PICKENS COUNTY SCHOOLS

Standards-Based Assignment Packet

Subject/Grade: Physics-Grade12

VOCABULARY REVIEW

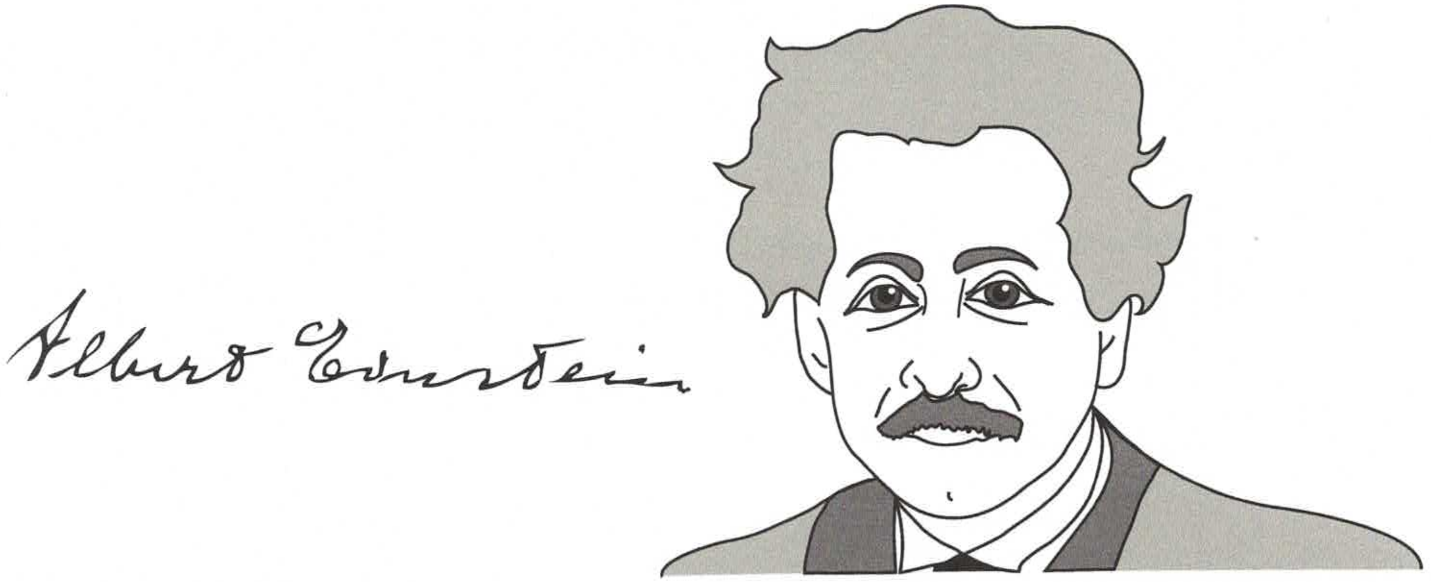
USE THE CLUES AND THE WORD BOX TO COMPLETE THE WORD SEARCH.

ENERGY	POTENTIAL	KINETIC	RENEWABLE	NON-RENEWABLE	BIOMASS
VOLCANO	FUMAROLE	GEYSER	HOT SPRING	SOLAR CELL	SOLAR PANEL
TURBINE	CONSERVE				

Tip: → ↓ ← ↗ ↘ ↙ ↖

P	V	B	I	O	M	A	S	S	C	A	G	Q	U	U	T	O	E	P	F
D	O	G	X	X	P	R	E	O	J	H	U	E	U	U	Q	L	I	A	O
R	L	Z	X	G	W	O	N	L	S	R	M	W	Y	Y	B	Q	H	R	T
T	C	W	S	R	P	S	T	O	O	M	E	D	I	A	X	C	O	J	R
U	A	T	A	O	E	U	L	E	R	R	K	S	W	G	F	O	T	E	C
R	N	S	W	R	E	A	E	A	N	T	A	E	Y	L	J	I	S	N	J
B	O	Z	V	I	R	N	R	N	N	T	N	M	U	E	S	G	P	E	M
I	G	E	O	C	I	L	I	M	I	E	I	M	U	N	G	L	R	R	S
N	P	A	E	B	G	G	M	X	R	V	A	A	O	F	E	M	I	G	G
E	T	L	R	S	O	L	A	R	P	A	N	E	L	O	P	S	N	Y	U
N	O	N	R	E	N	E	W	A	B	L	E	M	N	O	N	Z	G	O	D
L	L	E	C	R	A	L	O	S	G	W	K	I	N	E	T	I	C	L	B

- Energy in motion is called____________________ energy.
- Stored energy is called ____________________ energy.
- A machine powered by rotating blades is a ______________________.
- A spring that shoots out hot water is a _______________________.
- Sources of energy that will never run out are known as ____________________energy.
- Energy that comes from things such as plants and trees is known as _________________ energy.
- ______________________ is the ability to do work.
- A hole in the ground that has vapors or gases coming out is called a ___________________.
- A tool that changes light energy into electricity is a ______________________.
- ______________________ means to use something in small amounts.
- A ______________________ is a vent in the Earth's crust in which melted rock comes out.
- Energy available in a specific amount that will not regenerate is known as: ________ _________________________ energy.
- A ___________________________ is a group of solar cells connected to form a large, flat surface.
- A source of warm water is called a _________________________.



