

## NOTESallIANS

Look below for ALL  
answers to notes - if you find mistakes, let me know

## Sinusoidal Functions Unit

Tentative TEST date \_\_\_\_\_



**Reflect** – previous TEST mark \_\_\_\_\_, Overall mark now \_\_\_\_\_.  
Looking back, what can you improve upon?



### Big idea/Learning Goals

In this unit you will learn how trigonometry can be used to model wavelike relationships. These wavelike functions are called **sinusoidal functions**. You will study key properties of the sine function and use these properties to sketch these functions, to model real life situations and to solve problems. If you go on studying math you will learn that the cosine function is very similar to sine function, however the tangent function is very different.



### Success Criteria


- ☐ I am ready for this unit if I am confident in the following review topics  
(circle the topics you are good at & review the ones you left undirolled before you get too far behind)  
*Reading graphs, simplifying expressions, solving equations, transformations, function notation, domain & range*
- ☐ I understand the new topics for this unit if I can do the practice questions in the textbook/handouts  
(check off the topics for which you have finished the practice)

Date	Topics	Done?
	CBR Investigation of Motion Handout & EXTRA "Roll the Shape" Experiment	
	Periodic Behaviour Section 6.2 p331 #4,5,6,7,8 & EXTRA Handout	
	Sine Function Investigation Section 6.3 p339 #1,3,4,6,7,9 & EXTRA Handout	
	Comparing Sinusoidal Functions Section 6.4 p348 #3,4,5,6,7	
	Translating/Shifting the Sine Function Section 6.5 p365 #3,4,6,9,11	
	Stretching/Compressing the Sine Function Section 6.6 p375 #13,15,17,19 & Extra Handout	
	one EXTRA group Activity – if there is time one EXTRA Handout on KU APP COMM TIPS	

- ☐ I am prepared for the test/evaluation if
- ☐ I understand the main concepts from each lesson
    - if not, ask other students in class to help you study or visit the peer tutoring room or ask the teacher for help or get a private tutor
    - also practice "knowledge-understanding" questions from the textbook – look for questions marked by **K**
  - ☐ I can explain/communicate the ideas clearly
    - if not, practice explaining a solved question to someone else or complete the assigned journal questions
    - also practice "communication" questions from the textbook – look for questions marked by **C**
  - ☐ I can apply these concepts in word problems
    - if not, practice "application" questions from the textbook – look for questions marked by **A**
  - ☐ I did not just memorize steps to do for different types of questions, I understand the ideas behind each concept and therefore can do problems in new contexts
    - if not, practice "thinking-inquiry-problem-solving" questions from the textbook – look for questions marked by **T**
  - ☐ I can do questions independently
    - if not, try redoing an already solved example without looking at solutions
  - ☐ I can complete questions quickly and with confidence
    - if not, try timing yourself for similar type questions to see progress
  - ☐ I completed the review and/or practice test


Corrections for the textbook answers:

## CBR Investigation of Motion

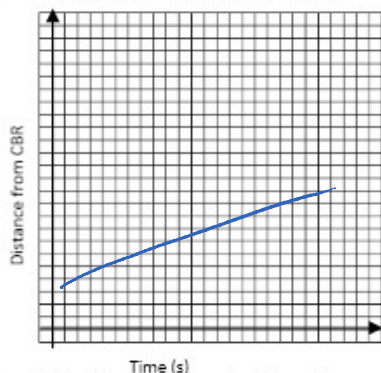
 The **Calculator Based Ranger - CBR** is a distance sensor that acts much the same as a submarine or bat to determine its location with respect to an object (it sends out sound waves then determines the time it takes for them to hit the object and bounce back, thus giving its location, or distance from the CBR).

CBR Set-up: (get program to work between calc and ranger) Calc: 2<sup>nd</sup>, Link, ->, Enter  
ranger: 82/83

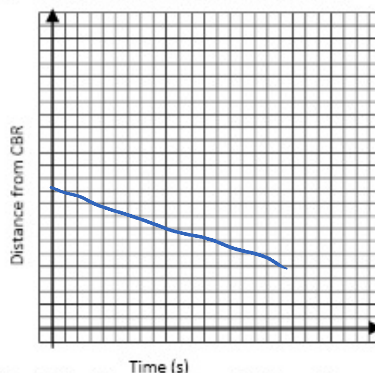
(get into program)	Program, Ranger, Enter
(get sample)	Set up, up, start now, ... repeat sample
(matching graphs)	Applications, meters, dist.match

 Instructions: create a clear area for walking in front of CBR, hold a flat surface (ie book) in front yourself as you walk, walk steady, ignore jumps in the graph, the instrument is not very precise. Sketch the graph first, then walk, then compare if your prediction was correct.

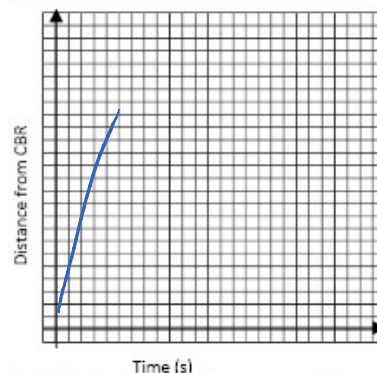
1. Student walks slowly away from CBR



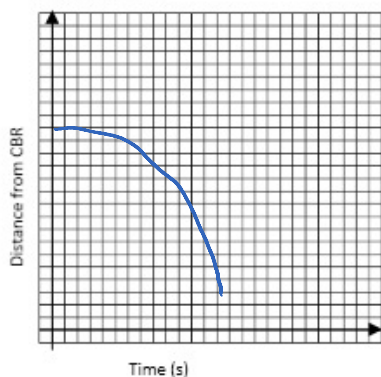
2. Student walks slowly toward the CBR



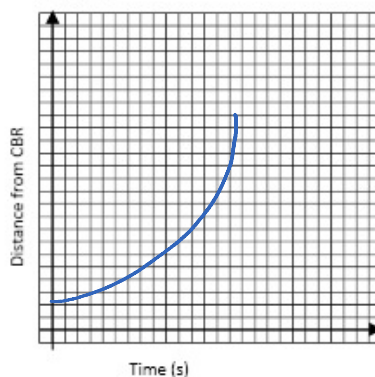
3. Students walks quickly toward the CBR



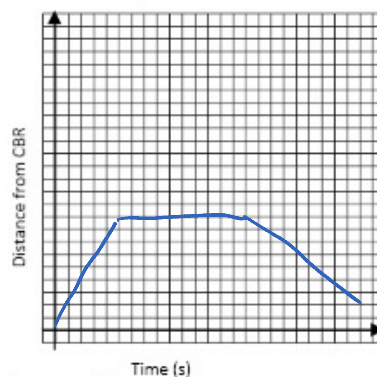
4. Student increases speed while walking toward the CBR



5. Student decreases speed while walking away from CBR



6. Student walks away from ranger, at 2 meters stops for 5 seconds, then returns at the same pace

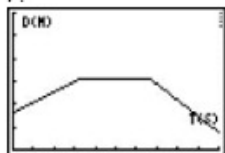


Do some **match the graph** activities on the CBR for practice, then answer the following questions.



