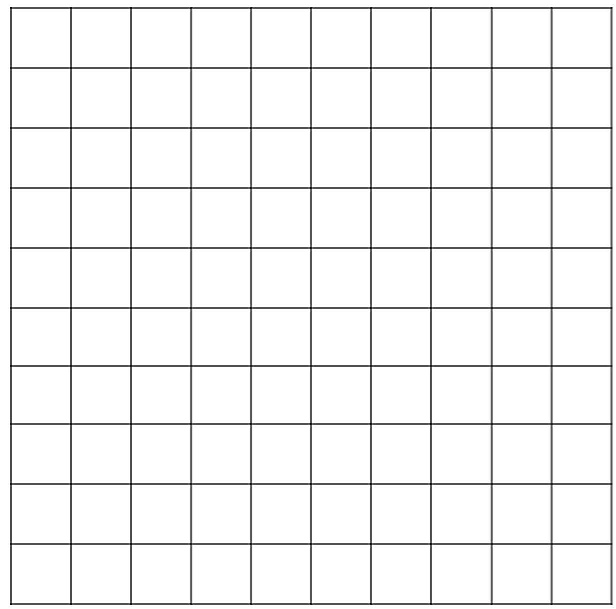
Algebra 2 Chapter 3 Linear Programming Extension Name: ____________________

Instructions – This can potentially be counted as your Chapter 3 Test Grade (you would still have to take the 9 problem Chapter 3 SAT/ACT Post-Test)
Please note the examples from the “Linear Programming Activity”. Develop a real-life or possible real-life problem that requires linear programming to solve. Then solve for the objective function and provide a detailed written summary of your solutions.

Requirements:
__ An objective function
__ At least 3 constraints
__ At least 1 constraint must be in standard linear form with 2 variables
__ Graph of the feasible region
__ Algebraic reasoning showing the minimum and maximums of the objective function
__ Written explanations of what the minimums and maximums mean in terms of solving the real-life problem



CCSS Assessed: N-Q.1,2,3, A.CED.1,2,3, A.REI.3,5,6,10,11,12, F-IF.1,2,4,5,7, F-BF.1
Learning Targets Assessed: Understand linear programming is a process of using systems of linear inequalities to model the possible solutions for given constraints.

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Name:________________ Class: ______ Self-Assessment: _____ Teacher-Assessment: _____
Checked Boxes: 1 = D-, 2 = D, 3 = D+, 4-5 = C-, 6 = C, 7 = C+, 8 = B-, 9 = B, 10 = B+, 11-12 = A-, 13 = A, 14 = A+

Assignment		Linear Programming Extension (Chapter 3 Test Alternative Assessment **due 12/15 @ 1:46**)
Learning Target		Understand linear programming is a process of using systems of linear inequalities to model the possible solutions for given constraints.
Success Criteria		Students will use software such as *Word*, *Power Point, etc.* to **1)** create, type and solve a real-life problem using linear programming methods including graphical and algebraic solutions; **2)** turn-in this rubric, a paper copy & e-mail the digital file to **bklee@ccs.coloma.org**.
Self	**Teacher**	You must assess yourself or you will lose 1 checked box. You must assess yourself accurately within 1 checked box or will lose 1 checked box.
4 or A+ (mastery)		
		4.4 All of the problems AND solutions are typed, in a single digital file and a copy is e-mailed to **bklee@ccs.coloma.org**.
		4.3 All of the problems AND solutions are typed and a copy is turned in.
		4.2 (+3.3 and 3.4) A written explanation of what each possible solution in the objective function shows in context of the real-life problem.
		4.1 (+3.1) A written explanation of what each intersection on the graph shows in context of the real-life problem.
3 or B+ (advanced proficiency)		
		3.4 The solution to the real-life problem is provided with appropriate reasoning.
		3.3 The objective function is clearly evaluated for all possible values.
		3.2 Algebraic reasoning such as substitution or elimination methods is used to confirm any approximated intersections.
		3.1 (+2.1 and 2.3) The feasible region is graphed showing all the constraints (this can be done either by hand or by using software such as DESMOS).
2 or C (basic proficiency)		
		2.4 (+2.2) Algebraic reasoning shows how to graph any constraints written in standard form (either zeros are used to find the *x*-intercept and *y*-intercept or the equation is re-written in slope-intercept form $y = mx + b$).
		2.3 An objective function is written and clearly explained
		2.2 At least 1 of the constraints is written and represented as an inequality in standard form $Ax + By \leq C$ or $Ax + By \geq C$
		2.1 At least 2 unique constraints in addition to $x \leq 0$ and to $y \leq 0$ are written and represented as linear inequalities
1 or D (some basic problems with minimal help)		
		A problem is created with an objective function, constraints and some correct solutions
0.5 or D- (some basic problems with considerable help)		
		A problem is created that would require linear programming to solve and solutions are given
0 or E (displays no ability or understanding)		

