

## Honors Physics

### Summer Packet- Useful Reference Material

Welcome to Honors Physics. This packet is your guide to the background knowledge and skills you will need to be successful. It is provided to you in the summer to help you prepare for a challenging and stimulating science course. If you have reviewed and practiced this material, you will have a smoother start to physics in the fall. I look forward to an exciting year of physics and with this packet well-understood, we will start with some initial velocity!

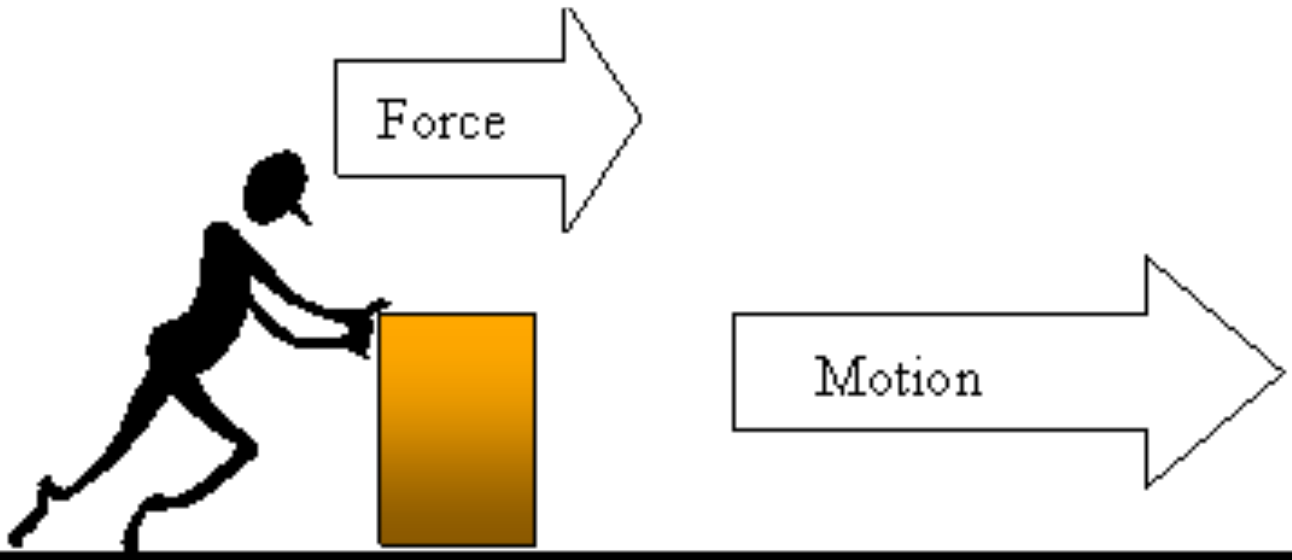
- Dr. Hair

#### Contents

Prerequisites for Success in Honors Physics .....	2
Problem Solving .....	3
Significant Figures .....	5
Units in Physics .....	8
Practice Quiz .....	10

**Keep this packet handy and use it for reference when working on problem sets and labs, or preparing for quizzes and tests.**

This summer packet should be completed before the first day of school. There will be a comprehensive quiz on this material the first week of school.



[http://w3.shorecrest.org/~Lisa\\_Peck/Physics/syllabus/mechanics/newtonlaws/Newton\\_webpage/2011/Lauren2/NEWTON2IMAGE2.ğ](http://w3.shorecrest.org/~Lisa_Peck/Physics/syllabus/mechanics/newtonlaws/Newton_webpage/2011/Lauren2/NEWTON2IMAGE2.ğ)

## Is Honors Physics the Right Course for You?

[http://etc.usf.edu/clipart/50100/50139/50139\\_algebra\\_sm.gif](http://etc.usf.edu/clipart/50100/50139/50139_algebra_sm.gif)



### Prerequisites for Success

#### Math Skills

- Problem solving
- Algebraic manipulation
- Number sense
- Vectors

Physics is a mathematical science. These key concepts and skills are needed to be successful in Honors Physics. Success in Advanced Math Honors will serve you well. Practice problems in this packet will allow you to assess and practice your skills.

