Yorktown Community Schools
HOME OF THE TIGERS

Greetings Future AP Physics 1 Success Story:

Congratulations, you made a decision signing up for AP Physics 1! I think it will prove to be a good decision. This class will be a challenging class. There will be times you will love your decision to sign up and there will be times you will question sanity during last year's course request. But you're in it now. We're in it together. Buckle up. We have work to do.

The information covered in AP Physics 1 is similar in scope and rigor to that of the first semester of a serious college physics course. This year we will conceptually and mathematically dominate the topics of motion in one and two dimensions, forces, circular motion, energy, momentum, things that rotate, electrostatics, circuits with resistors…oh yeah, and wave motion, simple harmonic oscillators, and sound.

My promise to you is that I will take this course seriously and do everything possible to prepare you for the exam. Your first step is to do the reading and math work in this summer packet. Please **ALWAYS SHOW WORK**. Have this summer assignment done by day 1. You will need it during our first labs and quizzes.

Your summer assignment consists of two parts:

1) Attached to this letter are some sheets reviewing mathematical concepts. If you have troubles with this assignment ask friends, the internet, or me for help. My contact information is below.
2) Check the following website. I will post some readings and solutions (to the attached worksheets) on the following webpage: https://goo.gl/pQMSB9
(or https://sites.google.com/site/yorktownphysics/ and click summer assignment)

If you have ANY questions, please feel free to contact me by email @ bbuehler@yorktown.k12.in.us or on Twitter @thebenbuehler . Have an awesome summer. I will see you in the fall.

Yours in Physics,

Mr. Ben Buehler

AP Physics 1 Summer Assignment

1. Scientific Notation:

The following are ordinary physics problems. Write the answer in scientific notation and simplify the units (π=3).

a. $T_s = 2\pi\sqrt{\dfrac{4.5\times10^{-2}\,kg}{2.0\times10^{3}\,kg/s^{2}}} =$ T_s=________________

b. $F = \left(9.0\times10^{9}\,\dfrac{N\cdot m^{2}}{C^{2}}\right)\dfrac{\left(3.2\times10^{-9}C\right)\left(9.6\times10^{-9}C\right)}{\left(0.32m\right)^{2}}$ F=________________

c. $\dfrac{1}{R_p} = \dfrac{1}{4.5\times10^{2}\Omega} + \dfrac{1}{9.4\times10^{2}\Omega}$ R_p=________________

d. $K_{max} = \left(6.63\times10^{-34}\,J\cdot s\right)\left(7.09\times10^{14}\,s\right) - 2.17\times10^{-19}\,J$ K_{max}=________________

e. $\gamma = 1 \Big/ \sqrt{1-\dfrac{2.25\times10^{8}\,m/s}{3.00\times10^{8}\,m/s}}$ γ=________________

f. $K = \dfrac{1}{2}\left(6.6\times10^{2}\ \text{kg}\right)\left(2.11\times10^{4}\ \text{m/s}\right)^{2} =$ K=________________

g. $\left(1.33\right)\sin 25.0^{\circ} = \left(1.50\right)\sin\theta$ θ=________________

2. Solving Equations:

Often problems on the AP exam are done with variables only. Solve for the variable indicated. Don't let the different letters confuse you. Manipulate them algebraically as though they were numbers.

a. $K = \frac{1}{2}kx^2$, $x =$ ______________

b. $T_p = 2\pi\sqrt{\frac{\ell}{g}}$, $g =$ ______________

c. $F_g = G\frac{m_1 m_2}{r^2}$, $r =$ ______________

d. $mgh = \frac{1}{2}mv^2$, $v =$ ______________

e. $x = x_o + v_o t + \frac{1}{2}at^2$, $t =$ ______________

f. $B = \frac{\mu_o}{2\pi}\frac{I}{r}$, $r =$ ______________

g. $x_m = \frac{m\lambda L}{d}$, $d =$ ______________

h. $pV = nRT$, $T =$ ______________

i. $\sin\theta_c = \frac{n_1}{n_2}$, $\theta_c =$ ______________

j. $qV = \frac{1}{2}mv^2$, $v =$ ______________

3. Conversion

Science uses the ***KMS*** system (***SI***: System Internationale). ***KMS*** stands for kilogram, meter, second. These are the units of choice of physics. The equations in physics depend on unit agreement. So you must convert to ***KMS*** in most problems to arrive at the correct answer.

