Arabia Mountain High School – Summer Assignment

Accelerated and AP Physics

In order for you to be prepared to tackle the exciting science of physics you must know some basic math. The purpose of this packet is to review math techniques that you will come across in Physics. These are essential prerequisite skills needed for success in Accelerated / AP Physics!

If you get stuck, help is just an email away! The AMHS Physics teachers can be contacted at ***jeffrey_s_fitz@dekalb schoolsga.org*** or ***keshavareddy_boreddi@dekalbschoolsga.org***. We will be checking our email at least twice each week over the summer. So make sure you ask for help if you are not sure what to do!

You are responsible for knowing this material on the first day of school when you walk into class!!!!

The summer packet is due on the first day of class - we will review this material in class during the first week of school. You will be tested over this material on Friday of the first week of school. This will be your first summative assessment score of the year in *Accelerated / AP Physics.*

You may print off this packet or do all of your work on loose leaf paper. Show all of your work when you are doing the problems. Make sure your work is neat and organized! Put a box around your final answer.

Example from Manipulating Equations Part 1:

Question:	Answer: (What you write)
$v_f^2 = v_i^2 + 2ad$	$v_f^2 = v_i^2 + 2ad$ $v_f^2 - v_i^2 = 2ad$ $\frac{v_f^2 - v_i^2}{2d} = \frac{2ad}{2d}$ $\frac{v_f^2 - v_i^2}{2d} = a$

Example from Manipulating Equations Part 2:

Question:	Answer: (What you write)
Use the equation # 2. If d = 1.2, t = 0.62, what is v?	$v = \frac{d}{t}$ $v = \frac{1.2}{0.62}$ $v = 1.9$

If you talk to any of your friends over the summer who have been newly accepted at AMHS and will be taking Accelerated or AP Physics, ask them if they have picked up the summer assignment. If not, tell them to check the Summer Assignment list on the school website at http://www.arabiamtnhs.dekalb.k12.ga.us/. If not, they will be expected to do the whole packet for homework on the first day of school.

Manipulating Equations: Review of Basic Math Techniques

Part 1: Isolating variables in algebraic equations. Circle your final answer.
Solve for the variable in bold print. ***Show all steps***. Remember, what you do to one side of the equation you must do to the other. Imitate the examples from page 1. Note that equal signs are under each other.

~ notes for part 1:

# 10 you are solving for *vf*	# 23 you are solving for ***m***
# 11 you are solving for *vi*	# 26 you are solving for Θ
# 16 you are solving for ***I***	# 28 you are solving for ***v***
# 17 you are solving for ***d2***	

1. $\frac{\mathbf{d}}{t} = v$

2. $v = \frac{d}{\mathbf{t}}$

3. $d = v\mathbf{t}$

4. $d = \frac{1}{2}(\mathbf{v_f} + v_i)t$

5. $F = m\mathbf{a}$

6. $d = \frac{1}{2}(v_f + v_i)\mathbf{t}$

7. $v_f = \mathbf{v_i} + at$

8. $v_f = v_i + \mathbf{a}t$

9. $v_f^2 = v_i^2 + 2a\mathbf{d}$

10. $\mathbf{v_f^2} = v_i^2 + 2ad$

11. $v_f^2 = \mathbf{v_i^2} + 2ad$

12. $d = v_i t + \frac{1}{2}\mathbf{a}t^2$

13. $d = \mathbf{v_i}t + \frac{1}{2}at^2$

14. $Ft = \mathbf{m}v$

15. $ma = F_{app} - m\mathbf{g}$

16. $Q = \mathbf{I}^2 Rt$

17. $\dfrac{Gm_1m_2}{\mathbf{d}^2} = F$

18. $Ft = m\mathbf{v}$

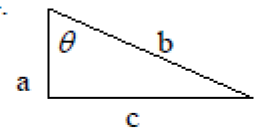
19. $\dfrac{G\mathbf{m_1}m_2}{d^2} = F$

20. $m\mathbf{a} = F_{app} - mg$

21. $ma = \mathbf{F_{app}} - mg$

22. $F\mathbf{t} = mv$

23. $\mathbf{m}a = F_{app} - \mathbf{m}g$

24. 

cos θ= _______

sin θ= _______

tan θ= _______

25. $W = F\mathbf{d}\ cos\theta$

26. $\mathrm{W} = \mathrm{Fd}\cos\boldsymbol{\theta}$

27. $F_c = \dfrac{mv^2}{\mathbf{r}}$

28. $F_c = \dfrac{m\mathbf{v}^2}{r}$

29. $m_1v_1 + m_2v_2 = m_1v_1' + m_2\mathbf{v}_2'$

30. $m_1v_1 + m_2v_2 = (m_1 + m_2)\mathbf{v}'$

Part 2: Solving algebraic equations. *Solve for the following problems for the variable in bold print.* ***Show every step.***

Use must use the equation indicated from the previous pages of this worksheet to answer the problem. Remember, what you do to one side of the equation you must do to the other. I cannot read your mind nor will I assume to know what you did to get the answer, so ***no shown work = no credit***. Circle your final answer.

