AP Precalculus FRQ #2 Practice

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- Note that starting in the 2026/27 school year, the format of FRQ 2 is slightly changed. The former part B(iii) is eliminated. Further, part C used to be a single point, but it is now broken up into two: part C(i) and part C(ii).
- Some problems in this document are a little more silly than an actual FRQ 2 from the AP exam would be (e.g. the "Ed <3 Sandra" problem). It does not affect the quality of the practice these problems provide. I only mention it for the sake of transparency.
- In case you are looking for a specific type of problem, the following table summarizes the problems found in this document. By "Built-In Regression?", I mean "Is the form of the model being constructed one that is typically a default regression form in a graphing calculator or Desmos?"

	Model Type	**Built-In Regression?**	**Number of Parameters**	**Part B(ii)**	**Part C**
Baked Potato	Exponential	No	2	Linear Interpolation	Given lower bound of range Find upper bound of domain
Carbon Dioxide	Exponential	Yes	2	Linear Extrapolation (after upper t)	Given lower bound of domain Find lower bound of range
Dehydrating Spinach	Exponential	No	2	Interpret AROC	Given lower bound of range Find upper bound of domain
Drying Drywall	Exponential	No	2	Linear Extrapolation (after upper t)	Given upper bound of range Find upper bound of domain
Ed <3 Sandra	Logarithmic	No	2	Linear Extrapolation (after upper t)	Given upper bound of range Find upper bound of domain
Everglades Pollution	Quadratic	Yes	3	Linear Extrapolation (before lower t)	Given upper bound on domain Find upper bound on range
Flooded Road	Quadratic	Yes	3	Linear Interpolation	Determine range based on extrema and context
Giant Tortoise	Piecewise	No	3	Linear extrapolation (after upper t)	Given upper bound of domain Find upper bound of range
Hair Dryers	Logarithmic	No ($\log_{10}$)	2	Linear Extrapolation (after upper t)	Given upper bound of range Find upper bound of domain

Horace's Pedometer	Quadratic	No	2	Linear Extrapolation (before lower t)	Determine domain based on extrema and context
Ira's Glass	Quadratic	Yes	3	Linear Extrapolation (before lower t)	Determine domain based on extrema and context
Lawn Be Gone	Exponential	Yes	2	Linear Interpolation	Given upper bound of range Find upper bound of domain
Moore's Law	Exponential	No	2	Interpret AROC	Given lower bound of domain Find lower bound of range
Moving Manure	Quadratic	Yes	3	Linear Interpolation	Given lower bound of range Find upper bound of domain
Naming Babies Ashley	Quadratic	Yes	3	Linear Interpolation	Find zeros. Determine domain.
Pet Rocks	Quadratic	Yes	3	Linear Interpolation	Given lower bound of range Find upper bound of domain
Swift Fall	Logarithmic	No	2	Linear Extrapolation (before lower t)	Given lower bound of range Find upper bound of domain

The final four problems in this document are all identical other than part C. They have the same set up, data points, part A, and part B.

Mold Version 1	Cubic	No	3	Interpret AROC	Given lower bound of range Find upper bound of domain
Mold Version 2	Cubic	No	3	Interpret AROC	Given upper bound of range Find lower bound of domain
Mold Version 3	Cubic	No	3	Interpret AROC	Given upper bound of domain Find lower bound of range
Mold Version 4	Cubic	No	3	Interpret AROC	Given lower bound of domain Find upper bound of range

FRQ 2 Practice – Baked Potato

An instant thermometer is used to monitor the core temperature of a baked potato after it is removed from an oven and left to cool on a countertop. Ten minutes after removal from the oven ($t = 10$), the core temperature of the potato is 185°F. Thirty minutes after removal from the oven ($t = 30$), the core temperature of the potato is 153°F.

The temperature of the potato can be modeled by the function H given by $H(t) = 70 + a(b)^t$, where $H(t)$ is the core temperature, in °F, t minutes after the potato is removed from the oven.

A.

(i) Use the given data to write two equations that can be used to find the values for constants a and b in the expression for $H(t)$.

(ii) Find the values for a and b as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the core temperature of the potato, in °F per minute, from $t = 10$ to $t = 30$. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Use the average rate of change found in part B(i) to estimate the core temperature of the potato for $t = 18$ minutes after the potato was removed from the oven.

C. Once the potato reaches 140°F, it will be eaten. Use model H to respond to the following.

(i) Write and solve an equation whose solution gives the time t, in minutes since removal from the oven, when the core temperature of the potato reaches 140°F. Express your value for t as a decimal approximation.

(ii) Explain how the value for t found in part C(i) can be used to determine an appropriate domain restriction for the model H. Refer to the context of the question in your explanation.

FRQ 2 Practice – Carbon Dioxide

Earth's global average atmospheric concentration of CO_2 has been increasing since the start of the Industrial Revolution. One hundred years after the start of the Industrial Revolution ($t = 100$), the concentration of CO_2 was 332 ppm. One hundred years after that ($t = 200$), the concentration was 393 ppm.

The global average atmospheric concentration of CO_2 in earth's atmosphere can be modeled by the exponential function C given by $C(t) = ab^t$, where $C(t)$ is the concentration of CO_2, given in ppm, t years after the Industrial Revolution began.

A.

(i) Use the given data to write two equations that can be used to find the values for the constants a and b in the expression for $C(t)$.

(ii) Find the values for a and b as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the atmospheric concentration of CO_2, in ppm per year, from $t = 100$ to $t = 200$. Show the computation that leads to your answer.

(ii) Use the average rate of change found in part B(i) to estimate the atmospheric concentration of CO_2 250 years after the Industrial Revolution began.

C. Scientists study tiny bubbles of trapped air in ice to determine past CO_2 concentrations. They have determined that for thousands of years prior to the start of the Industrial Revolution ($t = 0$), earth's average atmospheric concentration of CO_2 was relatively constant. Use model C to respond to the following.

(i) Write an expression that gives the global average atmospheric concentration of CO_2, in ppm, at the start of the Industrial Revolution. Express the concentration as a decimal approximation.

(ii) Explain how the CO_2 concentration found in part C(i) corresponding with the start of the Industrial Revolution can be used to determine a bound on the range of model C. Refer to the context of the question in your explanation.

FRQ 2 Practice – Dehydrating Spinach

Vern is bringing spinach on a backpacking trip. In an effort to lessen the weight of her supplies, she puts the spinach in a food dehydrator machine. Initially ($t = 0$), her spinach weighs 16 ounces. After four hours of dehydrating ($t = 4$), Vern's spinach weighs only 3.5 ounces.

The weight of Vern's spinach can be modeled by the function W given by $W(t) = 1 + a(b)^t$, where $W(t)$ is the weight of the spinach, in ounces, t hours after dehydrating has begun.

A.

(i) Use the given data to write two equations that can be used to find the values for constants a and b in the expression for $W(t)$.

(ii) Find the values for a and b as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the weight of the spinach, in ounces per hour, from $t = 0$ to $t = 4$ hours. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Interpret the meaning of your answer from (i) in the context of the problem.

C. Vern plans to remove the spinach from the dehydrator once the weight of the spinach reaches 1.5 ounces. Use model W to respond to the following.

(i) Write and solve an equation whose solution gives the time t, in hours after the dehydration process begins, when the weight of the spinach reaches 1.5 ounces. Express your value for t as a decimal approximation.

(ii) Explain how the value for t found in part C(i) can be used to determine an appropriate domain restriction for the model W. Refer to the context of the question in your explanation.

