

NOTE: All responses to questions must be typed and work should be on a separate sheet of paper. In general, all typed answers should be in sentence form. Part of your grade will be based on your use of the English language. There are three problems.

1. Answer the following questions about average global temperature, $T(x)$.

- (a) Use function composition to convert the $T_c(x)$ function so that the output is Fahrenheit [ie you need to find $F(T_c(x))$]. Simplify your expression. Recall that $F(C) = 9C/5 + 32$.
 • $T_f(x) = 0.0005004x^2 - 0.005274x + 57.13718^\circ F$, x years after 1950.
- (b) Based on the model what is the predicted global average temperature for 2050? 2100? How much of a change is that since 2000 (2000 is the baseline year the IPCC uses) for each of those years?
 • 2050 average global temp is $61.61^\circ F$ with a change from 2000 of $3.49^\circ F$
 • 2100 average global temp is $67.61^\circ F$ with a change from 2000 of $9.48^\circ F$
- (c) What is the current (use 2008) rate of change of average global temperature? Find the equation of the tangent line at 2008 and use it to predict the temperature for 2050? 2100? How much of a change in temperature will there be compared to 2000 for each of those years?
 • 2008 rate of change is $0.05277^\circ F$ per year. • Tangent line $L(x) = 0.05277x + 55.4538344^\circ F$ x years after 1050. • 2050 average global temp is $60.73^\circ F$ with a change from 2000 of $2.61^\circ F$
 • 2100 average global temp is $63.37^\circ F$ with a change from 2000 of $5.24^\circ F$
- (d) Which information is more useful the temperature prediction or the change in temperature prediction? Why?
 • Change is easier to interpret and understand here.
- (e) Explain why your two predictions are different and which is a more conservative prediction.
 • One follows the curve, the other follows the tangent which assumes constant rates of change. Tangent line is more conservative.
- (f) Use the information above to fill in the blanks (use Fahrenheit):
 According to the model, if current temperature trends continue, in 2100 the average global temperature will be _____, which is an increase of _____ above the 2000 average temperature. On the other hand, if we assume that the rate of temperature increase remains constant at 2008 rates of _____, then the average global temperature will be _____ in 2100, which is an increase of _____ above the 2000 average temperature.
- (g) Provide a (general or real world related) question that you would like answered based on your work here. This should not be something that you could answer yourself with a little work.

2. Answer the following questions about CO_2 , $\text{CO}_2(x)$ function, in the atmosphere based on year.

- (a) Based on the model what is the predicted CO_2 levels in the atmosphere for 2050? 2100? How much of an increase is that for each of those years based on the current (use 2008) CO_2 levels? • 2050 CO_2 levels of 497.65 ppm with a change of 111.78 from 2008. • 2100 CO_2 levels of 693.37 ppm with a change of 307.50 from 2008.
- (b) Assume the rate of change of CO_2 remains constant at 2008 levels. Based on this, what is the predicted increase in CO_2 by 2050? 2100? and what will be the CO_2 levels for those years? • 2050 CO_2 levels of 473.63 ppm with a change of 87.755 from 2008. • 2100 CO_2 levels of 578.10 ppm with a change of 192.23 from 2008. • 2008 rate is 2.089411 ppm/yr
- (c) Explain why your two predictions are different and which is a more conservative prediction. • Following the tangent line gives a more conservative prediction here because we assume constant 2008 rates of increase.
- (d) Which information is more useful the CO_2 prediction or the change in CO_2 prediction? Why? • Actual CO_2 levels are just as useful as change here.
- (e) Provide a short summary similar to (1f) above.
- (f) Provide a (general or real world related) question that you would like answered based on your work here. This should not be something that you could answer yourself with a little work.

3. Answer the following question about grain production per person.

- (a) According to the model what is the current (2009) grain production, what is the rate of change, and current percentage rate of change (percentage rate of change is calculated by $(f'(a)/f(a))100\%$). What type of information does percentage rate of change tell us? • 2009: 300 kg/person; Rate: -2.456 kg/person/yr; Percentage Rate of Change: -0.8196 %/yr. The percentage rate of change gives instantaneous change as a percentage of current production per person. In a sentence: In 2009 grain production per person is decreasing at a rate of -0.8196 percent per year.
- (b) According to the model when will the grain production be 200 kg per person (Note: Here is one source that suggest that 200 Kg per person is the minimum needed for survival: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1116809>). • 2033.5
- (c) According to the tangent line, in other words assuming the current rates of change remain constant, when does production fall to 200 kg per person? • 2049.6

- (d) Explain why your two predictions are different and which is a more conservative prediction. • As above the tangent line gives a more conservative result because it assumes constant rates.
- (e) Would a change in grain production be useful or not particularly? Why? • A change of grain production might help, but production per person is tied to population growth.
- (f) Provide a short summary similar to (1f) above.
- (g) Provide a (general or real world related) question that you would like answered based on your work here. This should not be something that you could answer yourself with a little work.