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Air Monitoring Specialist
Math Refresher Exercise

The Air Monitoring Specialist class involves more math problems than other asbestos classes. Since many people do not do math (or use a calculator) on a regular basis, this exercise is intended to refresh you on the basic math operations needed for the class. Familiarization with these operations will significantly increase your exam success.

So get out your calculator (any calculator will do – you do not have to buy a special one - but it is best if you use the same type as you will to use on the job).

Let's review the following math operations and complete the problems (fill in all blanks in the exercise).

I. Units

A unit is the symbol that follows a number and describes what the number means. All numbers should be followed by its appropriate unit. Examples of units that we will use in this class:

Absolute units:
f = fibers
fld = field
sec = seconds
min = minutes
hr = hour
% = percent

Unit of area: mm^2 = millimeter squared (or square millimeter)

Units of volume:
L = liters
cc = cubic centimeters

Units of airborne fiber concentration:
f/cc = fibers per cubic centimeter
s/cc = structures per cubic centimeter

Unit of flowrate: L/min = lpm = liters per minute

II. Rounding off numbers

You do not need to write down all the digits in the numerical answer displayed on the calculator.* Instead, you should "round off" the final answer to the appropriate number of significant figures (see Section III on next page). To round off a number:

1. Look at the first digit that you will NOT include in the final answer.

2. If that digit is less than 5, drop it and all the digits that follow (to the right).

   Example: Round 19.3424 f/mm^2 to one decimal place = 19.3 f/mm^2

   Note: When we say 'so many decimal places', we mean how many numbers will remain to the right of the decimal point.

   Problem Ia: Round 370.232 L to one decimal place = _____

   Problem Ib: Round 0.1917 f/cc to two decimal places = _____

3. If that digit is equal to or greater than 5, round up (or increase the number to the left by 1) and drop all the digits that follow (to the right).

   Example: Round 129.3623 f/mm^2 to one decimal place = 129.4 f/mm^2

   Problem IIa: Round 17,940.1502 f/mm^2 to one decimal place = _____

   Problem IIb: Round 31.9556 L to one decimal place = _____

   Problem IIc: Round 31.9556 L to two decimal places = _____

* Note: It is fine to keep all the digits on the calculator during the calculation. Rounding should only be applied at the end – when you have the final answer.

III. How many numbers to keep (Significant figures)

Your calculator will display a very long number (sometimes as many as 10 digits) after doing a math problem. You should not write all these numbers down in your final answer. While a complete understanding of significant figures is beyond the scope this course, some basic rules will apply:

a. Keep at least three digits in the final answer.

Examples: 69.721 L = 69.7 L
1.2981 f/cc = 1.30 f/cc
0.0215 f/cc = 0.022 f/cc
(Note: The zero before the decimal point is only a place holder.)

Problem IIIa: Write down the final 3-digit answer if the following are displayed on your calculator:

32.588344 sec = _____

8.256 hr = _____

0.1792 L = _____

b. Keep all digits to the left of the decimal point.

Examples: 781.223 L = 781 L
129,020.29 f/mm^2 = 129,020 f/mm^2

Problem IIIb: Write down the final answer if the following are displayed on your calculator:

1205.78 L = _____

845,502 cc = _____

c. When a zero is before the decimal place, round to 3 decimal places.

Example: 0.12346 f/cc = 0.123 f/cc

Problem IIIc: 0.01792 f/cc = _____

IV. Use of Calculator/Working with Equations

Addition

When adding two numbers,

1. Punch the first number into the calculator
2. Hit the '+' button
3. Punch the second number into the calculate
4. Hit the '=' button
5. The number in the display is the sum of the two numbers.

Do the same when adding three or more numbers.

Example: 0.0045 s/cc + 0.0025 s/cc = 0.0070 s/cc

Problem IVa: 20.27 sec + 19.73 sec + 21.02 sec = _____

3.10 L/min + 3.23 L/min = _____

Multiplication

Two numbers are to be multiplied together when an 'x' or a '( )' are between them. On your calculator, do the same as for addition, except that you will hit the 'X' button.