#### Science Skills and Interest

- Measurement
- Significant figures
- Error analysis
- Critical, logical thinking
- Questioning and seeking deeper understanding
- Abstract thinking ability

Honors Physics is modeled after a college lab course with high expectations. It is assumed that you remember skills and ideas from all your previous science courses and can apply them to new situations in this class. Work the practice problems in this packet to test yourself.

### Communication

- Showing your work clearly on paper
- Asking for help, after you tried to understand by yourself

Your job is to communicate your understanding to others. It is very important to be able to write clearly and to show your problem solving in words and equations. You also need to communicate positively with your teacher, lab partners, and other students.

### Commitment

- Time and energy
- Making Physics class a priority
- Persistence

Success in Honors Physics requires consistent study and work outside of class. You must do the reading and work on the practice problems to be successful. If you have many other commitments, you might not be able to do as well in physics class as you would like. It may take more time and effort than you can make, if you have other priorities and commitments.

### Behavior and Maturity

- Focus and concentration
- Being helpful to others

The expectations of attention and focus in Honors Physics are more like that of a college course than a high school class. If you have difficulty staying focused in class, Honors Physics will be hard for you. Students who are distracting to others will be asked to leave the classroom. This can make it difficult to succeed in Honors Physics.

## An Effective Problem Solving Method

---

1. **Read** the problem carefully and think about what is happening physically. Identify the unknown you are trying to calculate.
2. **Draw** a picture to illustrate what is happening in the problem. Label your drawing with the given values or information. Label unknowns with a letter symbol. Include a coordinate system appropriate to the problem, showing the positive direction(s).
3. **Write an equation** that relates the unknown and known quantities. Always write the equation in symbols first.
4. **Solve the equation in symbols** for the unknown you want. Simplify, if you can.
5. **Substitute** in the values for the known quantities with their **units**.
6. **Calculate** your answer and its units.
7. **Check** your results for
  - correct units expected for the result.
  - correct significant figures.
  - reasonable magnitude and direction.