Albert Einstein was a physicist and professor who was born in Ulm, Germany in 1879. At the age of ten, he set up a program of study for himself, reading extensively about science. He also studied violin and piano, establishing a love of music that would carry into adulthood.

At age 17, Einstein graduated high school and enrolled in the Federal Institute of Technology in Zurich, Switzerland. There, he fell in love with fellow student Mileva Marić. After graduation, Einstein spent two years looking for teaching work, finally taking a job at the Swiss Patent Office. In 1903, the position became permanent, and in the same year, Einstein and Marić married. The pair had three children before they divorced in early 1919.

In 1905, Einstein was awarded a Ph.D. by the University of Zurich. That same year, he published four important papers on physics, including the one containing his famous $E = mc^2$ equation. He began to attain recognition for his work, and was hired as a lecturer at the University of Bern in Switzerland in 1908. From there, he went on to more and greater positions, refining and building on his theories along the way.

In 1919, he married Elsa Löwenthal, and in 1933, they emigrated to the United States to escape the dangers of Nazi Germany. They settled in Princeton, New Jersey, where Einstein took a post at the Institute for Advanced Study. He continued to work on his theories for the remainder of his life, and his work remains some of the most important in the history of theoretical physics.

Word scramble!

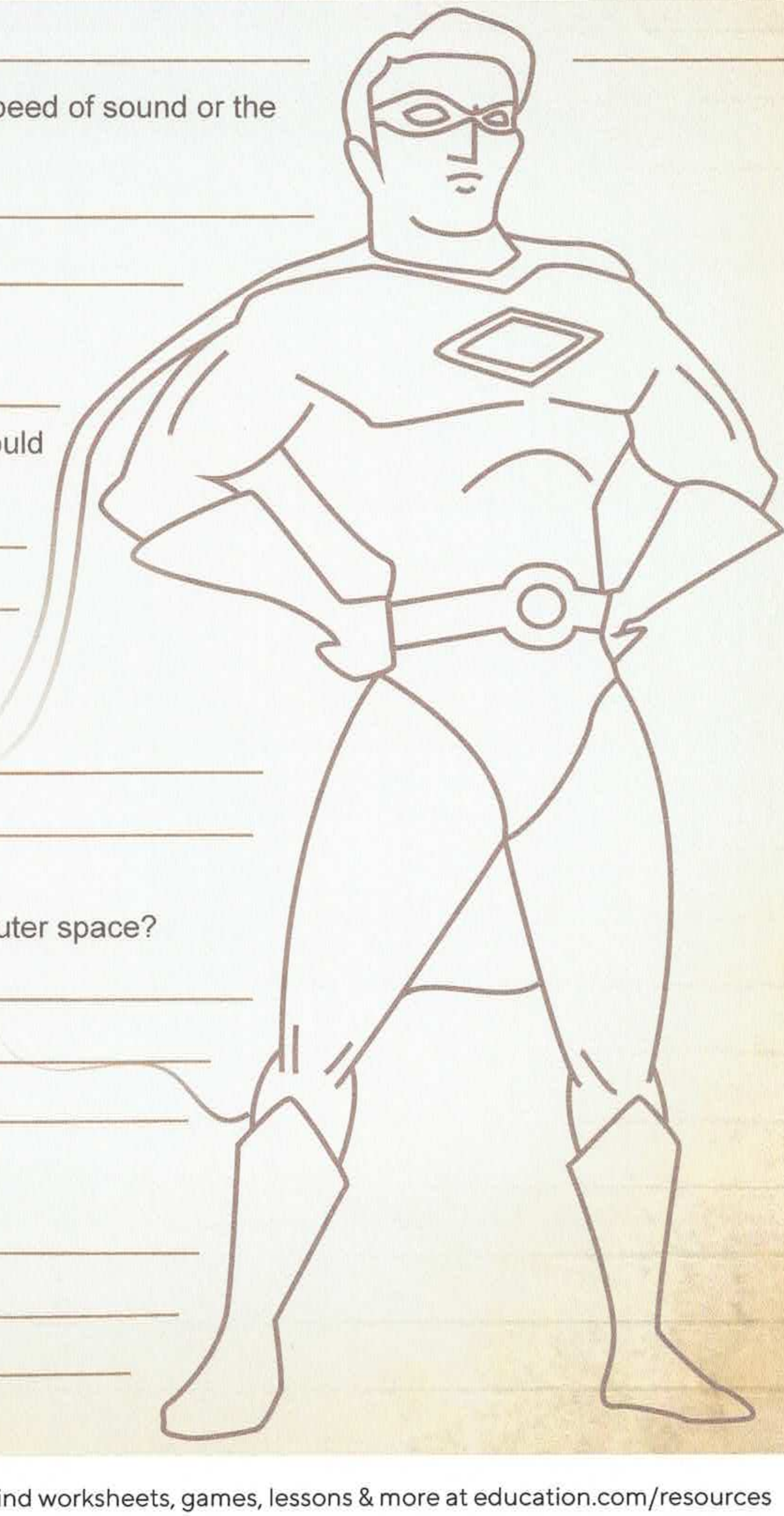
Unscramble the letters to form the word that completes the sentence.