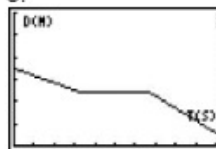
Describe how to create or explain why it is impossible to create the following graphs.

7.



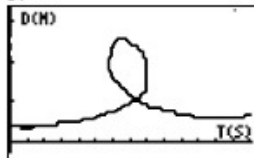
walk away  
stop  
walk toward, faster

8.



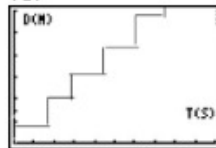
walk toward  
stop  
walk toward

9.



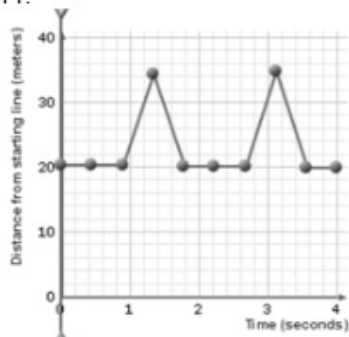
impossible  
can't travel back in time

10.



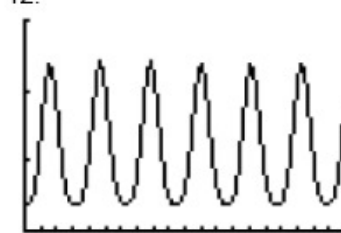
impossible  
can't appear suddenly  
further away at the same time

11.



- stop  
- walk away  
- walk toward  
- stop  
- repeat ...

12.



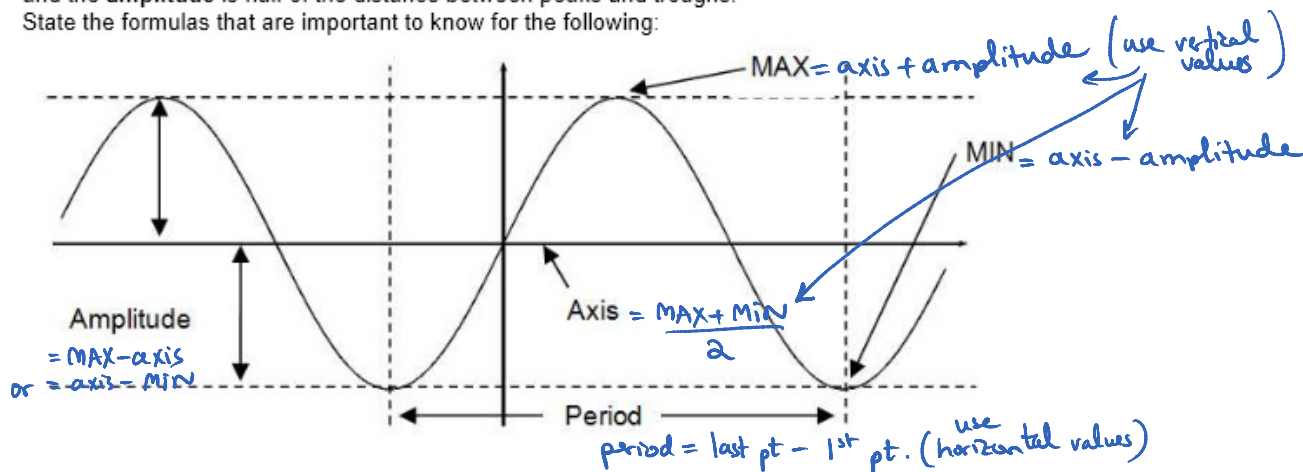
- gradually change speeds  
walk away  
then toward  
+ repeat

OR  
- walk constantly  
in a circle

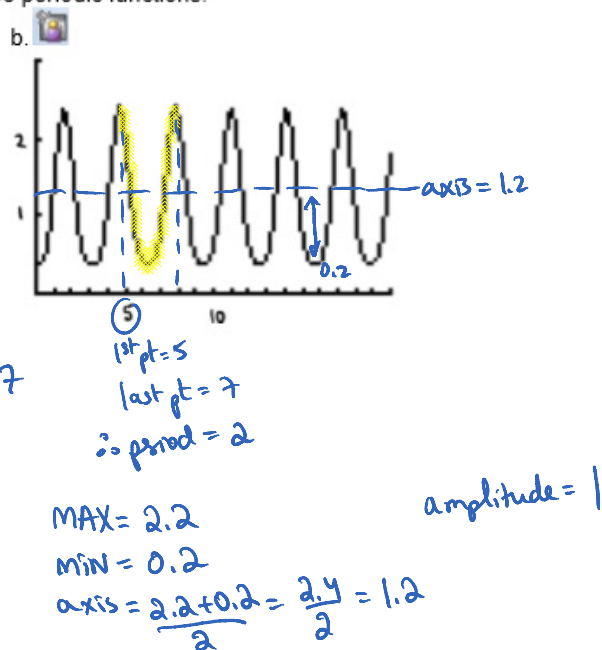
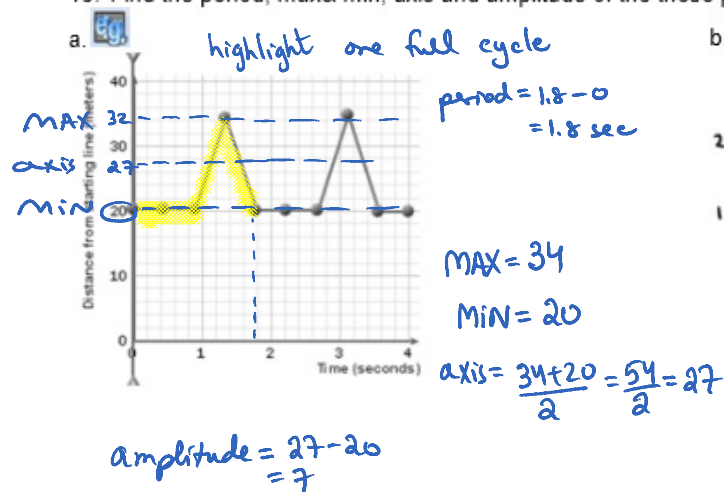


The last two graphs are examples of **periodic motion**, since they repeat in exact same cycles. A **cycle** is a series of events that are regularly repeated, a complete set of changes, starting from one point and returning to the same point in the same way. The **period** is the interval of the independent variable (usually time) needed for one complete cycle. Peaks are MAX values and troughs are MIN values of the graph. The **axis** is the average value of the peaks and troughs, and the **amplitude** is half of the distance between peaks and troughs.

