SOLUTIONS

SPH3U: Scientific notation

Scientific notation is used to express very large or very small measurements.

The general form for scientific notation is: **M x 10ⁿ** where **M** is a number that has only 1 digit placed to the left of the decimal ($1<=M<10$) and **n** is the integer exponent of 10

A: Scientific notation

1. Observe the following examples of numbers in standard form and in scientific notation. Then make a set of rules to convert to standard form and a set of rules to convert into scientific notation.

98 700 000	=	9.87×10^7
0.000 307	=	3.07×10^{-4}
2000	=	2×10^3
205	=	2.05×10^2
0.001430	=	1.430×10^{-3}

B: Scientific notation - practice

2. Express each of the following in scientific notation:

524 000 000 000 = 5.24×10^{10}

904 510 = ______

0.000 000 043 = 4.3×10^{-8}

0.76 = 7.6×10^{-1}

894×10^2 = 8.94×10^4

0.004×10^{11} = 4×10^8

0.35×10^{-6} = 3.5×10^{-7}

333×10^{-6} = 3.33×10^{-4}

speed of light in a vacuum, 299 792 458 m/s

2.99×10^8

number of seconds in a day, 86 400 s

8.64×10^4

mean radius of Earth, 6 378 000 m

6.378×10^6

3. Convert into standard form:

2.62×10^5 = 262 000

1.365×10^2 = 136.5

7.04×10^{-5} = 0.0000705

1.2×10 = 12

3.105×10^{-4} = 0.0003105

6.701×10^2= 670.1

4. Use a calculator to calculate the following: Express in scientific notation.

a) $(3.2 \times 10^3)(5.8 \times 10^2)$

$= 1856000$

$= 1.856 \times 10^6$

b) $(6 \times 10^{-4})(8 \times 10^{-2})$

$= 0.000048$

$= 4.8 \times 10^{-5}$

iphone 6 EE +/− 4

c) $(-4.5 \times 10^{-7})(3 \times 10^9)$

$= -1350$

$= 1.35 \times 10^3$

SPH3U: Measurement, Numbers, Significant Digits

Measure. Students in the classroom will measure the length of their desk, in m. Here are some sample measurements:	Someone walks in the room and asks "How long is a desk in meters?". What number can we confidently tell them?
When recording measurements in science we want to include all the digits we are confident in, plus one estimated digit. We call these ***significant digits***. Including all significant digits, how long is a desk?	Now measure and record the width of your desk in units of hands (using the **width** of the 4-fingers in your hand), considering the appropriate number of significant digits.

The term *significant digits* describes the digits in a number or measurement that are physically meaningful or reliable. In order to determine the number of significant digits, follow the 4-rules:

Rule #1: Non-zero digits are always significant

Rule #2: Any zeros between two significant digits are significant

Rule #3: A final zero or trailing zeros in the decimal portion ONLY are significant

Rule #4: If scientific notation is used, all digits shown are significant

• exact things (ex people, pieces of paper) have infinite sig digits

How many significant digits do these numbers have?			Round to 3 significant digits		
a) 52400	b) 0.00504	c) 123.750×10^5	a) 466810	b) 0.0805372	c) 123.750×10^5
3	3	6	467000	0.0805	124×10^5

1. Determine the number of significant digits in the following numbers:

a) 1570	b) 3072	c) 0.0325	d) 10.4	e) 15 000
3	4	3	3	2
f) 15001	g) 0.0205	h) 100	i) 3.05×10^3	j) 2.10×10^{-2}
5	3	1	3	3

When performing calculations, your answer should have no more significant digits than the least number of significant digits given in the question. (this is a simplified version of significant digits rules)

in scientific? • +/− : lowest # of decimals

2. Perform the following calculations and answer using the correct number of significant digits

a) 88 + 24.25	b) 47.5 x 52	c) 5.3 x 3.9	d) 31.7 x 2.5
= 112	= 2470 ≐ 2500	= 20.07 ≐ 21	= 79.25 ≐ 79
d) 2.32 + 1.2	e) 120 + 8.2	f) 9.42 − 3.22	g) 2300 + 125
= 3.52 ≐ 3.5	= 128.2 ≐ 128	= 6.20	= 2425

• x/÷ lowest # of sig digits

• rounding if 5

• 100 vs. 100. vs 100.0

SPH3U: Conversions

Some useful conversions:	
1 kg = 2.2 lbs	1 min = 60 s
1 hour = 60 mins	1 hour = 3600 s
1 inch = 2.54 cm	1 foot = 12 inches

"Hey Dad! Drive the car as fast as Usain Bolt!"
When we multiply something by 1, that something is not changed.
We use this idea when converting between units.

100.

