A Significant Review

Let's start off with scientific notation…

Large numbers (numbers for which the absolute value is greater than 1) will always have a positive exponent when in scientific notation. When converting to scientific notation, you move the decimal point until there is a single digit to the left. The number of places that the decimal spot moved becomes the exponent and the "x10".

Example: -450000 → $-4.5x10^5$. The decimal point was moved 5 times to the left, so the exponent is 5.
Example: 106709001 → $1.06709001x10^8$. The decimal was moved to the left by 8 spots so the exponent is 8.
Example: 57293.264 → $5.7293264x10^4$ since the decimal was moved 4 times to the left.

Small numbers (numbers between 1 and -1) will always have a negative exponent when in scientific notation. When converting to scientific notation, you move the decimal point until there is a single digit to the left. The number of places that the decimal spot moved becomes the exponent and the "$x10^-$".

Example: 0.0003528 → $3.528x10^{-4}$. The decimal moved 4 times to the right, so the exponent become -4.
Example: -0.0000000000000058500 → $-5.8500x10^{-15}$. The decimal point was moved 15 times to the right, so the exponent became -15.
Example: 0.002 → $2x10^{-3}$ since the decimal was moved 3 times to the right.

You try:

1a) 54,670,000,000
1b) -5526.7
1c) 0.03289
1d) 100.00
1e) -0.000093740
1f) 9999.606
1g) 2800
1h) -0.00000005883
1i) 0.00008
1j) 0.11250

How many significant figures in a number:

First and foremost, you need to be able to tell how many sig. figs. are in a number. Here is a recap of the 3 rules I gave you:

1) If the number is in scientific notation:
The number of digits shown is equal to the number of sig. figs.

Examples:
$6.626x10^{-34}$ has **4** significant figures ($6.626x10^{-34}$)
$8.30x10^4$ has **3** significant figures ($8.30x10^4$)
$3.0x10^1$ has **2** sig. figs. ($3.0x10^1$)

2) If the number has a decimal in it:
Start at the RIGHT of the number and count to the left until you get to the last NONZERO number, this is the number of sig. figs. Any additional zeros to the left are NOT significant.

Examples:
195.3040 has **7** sig. figs. (195.3040)
0.003081 has **4** sig. Figs. (0.003081)
180048.00 has **8** sig. figs. (180048.00)
0.0000002 has 1 sig. fig. (0.0000002)
10. has 2 sig. fig. (10.)

3) If the number does NOT have a decimal in it:
Start at the LEFT of the number and count to the right until you get to the last NONZERO number, this is the number of sig. figs.

Examples:
160 has **2** sig. figs. (160)
20000 has **1** sig. figs (20000)
704 has **3** sig. figs. (704)
49003100 has **6** sig. figs. (49003100)
10 has 1 sig. fig. (10)

You try:
2a) 6200
2b) 1.032
2c) 420.
2d) 3.750×10^{-6}
2e) 0.0006000
2f) 1×10^{4}
2g) 35000000
2h) 23.4400
2i) 100.0003
2j) 100.

<u>Significant figures in calculations</u>

There are two distinct rules that you need to be able to use and keep straight.

Addition and/or subtraction:

The rule for addition and subtraction is based on the precision of the values being added and/or subtracted. In simpler terms, you need to count the number of decimal places in each of the values. The answer must have the same number of decimal places as the value in the problem that has the ***FEWEST*** **<u>DECIMAL PLACES</u>**. What does that mean? If you add 5.12345 (5 decimal places), 12.123 (3 decimal places), and 0.12 (2 decimal places), your answer must have 2 decimal places.

Example: $2500.0 + 1.236 + 367.01$

First, write the digits vertically with the decimal points **lined up** and find the number of decimal places for each value (this will help until you get more comfortable with the process). The answer must have the same number of decimal spots as the value in the problem with the fewest decimal places.

$$\begin{array}{r} 2500.0 \\ +\ \ \ \ 1.236 \\ +\ 367.01 \\ \hline \end{array}$$

2500.0 has one decimal spot, 1.236 has three decimal spots and 367.01 has two decimal spots, therefore the answer must have one decimal spot. You add them up and then round as follows:

$$\begin{array}{r} 2500.0 \\ +\ \ \ \ 1.236 \\ +\ 367.01 \\ \hline 2868.246 \end{array}$$

The number of decimal places allowed in the answer is dictated by the first value (because that value has the fewest decimal places), so you must round to that digit (the 2 in 2868.246 here). The answer is **2868.2**.

