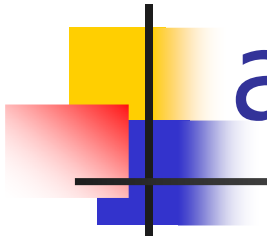
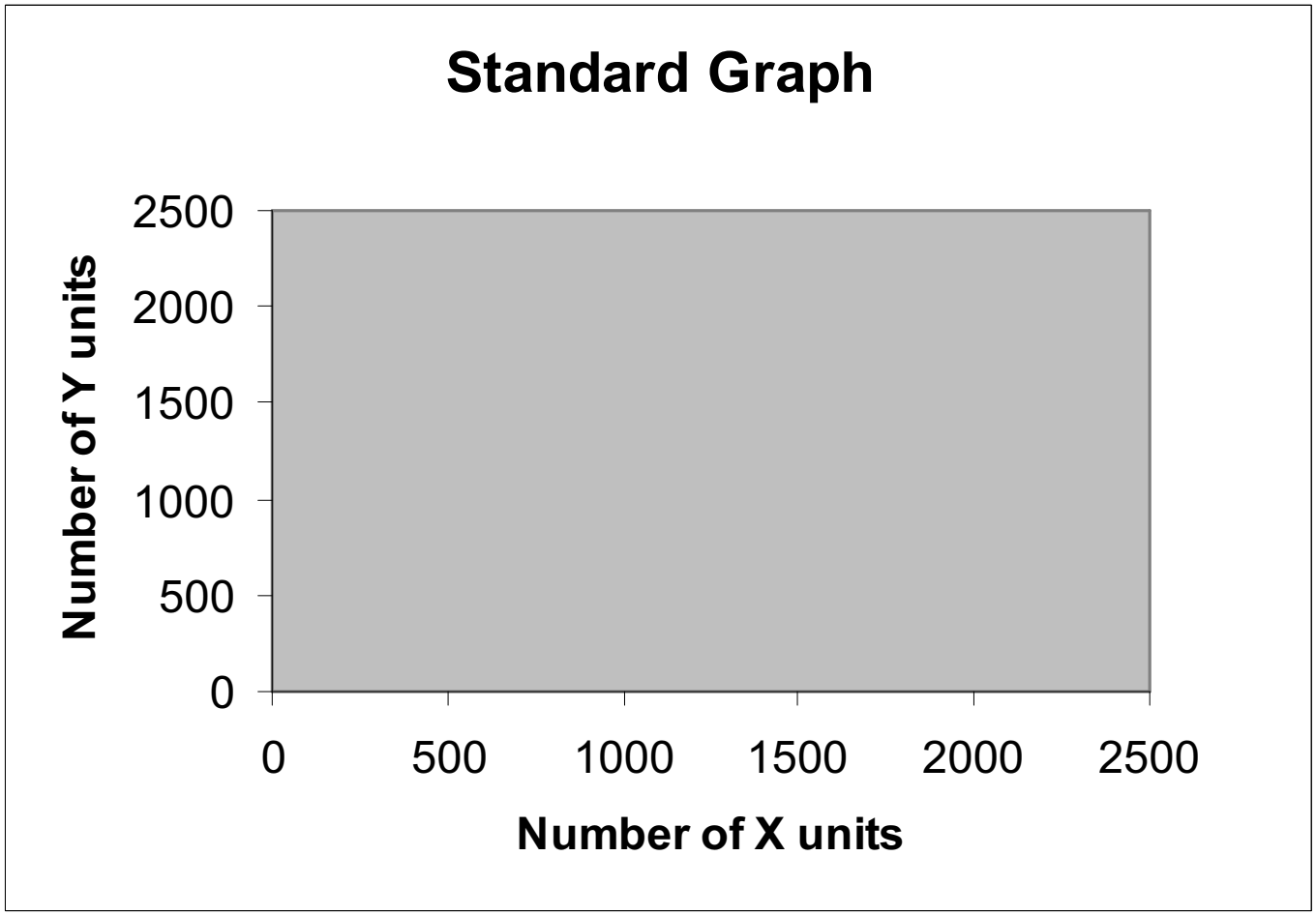
Ch 11 Resource Constraints and Linear Programming

