MA 153 Writing Assignment 4 **Due Wednesday 10-18-06 (10 pts)** Name_____

Measurement of Sound Intensity

The decibel was invented by engineers at Bell Telephone as a convenient way to measure sound intensity. The name is in tribute to the company's founder Alexander Graham Bell. Suppose L represents loudness level in decibels and I represents sound intensity. The following table gives several values.

Sound	Sound Intensity, I (W/cm^2)	Loudness Level, L (dB)
Threshold of hearing	$0.0000000000000001 = 10^{-16}$	0
Normal breathing	$0.000000000000001 = 10^{-15}$	10
Quiet library	$0.000000000001 = 10^{-12}$	40
Busy street traffic	$0.000000001 = 10^{-9}$	70
Jackhammer (at 2 m)	$0.000001 = 10^{-6}$	100
Jet plane takeoff (at 30 m)	$0.001 = 10^{-3}$	130
Rupture of eardrum	1	160

(1) 1. Given any value of I, we would like to determine how can we find L.
As a start, create a middle column called $X = \log I$.
Fill in the blanks to complete the third column in the table below.

Sound	Sound Intensity, I (W/cm^2)	$X = \log I$	Loudness Level, L (dB)
Threshold of hearing	10^{-16}	_____	0
Normal breathing	10^{-15}	_____	10
Quiet library	10^{-12}	_____	40
Busy street traffic	10^{-9}	_____	70
Jackhammer (at 2 m)	10^{-6}	_____	100
Jet plane takeoff (at 30 m)	10^{-3}	_____	130
Rupture of eardrum	1	_____	160

(1) 2. Look at the last two columns, X and L. How can you tell that the relationship is linear?
(You might make a column showing ΔX and ΔL and discuss what this tells you.)

(1) 3. Suppose L is written as a function of X.
Is this function **increasing**, **decreasing**, or **constant**? _____

(2) 4. If the equation of this function is written in the form $L = mX + b$, what is the value of m? _____
(This is where the "deci" comes from in the name decibel.) What is the value of b? _____
Before proceeding, check your equation is correct with a grapher by producing a table which matches the values for X and L above.

Select the best choice for your equation.

A. $L = \frac{1}{10}X$	F. $L = -\frac{1}{10}X$	K. $L = 10X$	P. $L = -10X$
B. $L = \frac{1}{10}X - 16$	G. $L = -\frac{1}{10}X - 16$	L. $L = 10X - 16$	Q. $L = -10X - 16$
C. $L = \frac{1}{10}X + 16$	H. $L = -\frac{1}{10}X + 16$	M. $L = 10X + 16$	R $L = -10X + 16$
D. $L = \frac{1}{10}X - 160$	I. $L = -\frac{1}{10}X - 160$	N. $L = 10X - 160$	S. $L = -10X - 160$
E. $L = \frac{1}{10}X + 160$	J. $L = -\frac{1}{10}X + 160$	O. $L = 10X + 160$	T. $L = -10X + 160$
			U. None of these

(1) 5. You have found L in terms of X.
Resubstitute $X = \log I$ in your equation
to write L in terms of I.

$L =$ [ ]

(An expression involving real numbers and I.)

	I	L
Threshold of hearing	10^{-16}	0
Normal breathing	10^{-15}	10
Quiet library	10^{-12}	40
Busy street traffic	10^{-9}	70
Jackhammer (at 2 m)	10^{-6}	100
Jet plane takeoff (at 30 m)	10^{-3}	130
Rupture of eardrum	1	160

(1) 6. If you sit in the front row of a rock concert,
its sound intensity is 10^{-4} W/cm^2.
What is the loudness level in decibels? _____
Use an equation and show work.

Check that your result is you expect, keeping in mind the table of sound intensity measurements.

(1) 7. The blast of 1 kiloton of T.N.T. is quite loud – about 240 dB. Give its sound intensity in W/cm^2.
Show work.

(1) 8. The sound of one Christmas caroler is about 60 dB.
Suppose we have 4 carolers, each singing at an intensity which produces a loudness level of 60 decibels.
What is the loudness level in decibels, of this quartet? _____ dB (round to 1 decimal place)
Hint 1: Use your equation.
Hint 2: The sound ***intensity*** is quadrupled.

(1) 9. Attach a typed page which addresses the following two items:
- o What did you learn from this assignment (or chapter 4) that you did not know before?
- o What questions do you have (if any) concerning concepts about which you are not quite clear?
- o You have seen what a decibel is. How would you think a Bel would be defined?