Give all answers to at least **4 significant figures**.

1. A number of dogs were fed Purina ONE dog food. Data was collected on the average weight of food (in grams) that each dog ate daily. An allometric model is created to find the relationship between the weight of the dog (in kg) and the amount of food consumed. Below is a table of the data collected.

Dog	Weight (kg)	Food (g)
Fox Terrier	4	85
Dachshund	12	180
Brittany Spaniel	17	220
Dalmatian	27	310
Labrador Retriever	33	360
Bloodhound	41	380
Great Dane	68	550

a. Let F be the amount of food ingested daily (in g) and w be the weight of the dog, then the power law expression relating the food consumption to the weight is given by

$$F = kw^a.$$

Use the power law under Excel's Trendline to best fit the data above. Write the formula giving the best values of k and a.

b. Find the percent error between the food consumption given by the model and the actual data for each of the dogs in the table above. (Assume that the weight in the table is accurate.) Which dog has the highest percent error and explain why you might expect this? Also, which dog has the lowest percent error and explain why this might be the case?

c. Use the model to find the missing entries in the table below.

Dog	Weight (kg)	Food (g)
Beagle	13	
Golden Retriever		340
Rottweiler	53	
Siberian Husky		250

d. The rate of change of food consumed as the weight of the dog increases is given by $\frac{dF}{dw}$ or $F'(w)$ evaluated at a particular weight. Find $F'(20)$ and $F'(40)$, which shows the change in amount (g) of food consumed for each kg of weight added by the dog. Which value is higher and what does this say about food consumption as weight increases?

2. Drugs are used for a wide variety of treatments in the U. S. Because toxicity of a drug, the drug is given in doses that build up in the body to a therapeutic dose. The dose is designed to be sufficiently high to be effective, but not so high as to be toxic. Suppose that a specific drug is monitored in a patient for its concentration in the blood (in μg/ml of blood serum). The table below shows the time course of the drug in this patient for the first five days.

Day	Concentration	Day	Concentration
0	0	3	2.47
1	1.87	4	2.52
2	2.31	5	2.55

a. One model for the concentration of the drug in the blood is given by

$$c(t) = c_\infty \left(1 - A\,e^{-bt}\right),$$

where the parameters c_∞, A, and b are fit to the data using a nonlinear least squares best fit. Determine the best fitting parameters and give the sum of square errors. Give the model values and find the percent error at $t = 2$ and 5. What is the c-intercept? Find the horizontal asymptote, which is the steady state level of the drug in this particular patient.

b. A drug entering the body is usually in a dynamic state of flux, which complicates maintenance of a therapeutic dose. The drug is taken at discrete times, then it is metabolized or excreted by the body (characteristic half-life of the drug). If the patient takes a constant amount of drug each day and is assumed to metabolize the drug at a consistent rate, then the following discrete dynamical model can be used to track the amount of drug in the body:

$$C_{n+1} = \alpha C_n + \mu,$$

where C_0 is the initial concentration and α and μ are parameters for the model. Simulate this model from $t = 0$ to 5 and use Excel's Solver to find the best fitting values for C_0, α, and μ. Give the sum of square errors. Give the model values and find the percent error at $t = 2$ and 5. Find the equilibrium for this model, which is the steady state level of the drug in this particular patient. Compare these two models.

c. Use Maple to find the derivative of the first model, $c'(t)$, then compute the rate of change of the drug in the body at $t = 0$, 1, and 2. Use the second model's values at C_0 and C_2 to estimate the rate of change at C_1, ΔC_1, with

$$\Delta C_1 = \frac{C_2 - C_0}{2}.$$

Compare this value to $c'(1)$.