This task was developed by high school and postsecondary mathematics and agriculture 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: GREENHOUSE MANAGEMENT

TARGET COMMON CORE STATE STANDARD(S) IN MATHEMATICS:

N.Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

G-MGD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

7.RP.3 Use proportional relationships to solve multi-step ratio and percent problems.

7.G.6 Solve real-world and mathematical problems involving area, volume and surface area of two- and three dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

6.RP.3b Solve unit rate problems including those involving unit pricing and constant speed.

6.RP.3d Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

TARGET STANDARDS FOR MATHEMATICAL PRACTICES

MP.1 Make sense of problems and persevere in solving them.

MP.2 Reason abstractly and quantitatively.

MP.3 Construct viable arguments and critique the reasoning of others.

MP.6 Attend to precision.

TARGET COMMON CORE STATE STANDARD(S) IN ELA/LITERACY:

RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

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.

RST.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

TARGET CAREER AND TECHNICAL EDUCATION (CTE) KNOWLEDGE & SKILLS STATEMENTS:

AGPB01.01.08 Employ basic methods for reproducing and propagating plants.

AGPG01.03 Manage budget, credit, and optimal application of Agriculture, Food, and Natural Resources (AFNR) business assets using generally accepted accounting principles to promote business financial well-being.

RECOMMENDED COURSE(S):

Algebra 1 or Geometry; Integrated I or II; Plant Science; Horticulture; Agribusiness Management

ADDITIONAL INSTRUCTIONS:

This task might be completed in one class period but may need an introduction to technical vocabulary and required supporting mathematical knowledge before work begins. Students would be expected to have a working knowledge of ratios and proportions. It may be used as a formative or summative assessment task.

* 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/agriculture.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

- Bench
- Centum weight / hundredweight (cwt)
- N-P-K (Nitrogen to Phosphorous to Potassium) ratio
- Production cost, Profit, Revenue, Mark-up
- Parts-per-million (ppm) calculation
- Active ingredient (AI)

GREENHOUSE MANAGEMENT – *The Task*

Your manager at the greenhouse where you work has asked you to help her produce a crop of Easter lilies. She has gathered some information but needs you to take over determining the costs and expenses for the crop. Show your work and thinking as you answer the questions below, so that you can make a presentation of your findings to the manager regarding this enterprise. Express estimates and answers using an appropriate level of precision.

Use the following information to answer questions 1-5:

- You have three benches measuring 5 feet 3 inches wide and are 100 feet long which is enough space for 1000 Easter lilies in 6" pots.

- Each case of 6" pots contains 500 pots and costs $48.00 per case.

- Pots have a diameter of 6", and a height of 8".

- Each bag of potting soil contains three cubic feet of soil and costs $7.50

- From previous experience you calculate your crop will require two 25 lb. bags of 10-12-5 (N-P-K) soluble fertilizer at a cost of $64.00 per cwt.

- Your growing consultant predicts your crop will require one five-pound bag of Marathon insecticide at a cost of $1780.00 per cwt.

- You will start your crop from bulbs and Easter lily bulbs are available at $1.56 each.

- You estimate overhead costs (electricity, water, and building) for the entire growing period to be $79.00 per month with a growing period of 5 months.

- You estimate labor costs for the entire growing period to be $1080.00

1. What is the combined area of the three bench tops where you will be growing your Easter lilies?

2. How many bags of soil will be required to plant the Easter lily crop? For purposes of this calculation, assume that you will be filling each pot to the top, and disregard the space that will be consumed by the lily bulb.

3. Considering only the costs shown above, what will be the total cost of producing a single Easter lily?

4. If you use both bags of fertilizer, how many ounces of Nitrogen will you apply?

5. If you have set a target profit of $3000.00 for your Easter lily crop, what will your mark-up percentage be on the production cost?

6. You have set aside 850 sq. ft. of bench space for a fern crop. If you decide to use this space to expand your Easter lily production, how many more Easter lilies could you produce? (Assume the same rate as the original 1,000 lilies planted previously.)

1. Using the information from the first bullet: 5 feet 3 inches = 5.25 feet

   (5.25 feet)(100 feet)(3 benches) = **1575 ft^2**

2. Volume of a cylindrical pot = πr^2 x height = π x 9 x 8 = 226.19 in^3 per pot = 226.2 in^3
   (Note: differences may occur if students calculate using 3.14 instead of π)

   1 cubic foot = 12" x 12" x 12" = 1728 in^3 per cubic foot
   (1728 in^3 per cubic foot) x (3 cubic feet per bag) = 5184 in^3 per bag
   (5184 in^3 per bag) divided by (226.2 in^3 per pot) = 22.9 pots per bag
   1000 pots/22.9 pots per bag = 43.67 bags of soil. Rounded to the nearest bag, this is **44 bags of soil.**

3.
   - **Pots:** 1000 pots = 2 cases $\Rightarrow$ 2 cases x $48.00/case = **$96.00**
   - **Soil:** 44 bags of soil x $7.50 per bag = **$330.00**
   - **Fertilizer:** 2 bags x 25 lbs. per bag = 50 lbs = 0.5 cwt
     0.5 cwt x $64.00 per cwt = **$32.00**
   - **Pesticide:** 5 lbs insecticide = 0.05 cwt
     0.05 cwt x $1780 per cwt = **$89.00**
   - **Bulbs:** 1000 bulbs x $1.56 per bulb = **$1,560.00**
   - **Utilities:** $79.00 per month x 5 months = **$395.00**
   - **Labor: $1080.00**

   TOTAL COST = $96.00 + $330.00 + $32.00 + $89.00 + $1560.00 + $395.00 + $1080.00 = **$3582.00**
   Since there are 1000 lilies being planted: $3582/1000 lilies = **$3.58 per lily**

4. 2 bags x 25 lbs per bag = 50 lbs of fertilizer

   Using the 10-12-5 percentage ratio of N-P-K given: (50 lbs of fertilizer) x (10% Nitrogen per lb) = 50 lbs x 0.1 = 5 lbs N
   5 lbs x 16 oz per lb = **80 oz of Nitrogen**

5. Total Cost + Profit = $3582.00 + $3000.00 = $6582.00
   $6582 / 1000 lilies = $6.58 total revenue needed per lily.
   The ratio of total revenue per lily to total cost per lily $\Rightarrow$$6.58/$3.58 = 1.838 = 183.8% or about 184%
   So the markup would be approximately **84%**.