State the formulas that are important to know for the following:



13. Find the period, max & min, axis and amplitude of the these periodic functions.



14. What real life relationships can be represented by periodic functions?

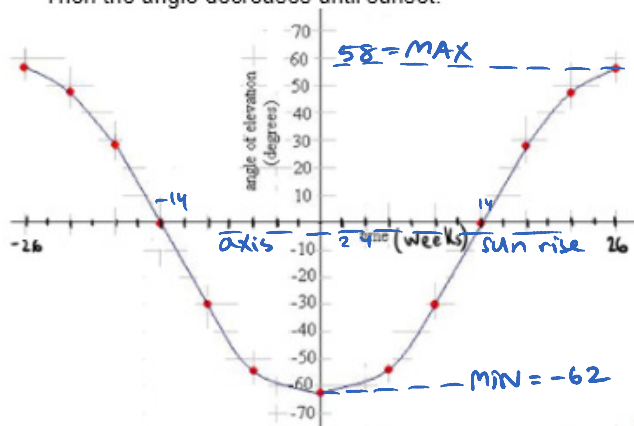
anything that repeats in a cycle

- breathing (volume in lungs)
- earth circling sun (seasons)
- earth circling on its axis (day + night)
- tides (high vs low - caused by the moon)
- riding a Ferris wheel

## Periodic Behaviour

There are many situations in real life that repeat in cycles. For example, ocean tides, daylight hours, average temperature for the year, heartbeat, volume of air in lungs, rides on ferris wheels, pendulum swings, frequency of musical notes, the list can go on.

1. After the sun rises, its angle of elevation increases rapidly at first, then more slowly, reaching a maximum in 26 weeks. Then the angle decreases until sunset.



- a. When does sunrise occur at this time of the year, for this particular spot on Earth?

after 14 weeks

(North pole has  $\frac{1}{2}$  year night and  $\frac{1}{2}$  year day)  
this may be somewhere close to North/South poles

- b. What is the period? What is longer the night or the day for this situation?

Night = 28 weeks  
Day = 24 weeks  
 $\therefore$  Night is longer

- c. What is the axis? amplitude? range?

axis =  $\frac{58 + (-62)}{2}$  Amplitude =  $60^\circ$   
 $= -2^\circ$  Range  $\{ \theta \in \mathbb{R}, -62^\circ \leq \theta \leq 58^\circ \}$

- d. Extrapolate the angle of elevation in  $30^\circ$  weeks and interpolate the angle of elevation in  $20^\circ$  weeks.

(read beyond given data  
read within given data)

$\theta(30) \doteq 48^\circ$   
 $\theta(20) \doteq 28^\circ$

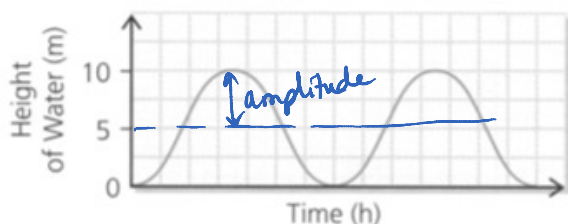
- e. During what times is the angle of elevation of the sun above 30 degrees?

approximately between

$30^\circ$  at -20 weeks  $\rightarrow$  add period = 52 to have positive value  
and 20 weeks

$\therefore$  between 20 weeks and 32 weeks  
the sun is higher than  $30^\circ$

2. The Bay of Fundy, which is between New Brunswick and Nova Scotia, has the highest tides in the world. There can be no water on the beach at low tide, while at high tide the water covers the beach.



- a. Why can you use periodic functions to model the tides?

since they repeat in cycles.

- b. What is the change in depth of water from low tide to high tide?

0 to 10 meters

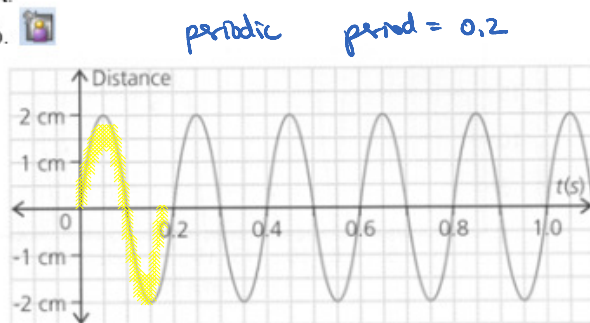
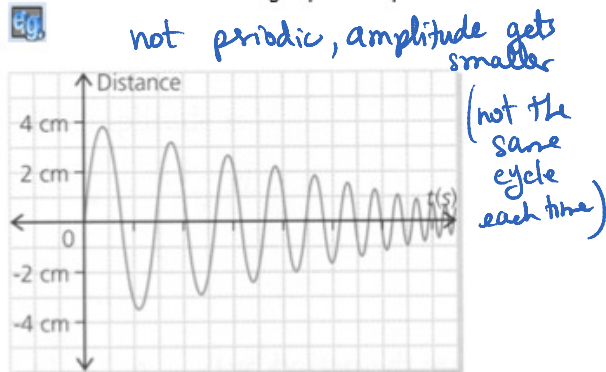
- c. Determine the equation of the axis of the curve.

axis =  $\frac{\text{MAX} + \text{MIN}}{2} = \frac{0 + 10}{2} = 5$

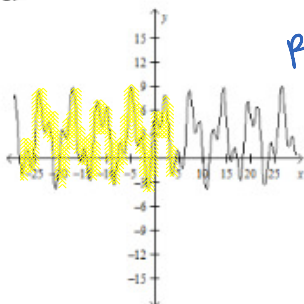
- d. What is the amplitude of the curve?

amplitude = 5

3. Determine if the following represent periodic functions or not.

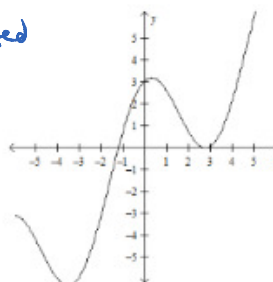


c.



periodic - see one period that's highlighted to see how it repeats.

d.



not periodic  
no constant MAX/MIN



Dependent = the horizontal distance travelled by the grandfather clock's pendulum  
Independent = time

periodic - repeats the same way all the time  
- has MAX & MIN

f. Dependent = cost of riding a taxi  
Independent = distance travelled

not periodic - linear - the more you travel the more it costs

g. Dependent = interest on the money invested at 5%  
Independent = principal deposited

not periodic - linear - the more you deposit, the more interest you'd get.

h. Dependent = the height of the pedal on a moving bicycle  
Independent = minutes

periodic - has MAX & MIN  
- repeats in same cycle as long as constant speed

i.

x	y
-3	7 MAX
1	4
5	1 MIN
9	4
13	7 MAX
17	4
21	1 MIN

check →  
x values  
are in  
order  
+ same  
skip  
count

periodic  
repetitive  
pattern

j.

x	y
0	-2
2	3 MAX
4	0
6	-2
8	-4 MIN
10	0
12	3 MAX

not  
symmetric  
∴ not  
periodic

## Sine Function Investigation

**Introduction:** In this investigation you are going to learn how the sine function you used to solve triangles in the last unit will relate to circular motion and how it creates wavelike graphs.