FRQ 2 Practice – Drying Drywall

Mr. Q's home had a small flood. To dry out his walls, he runs a dehumidifier machine. He turns on the machine 4 hours after the flood. So, four hours after the flood ($t = 4$), no water has yet been removed from his walls. Six hours later ($t = 10$), 5 liters of water have been removed from the walls.

The volume of water removed from the walls can be modeled by the function R given by $R(t) = 12 - a(b)^t$, where $R(t)$ is the total volume of water removed t hours after the flood.

A.

(i) Use the given data to write two equations that can be used to find the values for constants a and b in the expression for $R(t)$.

(ii) Find the values for a and b as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the volume of water removed, in liters per hour, from $t = 4$ to $t = 10$ hours. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Use the average rate of change found in (i) to estimate the volume of water removed 12 hours after the flood. Show the work that leads to your answer.

C. Mr. Q plans to turn off the dehumidifier after 11 liters of water have been removed from his walls. Use model R to respond to the following.

(i) Write and solve an equation whose solution gives the time t, in hours after the flood, when 11 liters of water are removed. Express your value for t as a decimal approximation.

(ii) Explain how the value for t found in part C(i) can be used to determine an appropriate domain restriction for the model R. Refer to the context of the question in your explanation.

FRQ 2 Practice – Ed <3 Sandra

Ed is deeply in love with Sandra. As time passes, his love only grows deeper. At first sight ($t = 0$), the depth of Ed's love was 4.4 thousand km. A week later ($t = 7$), the depth of Ed's love was 8.2 thousand km.

The depth of Ed's love for Sandra can be modeled by the function L given by $L(t) = a + b\ln(t + 2)$, where $L(t)$ is the depth of his love, in thousands of km, t days after first sight.

A.

(i) Use the given data to write two equations that can be used to find the values for constants a and b in the expression for $L(t)$.

(ii) Find the values for a and b as decimal approximations.

B.

(i) Use the given data to find the average rate of change of Ed's love, in thousands of km per day, from $t = 0$ to $t = 7$ days. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Use the average rate of change found in B (i) to estimate the depth of Ed's love, in thousands of km, on day $t = 15$. Show the work that leads to your answer.

C. Once Ed's love reaches a depth of 14 thousand km, his heart will explode. Top cardiac surgeons will repair the damage, but he'll never love the same way again. Use model L to respond to the following.

(i) Write and solve an equation whose solution gives the time t, in days after first sight, when the depth of Ed's love will be 14 thousand km. Express this value of t as a decimal approximation.

(ii) Explain how the value for t found in part C(i) can be used to determine an appropriate domain restriction for the model L. Refer to the context of the question in your explanation.

FRQ 2 Practice – Everglades Pollution

In 1980, a long term study of the level of pollution in the Florida Everglades started. Each year, the level of pollution is measured and assigned an "index score." Higher scores are indicative of higher levels of pollution. In 1980 ($t = 0$), the Everglades pollution level was an index score of 42. In 1990 ($t = 10$), the pollution level was an index score of 68. Only six years later, in 1996 ($t = 16$), the pollution level was a 79 index score.

The index score for the level of pollution in the Everglades can be modeled by the quadratic function P given by $P(t) = at^2 + bt + c$, where $P(t)$ is the pollution level index score t years after the study began.

A.

(i) Use the given data to write three equations that can be used to find the values for constants a, b, and c in the expression for $P(t)$.

(ii) Find the values for a, b, and c as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the pollution level, in index points per year, from $t = 10$ to $t = 16$. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Use the average rate of change found in B(i) to estimate the index score for the level of pollution in the Florida Everglades for $t = 7$ years after the study began.

C. In the year 2000 ($t = 20$), a large scale restoration effort was launched by Congress to improve water quality, restore natural water flow, and reduce ecological damage in the Everglades. This disrupted the Everglades pollution trend observed prior to 2000. Use model P to respond to the following.

(i) Write an expression that gives the index score representing the pollution level in the year 2000. Express the index score as a decimal approximation.

(ii) Explain how the index score for the year 2000 found in part C(i) can be used to determine an appropriate range restriction for the model P. Refer to the context of the question in your explanation.

FRQ 2 Practice – Flooded Road

t	3	6	13
Water Depth (inches)	6	9	7

During a certain rainstorm, a typically dry road temporarily flooded. The table gives the depth of the water covering the road at various times. Three hours after the rain began ($t = 3$), the road was covered in 6 inches of water. Three hours later ($t = 6$), the road was covered in 9 inches of water. Thirteen hours after the rain began ($t = 13$), the depth of the water covering the road was 7 inches.

The depth of the water covering the road can be modeled by the quadratic function D given by $D(t) = at^2 + bt + c$, where $D(t)$ is the depth of the water, in inches, t hours after the rain began.

A.

(i) Use the given data to write three equations that can be used to find the values for constants a, b, and c in the expression for $D(t)$.

(ii) Find the values for a, b, and c as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the depth of the water covering the road, in inches per hour, from $t = 6$ to $t = 13$ hours after the rain began.

(ii) Use the average rate of change found in part B(i) to estimate the depth of the water covering the road for $t = 10$ hours after the rain began.

C. The quadratic function model D has exactly one absolute maximum at the point $(t_1, D(t_1))$. Use model D to respond to the following.

(i) Write the coordinates of the point $(t_1, D(t_1))$. Express the coordinates as decimal approximations.

(ii) Explain how the coordinates for the point $(t_1, D(t_1))$ found in C(i) can be used to determine an appropriate range restriction for the model D. Refer to the context of the question in your explanation.

FRQ 2 Practice – Giant Tortoise

Aisha is studying the growth of giant tortoises. She tracks the weight of one wild tortoise across many years. Two years after hatching ($t = 2$), Aisha's tortoise weighs 0.3 pounds. Seven years after hatching ($t = 7$), the tortoise weighs 8.4 pounds. It then undergoes an incredible period of growth. Eleven years after hatching ($t = 11$), the tortoise weighs 92.2 pounds.

The weight of Aisha's tortoise can be modeled by the piecewise function W given by

$$W(t) = \begin{cases} a(b)^{t-10} & \text{for} \quad 0 \le t < 10 \\ c - a(b)^{10-t} & \text{for} \quad t \ge 10 \end{cases}$$

where $W(t)$ is the weight of the tortoise, in pounds, at time t years after hatching.

A.

(i) Use the given data to write three equations that can be used to find the values for constants a, b, and c in the expression for $W(t)$.

(ii) Find the values for a, b, and c as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the weight of Aisha's tortoise, in pounds per year, from $t = 7$ to $t = 11$. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Use the average rate of change found in B (i) to estimate the weight of Aisha's tortoise, in pounds, at time $t = 14$ years after hatching.

C. Fifteen years after hatching $t = 15$), a drought causes the tortoise's food supply to dwindle, and the growth of the tortoise is significantly affected.

(i) Write an expression that gives the weight of the tortoise, in pounds, at the time of the drought. Express the weight of the tortoise as a decimal approximation.

(ii) Explain how the tortoise's weight found in part C(i) can be used to determine an appropriate range restriction for the model W. Refer to the context of the question in your explanation.

FRQ 2 Practice – Hair Dryers

An appliance company is developing a new hair dryer meant to be used in the dog grooming industry. They are specifically focused on the endurance of the hair dryer, the number of hours the device may be used continuously without overheating. After 11 weeks of product development ($t = 11$), their hair dryer prototype could be used continuously for 3 hours before it overheated. After 20 weeks of product development ($t = 20$), their hair dryer could be used continuously for 5 hours before it overheated.

