This task was developed by high school and postsecondary mathematics and health sciences educators, and validated by content experts in the Common Core State Standards in mathematics and the National Career Clusters Knowledge & Skills Statements. It was developed with the purpose of demonstrating how the Common Core and CTE Knowledge & Skills Statements can be integrated into classroom learning – and to provide classroom teachers with a truly authentic task for either mathematics or CTE courses.

TASK: **MEDICATION DOSAGE**

TARGET COMMON CORE STATE STANDARD(S) IN MATHEMATICS:
A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*
F.IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*
F-BF.1a Determine an explicit expression, a recursive process, or steps for calculation from a context.*
F-LE.1c Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval to another.*

TARGET STANDARDS FOR MATHEMATICAL PRACTICES:
MP 1. Make sense of problems and persevere in solving them.
MP 3. Construct viable arguments and critique the reasoning of others.
MP 4. Model with mathematics.
MP 5. Use appropriate tools strategically.
MP 6: Attend to precision.
MP 7: Look for and make use of structure.

TARGET COMMON CORE STATE STANDARD(S) IN ELA/LITERACY:
RST.9-10.3 Follow precisely a complex multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
WHST.9-10.1 Write arguments focused on *discipline-specific content.*

TARGET CAREER AND TECHNICAL EDUCATION (CTE) KNOWLEDGE & SKILLS STATEMENTS:
HLC02 Use oral and written communication skills in creating, expressing, and interpreting information and ideas including technical terminology and information.
HLPBO2.01 Utilize the processes to assess and report patient's/client's health status in order to monitor and document patient progress.
HLPB04.01 Explain procedures and goals to the patient/client accurately and effectively, using strategies to respond to questions and concerns of the patient/client.
HLPA01.01 Explain planned procedures and goals to patients/clients utilizing various strategies of response to answer patient client questions and concerns.

RECOMMENDED COURSE(S):
Algebra II, Integrated Math II or III; Health Science or Medical Terminology

ADDITIONAL INSTRUCTIONS:
This task can be completed in one class period or given as a homework assignment.

* Modeling standards appear throughout the CCSS high school standards and are indicated by a star symbol (*).

About the Common Core State Standards in Mathematics

The Common Core State Standards (CCSS) for Mathematics are organized by grade level in grades K–8. At the high school level, the standards are organized by conceptual category (number and quantity, algebra, functions, geometry, and probability and statistics), showing the body of knowledge students should learn in each category to be college and career ready, and to be prepared to study more advanced mathematics. The Standards for Mathematical Practice describe ways in which developing student practitioners of the discipline of mathematics increasingly ought to engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle and high school years. www.corestandards.org

About the Common Core State Standards in English Language Arts/Literacy

The Common Core State Standards (CCSS) for ELA/Literacy are organized by grade level in grades K–8. At the high school level, the standards are organized by 9-10 and 11-12 grade bands. Across K-12 there are four major strands: Reading, Writing, Speaking and Listening, and Language. The CCSS also include Standards for Literacy in History/Social Studies, Science, and Technical Subjects, with content-specific (Reading and Writing) literacy standards provided for grades 6-8, 9-10, and 11-12, to demonstrate that literacy needs to be taught and nurtured across all subjects. www.corestandards.org

About the Career Cluster Knowledge and Skill Statements

As an organizing tool for curriculum design and instruction, Career Clusters™ provide the essential knowledge and skills for the 16 Career Clusters™ and their Career Pathways. It also functions as a useful guide in developing programs of study bridging secondary and postsecondary curriculum and for creating individual student plans of study for a complete range of career options. As such, it helps students discover their interests and their passions, and empowers them to choose the educational pathway that can lead to success in high school, college and career. http://www.careertech.org/career-clusters/resources/clusters/health.html. Although not included in this template, all Clusters and Pathways have Foundational Academic Expectations and Essential Knowledge & Skills Statements, which, in some cases, overlap with the Common Core State Standards.

