

# Required Summer Packet

## *AP Calculus AB* *or* *AP Calculus BC*



"IT ALL BEGAN WHEN WE TAUGHT HIM TO BARK TO FOUR."

# MATH SUMMER PACKET

## INSTRUCTIONS

Attached you will find a packet of exciting math problems for your enjoyment over the summer. The purpose of the summer packet is to review the topics you have already mastered in math, and to make sure that you are prepared for the class you are about to enter.

The packet contains a brief summary and explanation of the topics so you don't need to worry if you don't have your math book. You will find many sample problems, which would be great practice for you before you try your own problems. The explanations are divided into sections to match the sample problems so you should be able to reference the examples easily.

This packet will be **due the second day of class**. All of your hard work will receive credit. The answers are provided in the back of the packet; *however*, you must show an amount of work appropriate to each problem in order to receive credit. If you are unsure of how much work to show, let the sample problems be your guide. You will have an opportunity to show off your skills during the first week when your class takes a quiz on the material in the packet.

This packet is to help you maximize your previous math courses and to make sure that everyone is starting off on an even playing field on the first day of school. If you feel that you need additional help on one or two topics, you may want to try math websites such as: [www.mathforum.org](http://www.mathforum.org) or [www.askjeeves.com](http://www.askjeeves.com). Math teachers will be available for assistance at the high school the week before school. Check the marquee or the school website for specific times, which are to be determined.

Enjoy your summer and don't forget about the packet. August will be here before you know it! If you lose your packet the OPRFHS Bookstore will carry extra copies. You will also be able to access the packets on line at the school website, [www.oprfhs.org](http://www.oprfhs.org).

See you in August!

The OPRFHS Math Department

# SUMMER PACKET

## For students entering AP Calculus AB or BC

NAME: \_\_\_\_\_

Welcome to AP Calculus! This packet contains the topics that you have learned in your previous courses that are most important to calculus. Please read the information, do the sample problems and be prepared to turn this in when school begins again.

\* Denotes problems for BC calc students only

Enjoy your summer!

### I. Using your graphing calculator

- Be able to find the intersection of lines and curves.
- You will need to find the roots of equations on your calculator
- Do not be dependent on your calculator for graphs that should be memorized (see Function Section)
- Do not be dependent on your calculator for simple algebra, adding fractions, etc.

### II. Interval and set notation

- You will be expected to be able to read and write using different notation, for example notice the difference between the following solutions:

$$\text{Problem: } -\frac{x}{3} < 2x + 1 \qquad \text{Solution: } \left(-\frac{3}{7}, \infty\right)$$

$$\text{Problem: } -\frac{x}{3} \leq 2x + 1 \qquad \text{Solution: } \left[-\frac{3}{7}, \infty\right)$$

- Don't forget about the symbols that join information together:

$$\cup = \text{Union} \qquad \cap = \text{Intersection}$$

### III. Cartesian Coordinate System

- Know the quadrants, axes, and how to graph
- Know the different forms of the equation of a line
- Slope (incredibly important in calculus); think  $\frac{\Delta y}{\Delta x}$
- Parallel and perpendicular lines
- Remember that  $\parallel$  means parallel and  $\perp$  means perpendicular
- Distance Formula:  $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
- Equation of a circle:  $(x - h)^2 + (y - k)^2 = r^2$

### IV. Functions

We use functions almost everyday in calculus. It is critical that you are able to identify and do the following:

- Identify functions from equations, graphs, sets
- Use function notation:  $y = f(x)$  remember  $x$  is the independent variable and  $y$  is the dependent variable
- Find the domain and range of a function
- Identify functions as even, odd or neither. You should also be able to identify what lines of symmetry go with even and odd functions.
- Be able to graph (without a calculator) or identify:

$$\begin{aligned} y &= a \\ x &= b \end{aligned} \quad (\text{where } a \text{ and } b \text{ are constants})$$

$$\begin{array}{lll} f(x) = x & f(x) = x^2 & f(x) = x^3 \\ f(x) = |x| & f(x) = \sqrt{x} & f(x) = e^x \\ f(x) = \ln x & f(x) = \frac{1}{x} & f(x) = \frac{1}{x^2} \\ \star f(x) = \frac{1}{ax+b} & \star f(x) = x^{\frac{2}{3}} \text{ or } f(x) = x^{\frac{3}{2}} & \star f(x) = \frac{ax+b}{cx+d} \end{array}$$

