Regression and Other Calculator Skills Homework

Unless otherwise specified, any decimal approximations should be accurate to three places after the decimal point. This is true for all of AP Precalculus even if it is not written. Use Desmos or a graphing calculator. Do not use a calculator that does not have graphing capabilities.

1. As America's population grows, more telephone numbers are needed. Broward County only had the area code 954 until 2001 when the introduction of 754 became necessary. In 1997, there were only 151 different telephone area codes. Over the next six years, the number of area codes grew at a relatively steady rate until 2003 when there were 274 area codes. The table below shows the number of area codes in the intervening years (Source: USA Today, NeuStar, Inc.). Construct a linear regression model for $N(t)$, the number of area codes in the year t.

Year	1997	1998	1999	2000	2001	2002	2003
Number of Area Codes	151	186	204	226	239	262	274

   a. What in this scenario suggests that a linear model is appropriate?

   b. How many area codes does the model suggest would be needed in the year 2024?

   c. In what year does the model suggest 500 area codes would be needed? Round to the nearest year.

   d. Based on the model, how many years did it take to go from 200 area codes to 300 area codes?

2. Throughout the 1970s, scientists noted a growing area of depleted ozone over Antarctica. The mean area of the "ozone hole" for years in the 1980s is given below with unit "million km^2". Construct a linear regression model for $A(t)$, the size of the ozone hole, in million km^2, in the year t.
(*Source: https://ozonewatch.gsfc.nasa.gov*)

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Area	1.4	0.6	4.8	7.9	10.1	14.2	11.3	19.3	10	18.7

   Based on this model, extrapolate the size of the ozone hole in the year 2023.

3. In 1987, an international treaty known as the Montreal Protocol banned certain ozone depleting substances. Ozone levels stabilized around the year 2000 and then began dropping. The mean area of the "ozone hole" for years in the 2010s is given below with unit "million km^2". Construct a linear regression model for $A(t)$, the size of the ozone hole, in million km^2, in the year t. Construct a model using only the 2010s data. Do not include the 1980s data from the previous question. (*Source: https://ozonewatch.gsfc.nasa.gov*)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Area	19.4	24.7	17.8	21	20.9	25.6	20.7	17.4	22.9	9.3

   Based on this model, extrapolate the year in which the ozone hole will reach a size of zero. Round to the nearest year.

4. Water leaks from a broken pipe at a rate of $R(t) = t^3 - 5t^2 + 5t + 7$ gallons per minute, where t is in minutes since the pipe broke.
   a. Determine the interval over which $R(t)$ decreases.

   b. Determine the average rate of change of $R(t)$ over the interval $1 \leq t \leq 3$. Be sure to include the correct units.

5. In 1995, a population of grey wolves was reintroduced to Yellowstone National Park. At that time, a population of 52 wolves was placed in the park. Over the next fifteen years, the number of wolves in the park could be modelled by $P(t) = \frac{132.3}{1+1.5(2)^{-0.1189t}}$, where $P(t)$ is number of wolves and t is months since the reintroduction.
   a. Based on the model, approximately how many months did it take for the grey wolf population in Yellowstone to double to 104 wolves?

   b. Based on the model, what was the population of wolves after 15 months?

   c. Find the average rate of change of $P(t)$ over the interval $0 \leq t \leq 2$. Be sure to include the correct units.

6. Analyze the graph of $y = x^3 - 5x^2 + x + 7$. Let A be the x-value of the relative maximum of the function. Let B be the x-value of the relative minimum of the function.
   Find $B - A$.

Graph each of the functions on the right to match each description with the letter of the corresponding function.

7. This function has a local maximum at its only zero.

8. This function has a point of inflection at one of its zeros

9. The only point of inflection of this function is located exactly halfway between the x-value of its only local maximum and the x-value of its only local minimum.

10. Over the interval $(-1,1)$, this function has a decreasing rate of change. Over the intervals $(-\infty, -1)$ and $(1, \infty)$, this function has an increasing rate of change.

A) $y = x^3 - 3x^2 + 6$

B) $y = 3\sqrt[3]{x} - \frac{x}{4} - 4$

C) $y = \frac{10}{x^2+3}$

D) $y = \frac{1}{4}x^4 + x^3 - 4x$

11. On June 20, 2025, "KPop Demon Hunters" began streaming on Netflix. Below is data showing the number of views (in millions) that the movie received each week for the first eleven weeks after it was released. Week one (the week of release) was incomplete, so that data point is an extrapolation. Construct a quadratic regression model for this data. (*source: https://www.netflix.com/tudum/top10*)

Week	1	2	3	4	5	6	7	8	9	10	11
Views	21.5	24.2	22.7	24.2	25.8	26.3	26.3	25.9	26.0	25.4	30.1

a. According to the model, what is the maximum number of views KPop Demon Hunter will receive in a week?

b. In which week does the model predict no views of KPop Demon Hunter? Round to the nearest whole week.

c. Based on the model, after how many weeks will KPop Demon Hunter have 10 million views? Round to the nearest whole week.

d. Find the average rate of change of the number of weekly views over the interval $4 \leq t \leq 11$.

e. **Based on the average rate of change in part d**, how many weekly views will KPop Demon Hunter have after 15 weeks?

f. **Based on the quadratic regression model**, how many weekly views will KPop Demon Hunter have after 15 weeks?

12. Use a calculator to analyze the graph of the function $g(x) = \frac{x^2+5x+3}{3x-2}$.

a. Find $\lim_{x \to \frac{2}{3}^+} g(x)$

b. Find $\lim_{x \to \frac{2}{3}^-} g(x)$

c. Over what interval(s) is $g(x) \geq 0$?

Calculator Skills and Linear Regression HW Answers

1.
    a. The phrase "...grew at a relatively steady rate" suggests a constant rate of change. Linear functions have a constant rate of change.
    b. 696.857
    c. 2014
    d. 5.036 years
2. 81.767 million km^2
3. 2047
4.
    a. $R(t)$ decreases over the interval $0.613 \leq t \leq 2.721$
    b. $\frac{R(3\text{ min})-R(1\text{ min})}{(3\text{ min})-(1\text{ min})} = -2\frac{\text{gallon}/\text{min}}{\text{min}}$ (or $-2\frac{\text{gallon}}{\text{min}^2}$)
5.
    a. 20.712 months
    b. 92.149 wolves
    c. $\frac{P(2\text{ month})-P(0\text{ month})}{(2\text{ month})-(0\text{ month})} = 2.655\frac{\text{wolves}}{\text{month}}$
6. 3.127
7. B
8. D
9. A
10. C
11.
    a. 32.428 million views
    b. Week 85
    c. Week 76
    d. $\frac{30.1-24.2}{11-4} = 0.843$ million views
    e. 33.471 million views
    f. 29.555 million views
12.
    a. ∞
    b. $-\infty$
    c. $[-4.303, -0.697] \cup (0.667, \infty)$