This key should allow you to understand why you choose the option you did (beyond just getting a question right or wrong). More instructions on how to use this key can be found here.

If you have a suggestion to make the keys better, please fill out the short survey here.

Note: This key is auto-generated and may contain issues and/or errors. The keys are reviewed after each exam to ensure grading is done accurately. If there are issues (like duplicate options), they are noted in the offline gradebook. The keys are a work-in-progress to give students as many resources to improve as possible.

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1. The temperature of an object, T, in a different surrounding temperature T_s will behave according to the formula $T(t) = Ae^{kt} + T_s$, where t is minutes, A is a constant, and k is a constant. Use this formula and the situation below to construct a model that describes the uranium's temperature, T, based on the amount of time t (in minutes) that have passed. Choose the correct constant k from the options below.

   Uranium is taken out of the reactor with a temperature of $110°$ *C and is placed into a* $17°$ *C bath to cool. After 10 minutes, the uranium has cooled to* $54°$ *C.*

   The solution is None of the above, which is option E.

   A. $k = -0.06527$

      This uses A correctly and solves for k incorrectly.

   B. $k = -0.06334$

      This uses A as the initial temperature and solves for k incorrectly.

   C. $k = -0.10896$

      This uses A as the initial temperature and solves for k correctly.

   D. $k = -0.10896$

      This uses A as the initial temperature and solves for k incorrectly.

   E. None of the above

      * This is the correct answer as $k = -0.09217$.

   General Comment: The initial temperature is when $t = 0$. Unlike power models, that means A is not the initial temperature!

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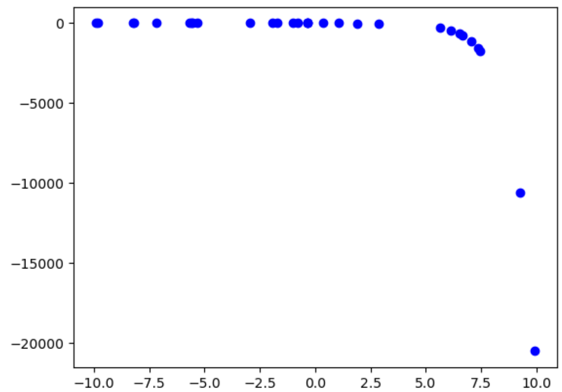
2. Determine the appropriate model for the graph of points below.



The solution is Exponential model, which is option A.

A. Exponential model

   For this to be the correct option, we want an extremely slow change early, then a rapid change later.

B. Logarithmic model

   For this to be the correct option, we want a rapid change early, then an extremely slow change later.

C. Non-linear Power model

   For this to be the correct option, we need to see a polynomial or rational shape.

D. Linear model

   For this to be the correct option, we need to see a mostly straight line of points.

E. None of the above

   For this to be the correct option, we want to see no pattern in the points.

General Comment: This question is testing if you can associate the models with their graphical representation. If you are having trouble, go back to the corresponding Core module to learn about the specific function you are having trouble recognizing.

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3. The temperature of an object, T, in a different surrounding temperature T_s will behave according to the formula $T(t) = Ae^{kt} + T_s$, where t is minutes, A is a constant, and k is a constant. Use this formula and the situation below to construct a model that describes the uranium's temperature, T, based on the amount of time t (in minutes) that have passed. Choose the correct constant k from the options below.

   Uranium is taken out of the reactor with a temperature of $200°$ *C and is placed into a* $11°$ *C bath to cool. After 22 minutes, the uranium has cooled to* $146°$ *C.*

   The solution is $k = -0.01529$, which is option B.

   A. $k = -0.03540$

      This uses A as the initial temperature and solves for k correctly.

   B. $k = -0.01529$

      * This is the correct option.

C. $k = -0.03572$

This uses A correctly but solves for k incorrectly.

D. $k = -0.01787$

This uses A as the initial temperature and solves for k incorrectly.

E. None of the above

If you chose this, please contact the coordinator to discuss why you believe none of the other answers are correct.