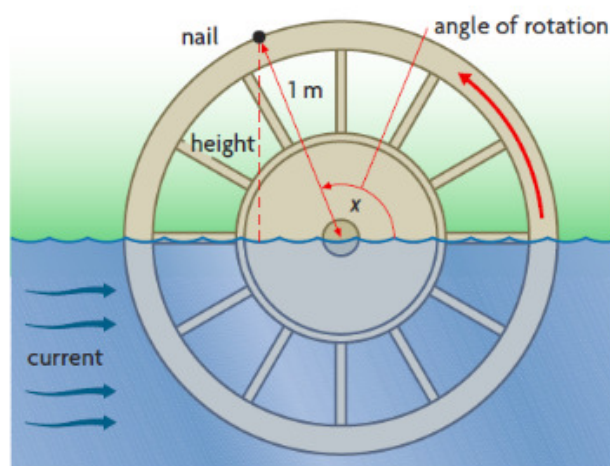
### Equipment needed:

- Template of circle with degrees on it shown to be halfway submerged in water.
- Template of circle with a drawn nail on it – to cut out
- Template of the ruler of the same size as the radius of the circle – to cut out
- Cardboard – to tape on it the circle submerged in water
- Tape
- Thumbtack – to pin the circle with nail to the centre of the circle submerged in water.
- Scientific calculator (with sin cos tan buttons)

Steve uses a generator powered by a water wheel to produce his own electricity.

- Half the water wheel is below the surface of the river.
- The wheel has a radius of 1 m.
- The wheel has a nail on its circumference.

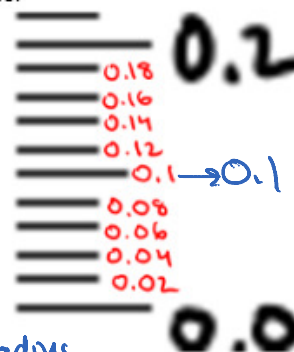
As the current flows, the wheel rotates in a counterclockwise direction to power the generator. The height of the nail, relative to the water level, as the wheel rotates is graphed in terms of the angle of rotation,  $x$ .



### Performing the Experiment:

1. Tape the circle that is shown to be halfway submerged in water onto the cardboard
2. Cut out the other circle with the nail drawn on it and cut out the ruler along the edge.
3. Pin the centres of the circles together in such a way so that the top circle, with the nail on it, can rotate and so that the degrees on the bigger circle are still visible.
4. Rotate the nail from the initial position at  $0^\circ$  to different degree measurements and record in the table below the heights of the nail above the surface of the water at these different angles.

Reading the ruler



Observations:

— record height using ruler → made to be of size = radius

Angle	0	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510
Height	0	0.5	0.86	1	0.86	0.5	0	-0.5	-0.86	-1	-0.86	-0.5	0	0.5	0.86			

↑  
from water to middle of nail  
once you see the pattern, fill in without measuring



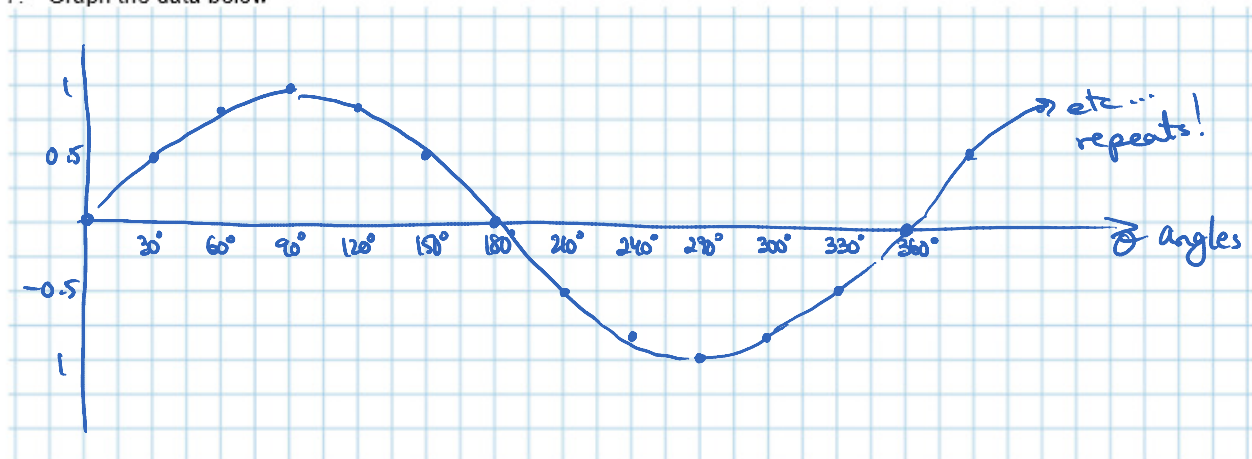
5. Now use the calculator in degree mode to calculate:

Angle (x)	0	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510
Sin(x)	0	0.5	0.87	1	0.87	0.5												

6. What do you notice?

the numbers are very close  $\therefore$  heights of rotation that starts on pos. x-axis and goes in counterclockwise direction is sine outputs.

7. Graph the data below



8. What is the period, max&amp;min, axis, and amplitude of this function?

period =  $360^\circ$  MAX = 1 MIN = -1 axis = 0 amplitude = 1

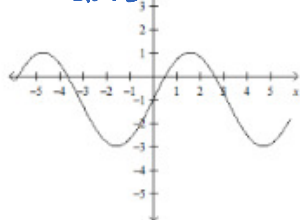
9. You will be studying **sinusoidal functions** – which are created by transforming (stretching/compressing, reflecting and shifting) this parent sine function. Identify the 5 key points on the graph of the parent sine function.

- 5 points:
1. First point
  2. Last point
  3. Middle point =  $\frac{1^{st} + last}{2}$  } all at axis
  4. Quarter way in pt. = MAX
  5. Three Quarters in = MIN

10. Classify each as periodic or nonperiodic and sinusoidal or non-sinusoidal

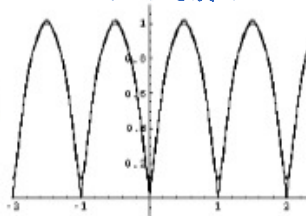
a.

- periodic  
- not sinusoidal



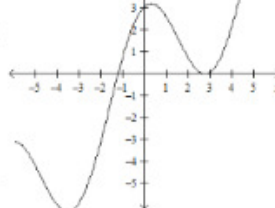
b.

- periodic  
- not sinusoidal



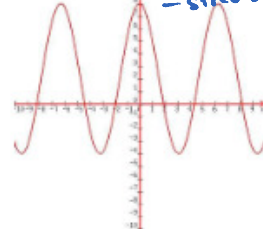
c.

- not periodic  
- not sinusoidal

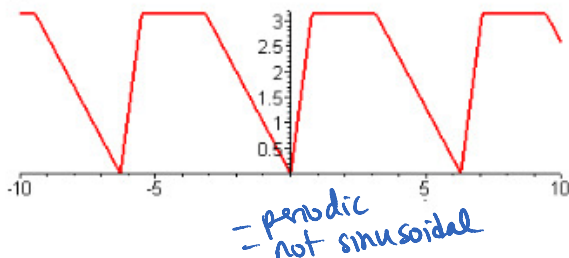


d.

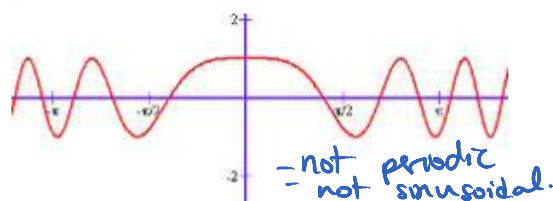
- periodic  
- sinusoidal



e.



f.



