=f(h)=f(\dfrac{−b}{2a}).\] HOWTO: Write a square function in a generic format Given a graph of a square function, write the equation of the function in general format. Determine the horizontal offset of the parable; This value is \(h\). Determine the vertical displacement of the parable; This value is \(k\). Replace the horizontal and vertical offset values with \(h\) and \(k\). \(f(x)=a(x–h)^2+k\). Replace the values of any point other than the top in the parable chart for \(x\) and \(f(x)\). Resolve for expansion factor, \(|a|\). If the parable opens, \(a>0\). If the parable opens down, \(a<0\) as this means that the chart is reflected on the x-axis. Example \(\PageIndex{2}\): Writing the equation of a square function from the chart Write an equation for the square function \(g\) in the \(\PageIndex{7}\) shape as a \(f(x)=x^2\) transformation, and then expand the formula and simplify the terms to write the equation in general format. Figure \(\PageIndex{7}\): Chart of a parable with its top in \((-2, -3)\). Workaround We can see the \(g\) chart is the chart of \(f(x)=x^2\) shifted to the left 2 and below 3, giving a formula in the format \(g(x)=a(x+2)^2–3\). By replacing the coordinates of a point on the curve, such as \(((0,−1)\), we can solve for the stretch factor. \[\begin{align} −1&=a(0+2)^2−3 \\ 2&=4a \\ a&=\dfrac{1}{2} \end{align}\] In standard format, the algebraic model for this chart is \(g(x)=\dfrac{1}{2}(x+2)^2–3\). To write this in polynomal form, we can expand the formula and simplify the terms. \[\begin{align} g(x)&=\dfrac{1}{2}(x+2)^2−3 \\ &=\dfrac{1}{2}(x+2)−3 \\ &=\dfrac{1}{2}(x^) 2+4x+4)−3 \\ &=\dfrac{1}{2}x^2+2x+2−3 \\ &=\dfrac{1}{2}x^2+2x−1 \end{align}\] Note that the horizontal and vertical shifts of the base graph of the square function determine the position of the top of the parable; The top is not affected by stretches and compressions. Analysis We can control our work using the table attribute in a chart utility. Type first \(\mathrm{Y1=\dfrac{1}{2}(x+2)^2−3}\). Then select \\mathrm{TBLSET}\), then use \\mathrm{TblStart=–6}\) and \\mathrm{DTbl = 2}\) and select \\mathrm{TABLE}\). See Table \(\PageIndex{1}\) Table \(\PageIndex{1}\) \(x\) -6 -4 -2 0 2 \(y\) -5 -1 -3 -1 5 The sorted pairs in the table correspond to points in the chart. Exercise \(\PageIndex{2}\) A coordinate grid is placed over the square path of a basketball in the shape \(\PageIndex{8}\). Find an equation for the course of the ball. The shooter's fixing the basket? Image \(\PageIndex{8}\): Stop filming a boy throwing a basketball at a wreath to show the parabolic curve he makes. (credit: modification of tasks by Dan Meyer) Reply The path passes through the source and has a peak in \((−4, 7)\), so \(h(x)=–\frac{7}{16}(x+4)^2+7\). To download, \(h(−7.5)\) must be about 4, but \(h(−7.5){\approximately 1.64\). Given a square function in general format, find the top of the parable. , evaluating \(k=f(h)=f\Big(−\frac{b}{2a}\Big)\). Example \\PageIndex{3}\): Find the top of a square function Find the top of the square function \(f(x)=2x^2–6x+7\). Rewrite the square to a standard format (peak format). Workaround The horizontal coordinate of the top will be at \\begin{align} h&=\dfrac{b}{2a} \\ \\ \\ dfrac{-6}{{ 2(2)} \\ \\ \\dfrac{6}{4} \\ &=\dfrac{3}{2}\end{align}\] The vertical coordinate of the peak will be in \[[\begin {align} k&=f(h) \\ \\f\Big(\dfrac{3}{2}\Big) \\ \\&=2\Big(\dfrac{3}{2}\Big)^2−6\Big(\dfrac{3}{2}\Big)+7\\ &=\dfrac{5}{2} \end{}alignt\] Rewrite to standard form , the stretch coefficient will be the same as \(a\) in the original square. \[f(x)=ax^2+bx+c \\ f(x)=2x^2−6x+7\] Use the peak to determine shifts, \[f(x)=2\Big(x–\dfrac{3}{2}\Big)^2+\dfrac{5}{2}\] Analysis One reason we may want to determine the top