- Remember the following function operations:

$$(f + g)(x) = f(x) + g(x)$$

$$(f - g)(x) = f(x) - g(x)$$

$$(fg)(x) = f(x)g(x)$$

$$\left(\frac{f}{g}\right)(x) = \frac{f(x)}{g(x)}$$

$$g(f(x)) = (g \circ f)(x)$$

- You must be able to graph and write the equations of piecewise functions
- You should be able to identify discontinuities, i.e.  $f(x) = \frac{6x^2 - 14x + 3}{2x^2 - 12x - 3}$
- Be able to graph piecewise functions, i.e.  $f(x) = \begin{cases} x^2 + 1, & \text{if } x < 0 \\ x^2 - 1, & \text{if } x \geq 0 \end{cases}$

## V. Polynomial Functions and Graphs

### A. Long Division

Remember that one of the main reasons we use long division is to check if an algebraic expression is a factor of a polynomial.

$$P(x) = (x - r)Q(x) + R$$

The    divisor    the quotient    the remainder

For example, is  $(x+1)$  a factor of  $x^3 + 2x^2 - 5x - 6$ ?

$$\begin{array}{r} x^2 + x - 6 \\ x+1 \overline{) x^3 + 2x^2 - 5x - 6} \\ \underline{x^3 + x^2} \phantom{- 6} \\ x^2 - 5x \phantom{- 6} \\ \underline{x^2 + x} \phantom{- 6} \\ -6x - 6 \\ \underline{-6x - 6} \\ 0 \end{array}$$

**Answer:**  $(x^3 + 2x^2 - 5x - 6) = (x+1)(x^2 + x - 6)$

If the remainder is 0, then it is a factor.

## B. Synthetic Division

Synthetic Division is an alternate method of long division where only the coefficients are used.

For example let's use synthetic division to find the quotient and remainder;

$(2x^3 + 7x^2 - 5) \div (x + 3)$  Remember divisor must be  $(x - a)$  form

$$\begin{array}{r|rrrr} -3 & 2 & 7 & 0 & -5 \\ & -6 & -3 & 9 & \\ \hline & 2 & 1 & -3 & 4 \end{array}$$

Note: We must write 0's for any missing terms

Therefore:  $2x^3 + 7x^2 - 5 = (2x^2 + x - 3)(x + 3) + 4$

## C. Finding Rational Zeros of Polynomials.

- You should be able to describe the left and right behavior of a graph.

## D. Rational Functions: finding vertical, horizontal and oblique asymptotes

## E. Partial Fractions\*

Remember that decomposing into partial fractions is basically reversing the process of adding rational expressions. If you have a rational expression  $P(x)/Q(x)$  that have no common factor other than 1 or -1 there are two possibilities:

- The degree of the numerator is larger than the degree of the denominator. You should then divide using long or synthetic division.
- If the degree of the denominator is larger than the degree of the numerator then do the following:

Ex.  $\frac{4x - 13}{2x^2 + x - 6}$

a) Factor the denominator  $\frac{4x - 13}{(x + 2)(2x - 3)}$

b) Write as a sum of terms:  $\frac{4x - 13}{(x + 2)(2x - 3)} = \frac{A}{x + 2} + \frac{B}{2x - 3}$

Do you remember how to determine the numerators?

c) Determine A and B by adding the fractions:

$$\frac{A(2x-3)+B(x+2)}{(x+2)(2x-3)} = \frac{4x-13}{(x+2)(2x-3)}$$

d) Set the two numerators equal to each other:

$$4x-13 = A(2x-3) + B(x+2)$$

Set  $2x-3 = 0$ , so  $x = +\frac{3}{2}$  and then substitute and solve for B.

Set  $x+2 = 0$  so  $x = -2$ , substitute and solve for A.

Set  $A = 3$  and  $B = -2$

e) The decomposition is:  $\frac{3}{x+2} + \frac{-2}{2x-3}$  or  $\frac{3}{x+2} - \frac{2}{2x-3}$

## VI. Logarithms and Exponentials

- Know the properties of exponents
- Know the properties of logarithms
- Remember basic facts such as:  $\ln e^x = x$  and  $e^{\ln x} = x$
- Remember to remove logarithms from an equation, exponentiate both sides.
- To remove exponentials from an equation, take the logarithm of both sides.