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Mr. Klee's Example Problem:
Mr. Klee decides to run a Geometry and Algebra 2 tutoring service by paying his students \$8 an hour to provide Geometry tutoring and \$10 an hour to provide Algebra 2 tutoring with a total weekly budget of \$5,000 or less. Due to limited class time only up to 550 hours of tutoring for either Geometry or Algebra 2 can be provided each week. Additionally, since only some students are in Algebra 2, no more than 180 hours of Algebra 2 tutoring can be provided. Finally, the profit from each hour of Geometry tutoring is \$15 and the profit from each hour of Algebra 2 is \$10. What possible combination of hours of Geometry and Algebra 2 tutoring will lead to the maximum profit?

Constraints:
let ***x* = hours of Geometry tutoring** and ***y* = hours of Algebra 2 tutoring**

$\mathbf{8x + 10y \le 5000}$, This equation shows that the \$8 costs to pay students to provide Geometry tutoring and \$10 costs to pay students to provide Algebra 2 tutoring must be under \$5,000

$\mathbf{x + y \le 550}$, This equation shows the hours of Geometry tutoring and the hours of Algebra 2 tutoring added together must be only up to 550 hours or less

$\mathbf{y \le 180}$, This equation shows the hours of Algebra 2 tutoring must be under 180 hours.

Calculating Intercepts:

Cost constraints		**Hour constraints**	
$8(0) + 10y = 5000$ $10y = 5000$ $y = 500$ so plot (0, 500)	$8x + 10(0) = 5000$ $8x = 5000$ $x = 625$ so plot (625, 0)	$(0) + y = 550$ $y = 550$ so plot (0, 550)	$x + (0) = 550$ $x = 530$ so plot (550, 0)

Slope-Intercept (this is just a different way to be able to get the graphs):

Cost constraints	**Hour constraints**
$8x + 10y \le 5000$ $10y \le 5000 - 8x$ $y \le 500 - 0.8x$ or $y \le -0.8x + 500$	$x + y \le 550$ $y \le 550 - x$ or $y \le -x + 550$

Algebraic Reasoning for other Intersection Points:

Costs & Hours Constraints	**Costs & 180 Constraints**	**Hours & 180 Constraints**
$x + y = 550$ equivalent to $y = 550 - x$ So substitute into… $8x + 10y = 5000$ to get… $8x + 10(550 - x) = 5000$ $8x + 5500 - 10x = 5000$ $-2x = -500$ $x = 250$ And substitute back into $y = 550 - x$ To get that $y = 550 - 250 = 300$ So plot (250, 300)	Substitute $y = 180$ into… $x + y = 550$ to get… $x + 180 = 550$ $x = 370$ So plot (370, 180)	Substitute $y = 180$ into… $8x + 10y = 5000$ to get… $8x + 10(180) = 5000$ $8x + 1800 = 5000$ $8x = 3200$ $x = 400$ So plot (400, 180)

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Feasible Region:

0, 0 represents that there can't be negative hours of either type of tutoring

0, 180 shows that there can be 0 hours of Geometry and 180 hours of Algebra 2 tutoring

0, 500 is the *y*-intercept and 625, 0 is the *x*-intercept of the costs constraint

0, 550 is the *y*-intercept and 550, 0 is the *x*-intercept of the hours constraint

250, 300 shows the solution to where the costs constraint and hours constraint are equal for Geometry and Algebra 2 tutoring hours

370, 180 shows the solution to where the costs constraint and hours constraint are equal for Geometry and Algebra 2 tutoring hours

Evaluating the Objective/Profit Function:

The profit function would be $P = 15x + 10y$ because a single hour of Geometry tutoring will earn a profit of $15 and a single hour of Algebra 2 tutoring will earn a profit of $15. So substitute and evaluate for the vertices of (180, 0), (370, 180) and (550, 0) that are on the intersection of the constraints of the feasible region.

$P = 15(0) + 10(180) = \$1800$ profit for 0 hours of Geometry and 180 hours of Algebra 2 tutoring

$P = 15(370) + 10(180) = \$7350$ profit for 370 hours of Geometry and 180 hours of Algebra 2 tutoring

$P = 15(550) + 10(0) = \$8250$ profit for 550 hours of Geometry and 0 hours of Algebra 2 tutoring

Solution:

After evaluating the objective/profit function for each of the vertices, it is clear that using all 550 hours to provide Geometry tutoring and 0 hours to provide Algebra 2 tutoring, the maximum profit would be $8,250.

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