Summer Packet – AP Physics B

Use the internet for additional reference on the following problems. Complete all problems!! You must bring this on the first day of school it will count as your first exam!! This material will NOT be reviewed it will be covered as it is encountered in our class.

Scientific Notation – Review

Scientific notation is the way that scientists easily handle very large numbers or very small numbers. For example, instead of writing 0.0000000056, we write 5.6×10^{-9}. So, how does this work?

We can think of 5.6×10^{-9} as the product of two numbers: 5.6 (the digit term) and 10^{-9} (the exponential term).

Here are some examples of scientific notation.

$10000 = 1 \times 10^4$	$24327 = 2.4327 \times 10^4$
$1000 = 1 \times 10^3$	$7354 = 7.354 \times 10^3$
$100 = 1 \times 10^2$	$482 = 4.82 \times 10^2$
$10 = 1 \times 10^1$	$89 = 8.9 \times 10^1$ (not usually done)
$1 = 10^0$	
$1/10 = 0.1 = 1 \times 10^{-1}$	$0.32 = 3.2 \times 10^{-1}$ (not usually done)
$1/100 = 0.01 = 1 \times 10^{-2}$	$0.053 = 5.3 \times 10^{-2}$
$1/1000 = 0.001 = 1 \times 10^{-3}$	$0.0078 = 7.8 \times 10^{-3}$
$1/10000 = 0.0001 = 1 \times 10^{-4}$	$0.00044 = 4.4 \times 10^{-4}$

As you can see, the exponent of 10 is the number of places the decimal point must be shifted to give the number in long form. A **positive** exponent shows that the decimal point is shifted that number of places to the right. A **negative** exponent shows that the decimal point is shifted that number of places to the left.

In scientific notation, the digit term indicates the number of significant figures in the number. The exponential term only places the decimal point. As an example,

$$46600000 = 4.66 \times 10^7$$

This number only has 3 significant figures. The zeros are not significant; they are only holding a place. As another example,

$$0.00053 = 5.3 \times 10^{-4}$$

This number has 2 significant figures. The zeros are only place holders.

How to do calculations:

Addition and Subtraction:

- All numbers are converted to the same power of 10, and the digit terms are added or subtracted.
- Example: $(4.215 \times 10^{-2}) + (3.2 \times 10^{-4}) = (4.215 \times 10^{-2}) + (0.032 \times 10^{-2}) = 4.247 \times 10^{-2}$
- Example: $(8.97 \times 10^4) - (2.62 \times 10^3) = (8.97 \times 10^4) - (0.262 \times 10^4) = 8.71 \times 10^4$

Multiplication:

- The digit terms are multiplied in the normal way and the exponents are added. The end result is changed so that there is only one nonzero digit to the left of the decimal.
- Example: $(3.4 \times 10^6)(4.2 \times 10^3) = (3.4)(4.2) \times 10^{(6+3)} = 14.28 \times 10^9 = 1.4 \times 10^{10}$ (to 2 significant figures)
- Example: $(6.73 \times 10^{-5})(2.91 \times 10^2) = (6.73)(2.91) \times 10^{(-5+2)} = 19.58 \times 10^{-3} = 1.96 \times 10^{-2}$ (to 3 significant figures)

Division:

- The digit terms are divided in the normal way and the exponents are subtracted. The quotient is changed (if necessary) so that there is only one nonzero digit to the left of the decimal.
- Example: $(6.4 \times 10^6)/(8.9 \times 10^2) = (6.4)/(8.9) \times 10^{(6-2)} = 0.719 \times 10^4 = 7.2 \times 10^3$ (to 2 significant figures)
- Example: $(3.2 \times 10^3)/(5.7 \times 10^{-2}) = (3.2)/(5.7) \times 10^{3-(-2)} = 0.561 \times 10^5 = 5.6 \times 10^4$ (to 2 significant figures)

Powers of Exponentials:

- The digit term is raised to the indicated power and the exponent is multiplied by the number that indicates the power.
- Example: $(2.4 \times 10^4)^3 = (2.4)^3 \times 10^{(4x3)} = 13.824 \times 10^{12} = 1.4 \times 10^{13}$ (to 2 significant figures)
- Example: $(6.53 \times 10^{-3})^2 = (6.53)^2 \times 10^{(-3)x2} = 42.64 \times 10^{-6} = 4.26 \times 10^{-5}$ (to 3 significant figures)