Ex. Find  $y$  if  $\ln y = 3t + 5$

Exponentiate both sides:  $e^{\ln y} = e^{3t+5}$   
 $y = e^{3t+5}$

Ex. Find  $k$  if  $e^{3k} = 10$

Take the natural log of both sides:  $\ln e^{3k} = \ln 10$   
 $3k = \ln 10$   
 $k = \frac{\ln 10}{3}$

## VII. Sequences and Series\*

### A. Writing the terms of a series

$$\text{Given } \sum_{k=1}^5 \frac{k-1}{k} = \frac{0}{1} + \frac{1}{2} + \frac{2}{3} + \frac{3}{4} + \frac{4}{5}$$

Replace "k" with consecutive integers starting with  $k = 1$ , and continue through  $k = 5$

### B. Find terms from a recursive formula, a formula that defines each term in terms of one or more preceding terms.

$$a_1 = 7 \quad a_n = a_{n-1} - 4 \quad n \geq 2$$

$$a_1 = 7$$

$$a_2 = a_1 - 4$$

$$= 7 - 4$$

$$= 3$$

$$a_3 = a_2 - a_1$$

$$= 3 - 7$$

$$= -4$$

### C Arithmetic and Geometric Sequences.

#### 1. $n$ th term of an Arithmetic Sequence :

$$a_n = a_1 + (n-1)d \quad \text{for every } n \geq 1$$

#### 2. $n$ th term of a Geometric Sequence:

$$a_n = a_1 r^{n-1} \quad \text{for every } n \geq 1$$

#### 3. Sum of an Arithmetic Series:

$$S_n = \frac{n}{2}(a_1 + a_n)$$

#### 4. Sum of a Geometric Series:

$$S_n = \frac{a_1 - a_1 r^n}{1 - r} \quad r \neq 1$$

#### 5. Sum of an Infinite Geometric Series:

$$S_n = \frac{a_1}{1 - r} \quad |r| < 1$$

## VIII. Trigonometry

The Pre-Calc or College Algebra Course you just completed was your formal trig course for your high school math career. However, we use the trig functions and a few of the identities regularly. The following items are the most important:

- Calculus is always in **Radians** - never degrees. Watch the mode on your calculator.
- You need to know, **without a calculator**,  $\sin\theta$ ,  $\cos\theta$ ,  $\tan\theta$ ,  $\sec\theta$ ,  $\csc\theta$ , and  $\cot\theta$  for the following values:  $\theta = \pi, \frac{\pi}{2}, \frac{\pi}{3}, \frac{\pi}{4}, \frac{\pi}{6}$
- Be able to identify and graph sine, cosine and tangent
- Know which trig functions are even or odd or neither
- The following identities are the most used:

$$\sin^2 \theta + \cos^2 \theta = 1$$

$$\cos 2\theta = 2\cos^2 \theta - 1$$

$$\tan^2 \theta + 1 = \sec^2 \theta$$

$$\sin 2\theta = 2\sin \theta \cos \theta$$

$$\cos 2\theta = \cos^2 \theta - \sin^2 \theta$$

$$\cos^2 \theta = \frac{1 + \cos(2\theta)}{2}$$

$$\cos 2\theta = 1 - 2\sin^2 \theta$$

$$\sin^2 \theta = \frac{1 - \cos(2\theta)}{2}$$

## IX. Polar and Rectangular Coordinates \*

Change coordinates from polar to rectangular and rectangular to polar

Ex. Given:  $\left(4, \frac{\pi}{3}\right)$  find  $(x, y)$

$$x = r \cos \theta$$

$$y = r \sin \theta$$

$$= 4 \cos\left(\frac{\pi}{3}\right)$$

$$= 4 \sin\left(\frac{\pi}{3}\right)$$

$$= 4\left(\frac{1}{2}\right)$$

$$= 4\left(\frac{\sqrt{3}}{2}\right)$$

$$x = 2 \quad y = 2\sqrt{3}$$

$$\text{So } (x, y) = (2, 2\sqrt{3})$$

Ex. Given:  $(-5, 12)$  find  $(r, \theta)$

$$(-5)^2 + (12)^2 = r^2$$

$$13 = r$$

$$\tan \theta = \frac{12}{-5} \sqrt{b^2 - 4ac} \quad \theta \text{ in QII}$$

$$\tan^{-1}\left(\frac{12}{-5}\right) \approx -1.1760 \text{ by restrictions in QIV}$$