The endurance of the prototype hair dryers can be modeled by the logarithmic function E given by $E(t) = a + b\log(t)$, where $E(t)$ is the number of hours the prototype can be left on before it overheats after t research weeks.

A.

(i) Use the given data to write two equations that can be used to find the values for the constants a and b in the expression for $E(t)$.

(ii) Find the values for a and b as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the endurance of the hair dryer prototype, in hours per week of research, from $t = 11$ to $t = 20$. Express your answer as a decimal approximation. Show the computation that leads to your answer.

(ii) Use $E(20)$ and the average rate of change found in (i) to estimate the endurance of the hair dryer after 25 weeks of research.

C. The company plans to stop development of the hair dryer once it reaches an endurance of 7 hours. Use model E to respond to the following.

(i) Write and solve an equation whose solution gives the number of research weeks t needed to create a prototype hair dryer with an endurance of 7 hours. Express your value of t as a decimal approximation.

(ii) Explain how the value of t found in part C(i) can be used to determine an appropriate domain restriction for the model E. Refer to the context of the question in your explanation.

FRQ 2 Practice – Horace's Pedometer

Horace is wearing a watch that tracks how many steps he takes as he hikes. After exactly three hours of hiking ($t = 3$), his watch indicates he has taken exactly 15 thousand steps. After exactly five hours of hiking ($t = 5$), his watch indicates he has taken exactly 21 thousand steps.

The number of steps Horace takes during his hike can be modeled by the quadratic function S given by $S(t) = at^2 + bt$, where $S(t)$ is the number of steps, in thousands, after t hours of hiking.

A.

(i) Use the given data to write two equations that can be used to find the values for constants a and b in the expression for $S(t)$.

(ii) Find the values for a and b as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the number of steps Horace takes, in thousands of steps per hour, from $t = 3$ to $t = 5$ hours. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Use the average rate of change found in part B(i) to estimate the number of steps Horace has taken in his first two hours of hiking ($t = 2$). Show the work that leads to your answer.

C. The quadratic model S has an absolute maximum at the point $\left(t_1, S(t_1)\right)$. Use model S to respond to the following.

(i) Write the coordinates of the point $\left(t_1, S(t_1)\right)$. Express the coordinates as decimal approximations.

(ii) Based on the context of the problem, explain how the maximum found in part C(i) can be used to determine a boundary for the domain of S.

FRQ 2 Practice – Ira's Glass

t	0	2	5
Thousands of Pounds	20	35	55

At the start of 2015, Ira opened a new business turning recycled glass into sand. At the end of each year, he reports to his social media followers how many total pounds of glass he has recycled since the business opened. At the end of 2015 ($t = 0$), he reports that he recycled 20 thousand pounds of glass. At the end of 2017 ($t = 2$), he reports that he recycled 35 thousand pounds of glass since the business began. At the end of 2020 ($t = 5$), he reports that he recycled 55 thousand pounds of glass since the business began.

The amount of glass that Ira's business recycled can be modeled by the quadratic function $R(t) = at^2 + bt + c$, where $R(t)$ is the total amount recycled, in thousands of pounds, since the business began, and t is years since the first end of year report for the business.

A.

(i) Use the given data to write three equations that can be used to find the values for the constants a, b, and c in the expression for $R(t)$.

(ii) Find the values for a, b, and c as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the total recycled amount, in thousands of pounds per year, from $t = 2$ to $t = 5$. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Use the average rate of change found in part B(i) to estimate the total amount recycled at the end of 2016 ($t = 1$). Show the work that leads to your answer.

C. The quadratic model R has exactly one absolute maximum or absolute minimum. This absolute maximum or minimum occurs at the point $(m, R(m))$. Use model R to respond to the following.

(i) Write the coordinates of the point $(m, R(m))$. Express the coordinates as decimal approximations.

(ii) Explain how the coordinates for the point $(m, R(m))$ found in part C(i) can be used to determine an appropriate domain restriction for the model R. Refer to the context of the question in your explanation.

FRQ 2 Practice – Lawn Be Gone

The company "Lawn Be Gone" sells pine straw as an alternative for homeowners wishing to replace grass lawns. On January 1st of 2020 $(t = 0)$, the company had sold 5000 bales of pine straw in the past year. On January 1st of 2026 $(t = 6)$, the company had sold $24{,}000$ bales of pine straw in the past year.

The amount of pine straw sold by this company can be modeled by the exponential function S given by $S(t) = a(b)^t$, where $S(t)$ is the number of bales sold in the year preceding time t, and t is the number of years since January 1st of 2020.

A.

(i) Use the given data to write two equations that can be used to find the values of a and b in the expression for $S(t)$.

(ii) Find the values for a and b as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the quantity sold, in bales per year, from $t = 0$ to $t = 6$ years. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Use the average rate of change found in (i) to estimate the quantity of pine straw sold, in bales, for $t = 4$. Show the work that leads to your answer.

C. Initially, Lawn Be Gone only sells their product at local stores. Once Lawn Be Gone's yearly sales reach $40{,}000$ bales, they plan to begin selling online and shipping to a wider audience. This will dramatically alter the quantity they sell. Use model S to respond to the following.

(i) Write and solve an equation whose solution gives the time t, in years since January 1st of 2010, when the yearly sales by Lawn Be Gone reaches $40{,}000$ bales. Express your value for t as a decimal approximation.

(ii) Explain how the value for t found in part C(i) can be used to determine an appropriate domain restriction for the model S. Refer to the context of the question in your response.

FRQ 2 Practice – Moore's Law

Transistors are a key component of digital electronics. In 1965, the scientist Gordon Moore published a now famous observation known as "Moore's Law" that relates the progress of time with the number of transistors that fit on an integrated circuit. In the year 1980 $(t = 15)$, the number of transistors that fit on a state-of-the-art integrated circuit was 40 thousand. By the year 1985 $(t = 20)$, the number of transistors that could fit on an integrated circuit had increased to 100 thousand.

The number of transistors that fit on an integrated circuit can be modeled by the exponential function N given by $N(t) = ab^{t-10}$, where $N(t)$ is the number of transistors that fit on an integrated circuit, in thousands, t years after Gordon Moore published his observation.

A.

(i) Use the given data to write two equations that can be used to find the values for the constants a and b in the expression for $N(t)$.

(ii) Find the values for a and b as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the number of transistors, in transistors per year, from $t = 15$ to $t = 20$. Show the computation that leads to your answer.

(ii) Interpret the meaning of your answer from part B(i) in the context of the problem.

C. The integrated circuit was invented in 1958 $(t = -7)$, so it is not appropriate to apply the model N for years prior to 1958. Use model N to respond to the following.

(i) Write an expression that gives the number of transistors, in thousands, that fit on an integrated circuit for the year 1958. Express the number of transistors as a decimal approximation.

(ii) Explain how the number of transistors for the year 1958 found in part C (i) can be used to determine an appropriate range restriction for the model N. Refer to the context of the question in your explanation.

FRQ 2 Practice – Moving Manure

Tommy is shoveling manure from a pile on his uncle's farm. As the day goes on, he finds ways to make the process more efficient, but he also eventually grows tired. So, his productivity level rises and falls throughout the day. At the start of the day ($t = 0$), Tommy can shovel $3.5\ \mathrm{kg}$ of manure in one minute. Three hours after he begins ($t = 3$), Tommy can shovel $6\ \mathrm{kg}$ of manure in one minute. Five hours after he begins ($t = 5$), Tommy has grown tired and can only shovel $3.1\ \mathrm{kg}$ of manure in one minute.

Tommy's productivity level can be modeled by the quadratic function P given by $P(t) = at^2 + bt + c$, where t is the time, in hours, after Tommy began, and $P(t)$ is the amount of manure, in kilograms, Tommy can shovel in one minute at that time.

