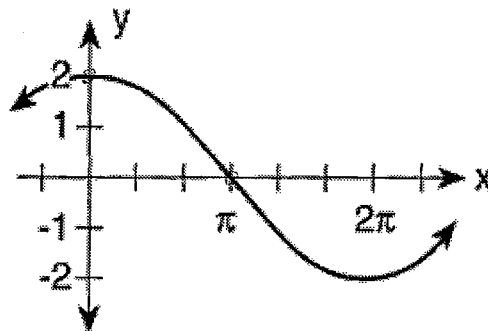


LESSON #5: VERTICAL AND PHASE SHIFTS

DO NOW:

Which equation is represented in the graph shown?

- ~~1)~~  $y = \frac{1}{2} \sin 2x$       3)  $y = 2 \cos \frac{1}{2}x$   
 2)  $y = 2 \sin \frac{1}{2}x$       ~~4)~~  $y = \frac{1}{2} \cos 2x$



I. Graphing Translations

For #1 & 2, the graph of  $y = \sin x$  is given over the interval  $-2\pi \leq x \leq 2\pi$ .

a) Graph  $y = \sin x + 3$  on the same axes.

midline =  $3 = y$

b) What happened to the graph of  $y = \sin x$ ?

UP 3 UNITS

b) What is the amplitude of  $y = \sin x + 3$ ?

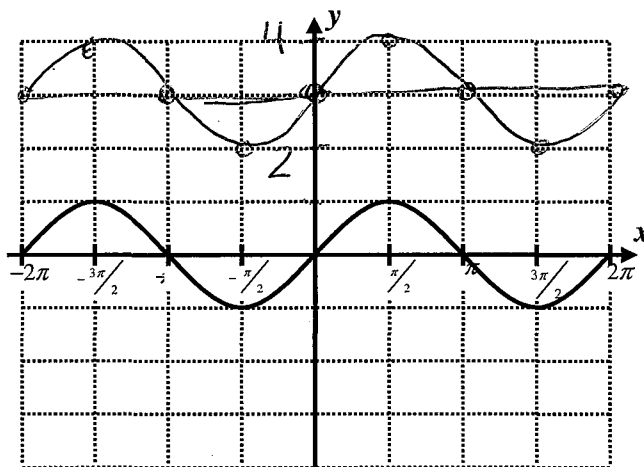
1

c) What is the frequency of  $y = \sin x + 3$ ?

1

d) What is the range of  $y = \sin x + 3$ ?

$[2, 4]$



2) a) Graph  $y = \sin\left(x + \frac{\pi}{2}\right)$  on the same axes.

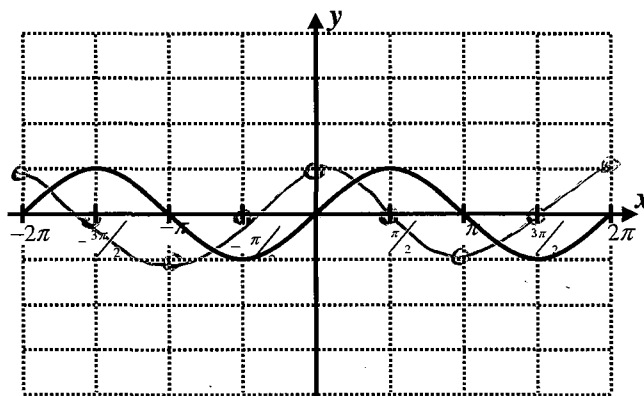
b) What happened to the graph of  $y = \sin x$ ?

left  $\frac{\pi}{2}$  UNITS

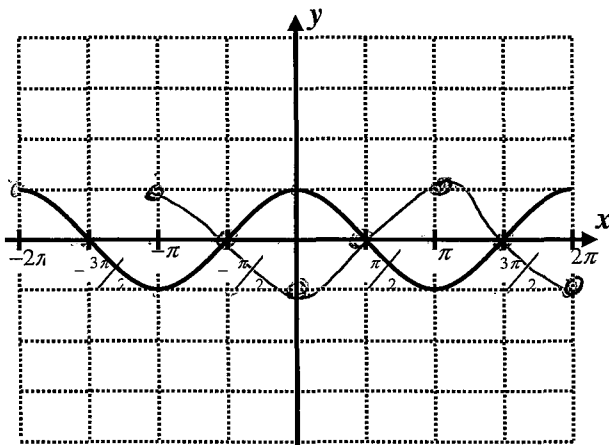
c) Write an equation that is equal

to  $y = \sin\left(x + \frac{\pi}{2}\right)$ ?  $= y = \cos x$

COFUNCTIONS!



3) The graph of  $y = \cos x$  is given on the graph



below over the interval  $-2\pi \leq x \leq 2\pi$ .

a) Sketch the graph of  $y = \cos x$  after a phase shift of  $\pi$  to the right and a vertical translation of 3 units down.

b) Write the equation of the new graph.

$$y = \cos(x - \pi)$$

**PUT IT ALL TOGETHER . . .**

Trigonometric functions that are translated by horizontal and vertical shifts now follow the equations:

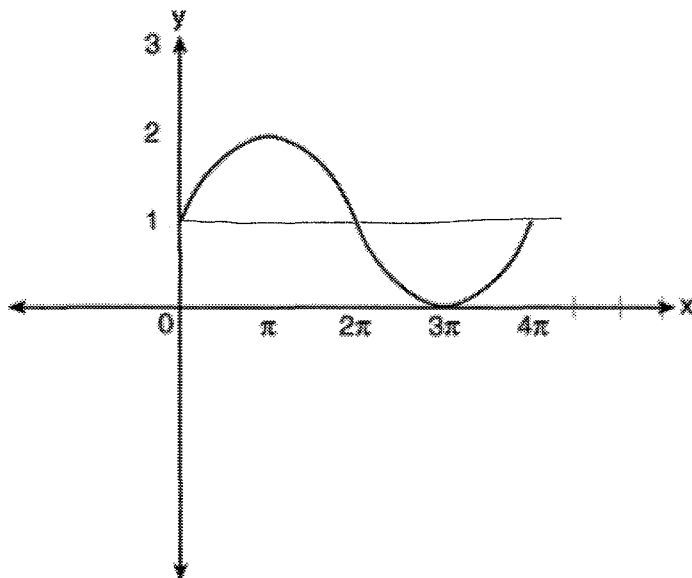
$$y = a \sin b(x \pm c) \pm d \quad \text{OR} \quad y = a \cos b(x \pm c) \pm d$$

where:  $a = \text{amplitude}$   $b = \text{frequency}$   $c = \text{phase shift (horizontal shift)}$   $d = \text{vertical shift}$

➤ **PERIOD** – answers the question “how long does it take to complete 1 full cycle on the graph”?

- Sine curve  $\rightarrow 2\pi$
- Cosine curve  $\rightarrow 2\pi$
- Formula  $\rightarrow \frac{2\pi}{b}$

4) In physics class, Eva noticed the pattern shown in the accompanying diagram on an oscilloscope.



a) At what value of  $y$  is the midline?

$$y = 1$$

b) What is the amplitude?

$$1$$

c) What is the frequency? *between  $(0 + 2\pi)$*

$$\frac{1}{2}$$

d) Write the equation of the graph in the form:  $y = a \sin bx + d$

$$y = \sin \frac{1}{2}x + 1$$

e) State the period of the graph?  $\frac{2\pi}{\frac{1}{2}} = 4\pi$

$$4\pi$$

f) State the range of the graph?

$$[0, 2]$$

Name: \_\_\_\_\_

Date: \_\_\_\_\_

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**LAB #3: VERTICAL AND PHASE SHIFTS OF TRIG GRAPHS**

Describe the phase shift and/or vertical shift, if any, in each equation.

1)  $y = 3 \sin x + 1$

up 1

2)  $y = \cos\left(x + \frac{\pi}{2}\right) + 2$

left  $\frac{\pi}{2}$  and up 2

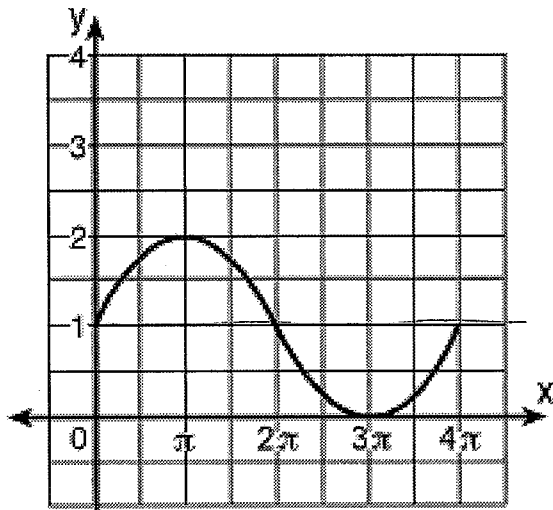
For #3 & 4, write an equation for each translation.

3)  $\frac{\pi}{2}$  units left and 4 units up on  $y = \cos x$ .  $y = \cos\left(x + \frac{\pi}{2}\right) + 4$

4)  $\pi$  units to the right and 2 units down on  $y = \sin x$ .  $y = \sin(x - \pi) - 2$

5) Write the equation for the following graphs in the form  $y = a \sin bx + d$ .

a)

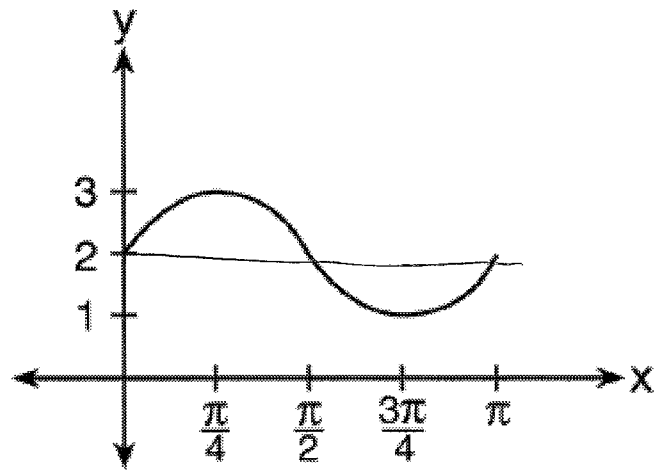


$a = 1$   
 $b = \frac{1}{2}$   
 $c = 0$   
 $d = +1$

$y = \sin\left(\frac{1}{2}\theta\right) + 1$

$\sin \theta$   
 period =  $4\pi$

b)



period =  $\pi = \frac{2\pi}{b}$   
 $\pi b = 2\pi$   
 $b = 2$

$a = 1$   
 $c = 0$   
 $d = +2$   
 $\sin \theta$

$y = \sin 2\theta + 2$