$$\theta = 180 - 1.1760 = 1.38149 \text{ (radians)}$$

$$\text{so } (r, \theta) = (13, 1.38149)$$

### Change equation to Polar Form

Given:  $x^2 + y^2 = 25$

$$(r \cos \theta)^2 + (r \sin \theta)^2 = 25$$

$$r^2 \cos^2 \theta + r^2 \sin^2 \theta = 25$$

$$r^2(\cos^2 \theta + \sin^2 \theta) = 25$$

$$r^2 = 25$$

$$r = 5$$

### X. Parametric Equations\*

Obtain an equation in  $x$  and  $y$  by eliminating the parameter and identify the curve (line, parabola, ellipse, circle and hyperbola)

A.  $x = t + 1 \quad -\infty < t < \infty$

$$y = t^2 - 2t$$

eliminate  $t$

so...  $t = x - 1$

$$\therefore y = (x - 1)^2 - 2(x - 1) \quad \text{parabola}$$

B.  $x = 3 \cos \theta \quad -\infty < \theta < \infty$

$$y = 4 \sin \theta$$

eliminate  $\theta$

so...  $\cos \theta = \frac{x}{3} \quad \sin \theta = \frac{y}{4}$

$$\cos^2 \theta + \sin^2 \theta = 1$$

$$\left(\frac{x}{3}\right)^2 + \left(\frac{y}{4}\right)^2 = 1$$

$$\frac{x^2}{9} + \frac{y^2}{16} = 1$$

$\therefore$  ellipse

∴

- C. Find the parametric equation for the conic section

$$x^2 - 16y^2 - 10x + 32y - 7 = 0$$

By completing the square in  $x$  and  $y$  we obtain the standard form

$$\frac{(x-5)^2}{16} - \frac{(y-1)^2}{1} = 1$$

So the graph is a hyperbola with center  $(5, 1)$  and transverse axis on the line  $y = 1$ . Since  $\sec^2 \theta - \tan^2 \theta = 1$ , a parametric representation with parameter  $\theta$  is obtained by letting  $\frac{x-5}{4} = \sec \theta$  and  $\frac{y-1}{1} = \tan \theta$  therefore we get...

$$\begin{aligned} x &= 4 \sec \theta + 5 & -\infty < \theta < \infty \\ y &= 1 + \tan \theta & \theta \neq \frac{\pi}{2} + k\pi, k \text{ is an integer} \end{aligned}$$

**Practice Problems.** Complete the problems below, showing work where necessary. Feel free to do your work on separate sheets of paper and remember you will be required to turn this in. An answer key is provided for you but in calculus the work is always more important than the answer!

**\*Problems should be completed by BC Calculus students only.**

Solve the following and write your answer in interval notation:

1.  $2x - \frac{1}{2} \geq 7x + \frac{7}{6}$

2.  $-\frac{x+5}{2} \leq \frac{12+3x}{4}$

3.  $\frac{x^2 + 5x + 6}{x^2 + 4x + 4} > 0$

4.  $2x^3 + x^2 > 6x$

5. Write an equation for each of the lines described, in point-slope form.

- a) passes through  $(-12, -9)$  and has slope 0
- b) passes through  $(5, -1)$  and is parallel to the line  $2x + 5y = 15$
- c) passes through  $(4, 10)$  and is perpendicular to the line  $6x - 3y = 5$

