Name:

Math 130: Biomodule #2:
You must show your work

On the afternoon of August 23, the east coast of the United States experienced an earthquake centered near Mineral, Virginia. Unlike earthquakes in California, this quake was felt from hundreds of miles away. To determine the magnitude of an earthquake, the USGS averages the magnitude calculated from seismographs surrounding the earthquake. Readings from some of these seismographs are recorded in the table below.

station	latitudinal distance* (miles)	actual distance* (miles)	Angle (degrees)**	distance in geocentric degrees	Amplitude (micro-meter)	Period (sec)	magnitude
Soldier's Delight, MD	101 N	117	60	1.7	150	0.95	6.3
Blacksburg, VA	51 S	145	200	2.1	130	0.98	6.3
Mont Chateau, WV		157	130	2.3	71	0.88	6.1
Basking Ridge, NJ	189 N	261	47	3.8	260	0.7	
Kings Mountain, SC	193 S		225	3.9	50	1.1	6.1
Plevna, Ontario	490 N	492	85	7.1	37	0.86	

* From epicenter
**Cartesian angle from epicenter with y-axis pointed north-south

1. Earthquakes send out seismic surface waves measured by a seismogram. The seismogram translates the waves into a chart, graphing the movement of the earth at that location over time. Researchers can then measure the amplitude and period of the waves, and use those values to calculate the magnitude of the earthquake using the following functions:

$$mbLg = 3.75 + 0.90 \log(D) + \log(A/T) \text{ for } 0.5° \leq D \leq 4.0°$$
$$mbLg = 3.30 + 1.66 \log(D) + \log(A/T) \text{ for } 4.0° \leq D \leq 30°$$

where mbLG is magnitude of the surface wave, D is the distance in geocentric degrees, A is the amplitude, and T is the period. Applying the formulas above, use logarithmic arithmetic to fill in the missing magnitudes in the table (1pt)

2. Using trigonometry, fill in the missing distances from the table (1pt).

3. Earthquakes do not necessarily travel in an exact circle. Does it appear that the earthquake was stronger in any particular direction? Explain your reasoning. From the data in the table, is there any other geological aspect that may have decreased the magnitude of the waves in a given area? (2pts)

Name:

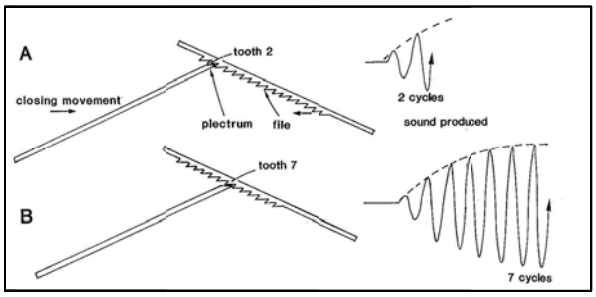
Dr. Shrewsbury is studying the spread of brown marmorated stink bugs through the orchards of Maryland. So far, he has found that the number of stink bugs (in thousands) is a function of the number of trees in the orchard:

$$N(t) = \left(\frac{850*t^2}{420+2*t^2}\right) - 20$$

4. Using this formula, how many stink bugs would you expect to find in an orchard with 50 trees? With 100 trees? (1pt)

5. What is the average increase in stink bugs between these two orchards? (1pt)

6. Is there a limit to how many stink bugs are found in a given orchard? If so, what is the limit? (1pt)



Ultradian rhythms have periods of less than one day, and can be used to describe insect sounds. Male crickets produce a song with a pulsed, sinusoidal sound wave by stridulating (rubbing their wings together), illustrated.

Image from F. Huber, et. al. 1989. Cricket Behavior and Neurobiology, Cornell Univ. Press.

7. Each pulse of sound has a carrier frequency proportional to male body size, and can be modeled by the equation $f_{0\ (\text{in Hertz})}$=625/(2π*mass in **grams**). Males range in weight from 19 to 25 **milligrams**. Determine the carrier frequency (in Hertz, abbreviated Hz, where 1 Hz = $1s^{-1}$) for a male of mass 19 mg and 25 mg. (1pt)

8. If females prefer songs with lower (smaller) carrier frequencies, which size males will they find most attractive? Determine the period for the songs of the most attractive males and write an equation to describe the sine wave for these males (amplitude = 20, no phase shift or vertical shift). Why do you think a female might have a preference for these males? (2pts)