31. Use the equation # 9. If $v_f = -73.5$ m/s, $v_i = 0$ m/s, and $a = -9.80$ m/s^2, what is **d**?

32. Use the equation # 12. If $d = 1.2$m, $a = 1.62$ m/s^2, and $v_i = 0$ m/s, what is **t**?

33. Use the equation # 6. If $v_f = 74$ m/s, $v_i = 145$ m/s, and $d = 1700$ m, what is **t**?

34. Use the equation # 23. If $F_{app} = 29600$ N, $g = 9.80$ m/s^2, and $a = 4.8$ m/s^2, what is **m**?

35. Use the equation # 27. If $F_c = 972$ N, $v = 8.0$ m/s, and $m = 60.0$ kg, what is **r**?

36. Use the equation # 27. If $F_c = 3.3$ N, $m = 97$ kg, and $r = 6.40 \times 10^6$ m, what is **v**?

37. Use the equation # 17. If F = 1.7×10^{-12}, m1 = m2 = 8.0 kg , and G = 6.67×10^{-11} N·m^2/kg^2, what is **d**?

38. Use the equation # 17. If F = $2.75\text{x}10^{-12}$ N, G = $6.67\text{x}10^{-11}$ N·m^2/kg^2, d = 2.6 m, and m1 = 0.37 kg, what is **m2**?

39. Use the equation # 29. If m1 = 0.035 kg, m2 = 2.5 kg, v1 = 475 m/s, v2 = 0 m/s, v1'= 275 m/s, what is **v2'**?

40. Use the equation # 25. If F = 805 N, W = $1.8\text{x}10^4$ J, ϴ = 32º, what is **d**?

41. Use the equation # 25. If F = 88 N, W = $8.0\text{x}10^4$ J, d = 1200 m, what is ϴ?

42. Use the equation # 16. If R = 4.0, Q = $1.1\text{x}10^6$ C and t = 300 s, what is **I**?

43. Use the equation # 30. If m1 = 0.115 kg, v1 = 35.0 m/s, m2 = 0.265 m/s, and v2 = 0 m/s, what is **v'**?

Review of Metric Conversions

Science uses many different units of measurement. In order to make our lives easier an International base system of units was developed. The base units are:

Measurement	Symbol	Base Unit	Units	Example
Mass	m	kilogram	kg	$m = 54.3$ kg
Length	d	meter	m	$d = 34.2$ m
Time	t	second	s	$t = 65.1$ s

All mathematical calculations that use scientific equations require the numbers entered into the equation to be in terms of the base units. Often these numbers will need to be converted into the base units. ***Complete the table for SI prefixes.***

Prefix													***base***						***micro***						
Symbol													***base***						***μ***						
Exponent	10^{12}			10^{9}			10^{6}			10^{3}	10^{2}	10^{1}	1	10^{-1}	10^{-2}	10^{-3}			10^{-6}			10^{-9}			10^{-12}
Decimal										***1,000***			***1***						**.000001**						

Below are the most common conversion factors needed for Accelerated / AP Physics:

Common Conversion Factors		Example Problems:
Mass	1000 g = 1 kg	How many grams are in 32.5 kg? $32.5kg \times \frac{1000g}{1kg} = 32{,}500g$
Length	1000 mm = 1 m 100 cm = 1 m 1000 m = 1 km	How many millimeters are in 8.45 km? $8.45km \times \frac{1000m}{1km} \times \frac{1000mm}{1m} = 8{,}450{,}000mm$
Time	60 s = 1 min 60 min = 1 hr 24 hrs = 1 day	How many seconds are in 2.5 days? $2.5days \times \frac{24hrs}{1day} \times \frac{60\min}{1hr} \times \frac{60s}{1\min} = 216{,}000s$
Volume	1000 mL = 1 L 1 mL = 1 cm^3	How many liters are in 53.4 mL? $53.4mL \times \frac{1L}{1000mL} = 0.0534mL$

Problems: Do the metric conversions. **Show how you made the conversion.** Circle your answer.