KEY TERMS

- SOAP Notes (Subjective, Objective, Assessment Plan)
- CBC = Complete Blood Count
- DIF = Differential counts of White Blood Cells (WBC)
- po = Administered orally (by mouth)
- q = Every
- h = Hours
- Function

MEDICATION DOSAGE – *The Task*

In the medical care world, data are collected in the following categories: Subjective, Objective, Assessment, and Plan (SOAP). The data collected are used to support patient care and foster communication among health care professionals about the care of a patient. The SOAP notes are found in the patient's chart. The following SOAP note is for a patient recently admitted to the Mercy Miracle Medical Center.

SOAP Notes

S: (Subjective): J. Doe, age 43, arrived at the Mercy Miracle Medical Center Emergency Room complaining of shortness of breath, nausea, fatigue, and headache.

O: (Objective): Temperature 101.2; Respiration rate 30; Pulse 100; Blood Pressure (BP): 121/82; Productive cough (sputum is dark green); Chest X-ray positive.

A: (Assessment): Pneumonia is confirmed.

P: (Plan):
1. Admit to medical surgical floor three
2. Start antibiotic 400 mg po (orally) q8h (every 8 hours) x 4 days (400 milligrams, by mouth, every eight hours, for four days)
3. Sputum culture x three days
4. Nebulizing treatments q4h (every four hours).
5. Repeat chest X-ray, a CBC with DIF

Complete the following tasks based upon the SOAP note above:

1. How many milligrams of medication will the patient get <u>within</u> a twenty-four hour period?

2. The patient's body eliminates forty percent (40%) of the medication from the bloodstream after 8 hours. Complete the table below to determine the total amount of medicine in the patient's bloodstream after each dose is taken at 8-hour intervals over 4 days. Use your table to answer the questions that follow.

Hours Since First Dose	Amount of Medicine (mg) Retained by Patient
0	400
8	
16	
24	
32	
40	
48	
56	
64	
72	
80	
88	

Table: *Medication retained in a patient's bloodstream.*

a. Explain the process you used to determine the amount of medicine in the patient's bloodstream at the end of any 8-hour interval of treatment.

b. What amount of medicine is in the patient's bloodstream after 16 hours? After 2 days?

c. Create a graph that shows the relationship between the amount of medicine (mg) in a patient's bloodstream and the number of hours since the initial dose of medicine was taken.

d. Do the table of values and the graph indicate a trend (pattern) about the amount of medication present in the patient's bloodstream? Explain the reasoning to support your answer.

e. This medicine is harmful if more than 1200 mg of it are in the bloodstream. Use your completed table and graph to make a conjecture about whether the medication will ever become harmful to the patient. Provide written justification supporting your answer and be prepared to argue your position orally.

3. Does the graph you constructed for Question 2d appear to represent a function? If so, what type of function best represents the relationship?

    a. What are the dependent and independent variables?

    b. Use technology to determine the equation that best fits the function. Explain how you determined this equation.

    c. Show that the function you have identified validates your findings in this task.

4. As the primary nurse, you are responsible for patient education. Describe what specifically you would communicate to the patient about their medication treatment plan.

MEDICATION DOSAGE – *Possible Solutions*

1. *How many milligrams of medication will the patient get <u>within</u> a twenty-four hour period?*

   The dosage of every 8 hours is considered <u>within</u> the 24-hour period. The first dose at 0 hours = 400 mg, the second dose at 8 hours = 400 mg, the third dose at 16 hours = 400 mg. The next dose (at 24 hours) would not be <u>within</u> the 24-hour period

   Total **= 1200 mg** = 400 + 400 + 400

2. *The patient's body eliminates forty percent (40%) of the medication from the bloodstream after 8 hours. Complete the table below to determine the total amount of medicine in the patient's bloodstream after each dose is taken at 8-hour intervals over 4 days. Use your table to answer the questions that follow.*

