Practice worksheet amplitude period and phase shift 2nd class maths

Recall that the sine and cosine functions relate real number values to the x– and y-coordinates of a point on the unit circle. So what do they look like on a graph on a coordinate plane? Let’s start with the sine function. We can create a table of values and use them to sketch a graph. (Figure) lists some of the values for the sine function on a unit circle.Plotting the points from the table and continuing along the x-axis gives the shape of the sine function. See (Figure). Figure 2. The sine function Notice how the sine values are positive between 0 andwhich correspond to the values of the sine function in quadrants I and II on the unit circle, and the sine values are negative betweenandwhich correspond to the values of the sine function in quadrants III and IV on the unit circle. See (Figure). Figure 3. Plotting values of the sine function Now let’s take a similar look at the cosine function. Again, we can create a table of values and use them to sketch a graph. (Figure) lists some of the values for the cosine function on a unit circle.As with the sine function, we can plots points to create a graph of the cosine function as in (Figure). Figure 4. The cosine function Because we can evaluate the sine and cosine of any real number, both of these functions are defined for all real numbers. By thinking of the sine and cosine values as coordinates of points on a unit circle, it becomes clear that the range of both functions must be the interval In both graphs, the shape of the graph repeats afterwhich means the functions are periodic with a period ofA periodic function is a function for which a specific horizontal shift, P, results in a function equal to the original function:for all values ofin the domain ofWhen this occurs, we call the smallest such horizontal shift withthe period of the function. (Figure) shows several periods of the sine and cosine functions. Figure 5. Looking again at the sine and cosine functions on a domain centered at the y-axis helps reveal symmetries. As we can see in (Figure), the sine function is symmetric about the origin. Recall from The Other Trigonometric Functions that we determined from the unit circle that the sine function is an odd function because Now we can clearly see this property from the graph. Figure 6. Odd symmetry of the sine function (Figure) shows that the cosine function is symmetric about the y-axis. Again, we determined that the cosine function is an even function. Now we can see from the graph that Figure 7. Even symmetry of the cosine function The sine and cosine functions have several distinct characteristics: They are periodic functions with a period of The domain of each function isand the range is The graph ofis symmetric about the origin, because it is an odd function. The graph ofis symmetric about theaxis, because it is an even function. As we can see, sine and cosine functions have a regular period and range. If we watch ocean waves or ripples on a pond, we will see that they resemble the sine or cosine functions. However, they are not necessarily identical. Some are taller or longer than others. A function that has the same general shape as a sine or cosine function is known as a sinusoidal function. The general forms of sinusoidal functions are Looking at the forms of sinusoidal functions, we can see that they are transformations of the sine and cosine functions. We can use what we know about transformations to determine the period. In the general formula,is related to the period byIfthen the period is less thanand the function undergoes a horizontal compression, whereas ifthen the period is greater thanand the function undergoes a horizontal stretch. For example,[latex]B=1,\,[/latex]so the period iswhich we knew. Ifthenso the period isand the graph is compressed. Ifthenso the period isand the graph is stretched. Notice in (Figure) how the period is indirectly related to Figure 8. If we letandin the general form equations of the sine and cosine functions, we obtain the forms The period is Determine the period of the function [reveal-answer q="fs-id1165137434852″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137434852″] Let’s begin by comparing the equation to the general form In the given equation,so the period will be [/hidden-answer] Determine the period of the function [reveal-answer q="fs-id1165137507692″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137507692″] [/hidden-answer] Returning to the general formula for a sinusoidal function, we have analyzed how the variablerelates to the period. Now let’s turn to the variableso we can analyze how it is related to the amplitude, or greatest distance from rest.represents the vertical stretch factor, and its absolute valueis the amplitude. The local maxima will be a distanceabove the horizontal midline of the graph, which is the linebecausein this case, the midline is the x-axis. The local minima will be the same distance below the midline. Ifthe function is stretched. For example, the amplitude ofis twice the amplitude ofIfthe function is compressed. (Figure) compares several sine functions with different amplitudes. Figure 9. If we letandin the general form equations of the sine and cosine functions, we obtain the forms The amplitude isand the vertical height from the midline isIn addition, notice in the example that What is the amplitude of the sinusoidal functionIs the function stretched or compressed vertically? [reveal-answer q="fs-id1165135195832″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135195832″] Let’s begin by comparing the function to the simplified form In the given function,so the amplitude isThe function is stretched.