of the parable is that this point will tell us what the maximum or minimum value of the function is , \(k)\)and where it appears, \(h)\). Exercise \(\PageIndex{3}\) Given the equation \(g(x)=13+x^2−6x\), write the equation in general format, and then in standard format. Response in general form. \(g(x)=(x−3)^2+4\) in standard format. Any number can be the input value of a square function. Therefore, the domain of any square function is all real numbers. Because parables have a maximum or minimum minimum range is limited. Since the top of a parable will be either maximum or minimum, the range will consist of all y values greater than or equal to the y-coordinate at the inflection point or less than or equal to the y-coordinate at the inflection point, depending on whether the parable opens up or down. Definition: Domain and region of a square function The domain of any square function is all real numbers. The range of a square function written in general format \(f(x)=ax^2+bx+c\) with a positive value \(a\) is \(f){\geq}f (−\frac{b}{2a}\Big)\) or \[f(−\frac{b}{2a}),∞) \); the range of a square function written in general format with a negative value is \(f(x) \leq f(−\frac{b}{2a})\) or \((−∞,f(−\frac{b}{2a})]\). standard format \(f)=a(x−h)^2+k\) with a positive value \(a\) is \(f)\19 \(x) \geq k;\) the range of a square function written in a standard format with a negative value \(a\) is \(f(x) \leq k\). Given a square function, find the domain and region. Identify the domain of any square function as all actual numbers. Determine whether \(a\) is positive or negative. If \(a\) is positive, the parable has a minimum. If \(a\) is negative, the parable has a maximum. Specify the maximum or minimum value of the parable, \(k\). If the parable has a minimum, the range is given by \(f(x){\geq}k\) or \\left[k,\infty\right)\). If the parable has a maximum, the range is given by \(f(x){\leq}k\) or \(\left(−\infty,k\right]\). Example \\PageIndex{4}\): Find the domain and region of a square function Find the domain and range \(f(x)=−5x^2+9x−1\). Solution As with any square function, the domain is all real numbers. Because \(a\) is negative, the parable opens down and has a maximum value. We need to determine the maximum value. We can start by finding the x value of the top. \\begin{align} h&=−\dfrac{b}{2a} \\ \\&=−\dfrac{9}{2(-5)} \\ &=\dfrac{9}{10} \end{align}\] The maximum value is given by \(f(h)\). \[\begin{align} f(\dfrac{9}{10})&5(\dfrac{9}{10})^2+9(\dfrac{9}{10})-1 \\&&&1 = \dfrac{61}{20} \end{align}\] The range is \(f){\leq}\frac{61}{20}\) or \\left(−\infty,\frac{61}{20}\right]\). Exercise \(\PageIndex{4}\) Find the domain and range \(f(x)=2\Big(x−\frac{4}{7}\Big)^2+\frac{8}{11}\). Answer The domain is all real numbers. The range is \(f(x){\geq}\frac{8}{11}\) or \(\left[\frac{8}{11},\infty\right)\). The output of the square function at the top is the maximum or minimum value of the function, depending on the orientation of the parable. We can see the maximum and minimum values in the \(\PageIndex{9}\). Figure \(\PageIndex{9}\): and maximum of two square functions. There are many real-world scenarios that include finding the maximum or minimum value of a square function, such as applications region and revenue. Example \\PageIndex{5}\): Find the maximum value of a square function A backyard farmer wants to enclose a rectangular space for a new garden inside her walled backyard. It has purchased 80 feet of wire fencing to enclose three sides, and will use a section of backyard fence as a fourth side. Find a formula for the area enclosed by the fence if the sides of the fence vertical to the existing fence have the length \(L\). What dimensions should her garden make to maximize the enclosed area? Workaround Let's use