   Note: Students might use a spreadsheet or a graphing calculator to perform the calculations for this table:

Hours Since First Dose	Amount of Medicine (mg) Retained by Patient
0	**400**
8	**(400 x 0.6) + 400 = 640**
16	**(640 x 0.6) + 400 = 784**
24	**870.40**
32	**922.24**
40	**953.34**
48	**972.01**
56	**983.21**
64	**989.93**
72	**993.96**
80	**996.37**
88	**997.82**

Table: *Medication retained by a patient's bloodstream.*

   a. *Explain the process you used to determine the amount of medicine in the patient's bloodstream at the end of any 8-hour interval of treatment.*

   Multiply the total number of milligrams from the previous line of the table by 0.6 and add 400 mg as the additional dosage. Use the previous amount as the baseline to determine residual, plus the newly administered dosage. For example, when the second dose of medication is administered 8 hours after the first dose, the amount retained in the patient's bloodstream is (400 mg x 0.6) + 400 mg = 640 mg.

   Students may also write the recursive formula: $x_{(n+1)} = 0.6x_{(n)} + 400$

   b. *What amount of medicine is in the patient's bloodstream after 16 hours? After 2 days?*

   16 hours = **784 mg** (obtained from the table above)
   2 days = 48 hours: **972.01 mg** (obtained from the table above)

c. *Create a graph that shows the relationship between the amount of medicine (mg) in a patient's bloodstream and the number of hours since the initial dose of medicine was taken.*
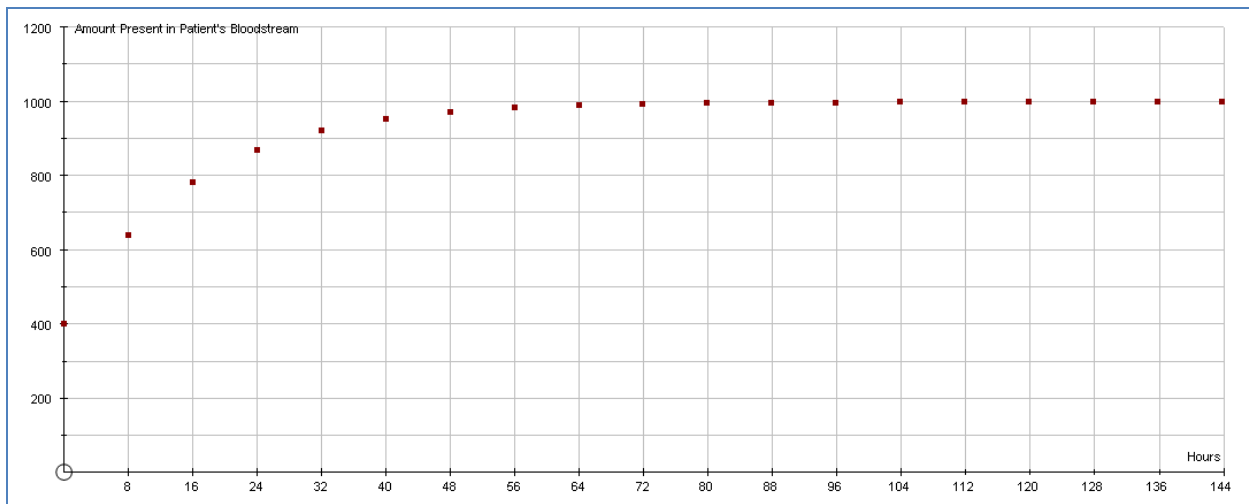
d. *Do the table of values and the graph indicate a trend (pattern) about the amount of medication present in the patient's bloodstream? Explain the reasoning to support your answer.*

YES; in both the table and in the graph the values level off, indicating that the maximum amount of medication in the bloodstream is approaching 1000 mg.