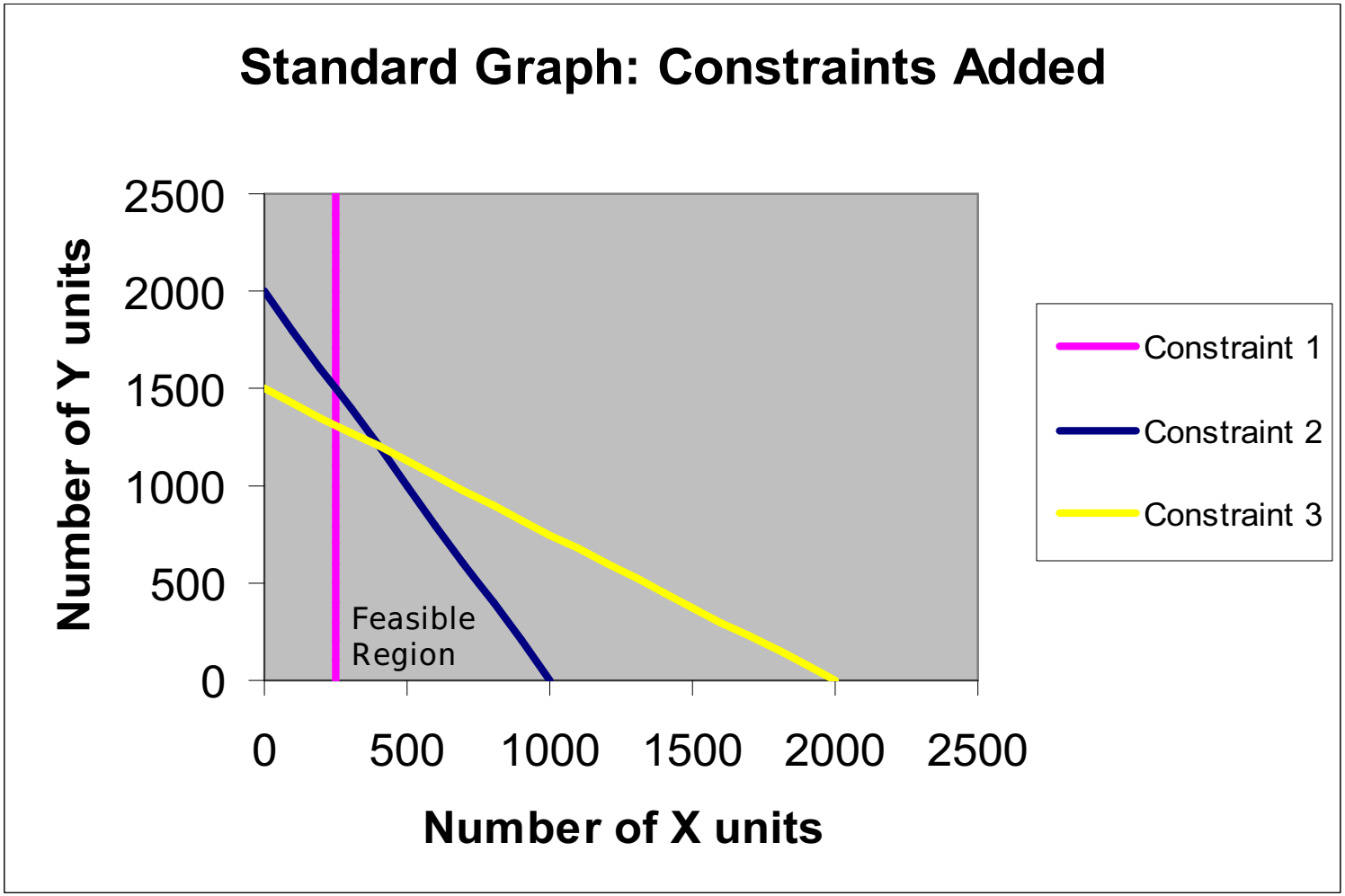


- The process of finding an optimum outcome from a set of constrained resources, where the objective function and the constraints can be expressed as linear equations.