[/hidden-answer] The negative value ofresults in a reflection across the x-axis of the sine function, as shown in (Figure). Figure 10. What is the amplitude of the sinusoidal functionIs the function stretched or compressed vertically? Now that we understand howandrelate to the general form equation for the sine and cosine functions, we will explore the variablesandRecall the general form: The valuefor a sinusoidal function is called the phase shift, or the horizontal displacement of the basic sine or cosine function. Ifthe graph shifts to the right. Ifthe graph shifts to the left. The greater the value ofthe more the graph is shifted. (Figure) shows that the graph ofshifts to the right byunits, which is more than we see in the graph ofwhich shifts to the right byunits. Figure 11. Whilerelates to the horizontal shift,indicates the vertical shift from the midline in the general formula for a sinusoidal function. See (Figure). The functionhas its midline at Figure 12. Any value ofother than zero shifts the graph up or down. (Figure) compareswithwhich is shifted 2 units up on a graph. Figure 13. Given an equation in the formor[latex]\frac{C}{B}\,[/latex]is the phase shift andis the vertical shift. Determine the direction and magnitude of the phase shift for [reveal-answer q="fs-id1165134483435″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165134483435″] Let’s begin by comparing the equation to the general form In the given equation, notice thatandSo the phase shift is orunits to the left.[/hidden-answer] We must pay attention to the sign in the equation for the general form of a sinusoidal function. The equation shows a minus sign beforeThereforecan be rewritten asIf the value ofis negative, the shift is to the left. Determine the direction and magnitude of the phase shift for [reveal-answer q="fs-id1165131959464″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165131959464″] right [/hidden-answer] Determine the direction and magnitude of the vertical shift for [reveal-answer q="fs-id1165137427502″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137427502″] Let’s begin by comparing the equation to the general form In the given equation,so the shift is 3 units downward. [/hidden-answer] Determine the direction and magnitude of the vertical shift for [reveal-answer q="fs-id1165137432579″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137432579″] 2 units up [/hidden-answer] Given a sinusoidal function in the formidentify the midline, amplitude, period, and phase shift. Determine the amplitude as Determine the period as Determine the phase shift as Determine the midline as Determine the midline, amplitude, period, and phase shift of the function [reveal-answer q="fs-id1165137454382″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137454382″] Let’s begin by comparing the equation to the general form so the amplitude is Next,so the period is There is no added constant inside the parentheses, soand the phase shift is Finally,so the midline is[/hidden-answer] Inspecting the graph, we can determine that the period isthe midline isand the amplitude is 3. See (Figure). Figure 14. Determine the midline, amplitude, period, and phase shift of the function [reveal-answer q="fs-id1165134042358″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165134042358″] midline:amplitude:period:phase shift: [/hidden-answer] Determine the formula for the cosine function in (Figure). Figure 15. [reveal-answer q="fs-id1165135329784″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135329784″] To determine the equation, we need to identify each value in the general form of a sinusoidal function. The graph could represent either a sine or a cosine function that is shifted and/or reflected. Whenthe graph has an extreme point,Since the cosine function has an extreme point forlet us write our equation in terms of a cosine function. Let’s start with the midline. We can see that the graph rises and falls an equal distance above and belowThis value, which is the midline, isin the equation, so The greatest distance above and below the midline is the amplitude. The maxima are 0.5 units above the midline and the minima are 0.5 units below the midline. SoAnother way we could have determined the amplitude is by recognizing that the difference between the height of local maxima and minima is 1, soAlso, the graph is reflected about the x-axis so that The graph is not horizontally stretched or compressed, soand the graph is not shifted horizontally, so Putting this all together, [/hidden-answer] Determine the formula for the sine function in (Figure). Figure 16. [reveal-answer q="fs-id1165137526465″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137526465″] [/hidden-answer] Determine the equation for the sinusoidal function in (Figure). Figure 17. [reveal-answer q="fs-id1165137598813″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137598813″] With the highest value at 1 and the lowest value atthe midline will be halfway between atSo The distance from the midline to the highest or lowest value gives an amplitude of The period of the graph is 6, which can be measured from the peak atto the next peak ator from the distance between the lowest points. Therefore,Using the positive value forwe find that So far, our equation is eitherorFor the shape and shift, we have more than one option. We could write this as any one of the following: a cosine shifted to the right a negative cosine shifted to the left a sine shifted to the left a negative sine shifted to the right While any of these would be correct, the cosine shifts are easier to work with than the sine shifts in this case because they involve integer values. So our function becomes Again, these functions are equivalent, so both yield the same graph.