Convert:

9 hours into minutes	30 lbs into kg	3.5 feet into cm
$9 \cancel{\text{hours}} \left(\frac{60 \text{ min}}{1 \cancel{\text{hour}}}\right)$ $= 540 \text{ mins}$	$30 \cancel{\text{lbs}} \left(\frac{1 \text{ kg}}{2.2 \cancel{\text{lbs}}}\right)$ $= 13.6 \text{ kg}$ $\doteq 14. \text{ kg}$	$3.5 \cancel{\text{feet}} \left(\frac{12 \cancel{\text{in}}}{1 \cancel{\text{ft}}}\right)\left(\frac{2.54 \text{ cm}}{1 \cancel{\text{in}}}\right)$ $= 106.68 \text{ cm}$ $\doteq 110 \text{ cm}$
720 cm into feet	**10 m/s into km/h**	
$720 \text{ cm}\left(\frac{1 \text{ in}}{2.54 \text{ cm}}\right)\left(\frac{1 \text{ foot}}{12 \text{ in}}\right)$ $= 23.6 \text{ ft}$	$10 \frac{\cancel{m}}{\cancel{s}}\left(\frac{1 \text{ km}}{1000 \cancel{m}}\right)\left(\frac{3600 \cancel{s}}{1 \text{ h}}\right)$ $= 36 \text{ km/h}$ $\frac{m}{s} \xrightarrow{\times 3.6} \frac{km}{h}$ $\frac{km}{h} \xrightarrow{\div 3.6} \frac{m}{s}$	

Practice

1. Convert the following quantities. Carefully show your conversion ratios and how the units divide out.

Convert to seconds 12.5 minutes $\left(\frac{60 \text{ s}}{1 \text{ min}}\right) = 750 \text{ s}$	Convert to kilometres 4.5 m $\left(\frac{1 \text{ km}}{1000 \text{ m}}\right) = 0.0045 \text{ km}$
Convert to kilograms m=138 lbs $\left(\frac{1 \text{ kg}}{2.2 \text{ lbs}}\right) = 62.7 \text{ kg}$	Convert to seconds $\Delta t = 3.0$ days $\left(\frac{24 \text{ hrs}}{1 \text{ day}}\right)\left(\frac{3600 \text{ s}}{1 \text{ hr}}\right) = 259200 \text{ s}$
Convert to m/s $v = 105 \frac{km}{h} \left(\frac{1000 \text{ m}}{1 \text{ km}}\right)\left(\frac{1 \text{ hr}}{3600 \text{ s}}\right) = 29.2 \text{ m/s}$	Convert to km/h $v = 87 \frac{m}{s} \left(\frac{1 \text{ km}}{1000 \text{ m}}\right)\left(\frac{3600 \text{ s}}{1 \text{ hr}}\right) = 313.2 \text{ km/h}$ $\doteq 310 \text{ km/h}$
Convert to days $\Delta t = 5.0 \times 10^5$ minutes $\left(\frac{1 \text{ hr}}{60 \text{ min}}\right)\left(\frac{1 \text{ day}}{24 \text{ hr}}\right) = 347.2 \text{ days}$	Convert to seconds $\Delta t = 1.0$ hour $\left(\frac{60 \text{ min}}{1 \text{ h}}\right)\left(\frac{60 \text{ s}}{1 \text{ min}}\right) = 3600 \text{ s}$

3. Your teacher is about 5'9" (5 foot 9). How tall is he in m? (There are 12 inches in a foot and 2.54 cm in an inch)

$5 \times 12 + 9 = 69$ inches

$69 \times 2.54 \div 100 \doteq 1.75$ m

4. Ussain Bolt ran 100 m in Berlin with a time of 9.58 s. How fast was he running on average in km/h?

speed $= \frac{100}{9.58} = 10.44$ m/s $\quad 10.44 \frac{m}{s}\left(\frac{1 \text{ km}}{1000 \text{ m}}\right)\left(\frac{3600 \text{ s}}{1 \text{ hour}}\right)$

$= 37.6$ km/h

5. Which quantity is ~~larger? Circle~~ the larger quantity. Perform a conversion to justify your answer.

a. 27 feet or 10 meters

$10 \times 3.28 = 32.8$ feet

b. 250 seconds or 4 minutes

$4 \times 60 = 240$ s

c. 170 lb or 75 kg

$75 \times 2.2 = 165$ lbs

d. 22 km/h or 6 m/s

$6 \frac{m}{s}\left(\frac{1 \text{ km}}{1000 \text{ m}}\right)\left(\frac{3600 \text{ s}}{1 \text{ hr}}\right)$

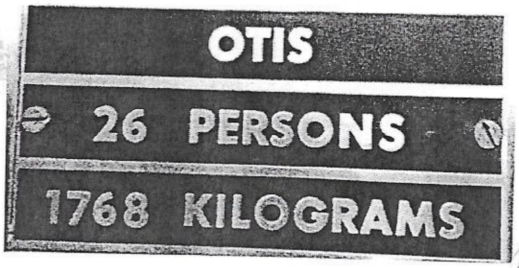
$= 21.6$ km/h

6. You are driving in the United States where the speed limits are marked in strange, foreign units. One sign reads 65 mph which should technically be written as 65 mi/h. You look at the speedometer of your Canadian car which reads 107 km/h. Are you breaking the speed limit? (1 mi = 1.60934 km)

$107 \frac{\text{km}}{\text{h}}\left(\frac{1 \text{ mi}}{1.60934 \text{ km}}\right) = 66.5 \text{ mi/h}$

speeding!