1. For his many important papers published that year, 1905 is referred to as Einstein's *Annus Mirabilis*, meaning "____________ ____________." LEMCIRA EAYR
2. Einstein won the ____________ ____________ in Physics for 1921. ENOLB IZEPR
3. In 1999, Einstein was named "Person of the ____________ " by TIME Magazine. YENTCRU

Answers: 1. MIRACLE YEAR 2. NOBEL PRIZE 3. CENTURY

Superhero Physics!

Now that you have learned all about physics, if you were a *Super Hero* what would your powers be?



Would you rather be able to move at the speed of sound or the speed of light?

Who is Sound Man's arch nemesis?

If you had the gift of super friction, what would you be able to do?

Lightning Boy is about to strike! Where will you hide?

Who does better in the water:
Sound Man or Light Man? What about in outer space?

What special features does Air Resistance Man's super suit have?

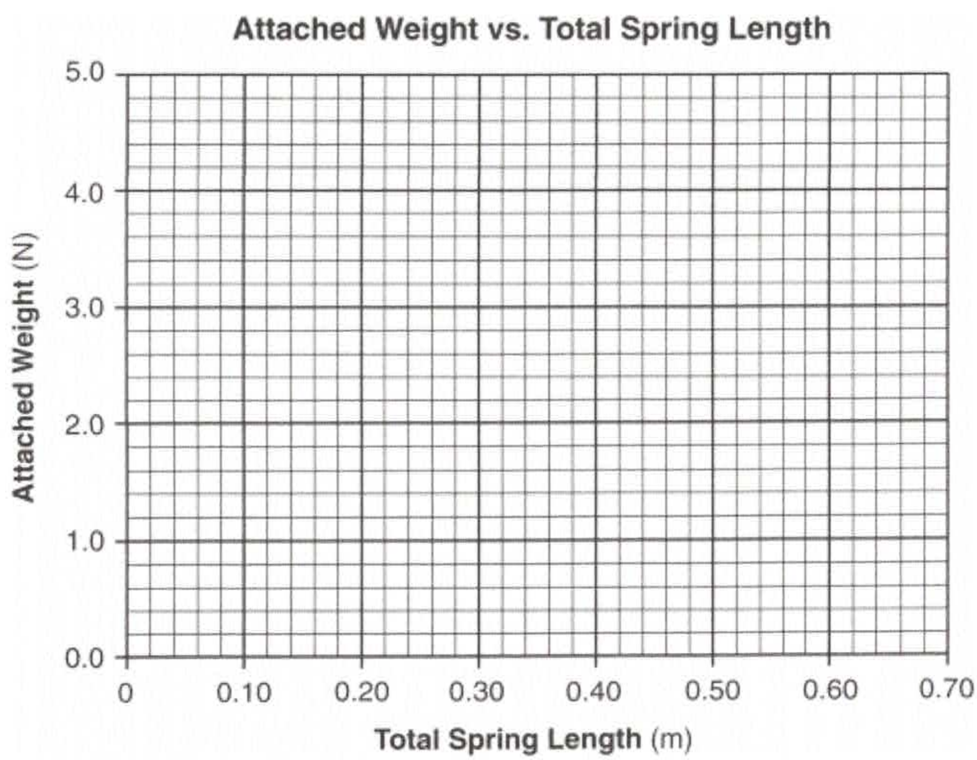
2. Experimental Design & Data Analysis

1. A student performed an experiment in which the weight attached to a suspended spring was varied and the resulting total length of the spring measured. The data for the experiment are in the table below.

   a. Plot the data points for the attached weight versus total spring length. Draw a line of best fit (best fit line) **using a ruler**.

Attached Weight vs. Total Spring Length

Attached Weight (N)	Total Spring Length (m)
0.98	0.37
1.96	0.42
2.94	0.51
3.92	0.59
4.91	0.64



b. Using one or more complete sentences, state a valid conclusion that relates increasing the attached weight to the total spring length.