A.

(i) Use the given data to write three equations that can be used to find the values for the constants a, b, and c in the expression for $P(t)$.

(ii) Find the values for a, b, and c as decimal approximations.

B.

(i) Use the given data to find the average rate of change, in kilograms per hour, of Tommy's productivity level from $t = 3$ to $t = 5$ hours. Express your answer as an exact decimal. Show the computations that lead to your answer.

(ii) Use the average rate of change found in (i) to estimate Tommy's productivity level, in kilograms, four hours after he begins ($t = 4$). Show the work that leads to your answer.

C. Tommy starts shoveling at $t = 0$ and plans to stop shoveling once his productivity level reaches the point where he can only shovel 2 kilograms of manure in a minute. Use model P to respond to the following.

(i) Write and solve an equation whose solution gives the time t, in hours since Tommy started, when Tommy can only shovel 2 kilograms in a minute. Express your value for t as a decimal approximation.

(ii) Explain how the value for t found in part C(i) can be used to determine an appropriate domain restriction for the model P. Refer to the context of the question in your explanation.

FRQ 2 Practice – Naming Babies Ashley

t (years since Dec 31, 1970)	15	18	20
Number of Ashleys (in thousands)	47	50	46

The table above shows the popularity of the name Ashley among newborns in the United States at different times. In 1985 ($t = 15$), 47 thousand American newborns were named Ashley. In 1988 ($t = 18$), 50 thousand American newborns were named Ashley. In 1990 ($t = 20$), 46 thousand American newborns were given the name Ashley.

The number of American newborns named Ashley can be modeled by the quadratic function N given by $N(t) = at^2 + bt + c$, where $N(t)$ is the number of newborns named Ashley, in thousands, in the one-year period preceding time t, where t is given in years since December 31st of 1970.

A.

(i) Use the given data to write three equations that can be used to find the values for constants a, b, and c in the expression for $N(t)$.

(ii) Find the values for a, b, and c as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the number of American newborns named Ashley, in thousands per year, from $t = 18$ to $t = 20$ years. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Use the average rate of change found in (i) to estimate the number of American newborns named Ashley in 1981 ($t = 11$). Show the work that leads to your answer.

C. The quadratic function model N has exactly two zeros. Use model N to respond to the following.

(i) Write and solve an equation whose solutions give the two zeros of model N. Express the zeros as decimal approximations.

(ii) Explain how the zeros found in part C(i) can be used to determine an appropriate domain restriction for the model N. Refer to the context of the question in your explanation.

FRQ 2 Practice – Pet Rocks

In 1975, Gary Dahl thought to himself “I bet I could make a lot of money selling rocks but branding them as pets.” They were an instant success. Immediately after going on sale ($t = 0$), Pet Rocks sold at a rate of 4.7 thousand rocks per day. Four months later ($t = 4$), they were selling at a rate of 7.4 thousand rocks per day. After one more month ($t = 5$), the Pet Rocks were only selling at a rate of 4 thousand rocks per day.

The sales rate of Pet Rocks can be modeled by the function S given by $S(t) = at^2 + bt + c$, where $S(t)$ is the sales rate (in thousands of rocks per day) t months after the launch of the product.

A.

- (i) Use the given data to write three equations that can be used to the find the values for constants a, b, and c in the expression for $S(t)$.
- (ii) Find the values for a, b, and c as decimal approximations.

B.

- (i) Use the given data to find the average rate of change of change of the Pet Rock sales rate, in thousands per day per month, from $t = 0$ to $t = 4$ months. Express your answer as a decimal approximation. Show the computations that lead to your answer.
- (ii) Use the average rate of change found in (i) to estimate the Pet Rock sales rate for $t = 3$ months. Show the work that leads to your answer.

C. The popularity of Pet Rocks was short lived. Once the sales rate of Pet Rocks decreased to 1.5 thousand rocks per day, the price was lowered for the first time. The new lower price had the desired effect of increasing the sales rate of Pet Rocks. Use model S to respond to the following.

- (i) Write and solve an equation whose solution gives the time t, in months since the launch of Pet Rocks, when the sales rate reached 1.5 thousand rocks per day leading to the price being lowered. Express your value for t as a decimal approximation.
- (ii) Explain how the value for t found in part C(i) can be used to determine an appropriate domain restriction for the model S. Refer to the context of the question in your explanation.

FRQ 2 Practice – Swift Fall

The Swift Observatory is a collection of telescopes launched into orbit in November of 2004. Due to strong solar activity, the Swift Observatory has been losing altitude over the past couple years. In December of 2025, NASA changed Swift's orientation in an attempt to make it more streamlined. Three months later ($t = 3$), the Swift Observatory was orbiting at an altitude of 399 km. But only four months after that ($t = 7$), the Swift Observatory was only orbiting at an altitude of 360 km.

The altitude of the Swift Observatory can be modeled by the function S given by $H(t) = a + b\ln(11 - t)$, where $H(t)$ is Swift's altitude, in kilometers, t months after December of 2025.

A.

(i) Use the given data to write two equations that can be used to the find the values for constants a and b in the expression for $H(t)$.

(ii) Find the values for a and b as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the altitude of the Swift Observatory, in kilometers per month, from $t = 3$ to $t = 7$ months. Express your answer as a decimal approximation. Show the computations that lead to your answer.

(ii) Use the average rate of change found in (i) to estimate the altitude of Swift Observatory for $t = 0$ months.

C. As objects fall from orbit, the heat of earth's atmosphere can cause a catastrophic breakup. When the Swift Observatory falls to an altitude of 80 km, its main structure will break into pieces and vaporize. Use model S to respond to the following.

(i) Write and solve an equation whose solution gives the time t, in months since December of 2025, when the altitude of the Swift Observatory reaches 80 km. Express your value for t as a decimal approximation.

(ii) Explain how the value for t found in part C(i) can be used to determine an appropriate domain restriction for the model H. Refer to the context of the question in your explanation.

FRQ 2 Practice – Mold Version 1

t (hours after noon)	0	2	5
Mold Concentration ($\frac{\text{spores}}{\text{m}^3}$)	600	560	450

The table gives the mold concentration in the air of a sealed room while a cleaning is conducted. At noon ($t = 0$), there are 600 mold spores per cubic meter of air. Two hours later ($t = 2$), there are 560 mold spores per cubic meter. Three hours after that ($t = 5$), there are 450 mold spores per cubic meter.

The concentration of mold in the air can be modeled by the cubic function M given by $M(t) = at^3 + bt + c$, where $M(t)$ represents the number of mold spores per cubic meter of air t hours after noon.

A.

(i) Use the given data to write three equations that can be used to find the values for the constants a, b, and c in the expression for $M(t)$.

(ii) Find the values for a, b, and c as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the concentration of mold, in $\frac{\text{spores}}{\text{m}^3}$ per hour, from $t = 0$ to $t = 2$. Show the computation that leads to your answer.

(ii) Interpret the meaning of your answer from (i) in the context of the problem.

C. The cleaning will continue until the concentration of mold is 0 spores per cubic meter. Use model M to respond to the following.

(i) Write and solve an equation whose solution gives the time t, in hours past noon, when the concentration of mold will reach 0 spores per cubic meter. Express your value of t as a decimal approximation.

(ii) Explain how the value for t found in part C(i) can be used to determine an appropriate domain restriction for the model M. Refer to the context of the question in your explanation.