44. 8.00 km → cm

49. 54.6 mm → m

45. 1.49 kg → g

50. 14.75 cm → mm

46. 6.05 kg → g

51. 3125 g → kg

47. 7.3 km → mm

52. 3.00 m → cm

48. 83.7 m → km

53. 100 cm → m

Review of Scientific Notation

Science often uses very large and very small quantities. For example:

- the mass of the Earth is 6,000,000,000,000,000,000,000,000 kg
- the mass of an electron is 0.000,000,000,000,000,000,000,000,000,000,911 kg.

Written in this form, the quantities take up much space and are difficult to use in calculations. To work with such numbers more easily, we write them in a short hand form by expressing decimal places as powers of ten. This method is called exponential notation. Scientific notation is based on exponential notation. In scientific notation, the numerical part of a measurement is expressed as a number between 1 and 10 multiplied by a whole-number power of ten.

$M \times 10^n$ In this expression and n is an integer.

For example 2000 meters can be written as 2×10^3 m and the mass of a 0.180 kg softball is 1.8×10^{-1} kg.

When dealing with really big numbers, you move the decimal to the right, counting each place it moves, until you have only 1 number in front of it. The number of places you move the decimal becomes the exponent. For example 23,454 m becomes 2.3454 x ^{104} m. *So the mass of the earth is about* 6.0×10^{21} *kg.*

When dealing with really small numbers, you move the decimal to the left, counting each place it moves, until you have a number other than zero in front of it. The number of places you move the decimal becomes the exponent. Because the number is less than 1, a negative sign is put in front of the exponent. For example, 0.000000023454 m becomes 2.3464 x 10^{-8} m. So the *mass of an electron is about* 9.11×10^{-31} *kg*.

When typing a number that is in scientific notation into your calculator you use the "EE" button over the ",". For example, if you want to type 2.35×10^{-8} into your calculator you would type 2.35E-8. Do not use the "^" button for the exponent. It will mess up your math. When writing your answer replace the "E" with "x10".

Problems: Write the following numbers in scientific notation

54. 83934 ____________________________

55. 0.23000 __________________________

56. 2.4309 ____________________________

57. 2.3000 ____________________________

58. 0.0002 ____________________________

59. 30000 ____________________________

60. 90.200 ____________________________

61. 1200.1 ____________________________

Write the following numbers in regular format.

62. 3.203×10^4 ____________________________

63. 1.23×10^{-3} __________________________

64. 2.43×10^{-1} ____________________________

65. 2.924×10^{-4} ____________________________

66. 3.00×10^2 __________________________

67. 9.34×10^1 ____________________________

Review of Significant Digits

Significant digits are digits in any measurement that are known with certainty. Significant digits are important in science because they tell you how accurate your measurements are. The number of significant digits depends on the precision of the tool used to make the measurement. If you are given the number 84.3 cm you know that the tool used to make the measurement had a precision of tenths of a centimeter and the 3 was estimated number of millimeters.

Rules for Significant Digits	Example	# of Sig.Digits
Rule 1: All numbers that do not contain zeros are significant.	3.1428 3.14 469	5 3 3
Rule 2: All zeros between significant digits are significant.	7.053 7053 302	4 4 3
Rule 3: All zeros to the left of nonzero digits are not significant. ~ The zeros in front are just place holders to tell you that the number is really small	0.0056 0.0789 0.000001	2 3 1
Rule 4: All zeros after nonzero digits to the right of the decimal point are significant.	43 43.0 43.000 0.00200 0.40050	2 3 5 3 5
Rule 5: In numbers that do not contain decimal points, and that end is one or more zeros, the zeros may or may not be significant. So if they are significant, write the number in scientific notation!	340 3.4×10^2 3.40×10^2 2000000 2.000000×10^6 2.00×10^{-4}	2 2 3 1 7 3

Problems: State the number of significant digits in each measurement.

68. 83934 ______________________________

69. 0.23000 ____________________________

70. 2.4309 ______________________________

71. 2.3000 ______________________________

72. 3.203×10^4 ______________________________

73. 1.23×10^{-3} ____________________________

74. 0.0002 ______________________________

75. 30000 ______________________________

76. 90.200 ____________________________

77. 1200.1 ______________________________

78. 9.34×10^1 ____________________________

79. 1.221×10^{-5} __________________________

Review of Rounding

When doing math, your calculator will often display eight or more digits. Not all of these digits are significant. This will guide you in your rounding.