2. Many people who are in favor of alternative medicine claim that large doses of vitamin C introduced into a vein speed up the healing of surgical wounds. Describe an experiment to test this hypothesis. Your answer must include at least:

- The difference between the experimental group of the study and the control group
- *Two* conditions that must be kept constant in both groups
- Data that should be collected
- An example of experimental results that would support the hypothesis

3. Unit Conversions

Show all work and put a box around your final answer.

Metric prefixes						
Prefix	Symbol	1000^m	10^n	Decimal	English word	
					short scale	long scale
yotta	Y	1000^8	10^{24}	1 000 000 000 000 000 000 000 000	septillion	quadrillion
zetta	Z	1000^7	10^{21}	1 000 000 000 000 000 000 000	sextillion	thousand trillion
exa	E	1000^6	10^{18}	1 000 000 000 000 000 000	quintillion	trillion
peta	P	1000^5	10^{15}	1 000 000 000 000 000	quadrillion	thousand billion
tera	T	1000^4	10^{12}	1 000 000 000 000	trillion	billion
giga	G	1000^3	10^9	1 000 000 000	billion	thousand million
mega	M	1000^2	10^6	1 000 000	million	
kilo	k	1000^1	10^3	1 000	thousand	
hecto	h	$1000^{2/3}$	10^2	100	hundred	
deca	da	$1000^{1/3}$	10^1	10	ten	
		1000^0	10^0	1	one	
deci	d	$1000^{-1/3}$	10^{-1}	0.1	tenth	
centi	c	$1000^{-2/3}$	10^{-2}	0.01	hundredth	
milli	m	1000^{-1}	10^{-3}	0.001	thousandth	
micro	μ	1000^{-2}	10^{-6}	0.000 001	millionth	
nano	n	1000^{-3}	10^{-9}	0.000 000 001	billionth	thousand millionth
pico	p	1000^{-4}	10^{-12}	0.000 000 000 001	trillionth	billionth
femto	f	1000^{-5}	10^{-15}	0.000 000 000 000 001	quadrillionth	thousand billionth
atto	a	1000^{-6}	10^{-18}	0.000 000 000 000 000 001	quintillionth	trillionth
zepto	z	1000^{-7}	10^{-21}	0.000 000 000 000 000 000 001	sextillionth	thousand trillionth
yocto	y	1000^{-8}	10^{-24}	0.000 000 000 000 000 000 000 001	septillionth	quadrillionth

Category	Name of Unit	Measure	
Length	Inch	$1/12^{th}$	ft
	Foot	1	ft
	Yard	3	ft
	Mile	5280	ft
	Nautical mile	6080	ft
Area	Acre	43,560	sq ft
Volume	Fluid ounce	$1/20^{th}$	pint
	Pint	1	pint
	Quart	2	pint
	Gallon	8	pint
Weight	Ounce	$1/16^{th}$	lb
	Pound	1	lb
	Stone	14	lb
	Ton	2240	lb

3. Convert 2.14 grams to kilograms.

4. Convert 5.0×10^3 milliliters to liters.

5. Convert 2,000 millimeters to kilometers.

6. Convert 0.050 kilograms to grams.

7. Find your age in seconds.

8. Express 72 kilometers per hour as meters per hours.

4. # Scientific Notation

Show all work and put a box around your final answer.

9. If 0.000023 is expressed in the form 2.3×10^n, what is the value of *n*?

10. Express in scientific notation the number 0.00017.

11. Which value for *n* makes this sentence true?

$$0.00045 = 4.5 \times 10^n$$

12. In scientific notation, 54,000,000 is expressed as:

13. If the fraction $\frac{123}{10,000}$ is expressed in the form 1.23×10^n, what is the value of n?

14. The mass of an orchid seed is approximately 0.0000035 gram. What is the mass equivalent to in scientific notation?

15. The mass of 60 paper clips is 18.0 grams. What is the mass of one paper clip in scientific notation?

Part 1: Algebra Review

Throughout the year, we'll be rearranging formulas and equations to solve for the variable we want to know. Refresh your algebra skills with the following:

Example:

Suppose we want to know the acceleration, a, in the following formula:

$$y = v_o t + \frac{1}{2} a t^2$$

y is the distance

v_o is the initial velocity

t is the time

Isolate the term with the variable of interest, a. In other words, get the ½ at^2 term by itself on one side of the equal sign. To do this we would have to subtract $v_o t$ term from both sides.

$$\begin{array}{rcl} y & = & v_o t + \frac{1}{2} a t^2 \\ -v_o t & & -v_o t \\ \hline y - v_o t & = & \frac{1}{2} a t^2 \end{array}$$

> Common error – dividing the ½ at^2 by ½ t^2 before isolating the term with the acceleration. If we wanted to do this, we would have to divide <u>all</u> the terms by ½ t^2, not just the ½ at^2 term.