[/hidden-answer] Write a formula for the function graphed in (Figure). Figure 18. [reveal-answer q="fs-id1165135173772″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135173772″] two possibilities:or [/hidden-answer] Throughout this section, we have learned about types of variations of sine and cosine functions and used that information to write equations from graphs. Now we can use the same information to create graphs from equations. Instead of focusing on the general form equations we will letandand work with a simplified form of the equations in the following examples. Given the functionsketch its graph. Identify the amplitude, Identify the period, Start at the origin, with the function increasing to the right ifis positive or decreasing ifis negative. Atthere is a local maximum foror a minimum forwith The curve returns to the x-axis at There is a local minimum for(maximum for) atwith The curve returns again to the x-axis at Sketch a graph of [reveal-answer q="fs-id1165134190732″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165134190732″] Let’s begin by comparing the equation to the form Step 1. We can see from the equation thatso the amplitude is 2. Step 2. The equation shows thatso the period is Step 3. Becauseis negative, the graph descends as we move to the right of the origin. Step 4–7. The x-intercepts are at the beginning of one period,the horizontal midpoints are atand at the end of one period at The quarter points include the minimum atand the maximum atA local minimum will occur 2 units below the midline, atand a local maximum will occur at 2 units above the midline, at(Figure) shows the graph of the function. Figure 19. [/hidden-answer] Sketch a graph ofDetermine the midline, amplitude, period, and phase shift. [reveal-answer q="fs-id1165135342790″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135342790″] midline:amplitude:period:phase shift: or none [/hidden-answer] Given a sinusoidal function with a phase shift and a vertical shift, sketch its graph. Express the function in the general form Identify the amplitude, Identify the period, Identify the phase shift, Draw the graph of shifted to the right or left byand up or down by Sketch a graph of [reveal-answer q="178576″]Show Solution[/reveal-answer] [hidden-answer a="178576″] Step 1. The function is already written in general form:This graph will have the shape of a sine function, starting at the midline and increasing to the right. Step 2.The amplitude is 3. Step 3. Sincewe determine the period as follows. The period is 8. Step 4. Sincethe phase shift is The phase shift is 1 unit. Step 5.(Figure) shows the graph of the function. Figure 20. A horizontally compressed, vertically stretched, and horizontally shifted sinusoid [/hidden-answer] Draw a graph ofDetermine the midline, amplitude, period, and phase shift. [reveal-answer q="fs-id1165137480594″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137480594″] midline:amplitude:period:phase shift: [/hidden-answer] Givendetermine the amplitude, period, phase shift, and horizontal shift. Then graph the function. [reveal-answer q="fs-id1165135487183″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135487183″] Begin by comparing the equation to the general form and use the steps outlined in (Figure). Step 1. The function is already written in general form. Step 2. Sincethe amplitude is Step 3.so the period isThe period is 4. Step 4.so we calculate the phase shift asThe phase shift is Step 5.so the midline isand the vertical shift is up 3. Sinceis negative, the graph of the cosine function has been reflected about the x-axis. (Figure) shows one cycle of the graph of the function. Figure 21. [/hidden-answer] We can use the transformations of sine and cosine functions in numerous applications. As mentioned at the beginning of the chapter, circular motion can be modeled using either the sine or cosine function. A point rotates around a circle of radius 3 centered at the origin. Sketch a graph of the y-coordinate of the point as a function of the angle of rotation. [reveal-answer q="fs-id1165137552985″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137552985″] Recall that, for a point on a circle of radius r, the y-coordinate of the point is so in this case, we get the equation The constant 3 causes a vertical stretch of the y-values of the function by a factor of 3, which we can see in the graph in (Figure). Figure 22. [/hidden-answer] Notice that the period of the function is stillas we travel around the circle, we return to the pointforBecause the outputs of the graph will now oscillate betweenandthe amplitude of the sine wave is What is the amplitude of the functionSketch a graph of this function. [reveal-answer q="fs-id1165137534006″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137534006″] 