kilometers (*km*) to meters (*m*)	and meters to kilometers	gram (*g*) to kilogram (*kg*)
centimeters (*cm*) to meters (*m*)	and meters to centimeters	Celsius (^oC) to Kelvin (*K*)
millimeters (*mm*) to meters (*m*)	and meters to millimeters	atmospheres (*atm*) to Pascals (*Pa*)
nanometers (*nm*) to meters (*m*)	and metes to nanometers	liters (*L*) to cubic meters (m^3)
micrometers (μm) to meters (*m*)		

Other conversions will be taught as they become necessary.

What if you don't know the conversion factors? Colleges want students who can find their own information (so do employers). Hint: Try a good dictionary and look under "measure" or "measurement". Or the Internet? Enjoy.

a. 4008 *g* = ________________ *kg*

b. 1.2 *km* = ________________ *m*

c. 823 *nm* = ________________ *m*

d. 298 *K* = ________________ ^oC

e. 0.77 *m* = ________________ *cm*

f. $8.8 \text{x} 10^{-8}$ *m* = ________________ *mm*

g. 1.2 *atm* = ________________ *Pa*

h. 25.0 μm = ________________ *m*

i. 2.65 *mm* = ________________ *m*

j. 8.23 *m* = ________________ *km*

k. 40.0 *cm* = ________________ *m*

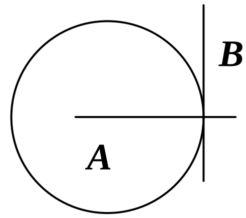
l. $6.23 \text{x} 10^{-7}$ *m* = ________________ *nm*

m. $1.5 \text{x} 10^{11}$ *m* = ________________ *km*

4. 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.



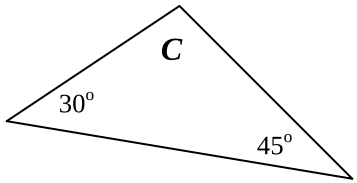
i. What is line ***B*** in reference to the circle?

____

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

____

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



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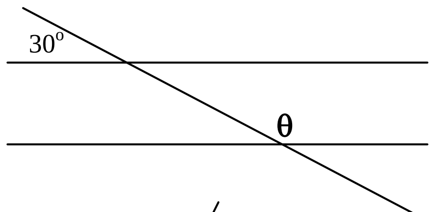
c. What is angle θ ?



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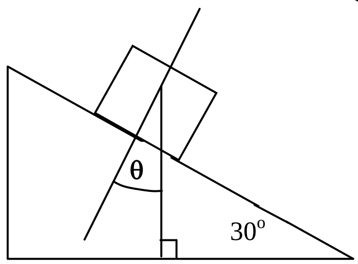
d. How large is ***θ***?



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

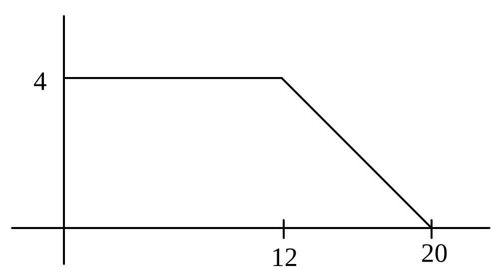
i. What is the circumference in <u>meters</u>?

____

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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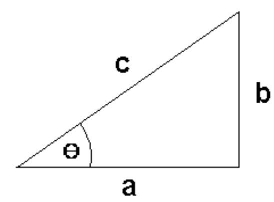
5. Trigonometry

Using the generic triangle to the right, Right Triangle Trigonometry and Pythagorean Theorem solve the following. ***<u>Your calculator must be in degree mode.</u>***



g. $\theta = 55^o$ and $\boldsymbol{c} = 32\ m$, solve for $\boldsymbol{a}$ and $\boldsymbol{b}$.