Mathematically advanced students might say something about the sequence of terms limiting at or approaching 1,000.

e. *This medicine is harmful if more than 1200 mg of it are in the bloodstream. Use your completed table and graph to make a conjecture about whether the medication will ever become harmful to the patient.*

Students should indicate that if the current dosage of the medication is taken as prescribed, the patient would never reach a point where the medication reaches a harmful level. If the medication were to be taken outside of the recommended dosage, harmful effects could result. Both the table and graph could be used as supporting documentation.

3. *Does the graph you constructed for Question 2d appear to represent a function? If so, what type of function best represents the relationship?*

YES, the graph appears to represent a logarithmic function. Students should use a graphing calculator, spreadsheet, or online graphing function.

a. *What are the dependent and independent variables?*

Dependent: Amount of medication retained in the patient's bloodstream (in milligrams)

Independent: Time (in 8-hour intervals)

b. *Use technology to determine the equation that best fits the function. Explain how you determined this equation.*

This graph is taken as a screenshot from meta-calculator.com. A graphing calculator (TI-84) was used to plot the data and to find the regression equation with the best correlation coefficient (r = 0.9175).

y = 375.572 + 147.909 ln (x)

Note: Teachers should remind students that a zero in the domain will not work for a logarithmic regression. They might delete the first ordered pair or use something close, e.g. (0.0000001, 400). They should compare the results of correlation coefficient and the graph reliability for both options.
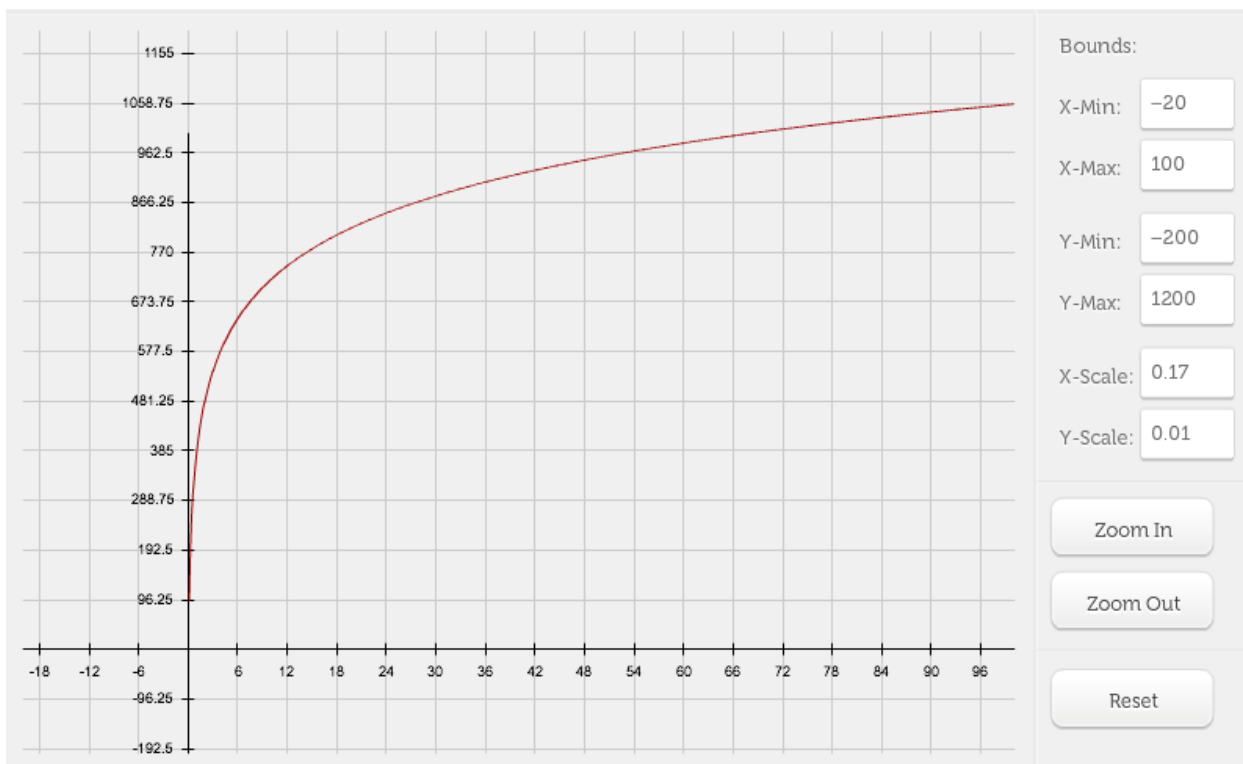
This graph was created with meta-calculator.com