6. 1000 lilies / 1575 square feet = 0.6349… lilies per square foot

   0.635 lilies per square foot x 850 square feet = 539.682 lilies

   Since there cannot be a partial lily planted, this solution will need to be rounded up: **539 lilies**

   Note: Students might also set up a proportion to solve this problem.

GREENHOUSE MANAGEMENT – *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. The easiest way to apply the fertilizer is through the misting system; however application directions require a part-per-million calculation (ppm). The fertilizer you are using is Calcium nitrate which contains 15% Nitrogen (N). If you are applying 1 ounce of fertilizer per 100 gallons of water, how much Nitrogen are you applying in parts-per-million (ppm)?

2. You also need to apply 150 ppm of active ingredient (AI) of insecticide to your Easter lilies. The percent AI for Marathon Insecticide is 33%. How many ounces of Marathon would you add to 100 gallons of water?

3. You will need to construct a container to hold the 100 gallons of water you are using as to apply the fertilizer and the insecticide simultaneously. Draw a cylinder to scale with the dimensions (including height and either diameter or radius) correctly labeled. The container needs to have a capacity of 110% of the required volume to alleviate any spillage concerns. The cylinder container must fit into a space, 3 foot by 3 foot, near the end of the greenhouse.

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)
GREENHOUSE MANAGEMENT	**MP.1** Make sense of problems and persevere in solving them.	N/A	3	For this task students analyze givens, constraints, relationships, and goals. They must make conjectures about the form and meaning of the solution and plan a solution pathway. They must check the reasonableness of their solution, continually asking themselves, "Does this make sense?"	This is a multi-stage problem with real life applications and considerations. Students must identify quantities and other measures to determine costs, using quantitative reasoning, practical situations, and accurate calculations.
	MP.2 Reason abstractly and quantitatively.	N/A	2	This task involves quantitative relationships. It requires that students make sense of quantities and their relationships in the problem situation. They need to consider the units involved and attend to the meaning of quantities, not just compute them. There is no emphasis on abstract reasoning in this task.	
	MP.3 Construct viable arguments and critique the reasoning of others.	N/A	1	Students are called upon in the prompt to show their work and thinking so they can make a presentation to the manager. No particular question in the task asks students to prepare such a presentation, however. There is no requirement to critique the reasoning of others.	
	MP.6 Attend to precision.	N/A	3	Rounding and approximation are a key part of the thinking that students must use to accurately answer the questions. Students also need to be careful about attending to units as they perform calculations and express numerical answers with a degree of precision that is appropriate for the problem context.	

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.)
GREENHOUSE MANAGEMENT	**N.Q.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*	2	3	This task emphasizes the use of units in every question. Using dimensional analysis is the most efficient way to answer the questions. This task does not deal with scale and origin in graphs or graphical displays.	This task requires a scale drawing and calculations for the greenhouse project. Measurements and quantities are fractional, requiring the use of positive rational numbers and estimation for reporting.
	N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *	3	3	There are several components in this task that require approximation and a realistic view of the precision possible in a large-scale project. While no particular question in this task asks students to prepare a presentation, the prompt is worded in such a way that students are to show their work and thinking so that they can make a presentation.	
	G-MGD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*	2	3	In question 2, students need to find the volume of a cylindrical pot. This task does not require students to use pyramids, cones, or spheres.	
	7.RP.3 Use proportional relationships to solve multi-step ratio and percent problems. *Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.*	3	3	Proportional relationships are used in most parts of this task. In particular, question 5 deals with percent mark-up.	
	7.G.6 Solve real-world and mathematical problems involving area, volume and surface area of two- and three dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.	2	3	Question 1 requires students to find the area of a rectangular shape. While question 2 involves volume, it is of a cylindrical shape, not a cube or right prism.	
	6.RP.3b Solve unit rate problems including those involving unit pricing and constant speed. *For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?*	3	3	In part 3 students must find the unit cost per lily. In other questions unit rates are prevalent.	

| | **6.RP.3d** Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. | **3** | **3** | Measurement conversion is an important part of this task, including gallons to ounces | |

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

Task-to-National Career Cluster Knowledge & Skills Statements Alignment Recording Sheet

Task Name	Aligned National Career Cluster Knowledge & Skills Statements	C	P	Alignment Comments	Task Comments
Greenhouse Management	**AGPB01.01.08** Employ basic methods for reproducing and propagating plants.	2	2	The task assumes the base skills for propagating exist and moves to the critical planning and financial evaluation of the plant production.	The task provides a realistic example of horticulture planning that provides an opportunity to demonstrate the importance of calculations and planning.
	AGPG01.03 Manage budget, credit, and optimal application of AFNR business assets using generally accepted accounting principles to promote business financial well-being.	2	2	The importance of budgeting and evaluating the capacity in planning is demonstrated through this task, but the lack of credit applications exists.	