## Comparing Sinusoidal Functions

- Some of the questions in the textbook require you to graph with technology. There are lots of applets you can use online, or you can download a free program to use on your computer offline.

### Online Graphing Calculator

[http://my.hrw.com/math06\\_07/nsmedia/tools/Graph\\_Calculator/graphCalc.html](http://my.hrw.com/math06_07/nsmedia/tools/Graph_Calculator/graphCalc.html)

### Download GeoGebra (offline and online)

<http://www.geogebra.org/cms/en/download>

select **webstart** for offline  
select **appletstart** for online

ex.  $y = 3 \sin 5^\circ x - 2$   
enter as  $y = 3 \sin(5^\circ \cdot \frac{\pi}{180^\circ} x) - 2$  to see graph in degrees

Graphing technology often does not have degrees as independent variable. It has radians – which you will learn in gr.12 (if you go on studying math – college technology then advanced functions)

For now, if the equation has a degree symbol in it

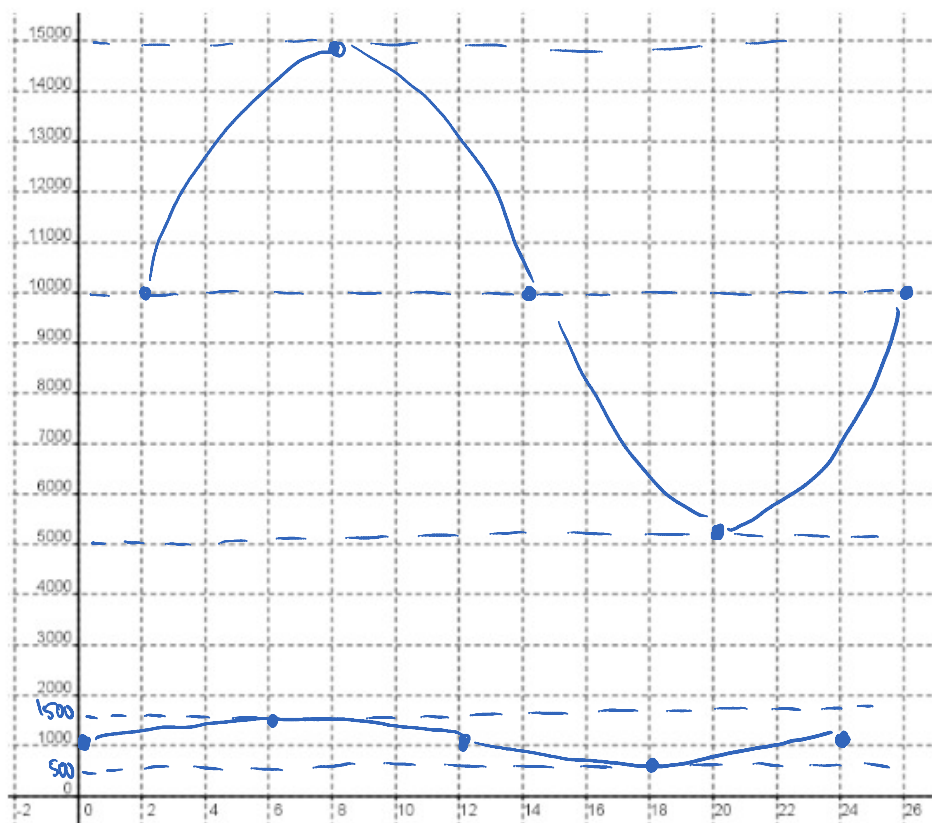
set  $k = \frac{\pi}{180^\circ}$  as a multiple of the given k value

1. The population,  $F$ , of foxes in the region is modelled by the function  $F(t) = 500 \sin(15t)^\circ + 1000$ , where  $t$  is the time in months. The population,  $R$ , of rabbits in the same region is modelled by the function,  $R(t) = 5000 \sin(15t - 30)^\circ + 10000$

- a. Graph  $F(t)$  and  $R(t)$ . Use technology to help you. From technology note where the cycle starts and ends on the axis, what the max and min values are, then use that information to sketch below:

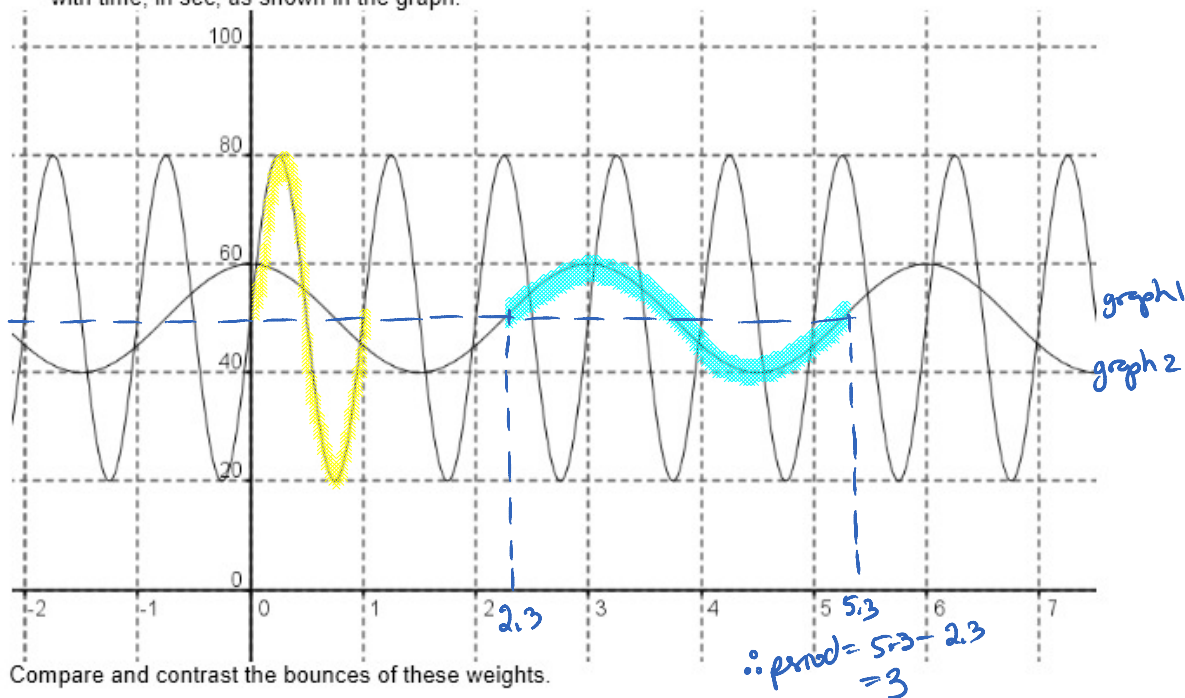
cycle starts at 2, ends at 26  
MAX = 15000 MIN = 5000  
axis = 10000

one cycle ends at 24  
MAX = 1500  
MIN = 500  
axis = 1000





2. Two weights attached to the end of two springs are bouncing up and down. As they bounce their height, in cm, varies with time, in sec, as shown in the graph:



same - both periodic (repeat in a pattern)  
 - both sinusoidal (wave-like)  
 - both have the same axis = 50

different:

graph 1	graph 2
period = 1	period = 3
amplitude = 30	amplitude = 10
1 <sup>st</sup> point = 0	1 <sup>st</sup> point = 2.3

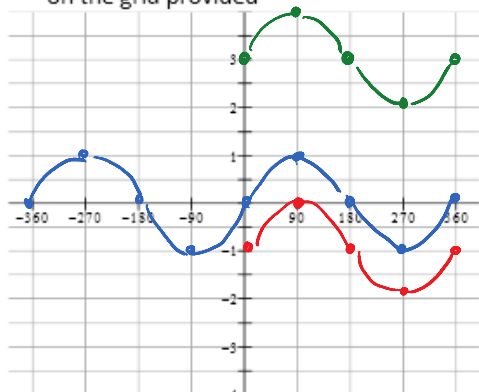


Start the homework practice in class.