Drawing the Linear Model

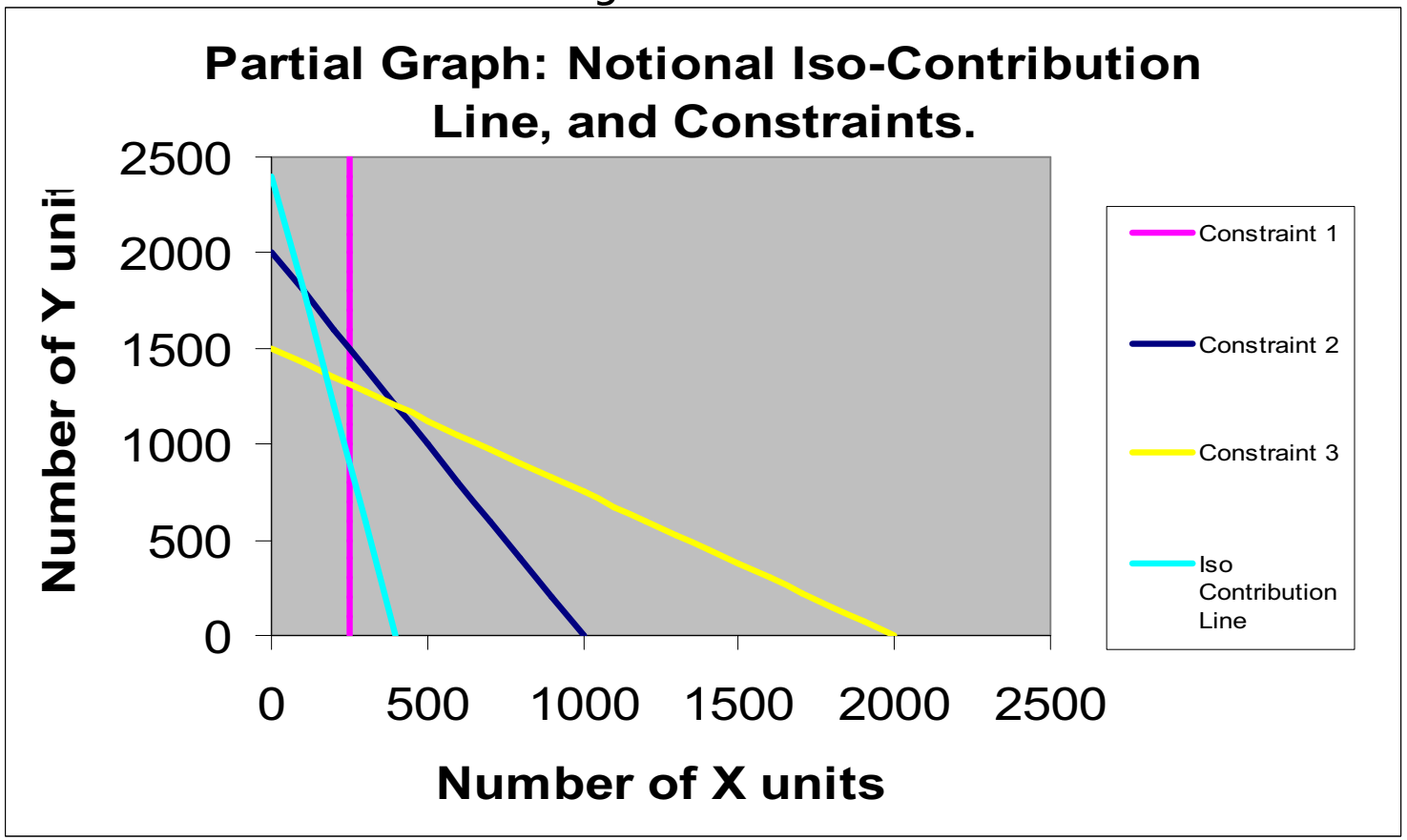


Adding the Linear Constraints



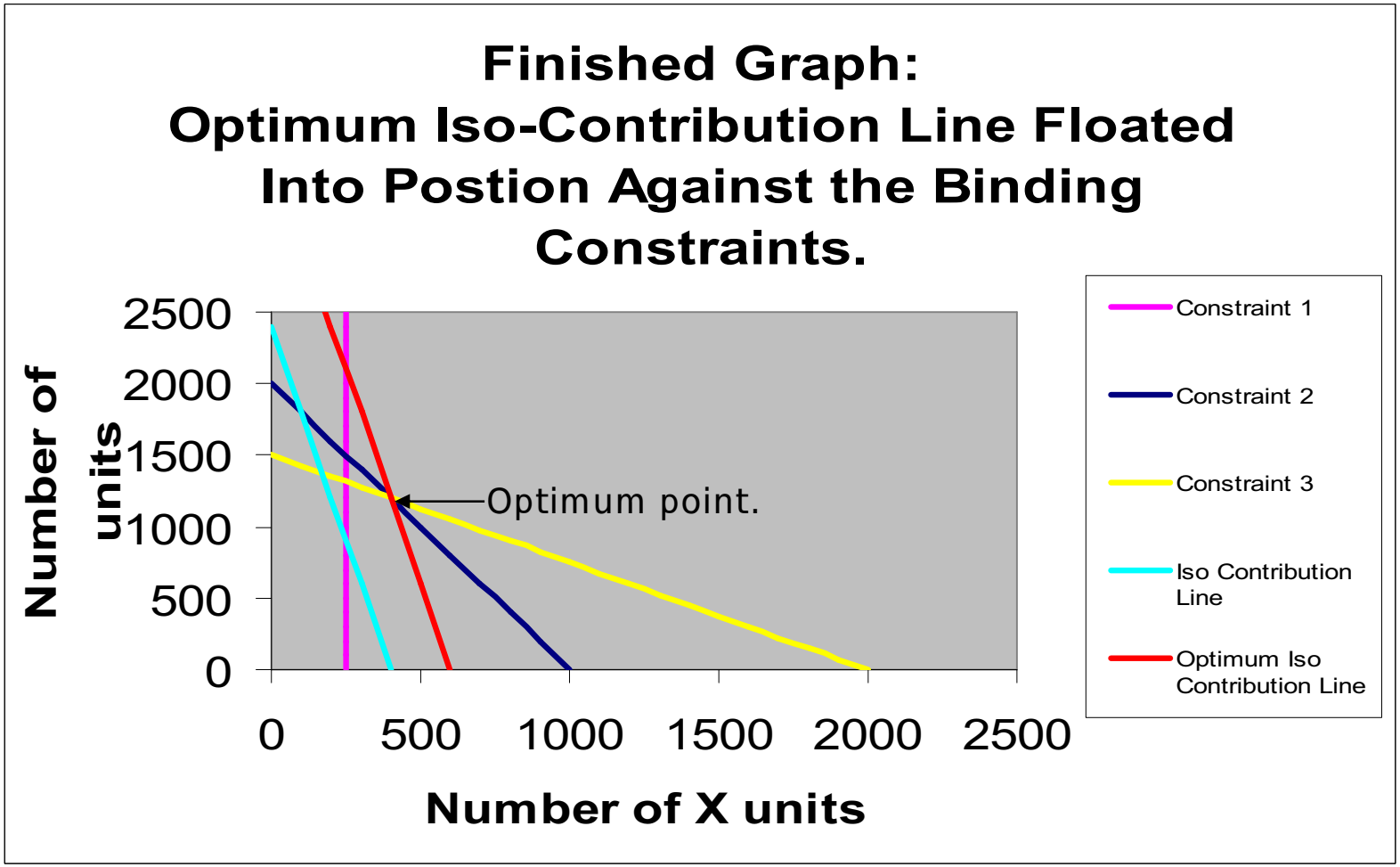
Adding the Iso-Contribution Line

- The iso-contribution line is a 'slope' which represents the objective function. It is drawn as a generic line, then 'floated' to an optimum location within the feasible region.



Finding the Optimum Point

- Float the iso-contribution line to an optimum position.



Algebraic Solution to an Example LP Problem

- Define the objective function:

$$Z = 0.75X + 1.82Y$$