Isolate the variable of interest, a. Now we can multiply both sides by 2 and divide both sides by t^2.

$$y - v_o t = \frac{1}{2} a t^2$$

$$\frac{2(y - v_o t)}{t^2} = \frac{\cancel{2}(\cancel{\tfrac{1}{2}}\, a \cancel{t^2})}{\cancel{t^2}}$$

$$\frac{2(y - v_o t)}{t^2} = a$$

Example: Solve the following.

$$6 = \frac{18 + 3x}{x}$$

In this case, we have to get all the terms with x's into 1 term. Multiply both sides by x.

$$6x = 18 + 3x$$

Combine the terms with the x's by subtracting 3x from each side

$$\begin{array}{rcl} 6x & = & 18 + 3x \\ -3x & & -3x \\ \hline 3x & = & 18 \end{array}$$

Divide both sides by 3.

$$X = 6$$

> Common error – dividing only the 6 and the 3x terms by x. We can't do this because the entire numerator (18 + 3x) is divided by x in the problem.

Name: ____

Solve these to refresh your algebra skills.

1. $X + 47 = 95$

2. $55 + a = -78$

3. $1/r = 1/5 + 1/15$

4. $1/32 = 1/f + 1/-8$

5. $37 = \frac{314.5}{x}$

6. $5 = \frac{3x - 4}{x}$

7. $2x = \frac{3x^2 - 16}{x}$

Solve for the given letter

1. $A = p + prt$ for t

2. $A = \frac{1}{2} d_1 d_2$ for d_1

3. $f_o = f_s \frac{(v + v_o)}{(v - v_s)}$ for v_o

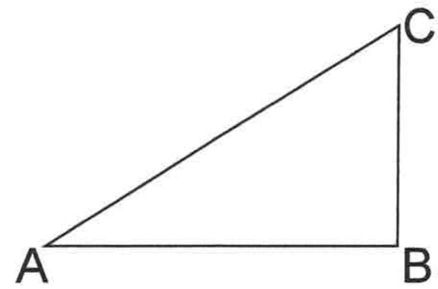
4. $y = mx + b$ for m

5. $v = \sqrt{\frac{GM}{r}}$ for r

6. $F = k \frac{Q_1 Q_2}{r^2}$ for r

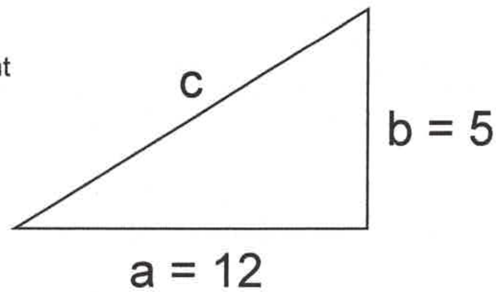
7. $F = \frac{m v^2}{r^2}$ for v

Right Triangles & Trigonometry



Suppose you wanted to get from point A to point C in the following diagram. You could go directly from A to C, or you could go to the right from A to B and then go straight up from B to C. Thus the direction we go is important. We will define the distance from C to A as our displacement. You'll see shortly that the displacement is a vector. In many cases, we will be interested in the x and y component of a vector. In this case, the x component is AB. The y component is BC.

Pythagorean Theorem



If two of the three sides of a right triangle are known, we can find the 3rd side using the Pythagorean Theorem.

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

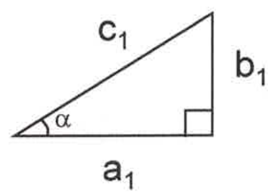
$12^2 + 5^2 = c^2$

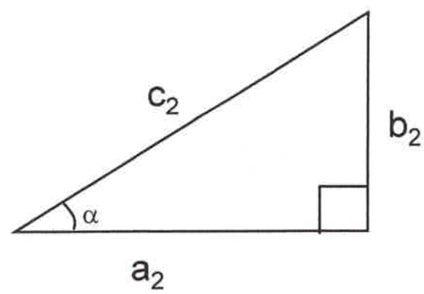
$144 + 25 = c^2$

$169 = c^2$

$13 = c$

Right Triangle Trigonometry





Both of the triangles shown are right triangles. Angle α is the same for both.