6. Find the center and radius for the following circles.

a)  $(x-1)^2 + (y+5)^2 = 3$

b)  $x^2 + y^2 - 8x + 4y + 16 = 0$

Center: \_\_\_\_\_

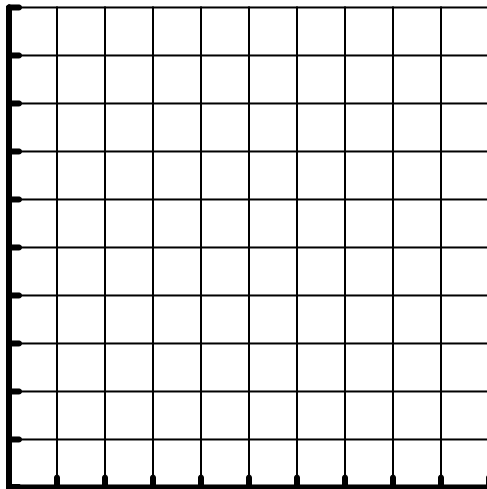
Center: \_\_\_\_\_

Radius: \_\_\_\_\_

Radius: \_\_\_\_\_

7. Use your calculator to sketch the following graphs, labeling their intersection points.

$$f(x) = (2 - \sqrt{x})^2 \text{ and } g(x) = \frac{1}{x+2}$$



8. If a particle starts at A (-2, 3) and its coordinates change by the increments  $\Delta x = 5$  and  $\Delta y = -6$ , find its new position.

9. Prove that the triangle formed by the points A (0,0), B (1,  $\sqrt{3}$ ), and C (2, 0) is equilateral.

10. Find the domain and range of the following functions:

a)  $f(x) = \sqrt{9-x^2}$

b)  $g(x) = \frac{1}{1+\sqrt{x}}$

c)  $\sqrt{\frac{x-1}{x+3}}$

Domain: \_\_\_\_\_

Domain: \_\_\_\_\_

Domain: \_\_\_\_\_

Range: \_\_\_\_\_

Range: \_\_\_\_\_

Range: \_\_\_\_\_

11. Which of the following functions are even, odd, neither?

a)  $f(x) = 3$

b)  $f(x) = x^{-5}$

c)  $f(x) = x^2 + 1$

d)  $f(x) = x^2 + x$

e)  $f(x) = x^3 + x$

f)  $f(x) = \frac{1}{x-1}$

g)  $f(x) = \frac{1}{x^2-1}$

h)  $f(x) = \frac{x}{x^2-1}$

i)  $f(x) = 2x+1$

j)  $f(x) = 2|x|+1$

Even: \_\_\_\_\_

Odd: \_\_\_\_\_

Neither: \_\_\_\_\_

12. If  $f(x) = x + 5$  and  $g(x) = x^2 - 3$ , find the following:

a)  $f(g(x))$

d)  $f(f(-5))$

b)  $g(f(x))$

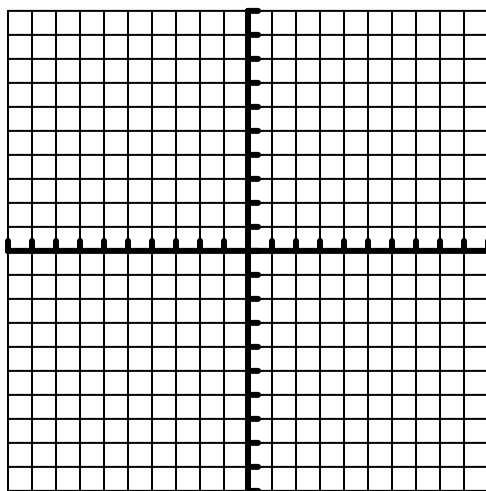
e)  $g(g(x))$

c)  $f(g(0))$

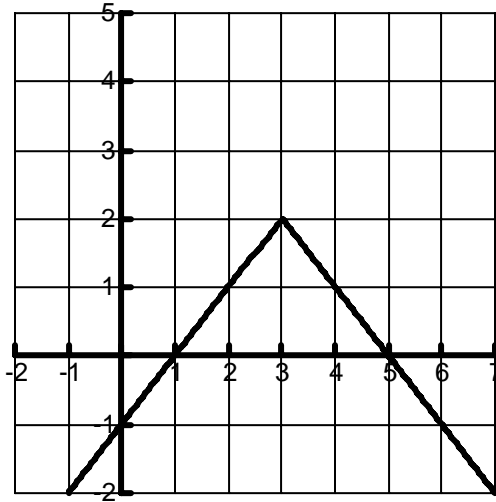
f)  $\frac{f(2+h) - f(2)}{h}$

13. Graph the following function.

$$f(x) = \begin{cases} 3 - x, & x \leq 1 \\ 2x, & x > 1 \end{cases}$$



14. Find a formula for the graphed function  $f(x)=?$



15. In the following 2 problems, a polynomial  $P(x)$  and a divisor  $d(x)$  are given. Find the quotient  $Q(x)$  and the remainder  $R(x)$  when  $P(x)$  is divided by  $d(x)$  and express  $P(x)$  in the form  $P(x) = d(x)Q(x) + R(x)$