____

h. $\theta = 45^o$ and $\boldsymbol{a} = 15\ m/s$, solve for $\boldsymbol{b}$ and $\boldsymbol{c}$.

____

i. $\boldsymbol{b} = 17.8\ m$ and $\theta = 65^o$, solve for $\boldsymbol{a}$ and $\boldsymbol{c}$.

____

j. $\boldsymbol{a} = 250\ m$ and $\boldsymbol{b} = 180\ m$, solve for θ and $\boldsymbol{c}$.

____

k. $\boldsymbol{a} = 25\ cm$ and $\boldsymbol{c} = 32\ cm$, solve for $\boldsymbol{b}$ and θ.

____

l. $\boldsymbol{b} = 104\ cm$ and $\boldsymbol{c} = 65\ cm$, solve for $\boldsymbol{a}$ and θ.

____

Vectors

Most of the quantities in physics are vectors. ***This makes proficiency in vectors extremely important***.

Magnitude: Size or extend. The numerical value.

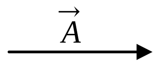
Direction: Alignment or orientation of any position with respect to any other position.

Scalars: A physical quantity described by a single number and units. A quantity described by **magnitude only**.

Examples: time, mass, and temperature

Vector: A physical quantity with **both a magnitude and a direction**. A directional quantity.

Examples: velocity, acceleration, force

Notation: $\vec{A}$ or 

Length of the arrow is proportional to the vectors magnitude.
Direction the arrow points is the direction of the vector.

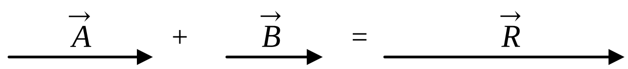
Negative Vectors

Negative vectors have the same magnitude as their positive counterpart. They are just pointing in the opposite direction.

Vector Addition and subtraction

Think of it as vector addition only. The result of adding vectors is called the resultant. $\vec{R}$

$\vec{A}+\vec{B}=\vec{R}$



So if ***A*** has a magnitude of 3 and ***B*** has a magnitude of 2, then ***R*** has a magnitude of 3+2=5.

When you need to subtract one vector from another think of the one being subtracted as being a negative vector. Then add them.

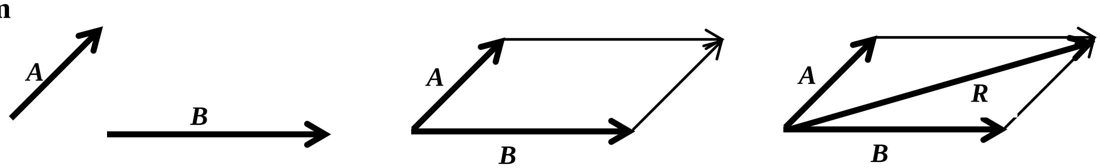
A negative vector has the same length as its positive counterpart, but its direction is reversed.
So if ***A*** has a magnitude of 3 and ***B*** has a magnitude of 2, then ***R*** has a magnitude of 3+(-2)=1.

This is very important. In physics a negative number does not always mean a smaller number. Mathematically –2 is smaller than +2, but in physics these numbers have the same magnitude (size), they just point in different directions (180^{o} apart).