Rules for Rounding	Examples	# of Sig. Figs. needed
Rule 1: Determine the number of significant digits you should have.	54.2 + 86.23 = 104.43 24.6 + 146.26 = 170.86 15-3.653 = 11.347 65-7.22 = 57.78 8.3452 x 34.2 = 285.40584 2.65 x 23.7596 = 62.96294 234÷45.234 = 5.173099881 3028.228÷315.8352107 = 9.588	4 (1 decimal place) 4 (1 decimal place) 2 (0 decimal places) 2 (0 decimal places) 3 3 3 3
Rule 2: If the digit that is to be rounded is followed by a number less than 5, leave the number as is and drop the rest of the digits.	104.43 → 104.4 11.347 → 11 285.40584 →285 5.173099881 →5.17	4 2 3 3
Rule 3: If the digit that is to be rounded is followed by a number that is 5 or greater, round that number up to the next number and drop the remaining digits.	170.86 → 170.9 57.78 →58 62.96294 → 63.0 9.588 →9.59	4 2 3 3
Rule 4: Rounding with 9's	9.999 → 10.0 136.983 → 137.0 9999.9 → 10,000 → $1.000 x 10^4$	3 4 4

Problems: Round each number to three digits.

80. 2643 ______________________

81. 6435.33 ______________________

82. 0.1232 ______________________

83. 459.3452 ______________________

84. 1200.1 ______________________

85. 2000.01 ______________________

86. 83934 ______________________

87. 0.23000 ______________________

88. 2.4309 ______________________

89. 2.99999 ______________________

90. 30000 ______________________

91. 90.200 ______________________

Review of Math and Rounding with Significant Digits

Math with Significant Digits	Example	# of Sig. Figs for answer	Final Answer
Multiplication and Division: An answer should have the number of significant digits found in the number with the fewest significant figures.	8.536 x 0.47 = 4.01192 3840 ÷ 285.3 = 13.459516 360.0 ÷ 3.000 = 12	2 3 4	4.0 13.5 12.00
Addition and Subtraction: The answer should not have digits beyond the last digit position common to all the numbers being added and subtracted.	34.6 + 17.8 + 15 = 67.4 20.02 + 20.002 + 20.0002 =60.0222 345.56-245.5=100.06	0 decimals 2 decimals 1 decimal	67 60.02 100.1
Combination Problems: Follow order of operations. Compare the number of significant digits you should have for the addition and subtraction part to the number you should have for the multiplication and division part. Use the smallest one.	(3.43+6.00) ÷ 4.5 = 2.09555555 3 to 2 (2.849-0.0023) x 34.8 = 99.06516 4 to 3	2 3	2.1 99.1

Problems: Write the answers to the following with the proper number of significant digits.

92. 235.14 + 234.4 = ____________________

93. 235 x 4.0 = ________________________

94. 75.23 + 362.4626 = __________________

95. 306.4937 x 3.11 = __________________

96. 852.8 - 37.253 = ___________________

97. 23.50 ÷ 4 = _________________________

98. 23.6 - 2.3053 = _____________________

99. 9.33 ÷ 2.3048 = ____________________

100. $\frac{(23.43-2.25)}{123.523} =$ _________________________

101. $9.002\times\frac{(1.25+63.42)}{0.0023} =$ __________________

102. $9\times10^4\ \frac{23.2}{(643.24-0.92)} =$ __________________

103. $(2.84\times10^5-3.253\times10^{-4})\times5 =$ ____________

104. $\frac{10.0\times2.34\times0.234}{9.0233\times10^{-5}} =$ _____________________

105. $0.0023-0.230+3.2\frac{235.4}{3.09\times10^{-2}} =$ __________

Review of Dimensional Analysis

DIRECTIONS: *Solve each problem using dimensional analysis. All work must be shown and every answer must have a unit.*

Conversion Factors			
1 hr = 60 min	**1 min = 60 sec**	**1 ton = 2000 lbs**	**7 days = 1 week**
24 hrs = 1 day	**1 kg = 2.2 lbs**	**1 gal = 3.79 L**	**264.2 gal = 1 cubic meter**
1 mi = 5,280 ft	**1 kg = 1000 g**	**1 lb = 16 oz**	**20 drops = 1 mL**
365 days = 1 yr	**52 weeks = 1 yr**	**2.54 cm = 1 in**	**1 L = 1000 mL**
0.621 mi = 1.00 km	**1 yd = 36 inches**	**1 cc = 1 cm^3**	**1 mL = 1 cm^3**