FRQ 2 Practice – Mold Version 2

t (hours after noon)	0	2	5
Mold Concentration ($\frac{\text{spores}}{\text{m}^3}$)	600	560	450

The table gives the mold concentration in the air of a sealed room while a cleaning is conducted. At noon ($t = 0$), there are 600 mold spores per cubic meter of air. Two hours later ($t = 2$), there are 560 mold spores per cubic meter. Three hours after that ($t = 5$), there are 450 mold spores per cubic meter.

The concentration of mold in the air can be modeled by the cubic function M given by $M(t) = at^3 + bt + c$, where $M(t)$ represents the number of mold spores per cubic meter of air t hours after noon.

A.

(i) Use the given data to write three equations that can be used to find the values for the constants a, b, and c in the expression for $M(t)$.

(ii) Find the values for a, b, and c as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the concentration of mold, in $\frac{\text{spores}}{\text{m}^3}$ per hour, from $t = 0$ to $t = 2$. Show the computation that leads to your answer.

(ii) Interpret the meaning of your answer from (i) in the context of the problem.

C. The cleaning is a machine automated process that began when the mold concentration was 800 spores per cubic meter. Use model M to respond to the following.

(i) Write and solve an equation whose solution gives the time t, in hours past noon, when the concentration of mold is 800 spores per cubic meter. Express your value of t as a decimal approximation.

(ii) Explain how the value for t found in part C(i) can be used to determine an appropriate domain restriction for the model M. Refer to the context of the question in your explanation.

FRQ 2 Practice – Mold Version 3

t (hours after noon)	0	2	5
Mold Concentration ($\frac{\text{spores}}{\text{m}^3}$)	600	560	450

The table gives the mold concentration in the air of a sealed room while a cleaning is conducted. At noon ($t = 0$), there are 600 mold spores per cubic meter of air. Two hours later ($t = 2$), there are 560 mold spores per cubic meter. Three hours after that ($t = 5$), there are 450 mold spores per cubic meter.

The concentration of mold in the air can be modeled by the cubic function M given by $M(t) = at^3 + bt + c$, where $M(t)$ represents the number of mold spores per cubic meter of air t hours after noon.

A.

(i) Use the given data to write three equations that can be used to find the values for the constants a, b, and c in the expression for $M(t)$.

(ii) Find the values for a, b, and c as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the concentration of mold, in $\frac{\text{spores}}{\text{m}^3}$ per hour, from $t = 0$ to $t = 2$. Show the computation that leads to your answer.

(ii) Interpret the meaning of your answer from (i) in the context of the problem.

C. The cleaning will continue until 8:00 PM ($t = 8$). Use model M to respond to the following.

(i) Write an expression that gives the mold concentration, in spores per cubic meter, at 8:00 PM. Express the mold concentration as a decimal approximation.

(ii) Explain how the mold concentration at 8:00 PM found in part C(i) can be used to determine an appropriate range restriction for the model M. Refer to the context of the question in your explanation.

FRQ 2 Practice – Mold Version 4

t (hours after noon)	0	2	5
Mold Concentration ($\frac{\text{spores}}{\text{m}^3}$)	600	560	450

The table gives the mold concentration in the air of a sealed room while a cleaning is conducted. At noon ($t = 0$), there are 600 mold spores per cubic meter of air. Two hours later ($t = 2$), there are 560 mold spores per cubic meter. Three hours after that ($t = 5$), there are 450 mold spores per cubic meter.

The concentration of mold in the air can be modeled by the cubic function M given by $M(t) = at^3 + bt + c$, where $M(t)$ represents the number of mold spores per cubic meter of air t hours after noon.

A.

(i) Use the given data to write three equations that can be used to find the values for the constants a, b, and c in the expression for $M(t)$.

(ii) Find the values for a, b, and c as decimal approximations.

B.

(i) Use the given data to find the average rate of change of the concentration of mold, in $\frac{\text{spores}}{\text{m}^3}$ per hour, from $t = 0$ to $t = 2$. Show the computation that leads to your answer.

(ii) Interpret the meaning of your answer from (i) in the context of the problem.

C. The cleaning began at 11:00 AM ($t = -1$). Use model M to respond to the following.

(i) Write an expression that gives the mold concentration, in spores per cubic meter, at 11:00 AM. Express the mold concentration as a decimal approximation.

(ii) Explain how the mold concentration at 11:00 AM found in part C(i) can be used to determine an appropriate range restriction for the model M. Refer to the context of the question in your explanation.

Solutions to FRQ 2 Practice – Baked Potato

A.

(i) $185 = 70 + a(b)^{10}$

$153 = 70 + a(b)^{30}$

(ii) $a = 135.365\ b = 0.984$

B.

(i) $\frac{H(30)-H(10)}{30-10} = \frac{153-185}{30-10} = \frac{-32}{20} = -\frac{8}{5} = -1.6$

(ii) $H(18) \approx H(10) + 8 \times \text{AROC} = 185 + 8\left(-\frac{8}{5}\right) = 172.2$

Alternatively:

$\frac{H(18)-H(10)}{18-10} \approx -\frac{8}{5}$

$\frac{H(18)-185}{8} \approx -\frac{8}{5}$

$H(18) \approx 185 + 8\left(-\frac{8}{5}\right) = 172.2$

C.

(i) $H(t) = 140$

$70 + 135.36541(0.983828)^t = 140$

$t = 40.448$

(ii) Once the potato has cooled to 140°F, it will be eaten, so any prediction of how it cools when left on the counter is meaningless after this point. The potato is eaten at after $t = 40.448$ minutes, so the model should only be applied to t-values prior to this time. The domain of the model should be restricted to $t < 40.448$. (and since the potato was not yet cooling on the counter for $t < 0$, we should further restrict the domain of the model to $0 < t < 40.448$)

Solutions to FRQ 2 Practice – Carbon Dioxide

A.

(i) $332 = ab^{100}$

$393 = ab^{200}$

(ii) $a = 280.468$ and $b = 1.002$

B.

(i) $\frac{C(200)-C(100)}{200-100} = \frac{393-332}{200-100} = \frac{61}{100} = 0.61$

(ii) $C(250) \approx C(200) + 50 \times \text{AROC} = 393 + 50\left(\frac{61}{100}\right) = 423.5$

Alternatively:

$\frac{C(250)-C(200)}{250-200} \approx \frac{61}{100}$

$\frac{C(250)-393}{50} \approx \frac{61}{100}$

$C(250) \approx 393 + (50)\left(\frac{61}{100}\right) = 423.5$

C.

(i) $C(0) = 280.468$

(ii) The model $C(t)$ is an increasing function. Notably, for $t < 0$, the model $C(t)$ increases. But in reality, prior to the start of the start of the Industrial Revolution ($t = 0$), the level of CO_2 in the atmosphere was relatively constant. So, it is not appropriate to apply $C(t)$ for negative t-values. Since $C(0) = 280.468$ and C is an increasing function, the range of C has a lower bound of 280.468. $C(t) \geq 280.468$ for all t in the domain $t \geq 0$.

Solutions to FRQ 2 Practice – Dehydrating Spinach

A.

(i) $16 = 1 + a(b)^0$

$3.5 = 1 + a(b)^4$

(ii) $a = 15$ and $b = 0.639$

B.

(i) $\frac{W(4)-W(0)}{4-0} = \frac{3.5-16}{4-0} = \frac{-12.5}{4} = -3.125$

(ii) Over the first four hours of dehydrating, the weight of Vern's spinach decreases on average by 3.125 ounces per hour.

C.