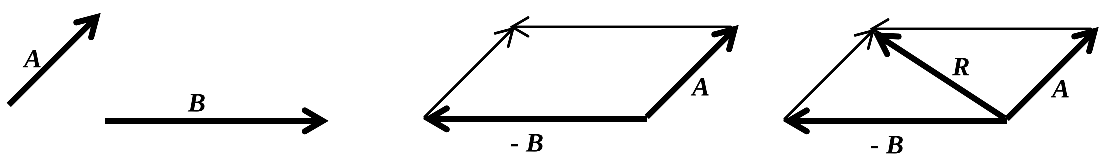
There are two methods of adding vectors

Parallelogram

A + ***B***

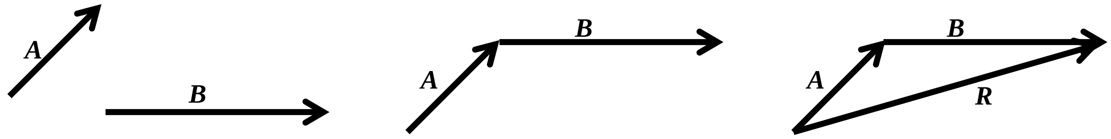


A – ***B***

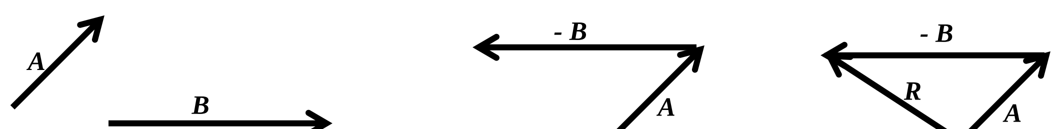


Tip to Tail

A + ***B***



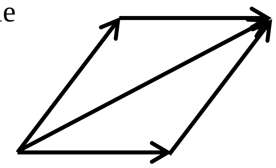
A – ***B***



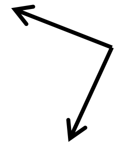
6. Drawing Resultant Vectors

Draw the resultant vector using the parallelogram method of vector addition.

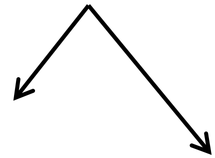
Example



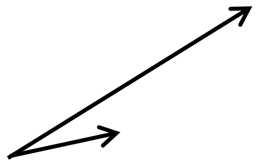
b.



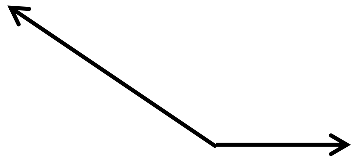
d.



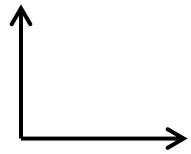
a.



c.

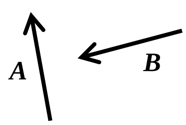


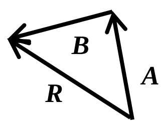
e.



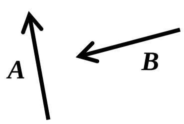
Draw the resultant vector using the tip to tail method of vector addition. Label the resultant as vector ***R***

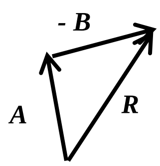
Example 1: ***A*** + ***B***



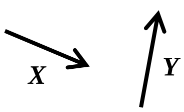


Example 2: ***A*** – ***B***

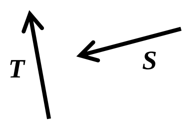




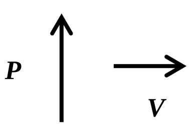
f. ***X*** + ***Y***



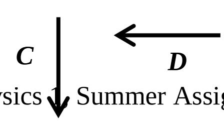
g. ***T*** – ***S***



h. ***P*** + ***V***



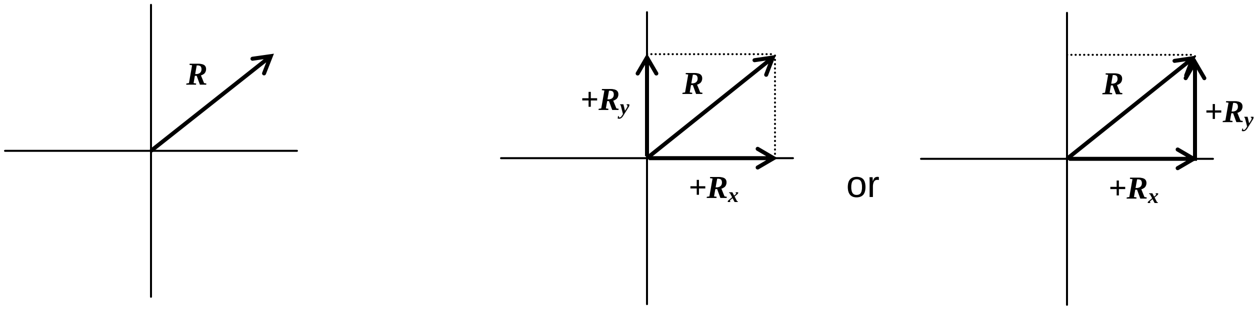
i. ***C*** – ***D***



Component Vectors

A resultant vector is a vector resulting from the sum of two or more other vectors. Mathematically the resultant has the same magnitude and direction as the total of the vectors that compose the resultant. Could a vector be described by two or more other vectors? Would they have the same total result?