Problems:

1) Write the following numbers using scientific notation.

a) 382,000,000,000 ____________________

b) 9,882 ____________________

c) 76.124 ____________________

d) 0.132 ____________________

e) 0.000,000,000,009 ____________________

2) Express the following as ordinary numbers.

a) 7.995×10^5 ____________________

b) 4.21×10^{-4} ____________________

c) 1.2×10^8 ____________________

d) 8.02×10^{-2} ____________________

e) 3.481763×10^6 ____________________

3) Perform the following calculations. Express the answers scientific notation. Do **NOT** use a calculator.

a) $400 \times 2,000 =$ ____________________

b) $7,000,000 \times 0.003 =$ ____________________

c) $\frac{25,000}{0.05} =$ ____________________

d) $\frac{0.000,008}{0.002} =$ ____________________

e) $4.3 \times 10^{-3} + 5.8 \times 10^{-4} =$ ____________________

f) $7.9 \times 10^4 - 9.8 \times 10^3 =$ ____________________

Significant Digits

Rules for Identifying Significant Digits

(1) Non-zero digits are always significant, as are zeroes between non-zero digits.

Example:
9,683 has four significant digits
15.60007 has 7 significant digits

(2) Leading zeroes before the first non-zero digit are not significant. They serve only as placeholders and do not represent measured data.

Example:
0.0005 has one significant digit

(3) Trailing zeroes right of the decimal point are always significant. They are not needed as placeholders, but represent actual measured data.

Example:
15.0000 has six significant digits
3.1560 has five significant digits

(4) Trailing zeroes left of the decimal point are ambiguous. They may be serving only as placeholders, or they may represent measured data. Written in this format, we can't know.

Example:
52,000 may have two, three, four, or five significant digits - we can't tell from the way it is written.

It is very poor form to report numbers with an ambiguous degree of uncertainty. In these cases, you should always use scientific notation.

Example:
5.2 x 104 has two significant digits
5.2000 x 104 has five significant digits

Exact Numbers

Some numbers are "exact", and can be considered to have an infinite number of significant digits. These include:

- **Cardinal numbers (counting numbers): A dozen eggs contains exactly 12 eggs, not 12.000001 eggs. Eggs only come in whole numbers.**
- **Some mathematical relationships or constants are exact by definition. For example, the speed of light is defined as exactly 299,792,458 m/s, and there are exactly 1,000 grams in a kilogram.**

Multiplication and Division

When quantities are multiplied or divided, the number of significant figures in the answer is equal to the number of significant figures in the quantity with the smallest number of significant figures.

Example:

`1.23 * 4567.89`

1.23 has three significant digits; 4567.89 has six significant digits. The result will have the smaller of these - three significant digits. Your calculator produces 5618.5047 as a result; round it to three significant digits and report 5.62×10^3.

Caution: Do not report 5620 as your result. The last zero would be ambiguous.

Addition and Subtraction

When quantities are added or subtracted, the number of decimal places in the answer is equal to the number of decimal places in the quantity with the smallest number of decimal places.

Example:

1.234 + 567.89

1.234 has three digits right of the decimal point; 567.89 has two. The result will have the smaller of these - two digits right of the decimal point.

This is easier to see if you line up the figures in a column:

```
   1.234
+ 567.89
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```

Your calculator produces 569.124 as a result; round it to two significant digits right of the decimal point and report 569.12.

Be especially careful with numbers which are given in scientific notation.

Example:

1.2 + (3.45 x 10-4)

The best way to solve this problem is to write the numbers in a column in ordinary notation:

```
  1.2
+ 0.000345
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Your calculator returns 1.200345, but only one digit right of the decimal is significant. Report your result as 1.2.