a diagram such as a \(\PageIndex{10}\) schema to capture the data. It is also useful to insert a temporary variable, \(W\), to represent the width of the garden and the length of the fence section alongside the backyard fence. Figure \(\PageIndex{10}\): Diagram of the garden and backyard. A. We know that we only have 80 feet of fence available, and \(L + W + L = 80 \), or more simply, \(2L + W = 80 \). This allows us to represent the width, \(W\), in terms of \(L\). \[W=80−2L\] Now we are ready to write an equation for the area enclosed by the fence. We know that the area of a rectangle is multiplied by width, so \\begin{align} A&=LW=L(80−2L) \A(L)&#80L−2L^2 \end{align}\] This formula represents the fence area in terms of variable length \(L\). The function, written in general format, is \[A(L)=−2L^2+80L\]. Square has a negative leading factor, so the chart will open down and the top will be the maximum value for the range. When finding the peak, we must be careful, because the equation is not written in typical polynomal form with descending force. That's why we rewrote the feature in general form above. Since \(a\) is the coefficient of the square term, \(a=−2\), \(b=80\) and \(c=0\). To find the top: \[\begin{align} h and =−\dfrac{80}{2(−2)} &k&=A(20) \\&=20 & \text{and} \?\\\\\\ &=80(20)−2(20)^2 \\&&&=800 \end{align}\] The maximum value of the function is an area of 800 square feet, which occurs when \(L=20\) feet. When the smaller sides are 20 feet, there is 40 feet of fencing left on the larger side. To maximize the area, it must enclose the garden so the two shorter sides have a length of 20 feet and the longer side parallel to the existing fence has a length of 40 feet. Analysis This problem could also be solved by graphing the square mode. We can see where the maximum range appears in a chart of the square function in the shape \\PageIndex{11}\). Shape Chart of parabolic function \(A(L)=-2L^2+80L\) Given an application that includes revenue, use a square equation to find the maximum. Write a square equation for revenue. Find the top of the square equation. Specify the y value of the peak. Example \\PageIndex{6}\): Find maximum income The unit price of an item affects its supply and demand. That's it, that's it. the unit price goes up, the demand for the item will usually decrease. For example, a local newspaper currently has 84,000 subscribers with a quarterly charge of $30. Market research has suggested that if owners raise the price to $32, they would lose 5,000 subscribers. Assuming subscriptions are linearly linked to the price, what price should the newspaper charge for a quarterly subscription to maximize their revenue? Revenue Solution is the amount of money a company brings. In this case, revenue can be found by multiplying the price per subscription times the number of subscribers or the quantity. We can enter variables, \(p\) for the value per subscription and \(Q\) for the quantity, giving us the equation \\text{Revenue}=pQ\). Because the number of subscribers changes with the price, we need to find a relationship between the variables. We know that at the moment \(p=30\) and \(Q=84,000\). We also know that if the price rises to $32, the newspaper will lose 5,000 subscribers, giving a second pair of prices, \(p = 32\) and \(Q = 79,000\). From this we can find a linear equation that concerns the two quantities. The gradient will be \\begin{align} m&=\dfrac{79,000−84,000}{32−30} \\ \\&=−\dfrac{5,000}{2} \\ &=−2,500 \end{}\t alignment\] This tells us that the paper will lose 2,500 subscribers for every dollar that raises the price. We can solve for the intercept. \[\begin{alignate} Q&=−2500p+b &\text{Substitute at $Q=84,000$ and $p=30$} \\ \\ 84,000&=−2500(30))+b &\text{Solve for b} \\ b&=159,000 \end{align}\] This gives us the linear equation \(Q=−2,500p+159,000\) about costs and subscribers. We are now returning to the equation of our revenues. \[\begin{align} \text{Revenue}&=pQ \\text{Revenue}&=p(−2,500p+159,000) \text{Revenue}&=−2,500p^2+159,000p \end{}align\] Now we have a square function for revenue as a function of subscription billing. To find the price that will maximize revenue for the newspaper, we can find the top. \\begin{align} h&=−\dfrac{159,000}{2(−2,500)} \\ \\=31.8 \end{align}\] The model informs us that maximum revenue will be generated if the newspaper charges $31.80 for a subscription. To find out what the maximum revenue is, we evaluate the revenue function. \[\begin{align} \text{maximum revenue}&=−2,500(31.8)^2+159,000(31.y 8) \\ &=2.528.100 \end bet{}\] Analysis This could also be resolved by a graph of the square item as in Figure \(\PageIn{12}\). We can see the maximum revenue in a graph of square operation. Figure \(\PageIndex{12}\): Chart of parabolic function As we did in the above application problems, we also need to find buried intercepts of square equations the parabolic graph. Remember that we find the y-intercepting of a square by evaluating the function in an introduction of zero, and we find the x-teller in places where the output is zero. Note in figure \\PageIndex{13}\) that the number of may vary depending on the position of the chart. Picture \\PageIndex{13}\): Number of x-swaps in a parable. Given a square function \(f(x)\), find the tops. Evaluate \(f(0)\) to find the intersection y. Solve the square equation \(f(x)=0\) to find the x-tations. Example \\PageIndex{7}\): Find the y and x tackles of a Parabola Find the intercepted y and x of the square \(f(x)=3x^2+5x−2\). Solution We find the y-intercept with the evaluation \(f(0)\). \[\begin{align} f(0)&3(0)^2+5(0)−2 \\ &=−2 \end{align}\] Thus, the y-intersection point is at \((0,−2)\). For x-funding, we find all the solutions of \(f(x)=0\). \[0=3x^2+5x−2\] In this case, the square can be easily taken into account, providing the simplest method for the solution. \[0=(3x−1)(x+2)\] \[\begin{align} 0&=3x−1 & 0&=x+2 \\x&= \frac{1}{3} &\text{or} \\\;\\\;\;\;\;\;\\\\\?x&=−2 \end{align}\] Επομένως, τα στοιχεία ελέγχου x είναι στα \((((/(/frac{1}{3},0)\) και \((−2,0)\). Ανάλυση Με γραφική παράσταση της συνάρτησης, μπορούμε να επιβεβαιώσουμε ότι το γράφημα διασχίζει τον άξονα \(y\)στο \((0,−2)\). Μπορούμε επίσης να επιβεβαιώσουμε ότι το γράφημα διασχίζει τον άξονα x στις 8\(\Big(\frac{1}{3},0\Big)\) και \((−2,0)\). Ανατρέξτε στην ενότητα Εικόνα \(\PageIndex{14}\). Εικόνα \(\PageIndex{14}\): Γράφημα μιας παραβολής. Στο παράδειγμα \(\PageIndex{7}\), το τετραγωνικό επιλύθηκε εύκολα με factoring. Ωστόσο, υπάρχουν πολλά τετράποδα που δεν μπορούν να συνυπολογιστούν. Μπορούμε να λύσουμε αυτά τα τετράρια με την πρώτη επανεγγραφή τους σε τυπική μορφή. Δεδομένης μιας τετραγωνικής συνάρτησης , find the x-rates by rewriting in standard format. Replace a and \(b\) to \(h=−\frac{b}{2a}\). Replace \(x=h\) in the general format of the square function to find \(k\). Rewrite the square to a standard format using \(h\) and \(k\). Solve when the output of the function will be zero to find the x-tell. Example \\PageIndex{8}\): Find the x-intercepts of the square function \(f(x)=2x^2+4x−4\). Workaround We start by resolving when the output will be zero. \[0=2x^2+4x−4 onumber\] Because square is not easily factorable in this case, we solve for interceptions by first rewriting the square in standard format. \[f(x)=a(x−h)^2+konumber\] We know that \(a=2\). Then we solve for \(h\) and \(k\). \[\begin{align*} h&=−\dfrac{b}{2a} & k&=f(−1) \\&#−\dfrac{4}{2(2)} & &=2(−1)^2+4(−1)−4 \\&#1 & &=−6 \end{align*}\] So now we can rewrite to standard format. \[f(x)=2(x+1)^2−6onumber\] We can now work out when the output will be zero. \[\begin{align*} 0&#2(x+1)^2−6 \\ 6&=2(x+1)^2 \\ 3&=(x+1)^2 \\ x+1&={\pm}\sqrt{3} \\ \end{align*}\] The chart has the x intercepts at 2\((−1−\sqrt{3}.0)\) and \(−1+\sqrt{3}.0)\). See image \\PageIndex{15}\). Picture \(\PageIndex{15}\): Chart of one which has the following x-rates: \(-2.732, 0)\) and \((0.732, 0)\). Exercise \(\PageIndex{1}\) In Try It \(\PageIndex{1}\), we found the standard and general form for \(g(x)=13+x^2−6x\). find y- and x-intercepts (if any{9}). 