Side c is the hypotenuse. Side a is adjacent to angle α. Side b is opposite angle α. If we divided side b by side a for both triangles we would get the same number. The only way we could get a different ratio would be if the angle changed. For example, if the angle increased, side b would have to increase, while side a remained the same. That would cause the ratio to increase. We call the ratio of side b to side a the tangent of the angle. The same logic is true for the ratios of any two sides. We will use three ratios:

Sine → $\text{Sin } \alpha = \dfrac{\text{Opposite}}{\text{Hypotenuse}} = \dfrac{b}{c}$

Cosine → $\text{Cos } \alpha = \dfrac{\text{Adjacent}}{\text{Hypotenuse}} = \dfrac{a}{c}$

Tangent → $\text{Tan } \alpha = \dfrac{\text{Opposite}}{\text{Adjacent}} = \dfrac{b}{a}$

An easy way to remember these is the acronym **SOHCAHTOA** (pronounced so ca toe a)

SOH → **S**ine is **O**pposite / **H**ypotneuse

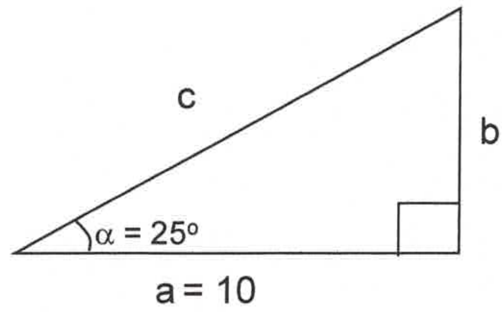
CAH → **C**osine is **A**djacent / **H**ypotenuse

TOA → **T**angent is **O**pposite / **A**djacent

> Make sure your calculator is in degree mode, not radian mode.

Examples

Find sides b and c.



$$\text{Tan } \alpha = \frac{\text{Opp}}{\text{Adj}} = \frac{b}{a}$$

$$\text{Tan } 25 = \frac{b}{10}$$

b= 10 tan 25 = 4.66

Now that we know side b, we can use trig or the Pythagorean theorem to find side c.

$$\text{Cos } \alpha = \frac{\text{Adjacent}}{\text{Hypotenuse}} = \frac{a}{c}$$

$$\text{Cos } 25 = \frac{10}{c}$$

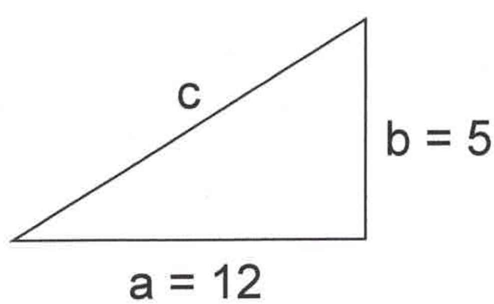
$$c = \frac{10}{\text{Cos } 25} = 11.03$$

Verify this answer by finding c using the Pythagorean theorem.

Finding angles

Since each angle has a unique sine, cosine and tangent value, we can use these values to find the angle. We call these functions the inverse tangent, inverse sine, or inverse cosine.

$$\alpha = \tan^{-1} \frac{\text{Opposite}}{\text{Adjacent}} = \tan^{-1} \frac{b}{a}$$



We'd read this equation as

"α is the angle whose tangent is b/a"

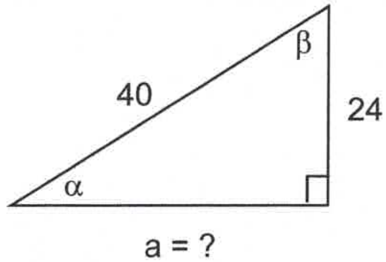
For our example,

$$\alpha = \tan^{-1} \frac{\text{Opposite}}{\text{Adjacent}} = \tan^{-1} \frac{5}{12}$$

The inverse functions are normally above (shift or 2nd function) the standard trig function button on your calculator.

$\alpha = 22.62°$

Name: ____



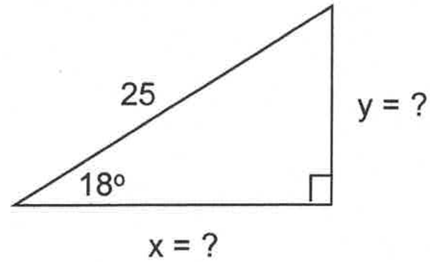
1. What is the length of side a?

3. What is the sine of angle α ?

4. What is the cosine of angle α ?

5. Angle α = ____________degrees.

3. Angle β = ____________degrees. (use trig and check to see if all the angles add to 180°)



1. What is the length of side x?

2. What is the length of side y?

3. Use the Pythagorean theorem to check your answers.

If the 25 was a vector quantity (see chapter 1), the values you found for x and y would be called the x and y components.

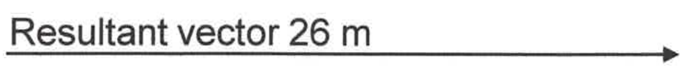
Part II: Vector Addition and Subtraction

Vectors have both magnitude and direction, thus we must take the direction into account when adding or subtracting vectors.

