International Leadership Charter High School
Physics
Summer Packet

Name: ________________________________

Units:

Units are extremely important in physics. In fact, a number is meaningless in physics unless it is accompanied by the appropriate units. Examples of units are seconds (time), miles (length), and pounds (force). These are examples of Imperial Units, which are used in the United States, Liberia, and Myanmar only. Every other country uses the metric system, which is closely related to the International System of Units (abbreviated SI) used by scientists. Examples of metric/SI units are meters (length), Newtons (force), and kilograms (mass).

The SI system of units has seven base units (see table below). These fundamental base units can be combined to form other derived units, such as the unit of velocity or speed, the meter-per-second (m/s).

Quantity	Basic Unit	Basic Unit Symbol
LENGTH	metre	m
MASS	kilogram	kg
TIME	second	s
TEMPERATURE	kelvin	K
QUANTITY OF MATTER	mole	mol
ELECTRIC CURRENT	ampere	A
LUMINOUS INTENSITY	candela	cd

Converting between different units is an important part of physics. Certain physical quantities can be described by different units that have different sizes. For example, time can be measured in seconds, minutes, or hours. Something more complicated like speed can be

Quantity	Conversion Factors
Length:	1 foot = 0.3048 meters 1 mile = 1609.34 meters 1 kilometer = 1000 meters 1 meter = 100 centimeters 1 meter = 1000 millimeters
Time:	1 hour = 60 minutes 1 minute = 60 seconds
Mass:	1 kilogram = 1000 grams 1 gram = 1000 miligrams

measured in miles-per-hour (mi/hr), feet-per-second (ft/s), meters-per-second (m/s), or kilometers-per-hour (km/hr).

So, how do we change the units associated with a physical quantity? We know that multiplying a number by 1 doesn't change the value of that number. ($5\times1 = 5$, for example). The key is to write the conversion factors in such a way that it equals 1 and multiply to cancel the unwanted unit. The second table on the previous page lists some common conversion factors.

Lets convert 10 feet to meters as an example. From the conversion factor table, we can see that 1 foot = 0.3048 meters. This conversion factor can be re-written to equal one in two ways:

$$1 = \frac{1\,\mathrm{ft}}{0.3048\,\mathrm{m}} \qquad\qquad 1 = \frac{0.3048\,\mathrm{m}}{1\,\mathrm{ft}}$$

Lets examine these two conversion factors. The first conversion factor has feet in the numerator and meters in the denominator. If we were to multiply 10 feet by the first factor, the unwanted unit of feet would not cancel. Thus, we should not use the first conversion factor. The second conversion factor has meters in the numerator and feet in the denominator. If we were to multiply 10 feet by the second conversion factor, the unwanted unit of feet would cancel, leaving meters alone in the numerator. This is exactly what we wanted!

$$10\,\mathrm{ft} = 10\,\mathrm{ft} \cdot \frac{0.3048\,\mathrm{m}}{1\,\mathrm{ft}} = 10 \cdot 0.3048\,\mathrm{m} = 3.048\,\mathrm{m}$$

Thus, we can see that 10 feet is equal to about 3 meters.

Use this example to do the following unit conversions:

1. Convert 15 feet to meters:

2. Convert 7 hours to seconds:

3. Convert 5 miles to meters:

4. Convert 4 meters to miles:

5. (Challenge question) Convert 1 mile-per-hour to meters-per-second:

<u>Algebra in Physics:</u>

At its core, physics is a mathematical science. Physicists use the language of mathematics to describe the physical world. Thus, fluency in mathematics is important for success in physics. The following problems are examples of the kind of algebra you will encounter during this course (don't worry about units for this part).

1. Solve the following equation for the time t: $v = v_0 + at$ (your answer should be a symbolic expression for t.)

2. Solve the following equation for the acceleration a: $v_f^2 = v_i^2 + 2ax$ (your answer should be a symbolic expression for a.)

3. The (average) speed v of a car is related to the distance d traveled and the travel time t through the equation $d = vt$. Consider a car that travels 100 miles in 5 hours. Calculate the (average) speed v of the car.

4. Einstein's famous equation $E = mc^2$ relates the mass m of an object to its (rest) energy E through the square of the speed of light c. Solve this equation algebraically for the speed of light c.

5. The mass of a penny is about 0.0025 kilograms (kg). The speed of light c is approximately equal to 3×10^8 meters per second. Use the equation $E = mc^2$ to calculate the energy E released if the mass of the penny were converted entirely to energy.

6. The vertical height h of a baseball in flight is given by the function $h(t) = 20 + 15t - 4.9t^2$. Determine what time t the ball hits the ground (solve the equation for t). You should get two solutions. Chose the one that makes the most physical sense (time cannot be negative!).

Trigonometry in Physics:

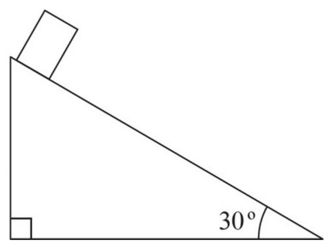
Trigonometric functions are also used in physics. The three main trigonometric functions are the sine, the cosine, and the tangent (which is equal to the sine divided by the cosine). They have many uses, most of which will be revealed and explored in further detail during lecture. Use the trigonometric functions to solve the following problems (make sure any calculator used is in degree mode, not radian mode!).

1. A right triangle has sides of length 5 m (a) and 3 m (b). Draw the triangle and label the sides with the given number. Determine the length of the hypotenuse (c) using the Pythagorean Theorem ($c^2 = a^2 + b^2$).

2. A right triangle with a hypotenuse of length 7 meters has one side that is 4 meters long. Draw the triangle and label the hypotenuse and side with the given number. Calculate the length of the other side using the Pythagorean Theorem.

3. (Challenge question) A right triangle has an adjacent side of length 3 m and an opposite side of length 4 m. Draw the triangle and label the adjacent and opposite sides correctly. Label the angle with the symbol θ (greek letter theta). Calculate the angle θ the hypotenuse makes with the adjacent side of the triangle.

4. A block slides down a ramp that is 3 meters long. The ramp makes a slope of 30° with the ground (horizontal line). Calculate the change in vertical height of the block as it slides down the ramp.



5. You are standing 47 meters away from a large tree. You determine that the top of the tree can be seen directly by tilting your head upwards at a 35° angle. Calculate the height of the tree.