

Apr 9-2:03 PM

**KEY CONCEPT** For Your Notebook

**Characteristics of  $y = \sin x$  and  $y = \cos x$**

- The domain of each function is all real numbers.
- The range of each function is  $-1 \leq y \leq 1$ . Therefore, the minimum value of each function is  $m = -1$  and the maximum value is  $M = 1$ .
- The **amplitude** of each function's graph is half the difference of the maximum  $M$  and the minimum  $m$ , or  $\frac{1}{2}(M - m) = \frac{1}{2}[1 - (-1)] = 1$ .
- Each function is **periodic**, which means that its graph has a repeating pattern. The shortest repeating portion of the graph is called a **cycle**. The horizontal length of each cycle is called the **period**. Each graph shown above has a period of  $2\pi$ .
- The x-intercepts for  $y = \sin x$  occur when  $x = 0, \pm\pi, \pm2\pi, \pm3\pi, \dots$
- The x-intercepts for  $y = \cos x$  occur when  $x = \pm\frac{\pi}{2}, \pm\frac{3\pi}{2}, \pm\frac{5\pi}{2}, \pm\frac{7\pi}{2}, \dots$

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Characteristics

Domain:  $\mathbb{R}$

Range: (for basic graph)  $-1 \leq y \leq 1$

Amplitude: distance from midline (middle) to the highest or lowest point.

Periodic: it repeats itself

Cycle: On non repeating portion of the graph.

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$= a \sin x$

**Graph  $f(x) = 4 \sin x$**

Amplitude:  $|a|$  4

Period: 0 to  $2\pi$

Domain:  $\mathbb{R}$

Range:  $-4 \leq y \leq 4$

X-int(s): 0,  $\pi$ ,  $2\pi$

Max: 4

Min: -4

Axis of Oscillation:  $y = 0$   
(midline)

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$y = a \cos x$

**Graph  $f(x) = 2 \cos x$**

Amplitude: 2

Period: 0 to  $2\pi$

Domain:  $\mathbb{R}$

Range:  $-2 \leq y \leq 2$

X-int(s):  $\frac{\pi}{2}, \frac{3\pi}{2}$

Max: 2

Min: -2

Axis of Oscillation:  $y = 0$

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Graph Reflections across the x axis... negative "a"

$y = -2 \sin x$

$y = -3 \cos x$

Amplitude  $|a| = 2$

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**PERIOD CHANGES** Our normal period is  $0-2\pi$

If our equation has a "b" - our period changes

**KEY CONCEPT** *For Your Notebook*

**Amplitude and Period**

The amplitude and period of the graphs of  $y = a \sin bx$  and  $y = a \cos bx$  where  $a$  and  $b$  are nonzero real numbers, are as follows:

Amplitude =  $|a|$       Period =  $\frac{2\pi}{|b|}$

We separate our cycle into 4 equal parts based on our "b"

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Graph  $f(x) = \sin 6x$   $y = a \sin bx$

Amplitude: 1  
 Period:  $0$  to  $\frac{\pi}{3}$  **New Period**  
 $\frac{2\pi}{6} = \frac{\pi}{3}$   
 Domain:  $\mathbb{R}$   
 Range:  $-1 \leq y \leq 1$   
 X-int(s):  $0, \frac{\pi}{6}, \frac{\pi}{3}$   
 Max: 1  
 Min: -1  
 Axis of Oscillation:  $y = 0$

1st half the half  
 2nd half halfway  
 3rd cut  
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**Graph**

Graph  $f(x) = \cos 4x$

**New Period**  
 $\frac{2\pi}{b} = \frac{2\pi}{4} = \frac{\pi}{2}$

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①  $f(x) = 2 \cos 8x$  **"a" Amplitude 2**

**Period**  
 $\frac{2\pi}{8} = \frac{\pi}{4}$

②  $f(x) = -3 \sin 4x$  **Amplitude 3**

**Period**  
 $\frac{2\pi}{4} = \frac{\pi}{2}$

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**KEY CONCEPT** *For Your Notebook*

**Translations of Sine and Cosine Graphs**

To graph  $y = a \sin b(x - h) + k$  or  $y = a \cos b(x - h) + k$  where  $a > 0$  and  $b > 0$ , follow these steps:

**STEP 1** Identify the amplitude  $a$ , the period  $\frac{2\pi}{b}$ , the horizontal shift  $h$  and the vertical shift  $k$  of the graph.