(i) $W(t) = 1.5$

$1 + 15(0.638943)^t = 1.5$

$t = 7.593$

(ii) For $t > 7.593$, the model W is decreasing and has output values less than 1.5. But in reality, the weight of the spinach will not decrease below 1.5 as the spinach will be removed from the dehydrator at that point. Beyond $t = 7.593$, the model does not reflect reality. So, we restrict the model's domain to $t \leq 7.593$.

Solutions to FRQ 2 Practice – Drying Drywall

A.

(i) $0 = 12 - a(b)^4$

$5 = 12 - a(b)^{10}$

(ii) $a = 17.189$ and $b = 0.914$

B.

(i) $\frac{R(10)-R(4)}{10-4} = \frac{5-0}{10-4} = \frac{5}{6} = 0.833$

(ii) $R(12) \approx R(10) + 2 \times \text{AROC} = 5 + 2\left(\frac{5}{6}\right) = 6.667$

Alternatively:

$\frac{R(12)-R(10)}{12-10} \approx \frac{5}{6}$

$\frac{R(12)-5}{2} \approx \frac{5}{6}$

$$R(12) \approx 5 + (2)\left(\frac{5}{6}\right) = 6.667$$

C.

(i) $R(t) = 11$

$12 - 17.18845(0.914084)^t = 11$

$t = 31.661$

(ii) For $t > 31.661$, the outputs of model $R(t)$ are greater than 11. But in reality, once 11 liter have been removed from the wall, the dehumidifier will have been turned off, so it will not remove any more than those 11 liters. It is not appropriate to apply the model representing the effect of the dehumidier to times after the dehumidifier is turned off. So, we must restrict the domain of model R to $t < 31.661$. (It similarly does not make sense to apply the model to times before the dehumidifier was turned on, so we further restrict the domain to $4 < t < 31.661$)

Solutions to FRQ 2 Practice – Ed <3 Sandra

A.

(i) $4.4 = a + b\ln(0+2)$
$8.2 = a + b\ln(7+2)$

(ii) $a = 2.649$ and $b = 2.526$

B.

(i) $\frac{L(7)-L(0)}{7-0} = \frac{8.2-4.4}{7-0} = \frac{3.8}{7} = 0.543$

(ii) $L(15) \approx L(7) + 8 \times \text{AROC} = 8.2 + 8\left(\frac{3.8}{7}\right) = 12.543$

Alternatively:
$\frac{L(15)-L(7)}{15-7} \approx \frac{3.8}{7}$
$\frac{L(15)-8.2}{8} \approx \frac{3.8}{7}$
$L(15) \approx 8.2 + (8)\left(\frac{3.8}{7}\right) = 12.543$

C.

(i) $L(t) = 14$
$2.64879 + 2.52647\ln(t+2) = 14$
$t = 87.382$

(ii) Since $L(87.382) = 14$, Ed's heart will explode $t = 87.382$ days after first seeing Sandra. Although he survives the incident, it is given that he cannot love the same way again. It is therefore inappropriate to use a function constructed based on pre-explosion love to model post-explosion love. So, we restrict the domain of L to $t < 87.382$. (we may further restrict the domain to $0 \le t < 87.382$ based on it being meaningless to model the depth of Ed's love for Sandra before they have ever met)

Solutions to FRQ 2 Practice – Everglades Pollution

A.

(i) $42 = a(0)^2 + b(0) + c$
$68 = a(10)^2 + b(10) + c$
$79 = a(16)^2 + b(16) + c$

(ii) $a = -0.048$, $b = 3.079$, and $c = 42$

B.

(i) $\frac{P(16)-P(10)}{16-10} = \frac{79-68}{16-10} = \frac{11}{6} = 1.833$

(ii) $P(7) \approx P(10) - 3 \times \text{AROC} = 68 - 3\left(\frac{11}{6}\right) = 62.5$

Alternately:
$\frac{P(7)-P(10)}{7-10} \approx \frac{11}{6}$
$\frac{P(7)-68}{-3} \approx \frac{11}{6}$
$P(7) \approx 68 + (-3)\left(\frac{11}{6}\right) = 62.5$

C.

(i) $P(20) = 84.417$

(ii) It is given that after the year 2000 ($t = 20$), the pollution trend changes significantly, so we should not apply the function based on pre-2000 data to model post-2000 pollution. We must restrict the domain of P to $t \le 20$. Since on this domain $P(t)$ is an increasing function, the greatest element of its range is $P(20) = 84.417$. On its domain, the range is $P(t) \le 84.417$.

Solutions to FRQ 2 Practice – Flooded Road

A.

(i) $6 = a(3)^2 + b(3) + c$
$9 = a(6)^2 + b(6) + c$
$7 = a(13)^2 + b(13) + c$

(ii) $a = -0.129$, $b = 2.157$, and $c = 0.686$

B.

(i) $\frac{D(13)-D(6)}{13-6} = \frac{7-9}{13-6} = \frac{-2}{7} = -0.286$

(ii) $D(10) \approx D(6) + 4 \times \text{AROC} = 9 + 4\left(-\frac{2}{7}\right) = 7.857$

Alternatively:
$\frac{D(10)-D(6)}{10-6} \approx -\frac{2}{7}$
$\frac{D(10)-9}{4} \approx -\frac{2}{7}$
$D(10) \approx 9 + (4)\left(-\frac{2}{7}\right) = 7.857$

C.

(i) The model D has an absolute maximum corresponding with the point $(8.389, 9.734)$.

(ii) The depth of water covering the road cannot be negative. Because D is a quadratic function whose graph is concave down on its domain, there is a maximum value for the depth of the water covering the road. Based on the model, the maximum is 9.734 inches. Therefore, an appropriate range restriction for the model D is $0 \leq D(t) \leq 9.734$ inches.

Solutions to FRQ 2 Practice – Giant Tortoise

A.

(i) $0.3 = a(b)^{2-10}$
$8.4 = a(b)^{7-10}$
$92.2 = c - a(b)^{10-11}$

(ii) $a = 62.026$, $b = 1.947$, and $c = 124.052$

B.

(i) $\frac{W(11)-W(7)}{11-7} = \frac{92.2-8.4}{11-7} = \frac{83.8}{4} = 20.95$

(ii) $W(14) \approx W(11) + 3 \times \text{AROC} = 92.2 + 3\left(\frac{83.8}{4}\right) = 155.05$

C.

(i) $W(15) = 121.837$

(ii) Although the tortoise may continue growing after $t = 15$, the model $W(t)$ is no longer appropriate to use after $t = 15$ since it is not appropriate to use a function based on pre-drought data to model post-drought tortoise weights. Since W is an increasing function and $t = 15$ is the upper bound on the domain of that model, 121.837 will be an upper bound to the range of $W(t)$.

Solutions to FRQ 2 Practice – Hair Dryers

A.

(i) $3 = a + b\log 11$
$5 = a + b\log 20$

(ii) $a = -5.022$ and $b = 7.703$

B.

(i) $\frac{E(20)-E(11)}{20-11} = \frac{5-3}{20-11} = \frac{2}{9} = 0.222$

(ii) $E(25) \approx E(20) + 5 \times \text{AROC} = 5 + 5\left(\frac{2}{9}\right) = 6.111$

Alternatively:
$\frac{E(25)-E(20)}{25-20} \approx \frac{2}{9}$
$\frac{E(25)-5}{5} \approx \frac{2}{9}$
$E(25) \approx 5 + (5)\left(\frac{2}{9}\right) = 6.111$

C.