This is the reverse of finding the resultant. You are given the resultant and must find the component vectors on the coordinate axis that describe the resultant.

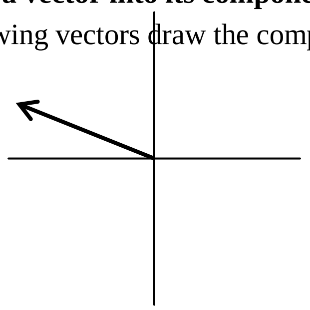


Any vector can be described by an ***x*** axis vector and a ***y*** axis vector which summed together mean the exact same thing. The advantage is you can then use plus and minus signs for direction instead of the angle.

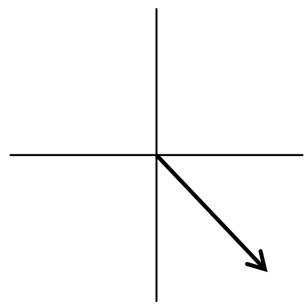
7. Resolving a vector into its components

For the following vectors draw the component vectors along the ***x*** and ***y*** axis.

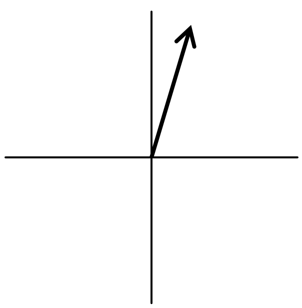
a.



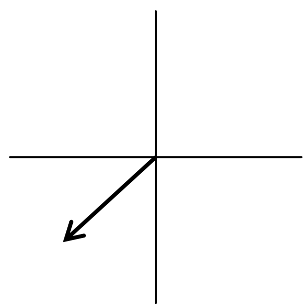
c.



b.



d.

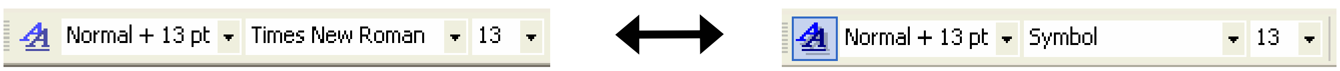


Obviously the quadrant that a vector is in determines the sign of the ***x*** and ***y*** component vectors.

Greek Letters

In math and science, especially physics, we use symbols to denote a variety of numbers and concepts. Many of these symbols are letters from the Greek alphabet. Become familiar with these letters if you aren't already. You do not need to memorize the letters at this point – using them enough during the year, you will surely get to know them well. However, you may want to create index ("flash") cards or your own creative game to be able to recognize, label, and draw the symbols correctly.

Hint: It may help to toggle between a standard font type and 'symbol' font on a computer keyboard to get a better sense of how to 'translate' these symbols. Becoming familiar with equation editors like MathType or Microsoft Equation Editor may also be helpful. Proper type-setting of symbols and equations in physics, math, and other subjects is a very useful skill!



