UNITS & MATH - Review Homework #1

This homework should be worked out individually. Show all work in the area provided. The assignment is worth 25 points and it is due on 9/16 in class.

A. Significant Digits

Determine the number of significant figures in the following numbers

1. 205.00
2. 32500
3. 0.0006070
4. 150800

B. Scientific Notation & Significant Digits

Write the following numbers in scientific notation, keeping the same number of significant digits as given. If not sure, write the number in scientific notation with 2 significant digits (in this case you may have to round the number off first).

5. 0.0000013
6. 0.80
7. 18540000000
8. 0.00018

C. Conversion of Units

9. What is the distance of Moon from Earth (Reference Table) as compared to the distance of a geostationary satellite from the center of Earth (such a satellite is approximately 22,000 miles above the Earth's equator)?

\[ \frac{23,900 \text{ mi}}{22,000 \text{ mi} + 4,000 \text{ mi}} \approx \frac{23,900}{26,000} \approx 9 \text{ times} \]

10. The wavelength of some X-rays is approximately \(1.0 \times 10^{-8}\) meter. Express this value in nanometers.

\[ 1 \text{ nm} = 10^{-9} \text{ m} \]

\[ 1.0 \times 10^{-8} \text{ m} = 1.0 \times 10 \times 10^{-9} \text{ m} = 1.0 \times 10^{-7} \text{ nm} \]

11. How much bigger (in orders of magnitude) in terms of the mass, is Earth than the Moon (Regents Reference Table)?

\[ \frac{5.9 \times 10^{24} \text{ kg}}{7.35 \times 10^{22} \text{ kg}} \approx 10^2 = 100 \text{ times} \]
D. SLOPE & LINE OR CURVE OF BEST-FIT

1. The number of hours spent on math homework each week and the final exam grades for twelve students in Mr. Dylan’s algebra class are plotted below.

![Graph showing Mr. Dylan's Class](image)

a. Draw the line of best fit. Explain how you drew the line of best fit.

The line of best fit goes through the middle of all the points, so all the distances of points on one side equal all distances of points on the other.

b. Find the value and the unit of the slope of the line of best fit you drew above.

\[
\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{10 \text{ percent}}{2 \text{ h}} = \left(\frac{5 \text{ percent}}{1 \text{ h}}\right) \rightarrow \text{shows the speed of the process.}
\]

2. A moving SUV gathers both amount of motion (in physics called momentum with a formula \( p = mv \)) and energy of motion (in physics called kinetic energy with a formula \( KE = \frac{1}{2}mv^2 \)). The mass of the car \( m \) is expressed in kg and the speed of the car \( v \) is expressed in m/s. The speed of the car doubles. What happens to momentum? What happens to energy of motion?

\[ p = mv \quad \text{(direct relationship)} \quad \text{- speed doubles then momentum doubles} \]

\[ KE = \frac{1}{2}mv^2 \quad \text{(quadratic relationship)} \quad \text{- speed doubles then KE quadruples} \]
E. AREA UNDER THE GRAPH

1. The relationship of a force vs. displacement is given in the graph below. Find the area under the graph (both value and unit) between 15 and 30 meters.

Area: \(1000\) \(\text{Unit: } N \cdot m\)

\[
\text{Area} = A_\square + A_\triangle
\]

\[
A_\square = (5\text{ m})(100\text{ N}) = 500\text{ N} \cdot \text{m}
\]

\[
A_\triangle = \frac{1}{2}(10\text{ m})(100\text{ N}) = 500\text{ N} \cdot \text{m}
\]

\[
\text{Area} = 500\text{ N} \cdot \text{m} + 500\text{ N} \cdot \text{m} = 1000\text{ N} \cdot \text{m}
\]

F. SOLVING A RIGHT TRIANGLE

1. A tree casts an 8.0 m shadow on a sunny day, as shown in the diagram below.

If the angle of elevation from the tip of the shadow to the top of the tree is \(32^\circ\), calculate the height of the tree.