2+x+2=0\). : \(x=\frac{−b{\pm}\sqrt{b^2−4ac}}{2a}\). When applying the square formula, we specify the factors \(a\), \(b\), and \(c\). For the \(x^2+x+2=0\), we have \(a=1\), \(b=1\), and \(c=2\). Replace these values in the formula we have: \\\begin{align*} x&=\dfrac{−b{\pm}\sqrt{b^2−4ac}}{2a} \\dfrac{−1{\pm}\sqrt{1^1^1 2−4;1}}{2;1} \\ \\dfrac{−1{\pm}\sqrt{1−8}}}{2} \\ &=\dfrac{−1{\pm}\sqrt{−7 }}{2} \\ &=\dfrac{−1{−pm}i\sqrt{7}}{2} \end{align*}\] The solutions in the equation are \(x=\fra c{−1+i\sqrt{7}}{2} \) and \(x=\frac{−1-i\sqrt{7}}{2}\) or \(x=−\frac{1}{2}+\frac{i\ sqrt{7}}{2}\) and \(x=\ frac{-1}{2}−\frac{i\sqrt{7}}{2}\). Example \\PageIndex{10}\): Applying the top and x-price of a Parabola One ball is thrown upwards from the top of a 40-foot high building at a speed of 80 feet per second. The height of the ball above the ground can be formed by the equation \(H(t)=−16t^2+80t+40\). When does the ball reach maximum height? What's the maximum height of the ball? When did the ball fall to the ground? The ball reaches the maximum height at the top of the parable. \\begin{align} h &= −\dfrac{80}{2(−16)} \\ \\ \\dfrac{80}{32} \\ &=\dfrac{5}{2} \\ \\& =2.5 \end{align}\] The ball reaches a maximum height after 2.5 seconds. To find the maximum height, find the y-coordinate of the top of the parable. \\begin{align} k &=H(−\dfrac{b}{2a}) \\ &=H(2.5) \\ &=−16(2.5)^2+80(2.5)+40 \\ &=140 \end{}\] The ball reaches a maximum height of 140 feet. To find out when the ball hits the ground, we need to determine when the height is zero, \(H(t)=0\). We use the square formula. \[\begin{align} t & =\dfrac{−80±\sqrt{80^2−4(−16)(40)}}}{2(−16)} \\ \\ & \dfrac{−80±\sqrt{8960}}{32} \end{align} \] Because the square root does not simplify, fine, we can use a computer to approximate solution values. \[t=\dfrac{−80-\sqrt{8960}}{−32} ≈5,458 \text{ or }t=\dfrac{−80+\sqrt{8960}}{−32} ≈−0.458 \] The second answer is outside the logical domain of our model, so we conclude that the ball will hit the ground after about 5,458 seconds. See image \\PageIndex{16}\). Figure \(\PageIndex{16}\) \(\PageIndex{5}\): A rock is tossed upwards from the top of a 112-foot-high cliff overlooking the ocean at a speed of 96 per second. The height of the rock above the ocean can be formed by the equation \(H(t)=−16t^2+96t+112\). When When Does the rock reach its maximum height? What's the maximum height of the rock? When did the rock hit the ocean? Solution a. 3 seconds b. 256 feet c. 7 seconds axis of symmetry a vertical line drawn through the top of a parable around which the parable is symmetrical; Defined by \(x=−\frac{b}{2a}\). general format of a square function, the function that describes a parable, written in the form \(f(x)=ax^2+bx+c\), where \(a,b,\) and \(c\) are real numbers and a≠0. standard format of a square function, the function that describes a parable, written as \(f(x)=a(x−h)^2+k\), where \(h, k)\) is the peak. top the point at which a parabola changes direction, corresponding to the minimum or maximum value of the square top function of a square function, another name for the standard form of a square function zeroes in on a given function, the \(x\) values in which \(y=0\), also called root roots