a)  $P(x) = x^3 + 6x^2 - x - 30$   
 $d(x) = x - 3$

b)  $P(x) = x^4 + 9x^2 + 20$   
 $d(x) = x + 4$

16. Use synthetic division to determine whether the numbers given are roots of the polynomials.

a)  $P(x) = (2x^4 + 7x^3 + x - 12)$ ;  $x = -3$ ,  $x = 2$

b)  $P(x) = 3x^3 + 11x^2 - 2x + 8$ ;  $x = 2$ ,  $x = -4$

17. Find all zeros exactly for  $P(x) = x^4 + 4x^3 + 10x^2 + 12x + 5$ . Describe the left and right behavior of the graph.

18. Find all vertical, horizontal or oblique asymptotes

a)  $f(x) = \frac{2}{x-4}$

b)  $f(x) = \frac{5x^2 - 7x}{2x^2 - 50}$

c)  $g(x) = \frac{x^2 - 4x + 3}{x - 2}$

19.\* Decompose the following into partial fractions

a)  $\frac{x+7}{(x-3)(x+2)}$

b)  $\frac{x^2 + 5x + 3}{x(x^2 + 1)}$

20. Write in expanded form without summation notation.

$$\sum_{k=1}^4 \frac{1}{k} x^{k+1}$$

21.\* Write the first 4 terms of  $a_n = (n+1)^n \quad n \geq 1$

22.\* Let  $a_1, a_2, a_3, \dots$  be an arithmetic sequence.

Given:  $a_4 = 27$  and  $a_9 = 62$ .

Find the indicated quantities:  $a_1 = ?$  and  $S_6 = ?$

23.\* Let  $a_1, a_2, a_3, \dots$  be a geometric sequence. Find the indicated quantity.

$$a_1 = 40$$

$$a_4 = 135$$

$$r = ?$$

$$S_5 = ?$$

24.\* Find the sum of the infinite geometric series...  $21 - 3 + \frac{3}{7} - \dots$

25. Simplify the following:

a)  $\ln e^5 = \underline{\hspace{2cm}}$

b)  $\ln \sqrt{e} = \underline{\hspace{2cm}}$

c)  $e^{3 \ln 2} = \underline{\hspace{2cm}}$

d)  $e^{x + \ln 2} = \underline{\hspace{2cm}}$

26. Solve for  $y$ :  $\ln(y-1) - \ln 2 = x + \ln x$

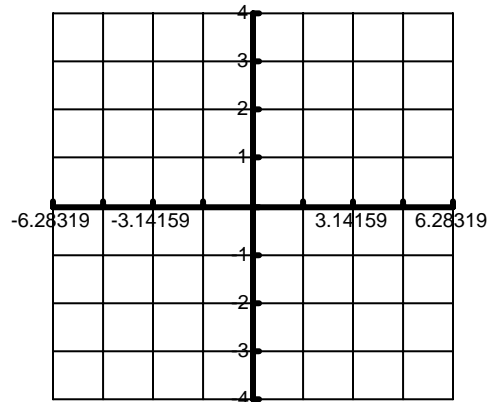
27. Complete the following tables. (Without your calculator!)

	$\pi$	$\frac{\pi}{2}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{6}$
<b>sin</b> $\theta$					
<b>cos</b> $\theta$					
<b>tan</b> $\theta$					

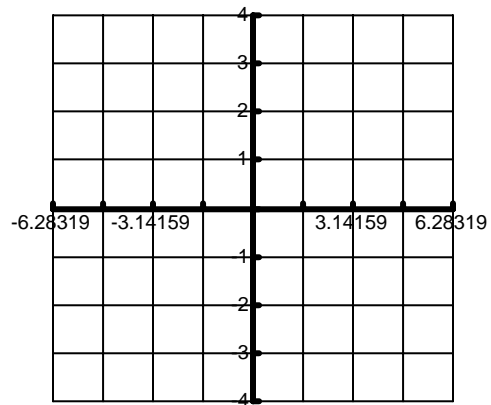
	$-\pi$	$\frac{3\pi}{2}$	$\frac{7\pi}{6}$	$\frac{5\pi}{4}$	$-\frac{5\pi}{3}$
<b>sin</b> $\theta$					
<b>cos</b> $\theta$					
<b>tan</b> $\theta$					