## Translating/Shifting the Sine Function $y = \sin \theta$

### Part 1: Vertical Displacements (Up & Down)

1. On the graphing calculator, draw the functions  $y = \sin \theta$ ,  $y = \sin \theta + 3$ , and  $y = \sin \theta - 1$ . Sketch the graphs below on the grid provided



STEPS USING THE GRAPHING CALCULATOR:

- Put the calculator in degree mode.**  
Press MODE. Scroll down and across to DEGREE. Press ENTER.
- Adjust the window to correspond to the given domain.** Use the following settings:  
Xmin=-360  
Xmax=360  
Xscl=90  
Ymin=-2  
Ymax=4
- Enter  $y = \sin x$  into the equation editor.**  
Press GRAPH. Enter remaining equations

2. Describe how the graphs of  $y = \sin \theta$ ,  $y = \sin \theta + 3$ , and  $y = \sin \theta - 1$  are related.

$y = \sin x$  is considered the Basic or Parent Function  
 $y = \sin x + 3$  is the parent shifted up 3  
 $y = \sin x - 1$  is the parent shifted down 3

3. Summarize what the letter  $c$  represents in  $y = \sin \theta + c$

$c$  = axis of the wobble (middle of MAX and MIN)

4. Fill in key characteristics of each graph.

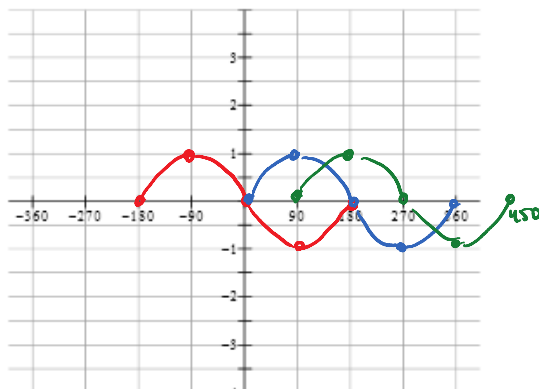
	$y = \sin \theta$	$y = \sin \theta + 3$	$y = \sin \theta - 1$
axis	0	3	-1
Max&Min	MAX=1 MIN=-1	MAX=4 MIN=2	MAX=0 MIN=-2
Period	360°	} —————> SAME	
Amplitude	1		
Where 1 <sup>st</sup> and last pts occur	1 <sup>st</sup> =0° last=360°		

5. Out of all the properties (axis, Max&Min, period, amplitude, five points of cycle), which get affected by  $c$ ?

" $c$ " affects - MAX + MIN values  
 - axis

**Part 2: Phase Shifts (Left & Right)**

6. On the graphing calculator, draw the functions  $y = \sin \theta$ ,  $y = \sin(\theta - 90^\circ)$ , and  $y = \sin(\theta + 180^\circ)$ . Sketch the graphs below on the grid provided.



7. Describe how the graphs of  $y = \sin \theta$ ,  $y = \sin(\theta - 90^\circ)$ , and  $y = \sin(\theta + 180^\circ)$  are related.

$y = \sin \theta$  is the parent  
 $y = \sin(\theta - 90^\circ)$  is the parent shifted  $90^\circ$  right  
 $y = \sin(\theta + 180^\circ)$  is parent shifted  $180^\circ$  left

8. Summarize what the letter d represents in  $y = \sin(\theta - d)$

$d = 1^{st}$  point of the cycle

9. Fill in key characteristics of each graph.

	$y = \sin \theta$	$y = \sin(\theta - 90^\circ)$	$y = \sin(\theta + 180^\circ)$
axis			
Max&Min	MAX=1 MIN=-1	} —————> SAME	
Period	$360^\circ$		
Amplitude	1		
Where 1 <sup>st</sup> and last pts occur	1 <sup>st</sup> = $0^\circ$ last= $360^\circ$	1 <sup>st</sup> = $90^\circ$ last= $450^\circ$	1 <sup>st</sup> = $-180^\circ$ last= $180^\circ$

10. Out of all the properties (period, Max&Min, axis, amplitude, five points of the cycle), which get affected by d?

5 points of the cycle get affected by "d"

11. Sketch and state the equation for the following  
 then identify the period, axis, amplitude, range, domain for the first cycle.

- a. the sine function has been moved 39 units down and  $23^\circ$  to the left

$$y = \sin(\theta + 23^\circ) - 39$$

period =  $360^\circ$   
 axis =  $-39$   
 amplitude = 1  
 range  $\{y \in \mathbb{R}, -40 \leq y \leq -38\}$   
 domain  $\{\theta \in \mathbb{R}, -23^\circ \leq \theta \leq 337^\circ\}$

1<sup>st</sup> pt =  $-23^\circ$   
 last pt =  $-23^\circ + 360^\circ = 337^\circ$

MIN MAX  
 1<sup>st</sup> last

- b. the sine function has been moved 30 units up and  $58^\circ$  to the right.

$$y = \sin(\theta - 58^\circ) + 30$$

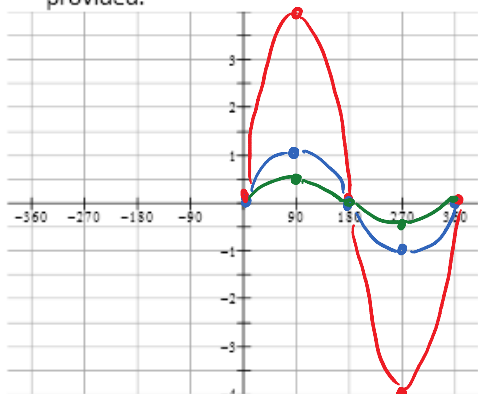
period =  $360^\circ$   
 axis = 30  
 amplitude = 1  
 range =  $\{y \in \mathbb{R}, -1 \leq y \leq 1\}$   
 domain =  $\{\theta \in \mathbb{R}, 58^\circ \leq \theta \leq 418^\circ\}$

## Stretching/Compressing the Sine Function $y = \sin \theta$



### Part 3: Amplitude

1. On the graphing calculator, draw the functions  $y = \sin \theta$  and  $y = 4 \sin \theta$ . Sketch the graphs below on the grid provided.