Greek Letter (Uppercase, lowercase)	***Name***	***Commonly Used to Represent***
Α, α	alpha	angular acceleration OR radiation particle (lowercase)
Β, β	beta	radiation particle (lowercase)
Γ, γ	gamma	radioactivity OR relativity/Lorentz factor (lowercase)
Δ, δ	delta	to show change in a quantity
Ε, ε	epsilon	permittivity (lowercase)
Ζ, ζ	zeta	
Η, η	eta	viscosity (lowercase)
Θ, θ	theta	angle measure (lowercase)
Ι, ι	iota	
Κ, κ	kappa	
Λ, λ	lambda	wavelength (lowercase)
Μ, μ	mu ('mew')	friction coefficient (lowercase)
Ν, ν	nu ('new')	wave frequency (lowercase)
Ξ, ξ	xi ('zeye')	electromotive force (Uppercase)
Ο, ο	omicron	
Π, π	pi	3.14159… (lowercase)
Ρ, ρ	rho ('row')	density, resistivity (lowercase)
Σ, σ	sigma	sum (Uppercase)
Τ, τ	tau	torque (Uppercase)
Υ, υ	upsilon	
ϑ, φ	phi ('feye')	field strength, magnetic flux, work function (Uppercase)
Χ, χ	chi	
Ψ, ψ	psi ('sigh')	wavefunction (Uppercase)
Ω, ω	omega	angular velocity (lowercase)

Units of Measurement

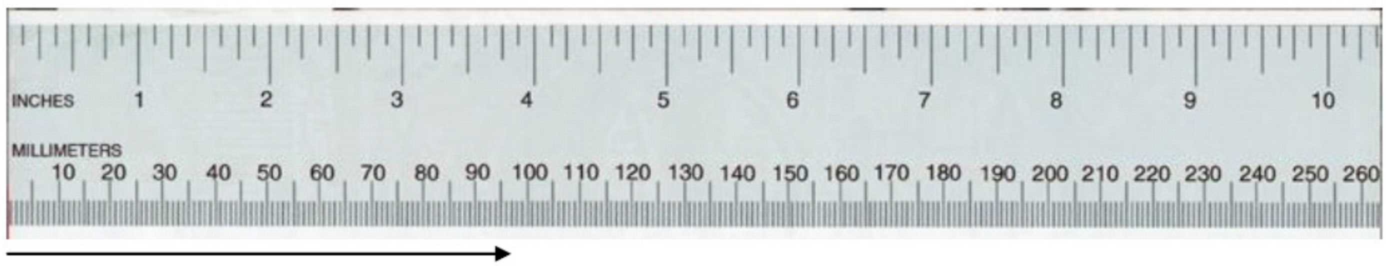
Nearly all measured values in physics contain a unit. You may see values reported in English/Imperial units (especially if you live in the United States!), but we will almost always convert them to a metric unit. The modern metric system we use is properly called SI (from the French, “Système International”). The three most fundamental (base) units we need to describe measurements in SI are meters, kilograms, and seconds. (There are seven base units altogether.) Other units we use are derived from these. Often, however, the quantities we use are so extreme (large or small) that we will also use prefixes to scale them to simpler numbers. Be familiar with these base units of measurement, the quantities they represent, their symbol/abbreviations, and the most common metric prefixes:

Quantity	Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Temperature	kelvin	K
Time	second	s
Amount of substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd

Prefix	***Numerical Value***	***Abbreviation (symbol)***
pico-	10^{-12}	p
nano-	10^{-9}	n
micro-	10^{-6}	μ
milli-	10^{-3}	M
Centi	10^{-2}	C
kilo-	10^{3}	K
mega-	10^{6}	M
giga-	10^{9}	G

Measurements and Significant Figures

When using any (analog) measuring tool, you must read the tool to its highest precision – that is, take advantage of the finest marking made into the instrument. Take a ruler, for example. If the smallest/finest markings on it represent increments of whole millimeters, you must report a measurement to the nearest tenth of a millimeter by estimating a point in between those finest markings. Use the ruler below to measure the length of the arrow. Your answer should be reported to the nearest tenth of a millimeter.



The length of the arrow is __________ mm.

This concept of precision is important when collecting any measured data and when solving problems with given data. It is sometimes referred to as “significant figures” or “significant digits”. There are rules for determining which numbers (figures) are significant, rather than ones that are ‘merely’ place-holders. This coincides with rules for rounding numbers up or down to the nearest, appropriate, decimal place.

RULES FOR SIG FIGS	EXAMPLE	# of sig.figs.
Non - zero numbers are significant.	126 245 g	6
Zeros between non - zero numbers are significant.	12 027 m	5
Zeros at the end of the number to the right of the decimal are significant.	23.00 kg	4
Zeros in front of non zero numbers are not significant.	0.0502 s	3
Zeros at the end of the number to the left of the decimal are not significant unless they were measured. Use scientific notation for clarity.	1000 m 1.00×10^3 m	unknown, could be 1 to 4 3, zeros would not be shown unless they were measured.