c. *Show that the function you have identified validates your findings in this task.*

Student responses will vary. Some may show that individual ordered pairs referenced in the task "fit" the graph they provided. In a TI-84 graphing calculator the student can graph the plot and the regression equation at the same time. They will see that the two are very close for the range we are using. They may see that they digress as the domain increases to very large numbers. A discussion of the relevance of that digression in the context of this problem could include the fact that a patient would not be advised to sustain use of any antibiotic over a very long period of time.

4. *As the primary nurse, you are responsible for patient education. Describe what specifically you would communicate to the patient about their medication treatment plan.*

The following is what might be included in the patient education statement:

- Discussion of any allergies that might arise and some of the symptoms of these allergies
- Discussion of the dosage and purpose of the medication
- Discussion of the side effects of the medication
- Discussion of drug interactions
- Discuss food and drug interactions
- Expectations for the effect of the drug
- Importance of reporting any discomforts or adverse reactions/effects
- Importance of following the prescribed timing and dosage.

MEDICATION DOSAGE - *Possible Extensions*

The extensions below represent potential ways in which mathematics and/or CTE teachers can build on the task above. All of the extensions are optional and can be used in the classroom, as homework assignments, and/or as long-term interdisciplinary projects.

1. Under the assumption that 40% of the medication is eliminated every eight hours, approximately how long would it take until the medication is eliminated (metabolized) from the patient's body to a negligible amount (less than 1 mg) after just one dosage?

2. Use the sequence of partial sums formula to write the (geometric series/sequences) formula. Build the geometric series and/or sequence from the graph developed/provided in the task.

The rating system used in the following charts is as follows:

3   EXCELLENT ALIGNMENT:
The content/performance of the task is clearly consistent with the content/performance of the Common Core State Standard.

2   GOOD ALIGNMENT:
The task is consistent with important elements of the content/performance of the CCSS statement, but part of the CCSS is not addressed.

1   WEAK ALIGNMENT:
There is a partial alignment between the task and the CCSS, however important elements of the CCSS are not addressed in the task.

N/A:
For Mathematical Practices a content rating does not apply.

In the charts **C = Content Rating** and **P = Performance Rating**

COLOR KEY

- **Black** = Part of CCSS/K&S Statement aligned to task
- **Gray** = Part of CCSS/K&S Statement *not* aligned to task