\[
\tan 32^\circ = \frac{\text{opp}}{\text{adj}} = \frac{h}{8.0\text{ m}}
\]

\[
h = 8.0\text{ m} \tan 32^\circ \approx 5.0\text{ m}
\]
2. A stake is to be driven into the ground away from the base of a 17.0 meter pole, as shown in the diagram below. A wire from the stake on the ground to the top of the pole is to be installed at an angle of elevation of 52°.

\[
\tan 52° = \frac{\text{opp.}}{\text{adj.}} = \frac{17.0\text{ m}}{x}
\]

\[
x = \frac{17.0\text{ m}}{\tan 52°} = 13\text{ m}
\]

How far away from the base of the pole should the stake be driven in?

3. The diagram below shows right triangle UPC.

\[
\sin P = \frac{8.0\text{ m}}{17.0\text{ m}}
\]

\[
P = \sin^{-1}\left(\frac{8.0}{17.0}\right)
\]

\[
P = 28°
\]

Find the measure of angle P.

You may use either of the functions (\(\cos P\) or \(\tan P\)). They all give the same answer.
6. LITERAL EQUATIONS

1. Solve for letter \( t \).
\[
d = \frac{1}{2} at^2
\]
\[
2d = \frac{1}{2} at^2
\]
\[
t^2 = \frac{2d}{a}
\]
\[
t = \sqrt{\frac{2d}{a}}
\]

2. Solve for letter \( R \).
\[
m g = m \frac{v^2}{R}
\]
\[
\frac{m g}{m} = \frac{1}{R} \cdot \frac{v^2}{R}
\]
\[
g = \frac{v^2}{R}
\]
\[
R g = \frac{v^2}{g} R
\]
\[
R g = \frac{v^2}{g}
\]
\[
R = \frac{v^2}{g}
\]

H. METRIC MEASURES OF COMMON OBJECTS

1. Calculate the number of seconds in a year. Write the answer in scientific notation.

\[
1 \text{ year} = 365(24)(60)(60) \text{s}
\]
\[
= 31536000 \text{s}
\]
\[
= 3.1536 \times 10^7 \text{s} \quad \text{or} \quad 7 \text{ orders of magnitude}
\]

2. Estimate the diameter of a DVD in meters. Write the answer in scientific notation.

\[
12 \text{ cm} = 0.12 \text{ m} = 1.2 \times 10^{-1} \text{ m}
\]
\[
10 \text{ cm} = 0.10 \text{ m} = 1.0 \times 10^{-1} \text{ m}
\]
\[
15 \text{ cm} = 0.15 \text{ m} = 1.5 \times 10^{-1} \text{ m}
\]

3. Estimate the length of a football field in meters.

Acceptable answers:

80 m, 100 m or 120 m
I. ABSOLUTE AND RELATIVE ERRORS

23. Let's say you managed to measure the length of your dog $L$ to be 85 cm with a precision 3 cm. Let's suppose you also regularly monitor the mass of your dog. Let's say you measured the mass of the dog to be 20 kg with a precision of 1 kg.

a. Write down the results for the length and the mass of your dog.

\[
85 \text{ cm} \pm 3 \text{ cm} \\
20 \text{ kg} \pm 1 \text{ kg}
\]

b. Calculate the percent error for the length and the mass of your dog.

\[
\frac{3}{85} \times 100\% = 3.5\%
\]

\[
\frac{1}{20} \times 100\% = 5\%
\]

24. How do you write $T = 1.25578 \text{ s} \pm 0.01247 \text{ s}$ keeping two significant digits in the error?

\[
T = (1.26 \pm 0.12) \text{ s}
\]

25. What is the relative error for $v = 12.25 \text{ m/s} \pm 0.25 \text{ m/s}$?

\[
\frac{0.25}{12.25} \times 100\% = 2.0\%
\]