(i) $E(t) = 7$
$-5.0219 + 7.70305\log(t) = 7$
$t = 29$

(ii) For $t > 29$, $E(t)$ increases and has values greater than 7. But in reality, the endurance of the hair dryer will be constant after the hair dryer reaches an endurance of 7 hours (which happens at $t = 29$ weeks of research) as after that point, no more work is done to improve the hair dryer. So, the model does not reflect reality for $t > 29$. We must restrict the domain of $E(t)$ to $t \leq 29$. (similarly, $E(t) < 0$ for $t < 4.487$, but in reality the endurance of the hair dryer cannot be a negative amount of time. So we further restrict out domain to $4.487 \leq t \leq 29$)

Solutions to FRQ 2 Practice – Horace's Pedometer

A.

(i) $15 = a(3)^2 + b(3)$
$21 = a(5)^2 + b(5)$

(ii) $a = -0.4$ and $b = 6.2$

B.

(i) $\frac{S(5)-S(3)}{5-3} = \frac{21-15}{5-3} = 3$

(ii) $S(2) \approx S(3) - 1 \times \text{AROC} = 15 - 1(3) = 12$

Alternatively:
$\frac{S(2)-S(3)}{2-3} \approx 3$
$\frac{S(2)-15}{-1} \approx 3$
$S(2) \approx 15 + (-1)(3) = 12$

C.

(i) The model S has a maximum at the point $(7.75, 24.025)$.

(ii) For $t > 7.75$, the model S decreases. But in reality, total steps taken cannot decrease. The model cannot reflect reality for t-values greater than the t-value of the maximum, so we restrict the domain of S to $t \leq 7.75$. (the lower bound of the domain should be $t = 0$ since it is not appropriate to model total steps hiked before the hike began, so we may further restrict the domain to $0 \leq t \leq 7.75$)

Solutions to FRQ 2 Practice – Ira's Glass

A.

(i) $20 = a(0)^2 + b(0) + c$
$35 = a(2)^2 + b(2) + c$
$55 = a(5)^2 + b(5) + c$

(ii) $a = -0.167$, $b = 7.833$, and $c = 20$

B.

(i) $\frac{R(5)-R(2)}{5-2} = \frac{55-35}{5-2} = \frac{20}{3} = 6.667$

(ii) $R(1) \approx R(2) - 1 \times \text{AROC} = 35 - 1\left(\frac{20}{3}\right) = 28.333$

Alternatively:
$\frac{R(1)-R(2)}{1-2} \approx \frac{20}{3}$
$\frac{R(1)-35}{-1} \approx \frac{20}{3}$
$R(1) \approx 35 + (-1)\left(\frac{20}{3}\right) = 28.333$

C.

(i) The model R has an absolute maximum corresponding with the point $(23.5, 112.042)$.

(ii) For $t > 23.5$, the model R decreases. But in reality, "total amount recycled since the business began" cannot decrease. So, for t-values greater than the t-value of the maximum, the model clearly does not reflect reality, and it would be inappropriate to apply the model for these t-values. $t = 23.5$ is an upper bound to the domain of R. The domain of R is $t < 23.5$.

Solutions to FRQ 2 Practice – Lawn Be Gone

A.

(i) $5000 = ab^0$
$24000 = ab^6$

(ii) $a = 5000$ and $b = 1.299$

B.

(i) $\frac{S(6)-S(0)}{6-0} = \frac{24000-5000}{6-0} = \frac{19000}{6} = 3166.667$

(ii) $S(4) \approx S(0) + 4 \times \text{AROC} = 5000 + 4\left(\frac{19000}{6}\right) = 17666.667$

Alternatively:
$\frac{S(4)-S(0)}{4-0} \approx \frac{19000}{6}$
$\frac{S(4)-5000}{4} \approx \frac{19000}{6}$
$S(4) \approx 5000 + (4)\left(\frac{19000}{6}\right) = 17666.667$

C.

(i) $S(t) = 40000$
$5000(1.29879)^t = 40000$
$t = 7.954$

(ii) Once Lawn Be Gone begins selling online and shipping to a wider audience, the quantity of pine straw they sell is dramatically altered. It is not appropriate to model sales quantities after that time based off sales quantities from before that time. The model predicts they will begin selling online and shipping to a wider audience at $t = 7.954$. We should restrict the domain of S to $t < 7.954$.

Solutions to FRQ 2 Practice – Moore's Law

A.

(i) $40 = a(b)^{15-10}$

$100 = a(b)^{20-10}$

(ii) $a = 16$ and $b = 1.201$

B.

(i) $\frac{N(20)-N(15)}{20-15} = \frac{100-40}{20-15} = \frac{60}{5} = 12$

(ii) Over the five year period from 1980 to 1985, the number of transistors that fit on an integrated circuit increased, on average, by 12 thousand transistors per year.

C.

(i) $N(-7) = 0.710$

(ii) It is given that it is not appropriate to apply the model N to times prior to 1958 ($t = -7$). At $t = -7$, the output of $N(t)$ is 0.710 thousand transistors. Since N is an increasing function, the outputs for $t > -7$ are always greater than 0.710. So, 0.710 is a lower bound of the range of $N(t)$. $N(t) \geq 0.710$ for all t in the domain.

Solutions to FRQ 2 Practice – Moving Manure

A.

(i) $3.5 = a(0)^2 + b(0) + c$

$6 = a(3)^2 + b(3) + c$

$3.1 = a(5)^2 + b(5) + c$

(ii) $a = -0.457$, $b = 2.203$, and $c = 3.5$

B.

(i) $\frac{P(5)-P(3)}{5-3} = \frac{3.1-6}{5-3} = \frac{-2.9}{2} = -1.45$

(ii) $P(4) \approx P(3) + 1 \times \text{AROC} = 6 + 1\left(-\frac{2.9}{2}\right) = 4.55$

Alternatively:

$\frac{P(4)-P(3)}{4-3} \approx -\frac{2.9}{2}$

$\frac{P(4)-6}{1} \approx -\frac{2.9}{2}$

$P(4) \approx 6 + (1)\left(-\frac{2.9}{2}\right) = 4.55$

C.

(i) $P(t) = 2$

$-0.456667t^2 + 2.20333t + 3.5 = 2$

$t = -0.60494$ or $t = 5.42976$

The time after Tommy started shoveling at which his productivity dropped to only 2 kilograms shoveled per minute is $t = 5.42976$.

(ii) For $t > 5.430$, the model P is decreasing with outputs less than 2. But in reality, Tommy's no longer shoveling so his productivity is no longer decreasing. So, we restrict the domain of model P to $t < 5.430$.

Solutions to FRQ 2 Practice – Naming Babies Ashley

A.

(i) $47 = a(15)^2 + b(15) + c$

$50 = a(18)^2 + b(18) + c$

$46 = a(20)^2 + b(20) + c$

(ii) $a = -0.6$ $b = 20.8$ $c = -130$

B.

(i) $\frac{N(20)-N(18)}{20-18} = \frac{46-50}{20-18} = -2$

(ii) $N(11) \approx N(18) - 7 \times \text{AROC} = 50 - 7(-2) = 64$

Alternatively:

$\frac{N(11)-N(18)}{11-18} \approx -2$

$\frac{N(11)-50}{-7} \approx -2$

$N(11) \approx 50 + (-7)(-2) = 64$

C.

(i) $N(t) = 0$

$-0.6t^2 + 20.8t - 130 = 0$

$t = 8.180$ and $t = 26.486$

(ii) For $t < 8.180$ and for $t > 26.486$, the model $N(t)$ has a negative output. But in reality, there cannot be a negative number of babies named Ashley in any year. Clearly outside the interval $8.180 < t < 26.486$ the model does not reflect reality, so we should restrict the domain to $8.180 < t < 26.486$.

Solutions to FRQ 2 Practice – Pet Rocks

A.