You may also convert all numbers into scientific notation with the same exponent:

Example:

(1.23x105) + (4.56x106) + (7.89x107)

```
   1.23 x 105
  45.6  x 105
+ 789.   x 105
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The full answer would be 835.83 x 105, but the last two digits are not significant. Report your result as 836. x 105 or 8.36 x 107.

Give the number of significant digits in each of the following measurements:

1. 1278.50 ________	**7. 8.002 ________**	**13. 43.050 ________**
2. 120000 ________	**8. 823.012 ________**	**14. 0.147 ________**
3. 90027.00 ________	**9. 0.005789 ________**	**15. 6271.91 ________**
4. 0.0053567 ________	**10. 2.60 ________**	**16. 6 ________**
5. 670 ________	**11. 542000. ________**	**17. 3.47 ________**
6. 0.00730 ________	**12. 2653008.0 ______**	**18. 387465 ________**

Round off the following numbers to three significant digits:

19. 120000 ____________	**22. 4.53619 ____________**
20. 5.457 ____________	**23. 43.659 ____________**
21. 0.0008769 ____________	**24. 876493 ____________**

25. 23.4 x 14 ____________	**28. 0.005 - 0.0007 ____________**
26. 7.895 + 3.4 ____________	**29. 7.895 / 34 ____________**
27. 0.0945 x 1.47 ____________	**30. 0.2 / 0.0005 ____________**

UNIT CONVERSIONS

In the field of science, the metric system is used in performing measurements. The metric system is actually easier to use than the English system, as you will see shortly. The metric system uses prefixes to indicate the magnitude of a measured quantity. The prefix itself gives the conversion factor. You should memorize some of the common prefixes, as you will be using them on a regular basis. Common prefixes are shown below:

Prefix	Symbol	Power	Prefix	Symbol	Power
mega-	M	10^{6}	centi-	c	10^{-2}
kilo-	k	10^{3}	milli-	m	10^{-3}
hecto-	h	10^{2}	micro-	µ	10^{-6}
deca-	D	10^{1}	nano-	n	10^{-9}</SUP< TD>
deci-	d	10^{-1}	pico-	p	10^{-12}

Metric - Metric Conversions

Suppose you wanted to convert the mass of a 250 mg aspirin tablet to grams. Start with what you know and let the conversion factor units decide how to set up the problem. If a unit to be converted is in the numerator, that unit must be in the denominator of the conversion factor in order for it to cancel.

$$\frac{250 \text{ mg}}{1} \times \frac{1 \times 10^{-3} \text{ g}}{1 \text{ mg}} = 0.250 \text{ g}$$

Notice how the units cancel to give grams. I've shown the conversion factor numerator as 1×10^{-3} because on most calculators, it must be entered in this fashion, not as just 10^{-3}. If you don't know how to use the scientific notation on your calculator, try to find out as soon as possible. Look in your calculator's manual, or ask someone who knows. Also, notice how the unit, mg is assigned the value of 1, and the prefix, milli-, is applied to the gram unit. In other words, 1 mg literally means 1×10^{-3} g.

Next, let's try a more involved conversion. Suppose you wanted to convert 250 mg to kg. You may or may not know a direct, one-step conversion. In fact, the better method (foolproof) to do the conversion would be to go to the base unit first, and then to the final unit you want. In other words, convert the milligrams to grams and then go to kilograms:

$$\frac{250 \text{ mg}}{1} \times \frac{1 \times 10^{-3} \text{ g}}{1 \text{ mg}} \times \frac{1 \text{ kg}}{1 \times 10^{3} \text{ g}} = 2.5 \times 10^{-4} \text{ kg}$$

English - Metric Conversions

These conversions are accomplished in the same way as metric - metric conversions. The only difference is the conversion factor used. It would be a good idea to memorize a few conversion factors involving converting mass, volume, length and temperature. Here are a few useful conversion factors:

length: 2.54 cm = 1 inch (exact)

mass: 454 g = 1 lb

volume: 0.946 L = 1 qt

temperature: $^{o}C = (^{o}F - 32)/1.8$

All of the above conversions are to three significant figures, except length, which is an exact number. As before, let the units help you set up the conversion.

Suppose you wanted to convert mass of my 23 lb cat to kilograms. One can quickly see that this conversion is not achieved in one step. The pound units will be converted to grams, and then from grams to kilograms. Let the units help you set up the problem:

$$\frac{23\ \text{lb}}{1} \times \frac{454\ \text{g}}{1\ \text{lb}} \times \frac{1\ \text{kg}}{1 \times 10^3\ \text{g}} = 10\ \text{kg}$$

Let's try a conversion which looks "intimidating", but actually uses the same basic concepts we have already examined. Suppose you wish to convert pressure of 14 lb/in^2 to g/cm^2. When setting up the conversion, worry about one unit at a time, for example, convert the pound units to gram units, first:

$$\frac{14\ \text{lb}}{\text{in}^2} \times \frac{454\ \text{g}}{1\ \text{lb}}$$

Next, convert in^2 to cm^2. Set up the conversion without the exponent first, using the conversion factor, 1 in = 2.54 cm. Since we need in^2 and cm^2, raise everything to the second power:

$$\frac{14\ \text{lb}}{\text{in}^2} \times \frac{454\ \text{g}}{1\ \text{lb}} \times \frac{1^2\ \text{in}^2}{2.54^2\text{cm}^2} = 9.9 \times 10^2\ \text{g/cm}^2$$

Notice how the units cancel to the units sought. Always check your units because they indicate whether or not the problem has been set up correctly.

Do all the following problems

1. 1.2 kg = ________dg
2. 2.00 x 10-5m = ________in
3. 25.4 mm = ________cm
4. 1.2 miles = ________km
5. 15.47 m^3 = ________km^3
6. 17.0 ft/s = ________m/min
7. 342 miles/hr = ________km/s
8. 45.1 yards = ________cm
9. 1.45 L = ________gallons
10. 4.100 g = ________mg
11. 1.2 kg/yard = ________lbs/m
12. 2.00ft^3/min = ________L/hour
13. 145 ml = ________cm^3
14. 6.51 miles = ________cm

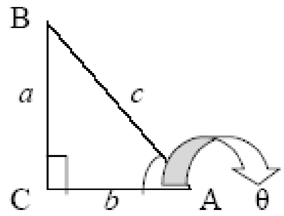
Metric to Metric Conversions

1. 14.4 m = __________ cm
2. 564 cg = __________ g
3. 58dg = __________ mg
4. 800L = __________ kL
5. 0.0687 km = __________ mm
6. 51.0 mg = __________ g
7. 210 cL = __________ dL
8. 4.51 x 10^3 dL = __________ mL
9. 45700 cg = __________ kg
10. 24.6 kL = __________ mL
11. 82.4 nm = __________ cm

Trig Review

Know the following trigonometric functions by memory!!!

Consider a right angle triangle



Let $\angle BAC = \theta$,
Side AB = c and side BC = a.
We can calculate Side AC = b, by Pythagorean Theorem

$$a^2 + b^2 = c^2$$

We can define 6 trigonometric ratios :

$$Sin\theta = \frac{Opposite\ Side}{Hypotenuse} = \frac{a}{c} \qquad Csc\theta = \frac{Hypotenuse}{Opposite\ Side} = \frac{c}{a}$$

$$Cos\theta = \frac{Adjacent\ Side}{Hypotenuse} = \frac{b}{c} \qquad Sec\theta = \frac{Hypotenuse}{Adjacent\ Side} = \frac{c}{b}$$

$$Tan\theta = \frac{Opposite\ Side}{Adjacent\ Side} = \frac{a}{b} \qquad Cot\theta = \frac{Adjacent\ Side}{Opposite\ Side} = \frac{b}{a}$$

From these definitions we can derive:

$$Sin\theta = \frac{1}{Csc\theta} \qquad Csc\theta = \frac{1}{Sin\theta}$$

$$Cos\theta = \frac{1}{Sec\theta} \qquad Sec\theta = \frac{1}{Cos\theta}$$

$$Tan\theta = \frac{1}{Cot\theta} \qquad Cot\theta = \frac{1}{Tan\theta}$$

Also,

$$Tan\theta = \frac{Sin\theta}{Cos\theta} \qquad Cot\theta = \frac{Cos\theta}{Sin\theta}$$

For Example

We have previously defined

$$Sin\theta = \frac{a}{c} \ , \ \frac{1}{Sin\theta} = \frac{c}{a} = Csc\theta$$

This can be done for the other trigonometric functions as well.