7 [/hidden-answer] A circle with radius 3 ft is mounted with its center 4 ft off the ground. The point closest to the ground is labeled P, as shown in (Figure). Sketch a graph of the height above the ground of the pointas the circle is rotated; then find a function that gives the height in terms of the angle of rotation. Figure 23. [reveal-answer q="fs-id1165137863854″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137863854″] Sketching the height, we note that it will start 1 ft above the ground, then increase up to 7 ft above the ground, and continue to oscillate 3 ft above and below the center value of 4 ft, as shown in (Figure). Figure 24. Although we could use a transformation of either the sine or cosine function, we start by looking for characteristics that would make one function easier to use than the other. Let’s use a cosine function because it starts at the highest or lowest value, while a sine function starts at the middle value. A standard cosine starts at the highest value, and this graph starts at the lowest value, so we need to incorporate a vertical reflection. Second, we see that the graph oscillates 3 above and below the center, while a basic cosine has an amplitude of 1, so this graph has been vertically stretched by 3, as in the last example. Finally, to move the center of the circle up to a height of 4, the graph has been vertically shifted up by 4. Putting these transformations together, we find that [/hidden-answer] A weight is attached to a spring that is then hung from a board, as shown in (Figure). As the spring oscillates up and down, the positionof the weight relative to the board ranges fromin. (at timetoin. (at timebelow the board. Assume the position ofis given as a sinusoidal function ofSketch a graph of the function, and then find a cosine function that gives the positionin terms of Figure 25. [reveal-answer q="fs-id1165137736527″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137736527″] [/hidden-answer] The London Eye is a huge Ferris wheel with a diameter of 135 meters (443 feet). It completes one rotation every 30 minutes. Riders board from a platform 2 meters above the ground. Express a rider’s height above ground as a function of time in minutes. [reveal-answer q="fs-id1165137837117″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137837117″] With a diameter of 135 m, the wheel has a radius of 67.5 m. The height will oscillate with amplitude 67.5 m above and below the center. Passengers board 2 m above ground level, so the center of the wheel must be locatedm above ground level. The midline of the oscillation will be at 69.5 m. The wheel takes 30 minutes to complete 1 revolution, so the height will oscillate with a period of 30 minutes. Lastly, because the rider boards at the lowest point, the height will start at the smallest value and increase, following the shape of a vertically reflected cosine curve. Amplitude:so Midline:so Period:so Shape: An equation for the rider’s height would be whereis in minutes andis measured in meters.[/hidden-answer] Why are the sine and cosine functions called periodic functions? [reveal-answer q="fs-id1165137415637″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137415637″] The sine and cosine functions have the property thatfor a certainThis means that the function values repeat for everyunits on the x-axis. [/hidden-answer] How does the graph of compare with the graph of Explain how you could horizontally translate the graph of to obtain For the equationwhat constants affect the range of the function and how do they affect the range? [reveal-answer q="fs-id1165137811265″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137811265″] The absolute value of the constant(amplitude) increases the total range and the constant(vertical shift) shifts the graph vertically. [/hidden-answer] How does the range of a translated sine function relate to the equation How can the unit circle be used to construct the graph of [reveal-answer q="fs-id1165137407584″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137407584″] At the point where the terminal side ofintersects the unit circle, you can determine that theequals the y-coordinate of the point. [/hidden-answer] For the following exercises, graph two full periods of each function and state the amplitude, period, and midline. State the maximum and minimum y-values and their corresponding x-values on one period forRound answers to two decimal places if necessary. [reveal-answer q="fs-id1165135456747″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135456747″] amplitude:period:midline:maximum:occurs atminimum:occurs atfor one period, the graph starts at 0 and ends at [/hidden-answer] [reveal-answer q="486349″]Show Solution[/reveal-answer] [hidden-answer a="486349″] amplitude: 4; period:midline:maximumoccurs atminimum:occurs atone full period occurs fromto [/hidden-answer] [reveal-answer q="fs-id1165137871346″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137871346″] amplitude: 1; period:midline:maximum:occurs atminimum:occurs atone full period is graphed fromto [/hidden-answer] [reveal-answer q="12808″]Show Solution[/reveal-answer] [hidden-answer a="12808″] amplitude: 4; period: 2; midline:maximum:occurs atminimum:occurs at [/hidden-answer] [reveal-answer q="fs-id1165137843946″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137843946″] amplitude: 