## Problem Grading

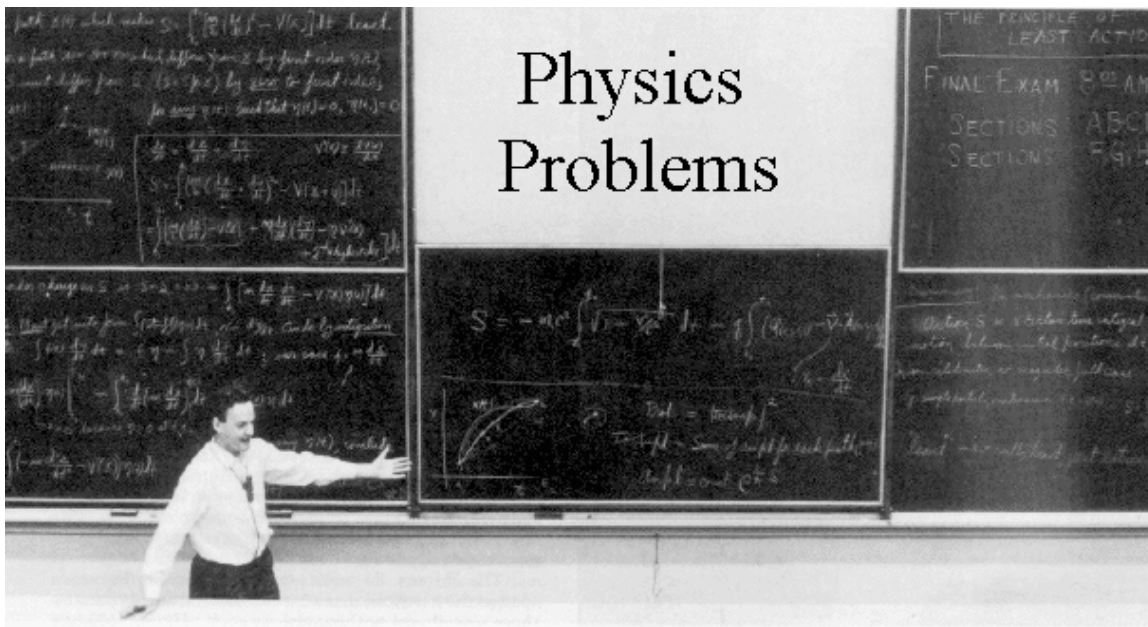
---

To earn full credit for problems you solve in physics class, be sure to show

Correct equation(s), picture  
Correct calculated result

Clear algebra in symbols  
Correct units

Correct substitution  
Correct sig. figs.



<http://jersey.uoregon.edu/~probs/clipart/feynbord.gif>



## What are Significant Figures?

Significant figures are used in science to indicate the degree of reliability or precision of a number. Most numbers used in science originate from a measurement. In experiments where measuring instruments are used it is important to use significant figures to indicate the precision of the data and the results.

A digit is significant if it is written to reflect the precision and reading of a measurement. If a digit is written *only* to indicate the size of the number (like the two zeros in 100), or for no meaningful purpose (such as the 0 in 0.56), it is not significant.

## What numbers are significant?

1. All non-zero integers are significant. (1, 2, 3...)
2. Zeros to the left of a decimal point are significant *IF* there is a counting number to their left and a decimal point appears (e.g. 100.2, both zeroes are significant).
3. Zeros to the right of a decimal place are significant *IF* there is a counting number to the left of them (e.g. 11.10 and 7.0, the zero is significant).
4. All numbers to the left of the multiplication sign ("X") in scientific notation are significant (e.g.  $3.20 \times 10^4$ , the zero is significant).
5. All zeros between significant figures are significant (e.g. 204, 1.03, both zeroes are significant).

## How do you use sig figs in calculations?

**Addition and Subtraction:** Use the **least accurate decimal place** to determine SF

$$\begin{array}{r} 3.823 \text{ km} + 13.56 \text{ km} - 8.10 \text{ km} = 9.28 \text{ km} \\ \phantom{3.823} \phantom{+} 13.56 \\ \phantom{3.823} \phantom{+} \underline{- 8.10} \\ \hline 9.28 \text{ km (1/100 place)} \end{array}$$

**Multiplication and Division:** Use the **least number of SF** to determine SF of result

$$16.83 \text{ kg} \times 2.1 \text{ m/s}^2 = 35 \text{ kg m/s}^2 \text{ (2 SF)} \qquad \frac{732.8 \text{ g}}{14682 \text{ mL}} = 1076 \text{ g/mL (4 SF)}$$

**Both in the same calculation:** Apply the appropriate rule to each part of problem, **one step at a time**. In this example, find the SF in the numerator with the subtraction rule (2 SF), and then use the division rule to determine the SF in the final answer (also 2 SF).

$$\% \text{ Difference} = \frac{|MA - LA|}{MA} \times 100 = \frac{|9.807 - 9.725|}{9.807} \times 100 = \frac{0.082(2 \text{ SF})}{9.807} \times 100 = 0.84\% (2 \text{ SF})$$

## FAQ:

**Q:** What digits are insignificant?

**A:** Zeroes are insignificant when they come before the first significant figures, or when they come after significant figures and no decimal point appears (e.g. 10, 200, .004, 0.2).

**Q:** How many sigfigs do counted values have?

**A:** Most counted numbers are known exactly. There is no uncertainty in them, so you can think of them as having infinite significant figures (e.g. 3 apples, 2 trials, 4 people).