In laboratory work, values calculated from measurements cannot be more precise than the least precise measurement. For example, we measure the sides of a cube to be 0.252 m, 0.253 m, and 0.251 m. But we want to calculate the cube's volume. Arithmetic gives 0.016002756 m^3. However, only 3 of the digits in that number are significant or meaningful by the measured values because the original measurements contained 3 significant digits at most. The final answer, then, should be rounded to and recorded as 0.0160 m^3.

The two major categories of arithmetic (addition/subtraction vs. multiplication/division) each have their own 'rule' about rounding for significant figures:

When adding or subtracting numbers, the precision of the answer can be no greater than the precision of the least precise value.

```
 97.3          ←   (least precise value, your answer will be rounded to
                    the same decimal place as this value)
   4.32
+  0.147
 101.767       →    round  to nearest  1/10th so final answer is 101.8
```

When multiplying or dividing numbers, the final answer has the same number of significant figures as the measurement having the smallest number of significant figures

```
  9.81                3 significant figures
x 0.0053              2 significant figures
  0.051993            round to 2 significant figures → 0.052
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Unit analysis and conversion

Although we use the MKS (meter, kilogram, second) version of the SI System, many measurements or data may be reported in other forms of these units or other unit systems altogether. Therefore, you want to be comfortable with converting a measured value into another unit. This may be done using a conversion factor. Sometimes, conversion factors are powers of ten, as when you convert from one prefix to another within a metric unit. Other times, conversion factors are pairings that you might know off-hand, or could look up, as in 4 quarts = 1 gallon or 1.8 degrees F = 1.0 degrees C. In any case, it is best to write conversions as factors (fractions) to represent units that are needed and units that are being cancelled – thus, the 'factor-label' or 'unit-cancellation' method of problem solving. Putting the final answer in scientific notation is also an important skill, leaving only one digit before the decimal point and using a power of 10 to describe the magnitude of the answer – this is especially true for extreme values, large or small.

The Making of a Scientist[*]
by Richard Feynman

Before I was born, my father told my mother, "If it's a boy, he's going to be a scientist."[**] When I was just a little kid, very small in a highchair, my father brought home a lot of little bathroom tiles—seconds—of different colors. We played with them, my father setting them up vertically on my highchair like dominoes, and I would push one end so they would all go down.

Then after a while, I'd help set them up. Pretty soon, we're setting them up in a more complicated way: two white tiles and a blue tile, two white tiles and a blue tile, and so on. When my mother saw that she said, "Leave the poor child alone. If he wants to put a blue tile, let him put a blue tile."

But my father said, "No, I want to show him what patterns are like and how interesting they are. It's a kind of elementary mathematics." So he started very early to tell me about the world and how interesting it is. We had the Encyclopedia Britannica at home. When I was a small boy he used to sit me on his lap and read to me from the Britannica. We would be reading, say, about dinosaurs. It would be talking about the Tyrannosaurus rex, and it would say something like, "This dinosaur is twenty-five feet high and its head is six feet across."

My father would stop reading and say, "Now, let's see what that means. That would mean that if he stood in our front yard, he would be tall enough to put his head through our window up here." (We were on the second floor.) "But his head would be too wide to fit in the window." Everything he read to me he would translate as best he could into some reality.

It was very exciting and very, very interesting to think there were animals of such magnitude—and that they all died out, and that nobody knew why. I wasn't frightened that there would be one coming in my window as a consequence of this. But I learned from my father to translate: everything I read I try to figure out what it really means, what it's really saying.

We used to go to the Catskill Mountains, a place where people from New York City would go in the summer. The fathers would all return to New York to work during the week and come back only for the weekend. On weekends, my father would take me for walks in the woods and he'd tell me about interesting things that were going on in the woods. When the other mothers saw this, they thought it was wonderful and that the other fathers should take their sons for walks. They tried to work on them but they didn't get anywhere at first. They wanted my father to take all the kids, but he didn't want to because he had a special relationship with me. So it ended up that the other fathers had to take their children for walks the next weekend.