3; period:midline:maximum:occurs atminimum:occurs athorizontal shift:vertical translation 5; one period occurs fromto [/hidden-answer] [reveal-answer q="fs-id1165134284471″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165134284471″] amplitude: 5; period:midline:maximum:occurs atminimum:occurs atphase shift:vertical translation:one full period can be graphed onto [/hidden-answer] For the following exercises, graph one full period of each function, starting atFor each function, state the amplitude, period, and midline. State the maximum and minimum y-values and their corresponding x-values on one period forState the phase shift and vertical translation, if applicable. Round answers to two decimal places if necessary. [reveal-answer q="fs-id1165134541171″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165134541171″] amplitude: 1 ; period:midline:maximum:occurs atmaximum:occurs atminimum:occurs atphase shift:vertical translation: 1; one full period is fromto [/hidden-answer] [reveal-answer q="fs-id1165137541180″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137541180″]amplitude: 1; period:midline:maximum:occurs atminimum:occurs atphase shift:vertical shift: 0[/hidden-answer] Determine the amplitude, midline, period, and an equation involving the sine function for the graph shown in (Figure). Figure 26. [reveal-answer q="fs-id1165135708054″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135708054″] amplitude: 2; midline:period: 4; equation: [/hidden-answer] Determine the amplitude, period, midline, and an equation involving cosine for the graph shown in (Figure). Figure 27. Determine the amplitude, period, midline, and an equation involving cosine for the graph shown in (Figure). Figure 28. [reveal-answer q="fs-id1165134378700″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165134378700″] amplitude: 2; period: 5; midline:equation: [/hidden-answer] Determine the amplitude, period, midline, and an equation involving sine for the graph shown in (Figure). Figure 29. Determine the amplitude, period, midline, and an equation involving cosine for the graph shown in (Figure). Figure 30. [reveal-answer q="fs-id1165135534972″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135534972″] amplitude: 4; period: 2; midline:equation: [/hidden-answer] Determine the amplitude, period, midline, and an equation involving sine for the graph shown in (Figure). Figure 31. Determine the amplitude, period, midline, and an equation involving cosine for the graph shown in (Figure). Figure 32. [reveal-answer q="fs-id1165137600948″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137600948″] amplitude: 2; period: 2; midlineequation: [/hidden-answer] Determine the amplitude, period, midline, and an equation involving sine for the graph shown in (Figure). Figure 33. For the following exercises, let Onsolve Onsolve [reveal-answer q="fs-id1165137832261″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137832261″] [/hidden-answer] Evaluate OnFind all values of [reveal-answer q="fs-id1165137837133″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137837133″] [/hidden-answer] Onthe maximum value(s) of the function occur(s) at what x-value(s)? Onthe minimum value(s) of the function occur(s) at what x-value(s)? [reveal-answer q="fs-id1165134042136″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165134042136″] [/hidden-answer] Show thatThis means thatis an odd function and possesses symmetry with respect to _____. For the following exercises, let Onsolve the equation [reveal-answer q="fs-id1165134129955″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165134129955″] [/hidden-answer] Onsolve Onfind the x-intercepts of [reveal-answer q="fs-id1165135440505″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135440505″] [/hidden-answer] Onfind the x-values at which the function has a maximum or minimum value. Onsolve the equation [reveal-answer q="fs-id1165137933103″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137933103″] [/hidden-answer] GraphonExplain why the graph appears as it does. GraphonDid the graph appear as predicted in the previous exercise? [reveal-answer q="fs-id1165137433807″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165137433807″] The graph appears linear. The linear functions dominate the shape of the graph for large values of [/hidden-answer] Graphonand verbalize how the graph varies from the graph of Graphon the windowand explain what the graph shows. [reveal-answer q="fs-id1165135322029″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135322029″] The graph is symmetric with respect to the y-axis and there is no amplitude because the function is not periodic. [/hidden-answer] Graphon the windowand explain what the graph shows. A Ferris wheel is 25 meters in diameter and boarded from a platform that is 1 meter above the ground. The six o’clock position on the Ferris wheel is level with the loading platform. The wheel completes 1 full revolution in 10 minutes. The functiongives a person’s height in meters above the ground t minutes after the wheel begins to turn. Find the amplitude, midline, and period of Find a formula for the height function How high off the ground is a person after 5 minutes? [reveal-answer q="fs-id1165135205671″]Show Solution[/reveal-answer] [hidden-answer a="fs-id1165135205671″] Amplitude: 12.5; period: 10; midline: 26 ft [/hidden-answer]

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