28. Graph the following. Identify the period of each.

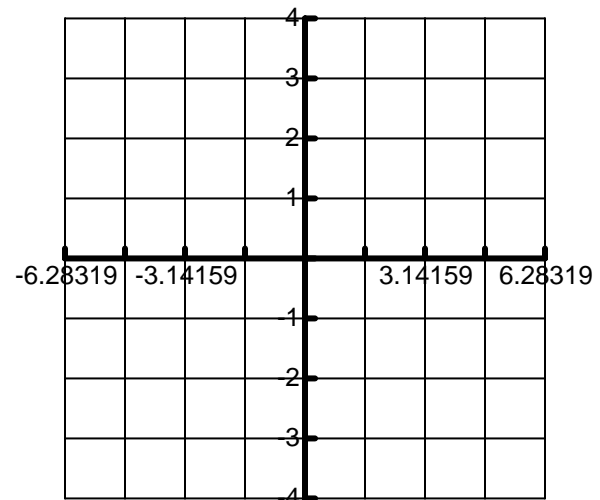
a)  $f(x) = 2\sin\left(\frac{1}{2}x\right)$



b)  $g(x) = -\cos\left(x + \frac{\pi}{4}\right)$



c)  $h(x) = -\tan\left(\frac{1}{2}x\right)$



29.\* Change from polar to rectangular. (note:  $\theta$  in radians)

a)  $(-2, \pi)$

b)  $(7, 2.418)$

30.\* Change from rectangular to polar

a)  $\left(-\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$

b)  $(8, -15)$

31.\* Change this rectangular equation to polar form.  
Identify the graph as a line, circle, etc....

a)  $x^2 + y^2 + 8x = 0$

b)  $x^2 = 5y$

32.\* Convert from polar form to an equation in rectangular form

$$r = 4 \sin \theta$$

33.\* Obtain an equation in  $x$  and  $y$  by eliminating the parameter, and identify the curve

a)  $x = 2t$   
 $y = t^2$

b)  $x = 2 + 2 \sin \theta$   
 $y = 3 + 2 \cos \theta$

**Answer Key:**

1.  $(-\infty, -\frac{1}{3}]$

2.  $[-\frac{22}{5}, \infty)$

3.  $(-\infty, -3) \cup (-2, \infty)$

4.  $(-2, 0) \cup (0, \frac{3}{2}) \cup (\frac{3}{2}, \infty)$

5. a)  $y + 9 = 0(x + 12)$       b)  $y + 1 = -\frac{2}{5}(x - 5)$       c)  $y - 10 = -\frac{1}{2}(x - 4)$

6. a) Center:  $(1, -5)$  Radius:  $\sqrt{3}$       b) Center:  $(4, -2)$  Radius: 2

7. Intersection:  $(2.304, 0.232)$   
and  $(5.584, 0.132)$

8.  $(3, -3)$

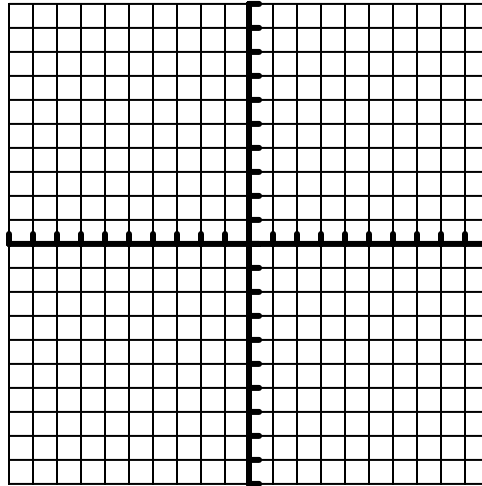
9. Prove by distance formula, all sides equal 2 units.

10. a) Domain:  $[-3, 3]$       b) Domain:  $[0, \infty]$       c) Domain:  $(-\infty, -3) \cup [1, \infty)$   
Range:  $[0, 3]$       Range:  $(0, 1]$       Range:  $[0, 1) \cup (1, \infty)$

11. Even: A, C, G, J      Odd: B, E, H      Neither: D, F, I

12. a)  $x^2 + 2$                       b)  $x^2 + 10x + 22$       c) 2  
 d) 5                                      e)  $x^4 - 6x^2 + 6$                       f) 1

13. Graph



14.  $f(x) = |x - 3| + 2$

15. a)  $P(x) = (x - 3)(x^2 + 9x + 26) + 48$

b)  $P(x) = (x + 4)(x^3 - 4x^2 + 25x - 100) + 420$

16. a) neither                      b)  $x = 2$  - no                       $x = -4$  yes

17. Zeros are at  $x = -1$ , (multiplicity 2) and  $x = -1 \pm 2i$

The left and right behavior of the graph is approaching positive infinity.