General Comment: The initial temperature is when $t = 0$. Unlike power models, that means A is not the initial temperature!

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4. Using the scenario below, model the population of bacteria α in terms of the number of minutes, t that pass. Then, choose the correct approximate *(rounded to the nearest minute)* replication rate of bacteria-α.

A newly discovered bacteria, α, is being examined in a lab. The lab started with a petri dish of 3 bacteria-α. After 1 hours, the petri dish has 8 bacteria-α. Based on similar bacteria, the lab believes bacteria-α doubles after some undetermined number of minutes.

The solution is None of the above, which is option E.

A. About 362 minutes

This uses the wrong base, does not solve for the constant correctly, AND converted incorrectly.

B. About 60 minutes

This uses the wrong base.

C. About 365 minutes

This uses the wrong base and solves for the constant correctly but converted incorrectly.

D. About 60 minutes

This uses the wrong base and does not solve for the constant correctly.

E. None of the above

* This is the correct option as all other options used the wrong base in their model.

General Comment: Your model should be $P(t) = P_0(b)^{kt}$, where $P(t)$ is the population at some time t, P_0 is the initial population, and k is the replication rate. Be sure you convert the hours into minutes!

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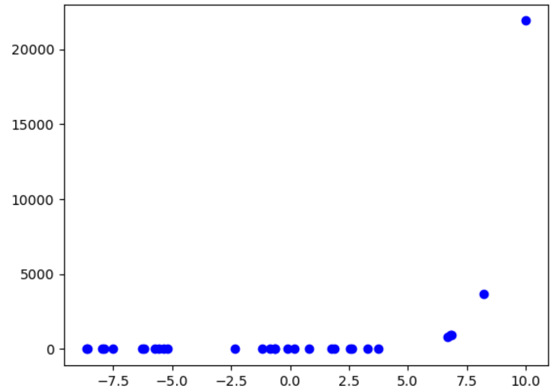
5. Determine the appropriate model for the graph of points below.



The solution is Exponential model, which is option A.

A. Exponential model

For this to be the correct option, we want an extremely slow change early, then a rapid change later.

B. Non-linear Power model

For this to be the correct option, we need to see a polynomial or rational shape.

C. Logarithmic model

For this to be the correct option, we want a rapid change early, then an extremely slow change later.

D. Linear model

For this to be the correct option, we need to see a mostly straight line of points.

E. None of the above

For this to be the correct option, we want to see no pattern in the points.

General Comment: This question is testing if you can associate the models with their graphical representation. If you are having trouble, go back to the corresponding Core module to learn about the specific function you are having trouble recognizing.

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6. A town has an initial population of 100000. The town's population for the next 10 years is provided below. Which type of function would be most appropriate to model the town's population?

Year	1	2	3	4	5	6	7	8	9
Pop	99970	99940	99910	99880	99850	99820	99790	99760	99730

The solution is Linear, which is option C.

A. Non-Linear Power

This suggests a growth faster than constant but slower than exponential.

B. Logarithmic

This suggests the slowest of growths that we know.

C. Linear

This suggests a constant growth. You would be able to add or subtract the same amount year-to-year if this is the correct answer.

D. Exponential

   This suggests the fastest of growths that we know.

E. None of the above

   Please contact the coordinator to discuss why you believe none of the options model the population.

General Comment: We are trying to compare the growth rate of the population. Growth rates can be characterized from slowest to fastest as: logarithmic, indirect, linear, direct, exponential. The best way to approach this is to first compare it to linear (is it linear, faster than linear, or slower than linear)? If faster, is it as fast as exponential? If slower, is it as slow as logarithmic?

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7. Using the scenario below, model the situation using an exponential function and a base of $\frac{1}{2}$. Then, solve for the half-life of the element, rounding to the nearest day.

   The half-life of an element is the amount of time it takes for the element to decay to half of its initial starting amount. There is initially 511 grams of element X and after 20 years there is 56 grams remaining.