- Set up the resource constraints :

$$32X + 59Y <= 4312$$

$$200X + 15Y <= 1819$$

- Set up any other limit constraints; e.g;

$$X >= 0$$

$$Y >= 0$$

$$X <= 19$$

Solving the Algebraic Problem 1

- In this simple case, the set of algebraic equations can be easily solved by substitution.
- In a more complex case, the Simplex method can be manually applied.
- As the Simplex method is tedious, and prone to error, the solution is best found with computer software such as Excel Solver.
- The standard Excel spreadsheet needs to be specially adapted to run Solver.

Solving the Algebraic Problem 2

- Additions to the standard spreadsheet are:

- An 'Activity Level' row for output levels.
- A 'Resource Supply' column for level of supply of constrained resources.
- A 'Resource Use' column for amount of each constrained resource used, and final objective function value.
- A 'Sign' column for the inequality signs:- (for information only; not for "Solver" solution.)

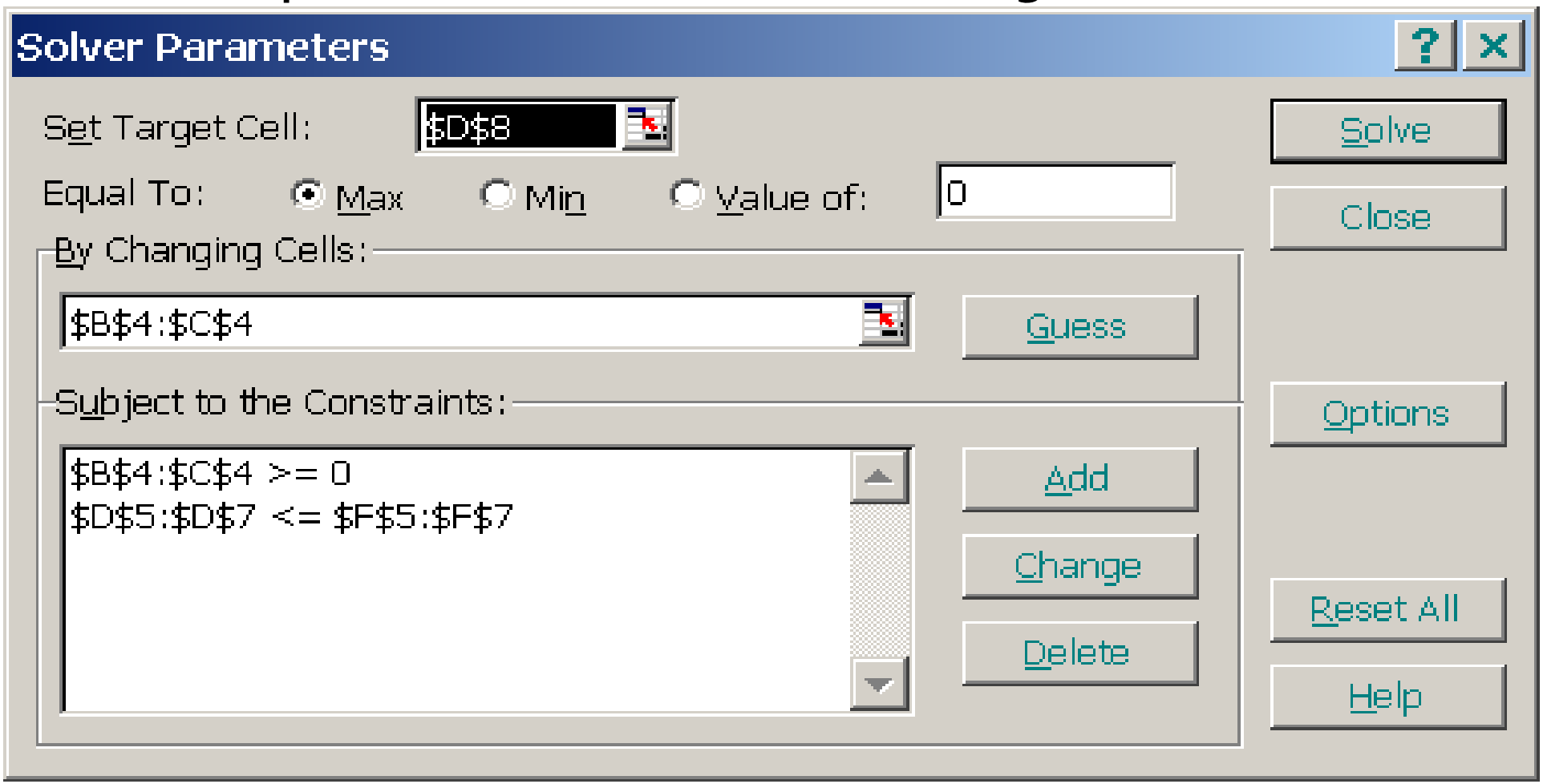
Solving the Algebraic Problem 3: The Adjusted Spreadsheet