(i) $4.7 = a(0)^2 + b(0) + c$

$7.4 = a(4)^2 + b(4) + c$

$4 = a(5)^2 + b(5) + c$

(ii) $a = -0.815$ $b = 3.935$ $c = 4.7$

B.

(i) $\frac{S(4)-S(0)}{4-0} = \frac{7.4-4.7}{4-0} = \frac{2.7}{4} = 0.675$

(ii) $S(3) \approx S(4) - 1 \times \text{AROC} = 7.4 - \frac{2.7}{4} = 6.725$

Alternatively:

$\frac{S(3)-S(4)}{3-4} \approx \frac{2.7}{4}$

$\frac{S(3)-7.4}{-1} \approx \frac{2.7}{4}$

$S(3) \approx 7.4 + (-1)\left(\frac{2.7}{4}\right) = 6.725$

C.

(i) $S(t) = 1.5$

$-0.815t^2 + 3.935t + 4.7 = 1.5$

$t = 5.537$

(ii) For $t > 5.537$, the model decreases. But in reality, we know there was an increase in the sales rate after $t = 5.537$. So, the model is not consistent with reality. It is not appropriate to use the model based on sales rates before the price drop to model sales rate after the price drop. The domain of model S should be restricted to $t < 5.537$. (It is similarly inappropriate to apply the model to times before the launch of the product, so we should further restrict the domain of the model to $0 < t < 5.537$)

Solutions to FRQ 2 Practice – Swift Fall

A.

(i) $399 = a + b\ln(11-3)$

$360 = a + b\ln(11-7)$

(ii) $a = 282 \qquad b = 56.265$

B.

(i) $\frac{H(7)-H(3)}{7-3} = \frac{360-399}{7-3} = \frac{-39}{4} = -9.75$

(ii) $H(0) \approx H(3) - 3 \times \text{AROC} = 399 - 3\left(-\frac{39}{4}\right) = 428.25$

Alternatively:

$\frac{H(0)-H(3)}{0-3} \approx -\frac{39}{4}$

$\frac{H(0)-399}{-3} \approx -\frac{39}{4}$

$H(0) \approx 399 + (-3)\left(-\frac{39}{4}\right) = 428.25$

C.

(i) $H(t) = 80$

$282 + 56.265\ln(11-t) = 80$

$t = 10.972$

(ii) For $t > 10.972$, the model has output values less than 80. In reality, however, the Swift Observatory would have experiences a catastrophic breakup before reaching an altitude of less than 80 km. In other words, Swift cannot exist and be falling at an altitude less than 80 km. So, the model is not consistent with reality for $t > 10.972$. Therefore $t = 10.972$ is an upper bound to the domain of model H. The domain of H is $t < 10.972$. (Further, a lower bound to the domain is $t = 0$. It is given that prior to that time, Swift had a less streamlined orientation and was therefore presumably following a different pattern of losing altitude, so the model constructed based on post $t = 0$ data is not representative of reality prior to $t = 0$)

A note to the problem solver: the Swift Observatory is entirely real and its fall from the sky is an entirely real possibility. By the time you read this, it may have already crashed/been vaporized. The t-value found in part C corresponds with October of 2026. If that month has come and gone by the time you complete this problem, you should take a moment to look up whether the Swift Observatory experienced catastrophic failure (and tell your teacher to update this question). On July 3rd 2026, a rescue spacecraft called LINK was launched with the goal of performing a first of its kind push to bring Swift back to a healthy orbit. But in late July, before LINK reached Swift, LINK experienced electrical power issues that caused two of its three orientation control systems to malfunction. As of the time of this writing, it is not yet clear whether LINK can still save Swift. Scientists believe for a save to be possible, it must be done before Swift reaches 298 km altitude. The model obtained in this problem suggests that will happen at $t = 9.671$ which corresponds with the start of the 2026/27 school year. Such suspense!

Solutions to FRQ 2 Practice – Mold Version 1

A.

(i) $600 = a(0)^3 + b(0) + c$
$560 = a(2)^3 + b(2) + c$
$450 = a(5)^3 + b(5) + c$

(ii) $a = -0.476$, $b = -18.095$, and $c = 600$

B.

(i) $\frac{M(2)-M(0)}{2-0} = \frac{560-600}{2-0} = \frac{-40}{2} = -20$

(ii) From noon to 2 PM, the concentration of mold in the room's air decreases on average by 20 spores per cubic meter.

C.

(i) $M(t) = 0$
$-0.47619t^3 - 18.09524t + 600 = 0$
$t = 9.633$

(ii) For $t > 9.633$, the output of $M(t)$ is negative and decreasing. But in reality, after $t = 9.633$ hours after noon, the cleaning has stopped since the concentration of mold hit zero, so the mold concentration in reality at those times will be neither decreasing nor negative. After $t = 9.633$, the model does not reflect reality. So, we restrict the domain of M to $t < 9.633$.

Solutions to FRQ 2 Practice – Mold Version 2

A.

(i) $600 = a(0)^3 + b(0) + c$
$560 = a(2)^3 + b(2) + c$
$450 = a(5)^3 + b(5) + c$

(ii) $a = -0.476$, $b = -18.095$, and $c = 600$

B.

(i) $\frac{M(2)-M(0)}{2-0} = \frac{560-600}{2-0} = \frac{-40}{2} = -20$

(ii) From noon to 2 PM, the concentration of mold in the room's air decreases on average by 20 spores per cubic meter.

C.

(i) $M(t) = 800$
$-0.47619t^3 - 18.09524t + 600 = 800$
$t = -5.832$

(ii) For $t < -5.832$, the output of $M(t)$ is decreasing. But in reality, the mold concentration will not be decreasing at these times as the cleaning will not have yet started. For $t < -5.832$, the model does not reflect reality. So, we restrict the domain of M to $t > -5.832$.

Solutions to FRQ 2 Practice – Mold Version 3

A.

(i) $600 = a(0)^3 + b(0) + c$
$560 = a(2)^3 + b(2) + c$
$450 = a(5)^3 + b(5) + c$

(ii) $a = -0.476$, $b = -18.095$, and $c = 600$

B.

(i) $\frac{M(2)-M(0)}{2-0} = \frac{560-600}{2-0} = \frac{-40}{2} = -20$

(ii) From noon to 2 PM, the concentration of mold in the room's air decreases on average by 20 spores per cubic meter.

C.

(i) $M(8) = 211.429$

(ii) The model will not reflect reality after the cleaning stops at 8:00 PM ($t = 8$). Since M is a decreasing function and $t = 8$ is the highest input in the domain of the function, the lowest output in the range of the function is $M(8) = 211.429$. The range is $M(t) \geq 211.429$.

Solutions to FRQ 2 Practice – Mold Version 4

A.

(i) $600 = a(0)^3 + b(0) + c$
$560 = a(2)^3 + b(2) + c$
$450 = a(5)^3 + b(5) + c$

(ii) $a = -0.476$, $b = -18.095$, and $c = 600$

B.

(i) $\frac{M(2)-M(0)}{2-0} = \frac{560-600}{2-0} = \frac{-40}{2} = -20$

(ii) From noon to 2 PM, the concentration of mold in the room's air decreases on average by 20 spores per cubic meter.

C.

(i) $M(-1) = 618.571$

(ii) The model is only appropriate to use once the cleaning begins. So, the least input value for which it is appropriate to use the model is $t = -1$, the input value corresponding with the start of the cleaning. Since M is a decreasing function and $t = -1$ is the least input in the domain of the function, the greatest output in the range of the function is $M(-1) = 618.571$. The range is $M(t) \leq 618.571$.