**STEP 2** Draw the horizontal line  $y = k$ , called the *midline* of the graph.

**STEP 3** Find the five key points by translating the key points of  $y = a \sin bx$  or  $y = a \cos bx$  horizontally  $h$  units and vertically  $k$  units.

**STEP 4** Draw the graph through the five translated key points.

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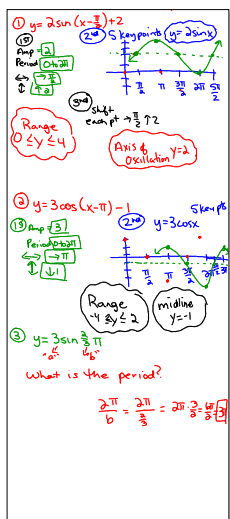
①  $y = 2 \sin(x - \frac{\pi}{4}) + 3$

**Shifts**  
 Amplitude = 2  
 Period =  $0$  to  $2\pi$   
 horizontal  $\rightarrow \frac{\pi}{4}$   
 vertical  $\uparrow 3$

②  $y = -3 \sin 4(x + \pi) - 1$

**Shifts**  
 amplitude = 3  
 Period =  $\frac{2\pi}{4} = \frac{\pi}{2}$   
 horizontal  $\leftarrow \pi$   
 vertical  $\downarrow 1$

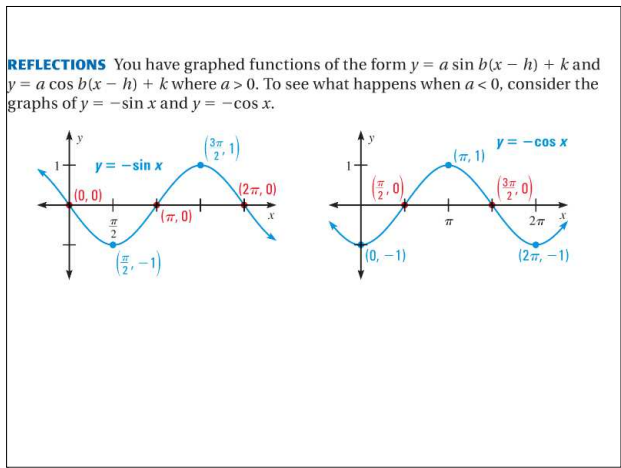
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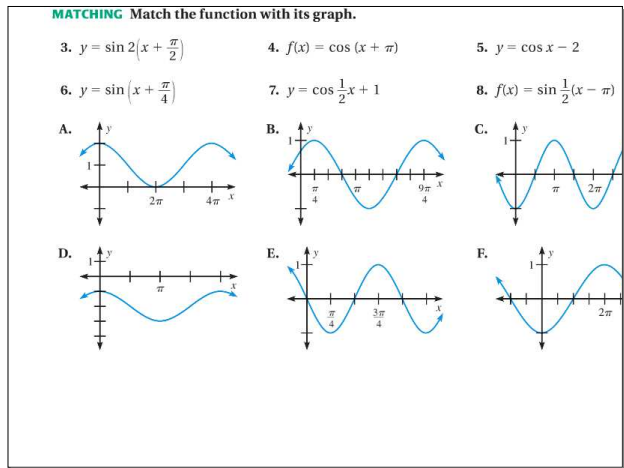
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$|a|$  = amplitude  
 $\frac{2\pi}{b}$  = period  
 $h$  = shifts graph horizontally  
 (+ $h$ : left, - $h$ : right)  
 $k$  = shifts graph vertically  
 (+ $k$ : up, - $k$ : down)

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**KEY CONCEPT** *For Your Notebook*

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Amplitude = $ a $	Period = $\frac{2\pi}{ b }$
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