Task-to-Mathematical Practice Alignment Recording Sheet

Task Name	Aligned CCSS Mathematical Practice Standards	C	P	Alignment Comments (Standards selection, partial alignments, reasons for rating, etc)	Task Comments (Strengths, weaknesses, possible improvements, effectiveness, etc)
MEDICATION DOSAGE	**MP 1.** Make sense of problems and persevere in solving them.	N/A	3	For this task students analyze the constraints, relationships, and goals of the task. They must make conjectures about the form and meaning of the solution and plan a solution pathway. They must check the reasonableness of their solutions, continually asking themselves, "Does this make sense?" The students must persevere in the calculations and analysis. They must also be able to see and understand the relationship between the data presented in a table and their graphical representation. They must graph data and search for trends.	This is a multi-stage problem with real life applications and considerations. Students must create a data table from a verbal description, using practical situations, and accurate quantitative calculations. They must support their reasoning at various steps in the process.
	MP 3. Construct viable arguments and critique the reasoning of others.	N/A	2	Students are not required to critique the reasoning of others.	
	MP 4. Model with mathematics.	N/A	3	This task requires that students translate constraints into data and then into a graph and an equation. They must then extract information from the models.	
	MP 5. Use appropriate tools strategically.	N/A	3	The use of online tools, a graphing calculator, and other devices provides an opportunity to integrate technology with this activity. The task may be weakened in performance if technology is not used. The task would also be expedited with the use of technology.	
	MP6: Attend to precision.	N/A	3	Students must perform calculations and label axes precisely. Rounding and estimation are a key part of the thinking that students must use to accurately answer the questions. Students need to calculate accurately and express answers with a degree of precision appropriate for the context.	
	MP7: Look for and make use of structure.	N/A	3	In Question 2e students must discern a pattern with data—that the amount of medication in the patient's bloodstream approaches 1000 mg but does not exceed it as long as prescribed dosages are followed. Similarly, students must discern a pattern in calculating the amount of medication remaining in the bloodstream at differing dosing times.	

Task-to-Common Core State Standards Alignment Recording Sheet

Task Name	Aligned CCSS Content Standards	C	P	Alignment Comments (Standards selection, partial alignments, reasons for rating, etc.)	Task Comments (Strengths, weaknesses, possible improvements, effectiveness, etc.)
MEDICATION DOSAGE	**A-CED.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*	3	3	A student might create an equation as a part of their description in question #2a. They must find and graph a regression equation for question #3.	This real-world task combines calculation with data analysis and interpretation. Some explanation and supporting justification are required.
	F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.**	2	2	For this task students must build a table and create a scatter plot. Then they are asked to identify a trend from that scatter plot and later to identify the regression equation. However this task does not ask students to interpret key features of a graph from a verbal description. Many of the key features specifically referenced in the standard are not addressed in this task.	
	F.IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*	2	2	Both Questions 2 and 3 of this task require graphic displays for a logarithmic relationship as demonstrated by the trend in the scatter plot and in the regression equation. In the regression search a student might try several different function types, including exponential, and in so doing would analyze the function characteristics for a match with the data trend. In this case there are no trigonometric functions involved and no direct call to show end behavior.	
	F-BF.1a Determine an explicit expression, a recursive process, or steps for calculation from a context.*	3	3	This task requires creation of either a description of steps for calculation or a recursive equation for Question #2a.	
	F-LE.1c Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval to another.*	3	3	This task requires the recognition of a decay function. There is no mention of a constant percent rate per unit between intervals, but this function demonstrates that phenomenon.	

Task Name	Aligned National Career Cluster Knowledge & Skills Statements	C	P	Alignment Comments	Task Comments
MEDICATION DOSAGE	**HLC02** Use oral and written communication skills in creating expressing and interpreting information and ideas including technical terminology and information.	2	2	The task uses only written communication obtained through the SOAP process, but does provide an opportunity to interpret technical terminology and information.	The task integrates the medical expectations and diagnostic approach with the calculations for medical dosage.
	HLPBO2.01 Utilize the processes to assess and report patient's health status in order to monitor and document patient progress.	2	2	The task creates an opportunity to assess the patient's health status and provides a vehicle for documenting progress under the medical dosage.	
	HLPB04.01 Explain procedures and goals to the patient accurately and effectively, using strategies to respond to questions and concerns of the patient.	3	2	Providing feedback on the plan to the patient in the task provides an experience that would be beneficial, especially if provided orally as well.	
	HLPA01.01 Explain planned procedures and goals to patients/clients utilizing various strategies of response to answer patient client questions and concerns.	2	1	The absence of feedback in providing planned procedures and goals to patients is not a part of the task, but the experience of preparing an explanation is provided.	