106. How many miles will a person run during a 10 kilometer race?

107. The moon is 250,000 miles away. How many feet is it from earth?

108. A family swimming pool holds 10,000 gallons of water. How many cubic meters is this?

109. The average American student is in class 330 minutes/day. How many hours/day is this? How many seconds is this?

110. How many seconds are there in 1 year?

111. Lake Lanier holds 1.3×10^{15} gallons of water. How many liters is this?

112. *Coca Cola* puts 355 ml in a soda pop can. How many drops is this? How many cubic meters is this?

113. Atlanta uses 1.2×10^{9} gallons of water /day. How many gallons per second must be pumped from the Lake Lanier every second to supply the city?

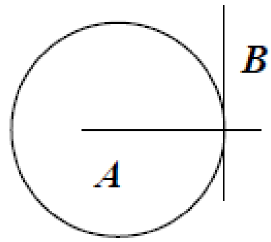
114. Sixty miles/ hour is how many feet/second?

115. Lake Lanier holds 1.3×10^{15} gallons of water. If just Atlanta removed water from the lake and it never rained again, how many days would the water last? Atlanta uses 1.2×10^{9} gallons of water /day

Review of Geometry

Solve the following geometric problems.

a. Line ***B*** touches the circle at a single point. Line ***A*** extends through the center of the circle.



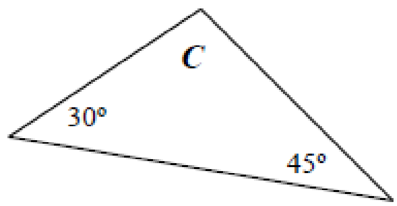
i. What is line ***B*** in reference to the circle?

____

ii. How large is the angle between lines ***A*** and ***B***?

____

b. What is angle ***C***?



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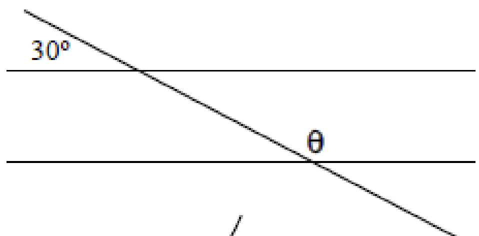
c. What is angle θ ?



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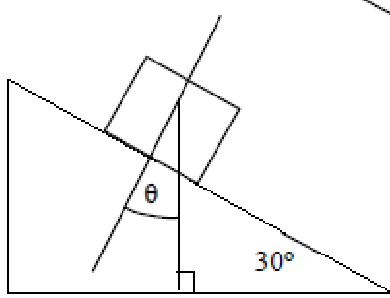
d. How large is *θ*?



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e. The radius of a circle is 5.5 *cm*,

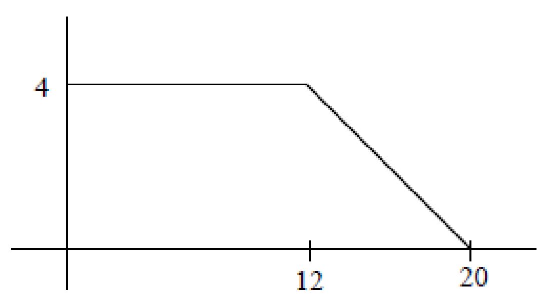
i. What is the circumference in <u>meters</u>?

____

ii. What is its area in <u>square meters</u>?

____

f. What is the area under the curve at the right?



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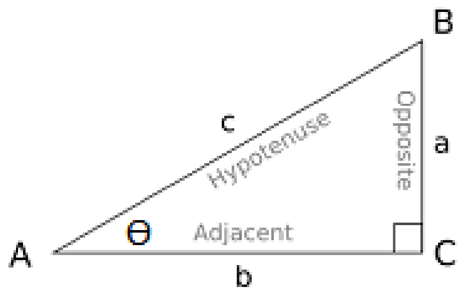
Review of Trigonometry, Pythagorean Theorem, and Vectors

Given a vector, you can draw the ***x*** and ***y*** component vectors. The sum of vectors ***x*** and ***y*** describe the vector exactly. Again, any math done with the component vectors will be as valid as with the original vector. The advantage is that math on the ***x*** and/or ***y*** axis is greatly simplified since direction can be specified with plus and minus signs instead of degrees. But, how do you mathematically find the length of the component vectors? Use trigonometry.