18. a) Vertical at  $x = 4$       Horizontal at  $y = 0$       No oblique asymptotes

b) Vertical at  $x = 5$       Horizontal at  $y = \frac{5}{2}$       No oblique asymptotes

c) Vertical at  $x = 2$       no Horizontal      Oblique at  $y = x - 2$

19. a)  $\frac{2}{x-3} + \frac{-1}{x+2}$                       b)  $\frac{3}{x} + \frac{-2x+5}{x^2+1}$

20.  $x^2 + \frac{1}{2}x^3 + \frac{1}{3}x^4 + \frac{1}{4}x^5$

21. 2, 9, 64, 625

22.  $a_1 = 6$  and  $S_6 = 141$

23.  $r = \frac{3}{2}$  and  $S_5 = 527.5$

24.  $\frac{147}{8}$

25. a) 5                      b)  $\frac{1}{2}$                       c) 8                      d)  $2e^x$

26.  $y = 2xe^x + 1$

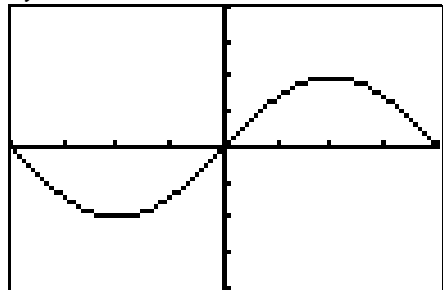
27.

	$\pi$	$\frac{\pi}{2}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{6}$
<b>sin</b> $\theta$	0	1	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$
<b>cos</b> $\theta$	-1	0	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$
<b>tan</b> $\theta$	0	Undefined	1	$\sqrt{3}$	$\frac{\sqrt{3}}{3}$

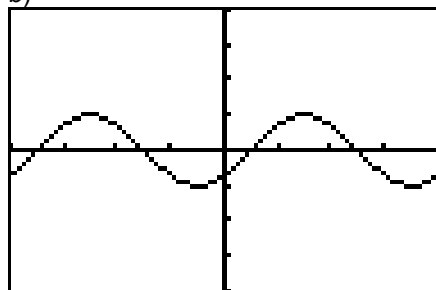
	$-\pi$	$\frac{3\pi}{2}$	$\frac{7\pi}{6}$	$\frac{5\pi}{4}$	$-\frac{5\pi}{3}$
<b>sin</b> $\theta$	0	-1	$\frac{1}{-2}$	$\frac{\sqrt{2}}{-2}$	$\frac{\sqrt{3}}{2}$
<b>cos</b> $\theta$	-1	0	$\frac{\sqrt{3}}{-2}$	$\frac{\sqrt{2}}{-2}$	$\frac{1}{2}$
<b>tan</b> $\theta$	0	Undefined	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$

28.

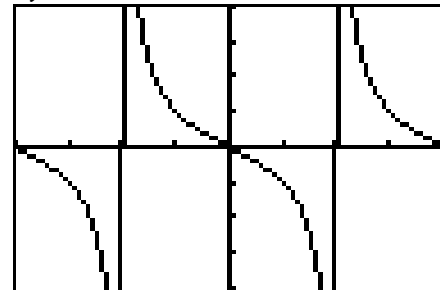
a)  $P = 4\pi$



b)  $P = 2\pi$



c)  $P = 2\pi$



29. a) (2, 0)

b) (-5.25, 4.64)

30. a)  $\left(1, \frac{2\pi}{3}\right)$       b)  $(17, -1.08)$  radians

31. a)  $r + 8\cos\theta = 0$       circle  
b)  $r = 5\tan\theta\sec\theta$       parabola

32.  $x^2 + y^2 = 4y$       circle

33. a)  $y = \left(\frac{x}{2}\right)^2$       parabola  
b)  $(x-2)^2 + (y-3)^2 = 4$       circle