   The solution is About 2190 days, which is option B.

   A. About 730 days

      This models half-life as a linear function.

   B. About 2190 days

      * This is the correct option.

   C. About 9855 days

      This uses the correct model but solves for the exponential constant incorrectly.

   D. About 3285 days

      This uses the correct model but a base of e rather than $\frac{1}{2}$.

   E. None of the above

      Please contact the coordinator if you believe all the options above are incorrect.

   General Comment: The model should be $A(t) = A_0(\frac{1}{2})^{kt}$, where $A(t)$ is the amount after t years, A_0 is the initial amount, and k is decay constant. To find the half-life, you need to solve for k by using the amount after x years, then solve for the time t when $A = \frac{A_0}{2}$. Your answer would be in years, so convert to days.

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8. A town has an initial population of 90000. The town's population for the next 10 years is provided below. Which type of function would be most appropriate to model the town's population?

Year	1	2	3	4	5	6	7	8	9
Pop	90000	89972	89956	89944	89935	89928	89922	89916	89912

   The solution is Logarithmic, which is option D.

   A. Linear

      This suggests a constant growth. You would be able to add or subtract the same amount year-to-year if this is the correct answer.

B. Non-Linear Power

This suggests a growth faster than constant but slower than exponential.

C. Exponential

This suggests the fastest of growths that we know.

D. Logarithmic

This suggests the slowest of growths that we know.

E. None of the above

Please contact the coordinator to discuss why you believe none of the options model the population.

General Comment: We are trying to compare the growth rate of the population. Growth rates can be characterized from slowest to fastest as: logarithmic, indirect, linear, direct, exponential. The best way to approach this is to first compare it to linear (is it linear, faster than linear, or slower than linear)? If faster, is it as fast as exponential? If slower, is it as slow as logarithmic?

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9. Using the scenario below, model the situation using an exponential function and a base of $\frac{1}{2}$. Then, solve for the half-life of the element, rounding to the nearest day.

The half-life of an element is the amount of time it takes for the element to decay to half of its initial starting amount. There is initially 558 grams of element X and after 14 years there is 93 grams remaining.

The solution is About 1825 days, which is option B.

A. About 2555 days

This uses the correct model but a base of e rather than $\frac{1}{2}$.

B. About 1825 days

* This is the correct option.

C. About 730 days

This models half-life as a linear function.

D. About 6205 days

This uses the correct model but solves for the exponential constant incorrectly.

E. None of the above

Please contact the coordinator if you believe all the options above are incorrect.

General Comment: The model should be $A(t) = A_0(\frac{1}{2})^{kt}$, where $A(t)$ is the amount after t years, A_0 is the initial amount, and k is decay constant. To find the half-life, you need to solve for k by using the amount after x years, then solve for the time t when $A = \frac{A_0}{2}$. Your answer would be in years, so convert to days.

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10. Using the scenario below, model the population of bacteria α in terms of the number of minutes, t that pass. Then, choose the correct approximate *(rounded to the nearest minute)* replication rate of bacteria-α.

A newly discovered bacteria, α, is being examined in a lab. The lab started with a petri dish of 2 bacteria-α. After 3 hours, the petri dish has 1261 bacteria-α. Based on similar bacteria, the lab believes bacteria-α triples after some undetermined number of minutes.

The solution is None of the above, which is option E.

A. About 209 minutes

   This uses the wrong base, does not solve for the constant correctly, AND converted incorrectly.

B. About 19 minutes

   This uses the wrong base.

C. About 116 minutes

   This uses the wrong base and solves for the constant correctly but converted incorrectly.

D. About 34 minutes

   This uses the wrong base and does not solve for the constant correctly.

E. None of the above

   * This is the correct option as all other options used the wrong base in their model.

General Comment: Your model should be $P(t) = P_0(b)^{kt}$, where $P(t)$ is the population at some time t, P_0 is the initial population, and k is the replication rate. Be sure you convert the hours into minutes!