7. You step into an elevator and notice the sign describing the weight limit for the device. What is the typical weight of a person in pounds according to the elevator engineers?



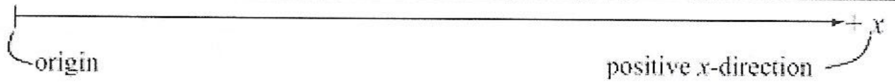
$1768 \text{ kg}\left(\frac{2.2 \text{ lbs}}{1 \text{ kg}}\right) = 3889.6$ lbs

$3889.6 \div 26 = 149.6$ lbs/person

C: Testing a Claim – Constant Speed

You have a hunch that your object / person moves with a constant speed. Now it is time to test this hypothesis.

To describe the *position* of an object along a line we need to know the distance of the object from a reference point, or origin, on that line and which direction it is in.



1. **Plan.** Discuss with your group a process that will allow you to test the hypothesis mentioned above using the idea of *position*. *Check this with your teacher.*

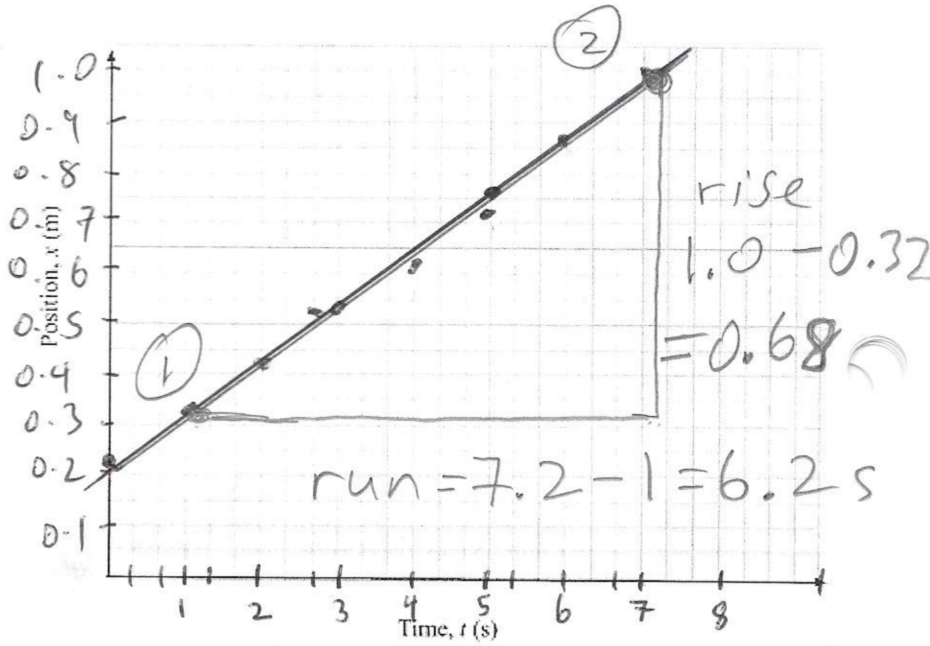
2. **Measure.** Record your data below for the motion of

Position (m)	0.21	0.32	0.42	0.53	0.66	0.77	0.88	1.00	1.12
Time (s)	0	1	2	3	4	5	6	7	8

Graphing. Choose a convenient scale for your physics graphs that uses most of the graph area. The scale should increase by simple increments. Label each axis with a name and units.

Line of Best-Fit. The purpose of a line of best fit is to highlight a pattern that we believe exists in the data. Real data always contains uncertainties that lead to *scatter* (wiggle) amongst the data points. A best-fit line helps to average out this scatter and uncertainty. Any useful calculations made from a graph should be based on the best-fit line and **not** on the data chart or individual points. As a result, we **never** connect the dots in our graphs of data.

3. **Represent.** Plot your data on a graph with position on the vertical axis and time on the horizontal axis.



4. **Calculate and Interpret.** Calculate the slope of the graph (using the line of best fit, don't forget the units). Interpret the meaning of the slope of a position-time graph. (What does this quantity tell us about the object?)
Reminder: slope = rise / run.

$$\frac{\text{rise}}{\text{run}} = \frac{0.68 \text{ m}}{6.2 \text{ s}} = 0.11 \text{ m/s}$$

5. **Reason.** Imagine an experiment with a different buggy that produced a similar graph, but with a steeper line of best fit. What does this tell us about that buggy? Explain.

moving faster

6. **Predict.** Predict (without using a graph) where the buggy would be found 2.0 s after your last measurement.

$1.12 + \text{slope} \times 2$ Y=