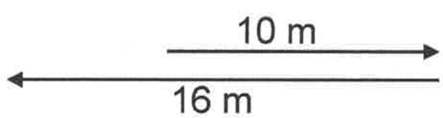
Adding Vectors:

1. The simplest case occurs when vectors are collinear. Vectors are normally represented by arrows. When adding, we used a tail-to-head relationship. Thus the tail of the vector being added to the original vector is placed at the head of the original vector. If they are in the same direction, simply add the magnitudes of the vectors. The direction will be the same as that of the individual vectors. For example, if someone walked 10 m East and then 16 meters East, we would draw the vectors as:

The resultant vector would be 26 m East. It is drawn from the tail of the first vector to the head of the second one.

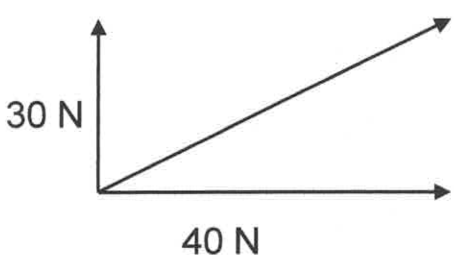


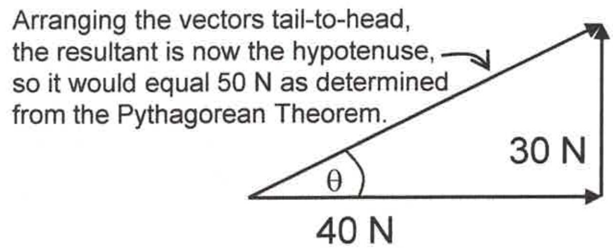
If vectors are in the opposite direction, add them, keeping in mind they have opposite signs.



The resultant vector would be 6 m West.

2. The next simplest case occurs when vectors are perpendicular to each other.. We use the Pythagorean theorem to add these vectors. For example, if we had a force of 40 N pushing an object due West and a force 30 N pushing an object due North, we know the object would move along a path between the two forces as shown by the dashed line.





To find the angle, θ, that the resultant force acts along, we can use the inverse tangent function.

$\theta = \text{Tan}^{-1}(30/40) = 37^\circ$ above the horizontal

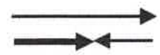
This tells us that the two original forces could be replaced by a single force of 50N acting at 37° above the horizontal. The 50N force at 37° is the sum of the original forces.

Subtracting Vectors:

To subtract two vectors, we simply have to take the opposite of the second vector and add it to the first.

Some examples:

30 m E – 10 m E = 30 m E + 10m W = 20 m E

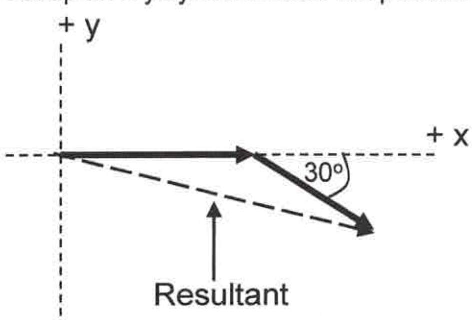


30m E – 10 m W 30m E + 10m E = 40 m W

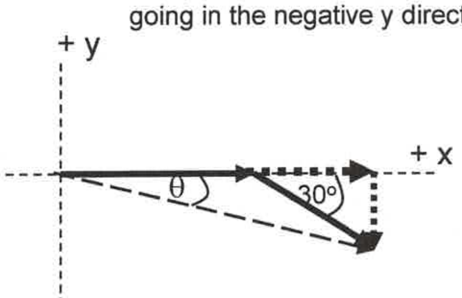
Adding Vectors that are not collinear and not perpendicular:

To add vectors such as 70 m due E to 50 m at 30° S of E, we need to break the vectors into x-y components.

1. Start by drawing a picture. Don't skip this step; it will help you avoid direction errors.
2. Set up an x-y system. Label the positive and negative directions.



3. Use trig to determine the x and y components of the vector. Be sure to take directions into account by using + and – signs.
   1. The 70 meter vector lies along the +x axis. Its x component is its full length, 70m and it has no y component.
   2. The 50 meter vector must be broken into components. Draw the components in the x and y direction to make a right triangle. The original vector is the hypotenuse.
   3. The x component of the 50 m vector can be found using the cosine function in this case. The y component can be found using the sine function Note the negative sign since we are going in the negative y direction.



Cos 30 = x/50, so x = 50 cos30 = 43.3 m

Sin 30 = -y/50, so y = -50 sin30 = -25 m

> Note: the x component won't always be cosine. It depends on the angle you use.