**Q:** How many sigfigs do conversion factors within the SI system have?

**A:** Conversion factors within the SI system are known exactly, so you can think of them as having infinite significant figures (e.g. 100 cm = 1 m, 1000 g = 1 kg)

**Q:** How many sigfigs do other conversion factors have?

**A:** Conversion factors between the English and metric systems are not known exactly--they are calculated based on measurements and therefore have finite significant figures (e.g. 1 lb = 0.453592... kg).

**Q:** How many sigfigs should you include in your calculations for a value or conversion factor you look up? (e.g. the speed of light =  $2.99792... \times 10^8$  m/s, 1 mile = 1609 m).

**A:** You should include at least as many sigfigs as the value in the calculation with the least number of measured sigfigs. Think of it this way: you wouldn't want the value you look up to be what limits the precision of your calculated results.

### Practice Problems

---

Indicate the # of sig figs in each value below.

1) 0.015

6) 40.00

2) 3409

7) 9380

3) 100

8) 0.230

4) 500.

9) 0.5010

5) 0.0404

10) 9.080

11) Dr. Hair weighs 125.2 pounds on her digital scale. Her cat weighs 18.0 pounds at the vet. The cat has a tick that weighs 30 mg. What will the scale read if Dr. Hair holds her cat and steps on it? How many significant figures does your answer have? What would the scale read, after the tick is removed?

How does this example illustrate the reason for using sig figs?

Complete the following calculations, keeping the rules of sigfigs in mind.

12)  $13.004\text{ m} + 3.09\text{ m} + 112.947\text{ m} = ?$

13) A stone has a mass of 24.595 grams and a volume of  $5.34\text{ cm}^3$ . What is the density of the stone in  $\text{g/cm}^3$ ? In  $\text{kg/L}$ ?

14)  $(3.12\text{ g} - 0.8\text{ g}) / 1.033\text{ mL} = ?$

15) You own four plates. Their masses are 99.997 g, 100.008 g, 100.011 g, and 100.005 g. What is the average mass of your plates?

16)  $123,000\text{ m} \times 3,234\text{ m} = ?$

17)  $123,000\text{ m} + 3,234\text{ m} = ?$

18)  $1.23\text{ m} \times 0.89\text{ m} = ?$

19)  $1.23\text{ m} + 0.89\text{ m} = ?$

20) Alex has a mass of 67.4 kg and a height of 5 feet 6 inches. What is Alex's weight in pounds and height in meters?

Calculate Alex's Body Mass Index, using the equation

$$BMI = \frac{\text{mass (kg)}}{(\text{height (m)})^2}$$

What are the units of BMI?

## Units in Physics

In Physics we will use the International System of Units (SI). Units can help you solve problems, prevent and fix mistakes, and check your answers. Dimensional analysis is a key skill for success in physics class. Please include units in every conversion or calculation you perform for this class. You'll be glad you did.

### Standard Units for Physics (SI units)

	Name	Symbol
<b>Distance</b>	Meter	m
<b>Time</b>	Second	s
<b>Mass</b>	Kilogram	kg
<b>Velocity</b>	Meter per second	m/s
<b>Acceleration</b>	Meter per second squared	m/s/s or m/s <sup>2</sup>
<b>Force</b>	Newton	N = kg m/s <sup>2</sup>

You should know these names and symbols for metric prefixes. Learn and remember them!

Metric Prefix	Symbol	Factor	Numerically	US Name
giga	G	10 <sup>9</sup>	1 000 000 000	billion
mega	M	10 <sup>6</sup>	1 000 000	million
kilo	k	10 <sup>3</sup>	1 000	thousand
centi	c	10 <sup>-2</sup>	0.01	hundredth
milli	m	10 <sup>-3</sup>	0.001	thousandth
micro	μ	10 <sup>-6</sup>	0.000 001	millionth
nano	n	10 <sup>-9</sup>	0.000 000 001	billionth

### Practice Problems

1. How far does light travel in a leap year? Find the speed of light on the web and show units on all conversion factors you use. How many sigfigs should your answer have?