$S\frac{O}{H}$ $C\frac{A}{H}$ $T\frac{O}{A}$



$\cos\Theta = \frac{adjacent}{hypotenuse}$

$\sin\Theta = \frac{opposite}{hypotenuse}$

$\tan\Theta = \frac{opposite}{adjacent}$

Pythagorean Theorem:

$$c^2 = a^2 + b^2$$

Part 1: **Right Triangle Trigonometry.** Using the generic triangle above, Right Triangle Trigonometry and Pythagorean Theorem solve the following problems. ***Your calculator must be in degree mode.***

a. θ = 55° and ***c*** = 32 *m*, solve for ***a*** and ***b***.

____

b. θ = 45° and ***a*** = 15 *m/s*, solve for ***b*** and ***c***.

____

c. ***b*** = 17.8 *m* and θ = 65°, solve for ***a*** and ***c***.

____

d. ***a*** = 250 *m* and ***b*** = 180 *m*, solve for θ and ***c***.

____

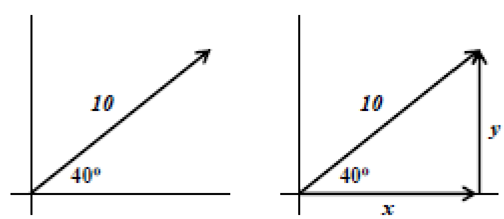
e. ***a*** =25 *cm* and ***c*** = 32 *cm*, solve for ***b*** and θ.

____

f. ***b*** =104 *cm* and ***c*** = 65 *cm*, solve for ***a*** and θ.

____

Part 2: Introduction to Vectors:



Example: ***x*** = 20, ***y*** = -15

$\cos\theta = \frac{adj}{hyp}$ $\sin\theta = \frac{opp}{hyp}$

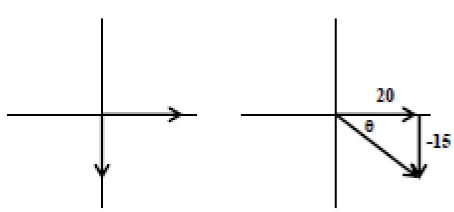
$adj = hyp\cos\theta$ $opp = hyp\sin\theta$

$x = hyp\cos\theta$ $y = hyp\sin\theta$

$x = 10\cos 40^\circ$ $y = 10\sin 40^\circ$

$x = 7.66$ $y = 6.43$

$R^2 = x^2 + y^2$ $\tan\theta = \frac{opp}{adj}$



$R = \sqrt{x^2 + y^2}$ $\theta = \tan^{-1}\left(\frac{opp}{adj}\right)$

$R = \sqrt{20^2 + 15^2}$ $\theta = \tan^{-1}\left(\frac{y}{x}\right)$

$R = 25$

$360^\circ - 36.9^\circ = 323.1^\circ$

Use sample problems above as a model to calculate and draw the resultant vectors:

a. ***x*** = 600m, ***y*** = 400m

b. ***x*** = -0.75 km, ***y*** = -1.25 km

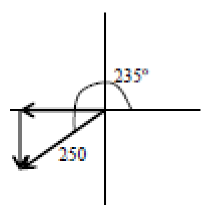
c. ***x*** = -32m/s, ***y*** = 16 m/s

d. ***x*** = 0.0065 m/s, ***y*** = -0.0090 m/s

<u>Solve the following problems</u>.

You will be converting from a polar vector, where direction is specified in ***degrees measured counterclockwise from east***, to component vectors along the ***x*** and ***y*** axis. Remember the plus and minus signs on you answers. They correspond with the quadrant the original vector is in. Hint: Draw the vector first to help you see the quadrant. Anticipate the sign on the ***x*** and ***y*** vectors. Do not bother to change the angle to less than 90^o. Using the number given will result in the correct + and – signs. The first number will be the magnitude (length of the vector) and the second the degrees from east. ***Your calculator must be in degree mode***

Example: 250 at 235°



$x = hyp\cos\theta$

$x = 250\cos 235°$

$x = -143$

$y = hyp\sin\theta$

$y = 250\sin 235°$

$y = -205$

Use the sample problems above to find x and y vector components and draw the resultant vectors:

a. 89N at 150^0

b. 6.50N at 345^0

c. $7.5x10^4$ N at 180^0

d. 12 N at 265^0

e. 990 N at 320^0

f. 8653 N at 225^0