2. a. How do these graphs differ from each other?  
Calculate the amplitude for both functions

$y = 4 \sin \theta$  is a stretch of the parent  
amplitude of parent = 1  
amplitude of stretched = 4

- b. What is the domain and range for both graphs for 1<sup>st</sup> cycle?

$$D = \{\theta \in \mathbb{R}, 0^\circ \leq \theta \leq 360^\circ\}$$

$$R_{\text{parent}} = \{y \in \mathbb{R}, -1 \leq y \leq 1\}$$

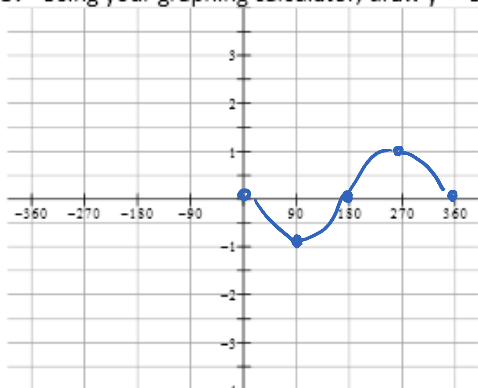
$$R_{\text{stretched}} = \{y \in \mathbb{R}, -4 \leq y \leq 4\}$$

3. On your graphing calculator, draw the function  $y = 0.5 \sin \theta$ . Sketch the graph on the same grid above.

4. How does  $y = 0.5 \sin \theta$  differ from  $y = \sin \theta$ ?

vertically compressed, amplitude is now 0.5

5. Using your graphing calculator, draw  $y = -\sin \theta$ . Sketch the graph below.



remember parent sine  
- starts at axis  
- then goes up

← this one got reflected in x-axis  
- starts at axis  
- then goes down

But amplitude is still 1



3. Summarize what the letter  $a$  represents in  $y = a \sin \theta$

"a" controls amplitude and reflections in x-axis

(stretch/compress)  
vertical

important to state!

12. Fill in key characteristics of each graph.

	$y = \sin \theta$	$y = 4 \sin \theta$	$y = 0.5 \sin \theta$
axis	0	→ same	
Max&Min	MAX=1 MIN=-1	MAX=4 MIN=-4	MAX=0.5 MIN=-0.5
Period	360°	→ same	
Amplitude	1	4	0.5
Where 1 <sup>st</sup> and last pts occur	1 <sup>st</sup> =0° last=360°	→ same	

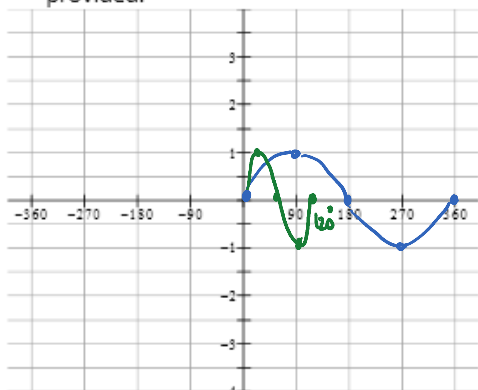
4. Out of all the properties (period, Max&Min, axis, amplitude, five points of cycle), which get affected by  $a$ ?

MAX + MIN  
amplitude } get affected by "a"



### Part 4: Horizontal Stretch or Compression

5. On the graphing calculator, draw the functions  $y = \sin \theta$  and  $y = \sin 3\theta$ . Sketch the graphs below on the grid provided.



6. How do these graphs differ from each other? Calculate the period for both graphs.

$y = \sin \theta$  is the parent

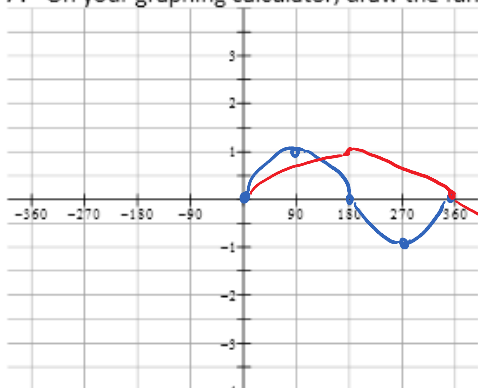
$y = \sin(3\theta)$  is horizontally compressed

period of parent =  $360^\circ$

period of compressed =  $\frac{360^\circ}{3} = 120^\circ$

$$\text{period} = \frac{360^\circ}{K}$$

7. On your graphing calculator, draw the functions  $y = \sin \theta$  and  $y = \sin 0.5\theta$ . Sketch these graphs below.



8. How do these graphs differ from each other? Calculate the period for both graphs.

$y = \sin \theta$  is parent

$y = \sin(0.5\theta)$  is horizontally stretched

period parent =  $360^\circ$

period stretched =  $\frac{360^\circ}{0.5} = 720^\circ$



9. Summarize what the letter  $k$  represents in  $y = \sin k\theta$

$k$  stretches/compresses the function horizontally.

Note if  $k$  is negative - reflects in y-axis

13. Fill in key characteristics of each graph.

	$y = \sin \theta$	$y = \sin 3\theta$	$y = \sin 0.5\theta$
axis	0	same	same
Max&Min	MAX=1 MIN=-1	same	same
Period	$360^\circ$	$120^\circ$	$720^\circ$
Amplitude	1	same	same
Where 1 <sup>st</sup> and last pts occur	1 <sup>st</sup> = $0^\circ$ last= $360^\circ$	1 <sup>st</sup> = $0^\circ$ last= $120^\circ$	1 <sup>st</sup> = $0^\circ$ last= $720^\circ$

10. Out of all the properties (period, Max&Min, axis, amplitude, five points of cycle), which get affected by  $k$ ?

$$\text{period} = \frac{360^\circ}{|k|}$$

ignore negatives

and 5 points of the cycle get affected by " $k$ "

11. Describe each equations key characteristics then sketch



a.  $y = -3\sin(x + 45) + 1$

$a = -3 \quad k = 1 \quad d = -45 \quad c = 1$

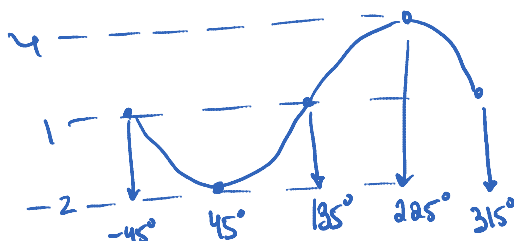
axis = 1

amplitude = 3

period =  $\frac{360^\circ}{1} = 360^\circ$

1st pt =  $-45^\circ$

last pt =  $-45^\circ + 360^\circ = 315^\circ$

shape  reflected!

b.  $y = \sin \frac{1}{4}(x - 60) - 1$

$a = 1 \quad k = \frac{1}{4} = 0.25 \quad d = 60 \quad c = -1$

axis = -1

amplitude = 1

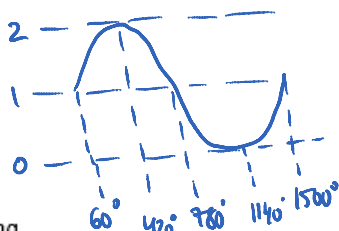
period =  $\frac{360^\circ}{0.25} = 1440^\circ$