Example: $\frac{2.12\ L}{min}$ x 70 min = 2.12 lpm (70 min) = 148.4 L (rounded off to 148 L)

Note: When the same units are in the top and bottom of an equation, they cancel. In the above case, min are in the top and bottom, they cancel, and that leaves L as the units in the answer.

Problem IVb: 9.74 L/min x 125 min = _____

494 L (1000cc/L) = _____

Division

In an equation, two numbers are to be divided when a horizontal line separates them. On your calculator, enter the top number, hit the '÷' button, enter the bottom number, then hit the '=' button. The display is your answer.

Example: $\frac{1.00\ L}{82\ sec}$ = 0.012195 L/min (rounds to 0.012 L/sec)

Problem IVc: $\frac{0.700\ L}{23.3\ sec}$ = _____

Mixed functions (addition plus multiplication/division)

Example: $\frac{1.00\ L}{82\ sec} \times \frac{60\ sec}{min}$ = 0.732 L/min

Problem IVd: $\frac{0.700\ L}{23.3\ sec} \times \frac{60\ sec}{min}$ = _____

$90\ L \times \frac{(273 + 20)}{(273 + 10)}$ = _____

V. Taking an Average

To average a group of numbers, add them together, and then divide by how many numbers you added together.

Example: Average of 2.13 lpm and 2.41 lpm = $\frac{(2.13 \text{ lpm} + 2.41 \text{ lpm})}{2}$ = 2.27 lpm

Problem Va: Average 2.74 lpm and 2.89 lpm = _____

Average 70 s/cc, 59 s/cc, and 80 s/cc = _____

VI. Percent Difference

Sometimes we look at how different two numbers are from each other, or how much something has changed over time. We use the percent difference calculation for this.

Percent difference is calculated by:

1. Subtracting the two numbers from each other (any order)
2. Dividing the difference from step 1 by the average of the two numbers.
3. Multiplying by 100

Example: The morning flowrate was 9.45 l/min. The afternoon flowrate was 9.17 lpm. What is the percent change in flowrate?

First, the average of two flowrates = $\frac{(9.45 \text{ lpm} + 9.17 \text{ lpm})}{2}$ = 9.31 lpm

% change = $\frac{(9.45 \text{ lpm} - 9.17 \text{ lpm})}{9.31 \text{ lpm}}$ x 100% = 3.00%

Problem VI a: The morning flowrate was 2.45 l/min. The afternoon flowrate was 2.17 lpm. What is the percent change in flowrate?

Problem VI b: The volume in Denver is 635 L. The volume in Leadville was 670 L. What is the percent difference in volume?

You should be able to do these calculations.

- Volumes, time, flowrate:

  Equation 1: Volume (L) = Flowrate (LPM) x Time (min)

  Equation 2: $\text{Time (min)} = \frac{\text{Volume (L)}}{\text{Flowrate (LPM)}}$

  Equation 3: $\text{Flowrate (LPM)} = \frac{\text{Volume (L)}}{\text{Time (sec)}} \times \frac{60 \text{ sec}}{\text{min}}$

- Airborne Fiber Concentration (from lab results)

  Step 1: Calculate volume

  Volume (L) = Flowrate (LPM) x Time (min)

  Step 2: Calculate fiber density (E)

$$E(f/mm^2) = \frac{(Sample\ f/field\ -\ Blank\ f/field)}{0.00785\ mm^2/field}$$

  Step 3: Calculate Fiber Concentration (for 25mm cassette)

$$C(f/cc) = \frac{E(f/mm^2) \times 385\ mm^2}{Volume(L) \times 1000\ cc/L}$$

(*Please see OSHA Appendix B F/cc Calculation.pdf for other equation arrangement/format*)