1. (20 pts) mathbioLibrary/setABiocLabs/Lab121_B2_absorb.pg
Because of the accuracy of WebWork, you should use 5 or 6 significant figures on all problems.

This problem examines some physiological data from the laboratory of Professor Carol Beuchat. Animals have evolved different mechanisms for excreting waste nitrogen. The principle means of excreting nitrogen are uric acid, urea, and ammonia. Unfortunately, the latter two are toxic so require larger volumes of water for excretion. Uric acid uses less water, but it requires more energy (ATP) to produce. Thus, animals must weigh their needs of water versus energy when selecting a means of excretion.

a. Here we only examine the amount of urea excreted. First, a standard is run to determine the absorbance at 570 nm as a function of the concentration of urea. (This is a standard technique using spectrophotometry.) The data are listed below:

Urea (mg/dl)	Absorbance	Urea (mg/dl)	Absorbance
2	0.122	80	2.367
10	0.322	100	2.982
20	0.612	130	3.847
40	1.227	150	4.51
50	1.543	200	6.013

Use the EXCEL's trendline feature on a scatterplot to find the best straight line through the data, where

$$A = mu + b,$$

is the straight line describing absorbance, A, as a function of the concentration of urea, u, with EXCEL determining the slope, m, and intercept, b.

$m =$ _____
$b =$ _____

The formula for the line satisfies:
$A =$ _____

Be sure to use the appropriate variable for the concentration of urea.

Find the expected absorbance for a sample containing 63 mg/dl of urea
$A =$ _____
and a sample containing 169 mg/dl of urea.
$A =$ _____

b. Use the formula for the line computed by Trendline in Part a to find the predicted value of absorbance, A, for the concentrations of urea, u, at 50, 100, and 200.

$A(50) =$ _____
$A(100) =$ _____
$A(200) =$ _____

Determine the absolute and percent errors for the concentrations of urea, u, at 50, 100, and 200. In this case, assume that the absorbance given by Trendline is the best value.

When $u = 50$, the absolute error = _____ and percent error = _____
When $u = 100$, the absolute error = _____ and percent error = _____
When $u = 200$, the absolute error = _____ and percent error = _____

Compute the sum of square errors, $J(m,b)$, that Trendline minimized to obtain the best fitting line to the data.
$J(m,b) =$ _____

c. In your Lab report, create a graph showing both the data and this linear model. Describe how well the linear model fits the data. Be sure to link this to your sum of square errors. Discuss what happens to the sum of square errors if you change m or b. Use words to describe what the sum of square errors is measuring. From the Lambert-Beer model, what value should you obtain for b? List one or two reasons why your value of b in Part a might not agree with the theoretical value.

d. In practice, one uses the spectrograph to measure the absorbance, and use the relationship between the two to calculate the urea levels. In order to do this you must now solve for u as a function of A, the inverse function. That is find a function $f(A)$ such that

$$u = f(A)$$

$u =$ _____ $A +$ _____

e. In Professor Beuchat's laboratory they found that the urine from a hummingbird kept at 10°C had an absorbance of 0.14.

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Concentration of urea = _____ mg/dl.

When the hummingbird was kept at 20°C, the absorbance for a urine sample was 0.198.

Concentration of urea = _____ mg/dl.

When the hummingbird was kept at 40°C the absorbance was 0.294.

Concentration of urea = _____ mg/dl.

f. In your lab report, give an explanation of these results with regard to either energy or water conservation by these hummingbirds? Write a paragraph explaining the trade-offs a hummingbird is making with energy and its need of water. Write a brief description of *torpor* and how this relates to hummingbirds. How might torpor affect hummingbird urine?

g. We would like to see if the analysis of urine samples tells us about other species. The table below lists different animals and the corresponding absorbances measured.

Animal	Absorbance
Chicken	3.121
Duck (Fresh Water)	0.474
Duck (Salt Water)	0.781
Frog	0.26
Turtle	1.135
Tortoise	6.769

Concentration of urea for the chicken = _____ mg/dl.
Concentration of urea for the duck (fresh water) = _____ mg/dl.
Concentration of urea for the duck (salt water) = _____ mg/dl.
Concentration of urea for the frog = _____ mg/dl.
Concentration of urea for the turtle = _____ mg/dl.
Concentration of urea for the tortoise = _____ mg/dl.

A hummingbird gets its energy from nectar, which is high in water content. Which animal has the excretion pattern most similar to a hummingbird? _____

h. In your lab report, write a paragraph discussing why the one animal's excretion pattern is similar to a hummingbird's excretion. Also discuss any why you would see the differ concentrations of urea for the different animals in the previous part of the problem. Is there a pattern between the different animals here, and can you offer some explanations?