1st pt =  $60^\circ$

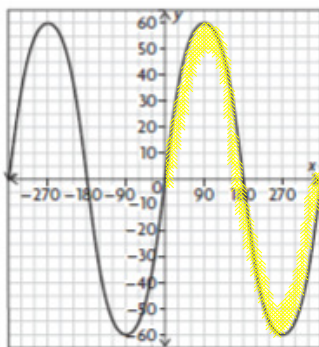
last =  $60^\circ + 1440^\circ = 1500^\circ$

shape 

not reflected



12. Find the equations for the following



axis = 0 = c

amplitude = 60 = a

1st pt = 0 = d

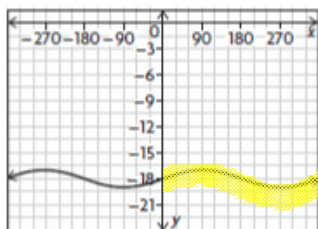
last pt =  $360^\circ$

$\therefore k = \frac{360^\circ}{360^\circ} = 1$

$\therefore y = 60\sin[1(\theta - 0)] + 0$

or  $y = 60\sin\theta$

b.



axis =  $-18 = c$

amplitude = 1 = a

1st pt = 0 = d

last pt =  $360^\circ$

$\therefore \text{period} = 360^\circ$

$\therefore k = 1$

$y = 1\sin[1(\theta - 0)] - 18$

or  $y = \sin\theta - 18$



c.  $y = \sin(-3x - 90)$

Hint: factor the k out

$y = 1\sin(-3(x + 30)) + 0$

$a = 1 \quad k = -3 \quad d = -30 \quad c = 0$

axis = c = 0

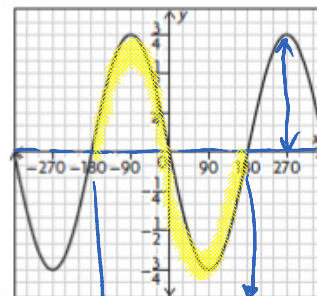
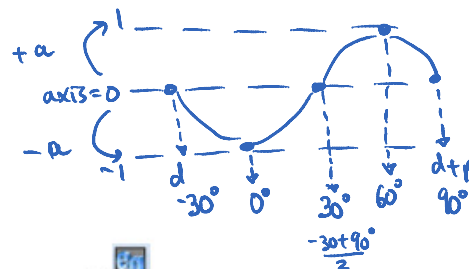
amplitude =  $|a| = 1$

period =  $\frac{360^\circ}{|k|} = \frac{360^\circ}{|-3|} = \frac{360^\circ}{3} = 120^\circ$

1st pt =  $d = -30^\circ$

last pt =  $d + \text{period}$

$= -30^\circ + 120^\circ = 90^\circ$

shape usually   
but got reflected 

axis = c = 0

amplitude =  $\frac{3}{4}$

1st pt =  $-180^\circ$

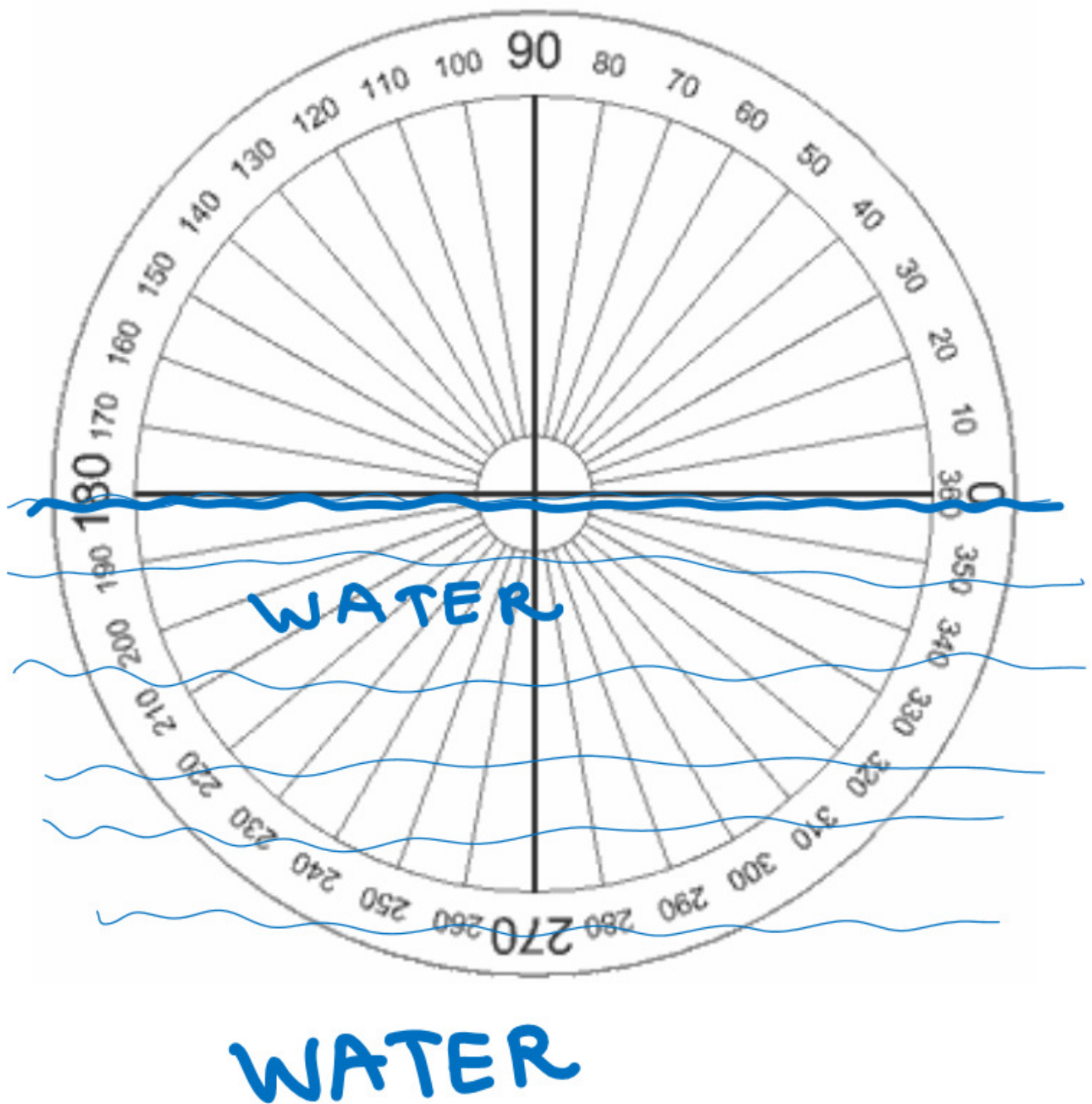
last pt =  $180^\circ$

$\therefore \text{period} = 360^\circ$

$\therefore k = \frac{360^\circ}{\text{period}} = \frac{360^\circ}{360^\circ} = 1$

no compression

$\therefore y = \frac{3}{4}\sin[1(x + 180^\circ)] + 0$



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