2. How many meters per second are you traveling when you drive 65 mph? Find conversion factors you need on the web but calculate the conversion yourself. Watch the sigfigs!
  
3. How many milliliters are there in 27.5 L of water? How many cups are there in 27.5 L of water? Find conversion factors you need on the web and do not allow conversion factors to limit your precision.
  
4. How many minutes go by in exactly 15 years? How many seconds go by in exactly 15 years?
  
5. How many feet are there in 5.0 km? How many millimeters? How many miles?



<http://imgs.xkcd.com/comics/mnemonics.png>

## Honors Physics Practice Quiz

Use the web to find any conversion factors you need, but calculate the conversions yourself.

1. You are riding home from a party and the driver has been drinking. The car is traveling at 60 mi per hour. Suddenly a child steps into the road ahead. Because the driver has been drinking his reaction time has been slowed by 1 second. How many feet toward the impending accident will the car travel before the driver begins to stop? Report your result to the correct number of significant figures. (Note: This is equal to the extra distance it will take to stop the car because the driver has been drinking.)

Correct equation(s)    Clear algebra in symbols    Correct substitution    Correct calculated result    Correct units    Correct sig. figs.

2. Your chemistry teacher empties his dehumidifier tank once a day. If the capacity of the tank is 2 gallons, determine how many molecules of water the dehumidifier collects from the air per millisecond. Report your result to the correct number of significant figures.

1 day is exactly 24 hours    1 quart = 0.94633 liter    4 quarts is exactly 1 gallon  
density of water = 1.0 g/mL    18.0 g water =  $6.02 \times 10^{23}$  molecules water

Correct equation(s)    Clear algebra in symbols    Correct substitution    Correct calculated result    Correct units    Correct sig. figs.

3. You measure your height and find it to be 1.8 m, and your doctor measures your height and finds it to be 5.98 ft. What is the percent difference between your measurements?  
1 meter = 3.28084 feet

Correct equation(s)    Clear algebra in symbols    Correct substitution    Correct calculated result    Correct units    Correct sig. figs.

4. Ben takes his little brother to a lemonade stand. He weighs 83.04 kg and his brother weighs 33.59 kg. Both drink 1 cup of lemonade. What is the percent increase of Ben's weight? Of his brother's weight? (Assume that lemonade has essentially the same density as water.) 1 cup = 0.236588 liter density of water = 1.0 g/mL

Correct equation(s)    Clear algebra in symbols    Correct substitution    Correct calculated result    Correct units    Correct sig. figs.

5. Use the definition for Body Mass Index on p. 7 and calculate a conversion factor for converting from BMI in  $\text{lbs}/\text{in}^2$  to  $\text{kg}/\text{m}^2$ . Calculate your own BMI with both units and use your conversion factor see if they agree. Check your answers with an online BMI calculator.

Correct equation(s)    Clear algebra in symbols    Correct substitution    Correct calculated result    Correct units    Correct sig. figs.

6. Which value has 3 significant figures?  
 A. 100.0    B. 0.40    C. 0.072    D. 237,000    E. 490
7. Which value has the most significant figures?  
 A.  $1.320 \times 10^3$     B. 4598    C. 9.81    D. 0.043036    E. 72,000
8. Which value has the fewest significant figures?  
 A.  $1.320 \times 10^3$     B. 4598    C. 9.81    D. 0.043036    E. 72,000
9. Which calculated result(s) will have 2 significant figures?  
 A.  $9.81 \times 3.5$     B.  $9.81 - 9.7$     C.  $9.81 - 9.71$     D.  $9.81 - 9.77$
10. Which calculated result(s) will have 1 significant figure?  
 A.  $9.81 \times 4$     B.  $9.81 - 9.7$     C.  $9.81 - 9.71$     D.  $9.81 - 8.77$