Example: $0.007560 + 0.0133$

$$\begin{array}{r} 0.007560 \\ +\ 0.0133 \\ \hline 0.020860 \end{array}$$

So the answer is 0.0209

Example: $0.01 - 0.006125$

$$\begin{array}{r} 0.01 \\ -\ 0.006125 \\ \hline 0.003875 \end{array}$$

You can only 2 decimal places, so the answer is 0.00

Example: $0.0417 + 0.956 + 0.0022954$

$$\begin{array}{r} 0.0417 \\ +\ 0.956 \\ +\ 0.0022954 \\ \hline 0.9999954 \end{array}$$

Again, your answer must have the same number of decimal spots as the value with the fewest in the question; 3 in this case, so the answer is **10.000**

Multiplication and/or division:

The rule for multiplication and division is all about how many sig. figs. a number has. The value in the calculation that has the ***FEWEST*** number of **SIGNIFICANT FIGURES** determines the number of sig. figs. in your answer. If you are multiplying 3 different numbers, one has 4 s.f., one has **2** s.f. and one has 7 s.f., your answer can only have **2** s.f.

Example: 0.01116 x 23.44600 = 0.26165736
0.01116 has 4 s.f. and 23.44600 has 7 s.f. Therefore the answer is limited to 4 s.f.
The answer would be rounded to **0.2617**

Example: 26.375 x 3791 = 99987.625
26.375 has 5 s.f. and 3791 has 4 s.f., so the answer is again limited to 4 s.f. This is a fairly large number, so put it into scientific notation before rounding. It becomes $9.9987625\text{x}10^4$. Now do your rounding and you get $10.00\text{x}10^4$. There can only be one digit to the left of the decimal, so the final answer is **$1.000\text{x}10^5$**.

Example: $\frac{3.14159}{502000} = 0.000006258$
3.14159 has 6 s.f. and 502000 has 3 s.f. so the answer can only have 3 s.f. The answer is **0.00000626** or **$6.26\text{x}10^{-6}$**

Examples: $\frac{536 \times 0.3301 \times 60.002}{0.0048 \times 12.1} = 182788.73738$
536 has 3 s.f., 0.3301 has 4 s.f., 60.002 has 5 s.f., 0.0048 has **2** s.f., and 12.1 has 3 s.f., so the answer can only have **2** s.f. This is a large number, so put it into scientific notation BEFORE rounding → $1.8278873738\text{x}10^5$. Since you can only keep 2 s.f., the answer is **$1.8\text{x}10^5$**.

You try:

3a) $160 \times 0.3490 \times 23.1$

3b) $2.3806 + 0.01$

3c) $\frac{0.2689}{0.000159}$

3d) $11.3 - 2$

3e) $1500. \div 25$

3f) $3.65 \times 10^{-3} \times 9.822 \times 10^{4}$

3g) $\dfrac{2.21100 \times 10^{2}}{32.1 \times 0.002000}$

3h) $0.34864 + 1$

3i) $26.1 - .00030000$

3j) $1200 + 49.49 + 1.004$

3k) 33.3×3.0

<u>Significant figures and defined values versus measured values</u>

All measured values have uncertainty associated with them (did I read that ruler right?) and therefore limit the sig figs your answer can have. Defined values do not uncertainty associated with them and therefore do not limit the number of sig figs in your answer (i.e. have infinite sig figs). The questions is, how can you tell? Conversions within a system of measure (i.e. metric to metric or standard to standard) and within the same type of unit (i.e. volume to volume or mass to mass) are defined values! Conversions between different systems (i.e. metric to standard) or conversions between different types of units (i.e. time to length or mass to volume) are considered measured values. What does all of this mean? Here are some examples:

$\dfrac{12\text{ in}}{1\text{ ft}}$ is defined because inches and feet are both in the same system of measure (standard) and are both length units. This conversion would not affect the sig figs in the answer.

$\dfrac{1\text{ mile}}{1609\text{ m}}$ is measured because miles are standard units of length while meters are metric units of length. This conversion WOULD affect the sig figs in the answer. (4 sig figs)

$\dfrac{13.2\text{ g}}{1\text{ mL}}$ is a measured value because grams are a unit of mass and mL are a unit of volume. This conversion WOULD affect the sig figs in your answer. (3 sig figs.)

$\dfrac{1 \times 10^{-3}\text{ L}}{1\text{ mL}}$ is defined because L and mL are both in the same system of measure (metric) and are both length volume. This conversion would not affect the sig figs in the answer.

Do all of the practice problems. I will send out a key soon, but you should try them without the key first since you won't have a key when you take the exam. When you do get the key; check your answers. If you missed any, don't say "Oh well, missed that one". Look and find out what you did wrong! Good luck!