The next Monday, when the fathers were all back at work, we kids were playing in a field. One kid says to me, "See that bird? What kind of bird is that?" I said, "I haven't the slightest idea what kind of a bird it is." He says, "It's a brown-throated thrush. Your father doesn't teach you anything!" But it was the opposite.

He had already taught me: "See that bird?" he says. "It's a Spencer's warbler." (I knew he didn't know the real name.) "Well, in Italian, it's a Chutto Lapittida. In Portuguese it's a Bom da Peida. In Chinese, it's a Chung-long-tah, and in Japanese, it's a Katano Tekeda. You can know the name of the bird in all the languages of the world, but when you're finished, you'll know absolutely nothing whatever about the bird. You'll only know about humans in different places, and what they call the bird. So let's look at the bird and see what it's doing—that's what counts." (I learned very early the difference between knowing the name of something and knowing something.)

He said, "For example, look: the bird pecks at its feathers all the time. See it walking around, pecking at its feathers?" "Yeah." He says, "Why do you think birds peck at their feathers?" I said, "Well, maybe they mess up their feathers when they fly, so they're pecking them in order to straighten them out." "All right," he says. "If that were the case, then they would peck a lot just after they've been flying. Then, after they've been on the ground a while, they wouldn't peck so much anymore—you know what I mean?" "Yeah." He says, "Let's look and see if they peck more just after they land."

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[*] Adapted from *Cricket* Magazine, October 1995 (Vol. 23, #2)

[**] Richard Feynman also had a younger sister who became a scientist and also earned a Ph.D. in physics.

It wasn't hard to tell: there was not much difference between the birds that had been walking around a bit and those that had just landed. So I said, "I give up. Why does a bird peck at its feathers?" "Because there are lice bothering it," he says. "The lice eat flakes of protein that come off its feathers." He continued, "Each louse has some waxy stuff on its legs, and little mites eat that. The mites don't digest it perfectly, so they emit from their rear ends a sugarlike material, in which bacteria grow." Finally he says, "So you see, everywhere there's a source of food, there's some form of life that finds it."

Now, I knew that it may not have been exactly a louse, that it might not be exactly true that the louse's legs have mites. That story was probably incorrect in detail, but what he was telling me was right in principle. Not having experience with many fathers, I didn't realize how remarkable he was. How did he learn the deep principles of science and the love of it, what's behind it, and why it's worth doing? I never really asked him, because I just assumed that those were things that fathers knew.

My father taught me to notice things. One day, I was playing with an "express wagon," a little wagon with a railing around it. It had a ball in it, and when I pulled the wagon, I noticed something about the way the ball moved. I went to my father and said, "Say, Pop, I noticed something. When I pull the wagon, the ball rolls to the back of the wagon. And when I'm pulling it along and I suddenly stop, the ball rolls to the front of the wagon. Why is that?" "That, nobody knows," he said. "The general principle is that things which are moving tend to keep on moving, and things which are standing still tend to stand still, unless you push them hard. This tendency is called 'inertia,' but nobody knows why it's true." Now, that's a deep understanding. He didn't just give me the name.

He went on to say, "If you look from the side, you'll see that it's the back of the wagon that you're pulling against the ball, and the ball stands still. As a matter of fact, from the friction it starts to move forward a little bit in relation to the ground. It doesn't move back." I ran back to the little wagon and set the ball up again and pulled the wagon. Looking sideways, I saw that indeed he was right. Relative to the sidewalk, it moved forward a little bit.

That's the way I was educated by my father, with those kinds of examples and discussions: no pressure—just lovely, interesting discussions. It has motivated me for the rest of my life, and makes me interested in all the sciences. (It just happens I do physics better.) I've been caught, so to speak—like someone who was given something wonderful when he was a child, and he's always looking for it again. I'm always looking, like a child, for the wonders I know I'm going to find—maybe not every time, but every once in a while.