4. Make a table to organize your data.

Vector	x	y
70 m	70	0
50 m	43.3	-25
Resultant	113.3	-25

5. Add the x components and the y components.
6. Use the Pythagorean Theorem to determine the resultant vector.

$$\sqrt{113.3^2 + 25^2} = 116 \text{ m}$$

7. Use the $\tan^{-1}$ function to find the angle

$\theta = \tan^{-1}(25/113.3) = 12.4°$

Name: ____

1. Add these vectors:

15 m/s N + 20 m/s S

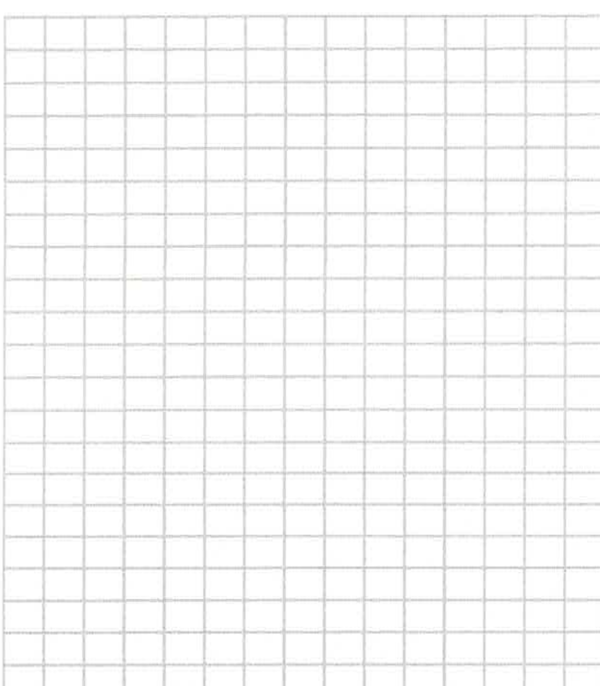
40 m E + 60 m N

2. Subtract

28 m N – 15 m S

3. Add:

22 m 15° N of E + 64 m 25° W of N + 38m due N (Draw the picture first)



Part III: Metric System and Unit Conversion

As you are well aware by this point in your science education, the US is one of only a few countries uses the "English" system of measurement. American scientists, like their global counterparts, use the metric system. In physics, you will use metric units, unless otherwise instructed. Therefore, you must be comfortable not only working with metric units and converting between them, but also with converting non-metric units to metric. This is not a skill that will be taught in your physics class; it is prerequisite to the course. If you need review, there are plenty of online tutorials for just that purpose. The following table displays the prefixes used in the metric system, as well as the symbols and multipliers/exponents for each prefix.

Metric Prefix Table

Prefix	Symbol	Multiplier	Exponential
giga	G	1,000,000,000	10^9
mega	M	1,000,000	10^6
kilo	k	1,000	10^3
hecto	h	100	10^2
deca	da	10	10^1
		1	10^0
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	µ	0.000001	10^{-6}
nano	n	0.000000001	10^{-9}

Ex: Convert 545 centimeters to meters.

There are 100 centimeters per meter…

545 ~~cm~~ x 1 m/100 ~~cm~~

= 0.545 m

In physics, you will often be dealing with units that represent rates. For example, velocity is the rate at which your position changes with respect to time. The SI units for velocity are meters per second (m/s). Generally speaking, you need to make sure that your work is in meters, seconds, and meters per second when solving motion problems. If you are provided information in miles and hours, you will need to convert to meters per second.

Some of the more common conversion factors you will need this year are below, but you may need to look others up online for the remainder of this packet.

1 m=39.37 in = 3.281 ft

1 in = 2.54 cm

1 km = 0.621 mi

1 mi= 5280 ft = 1.609 km

1 kg = 1000 g = 2.2 lb

1 min = 60 s

1 h = 3600 s

1 year = 365.24 days

1 rad= 57.3°

Perform the following conversions (show steps/work):

1. 5.46 mm = _______________km

2. 2.3×10^3 mm= ____________m

3. 26.86 ft/mile= _____________m/s

4. 53 cm^2 = _______m^2

5. 2.7 hours = _______________s

5. 3π rad = ________°

7. 165 lbs= ________kg

8. 9.461x 1015 m = __________Gm

9. 0.4 mT = _________________Gauss

10. 200 MW = ______________μW

Part IV: Scientific Notation

Like metric conversions, you should be very familiar with and comfortable with using scientific notation. Please convert the following quantities into (or out of) scientific notation:

1. **5.6 million= ______________________________**
2. **0.000007098= ______________________________**
3. **45,011= ______________________________**
4. **0.020202= ______________________________**
5. **909,000,000= ______________________________**

Complete the following operations (without a calculator):

6. $(1.5 \times 10^{5}) \div (1.5 \times 10^{-5})$= ______________________

7. $(2 \times 10^{4}) \times (3 \times 10^{5})$= ________________________

8. $(4.0 \times 10^{-3}) - (1.2 \times 10^{-3})$= ________________________________