- Spreadsheet ready for solution.

	A	B	C	D	E	F	G	H	I
1	**Chapter 11 Power Point Example**								
2	**Products X and Y**								
3	**Constraint or Objective**	**Product X**	**Product Y**	**Resource Use**	**Sign**	**Supply**			
4	Activity level	0	0				**<== Activity level row**		
5	Constraint 1	32	59	0	≤	4312			
6	Constraint 2	200	15	0	≤	1819			
7	Constraint 3	1	0	0	≤	19			
8	Total Dollar Contribution	$0.75	$1.82	$0.00					
9				^ ^ ^ ^	^ ^				
10				**Resource Use**	**Sign**				
11				**Column**	**Column**				
12									

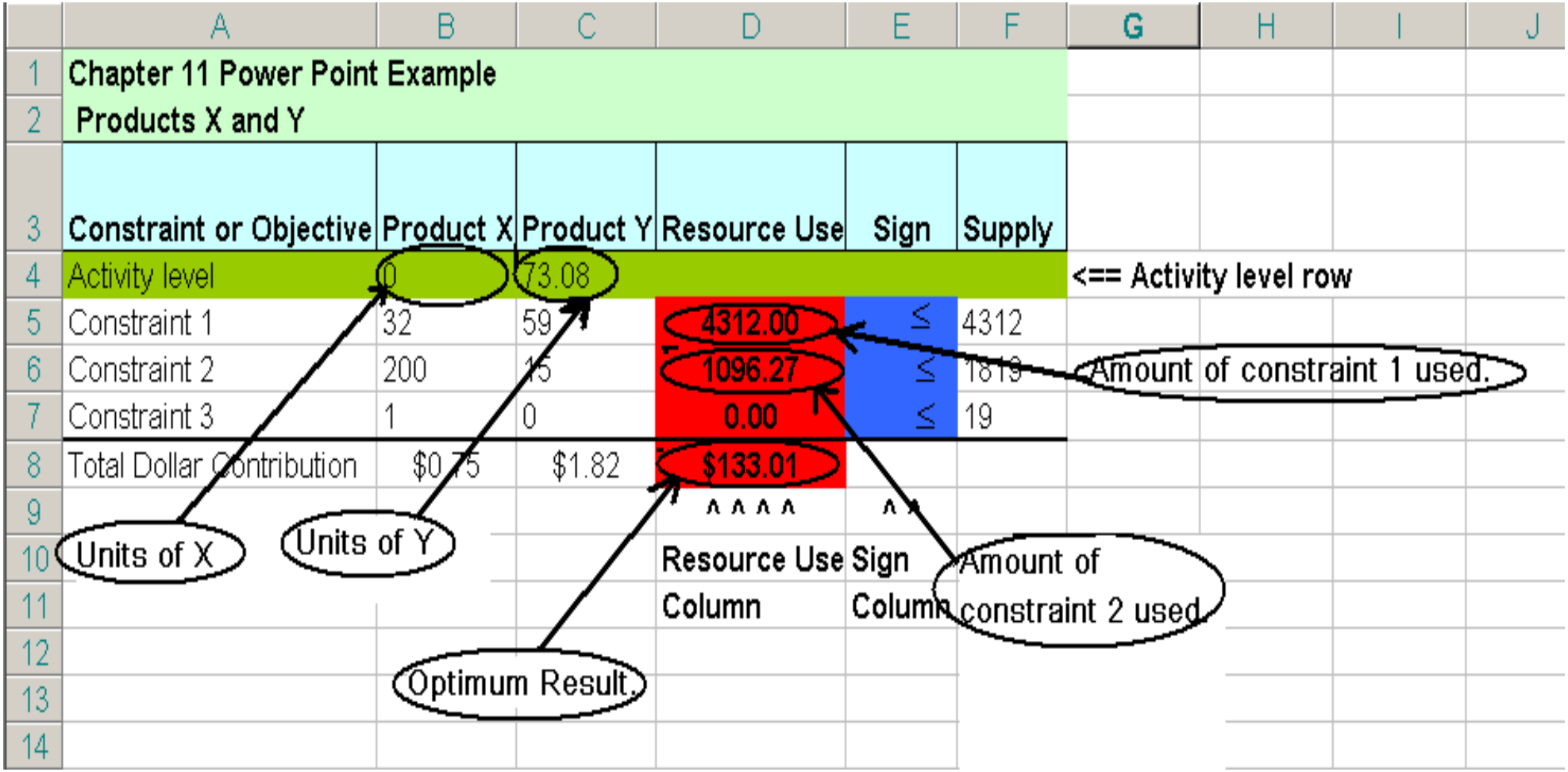
Solving the Algebraic Problem 4: Using Excel Solver

Inputs to the Solver dialog box.



Solving the Algebraic Problem 5: Reading the Solver Results

- Read the results from the Solved spreadsheet.



Solving the Algebraic Problem 6: Reading the Solver Reports (a).

- The answer report shows the solution.

Microsoft Excel 9.0 Answer Report
Worksheet: [Ch 11 PP Example.xls]Sheet1
Report Created:- Date:Time

Target Cell (Max)

Cell	Name	Original Value	Final Value	
$D$8	Total Dollar Contribution Resource Use	$133.01	**$133.01**	**<== Optimum dollar payoff.**

Adjustable Cells

Cell	Name	Original Value	Final Value	
$B$4	Activity level Product X	0	**0**	**<== Units of x in solution.**
$C$4	Activity level Product Y	73.08	**73.08**	**<== Units of Y in solution.**

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$D$5	Constraint 1 Resource Use	4312.00	$D$5<=$F$5	**Binding**	0
$D$6	Constraint 2 Resource Use	1096.27	$D$6<=$F$6	**Not Binding**	722.73
$D$7	Constraint 3 Resource Use	0.00	$D$7<=$F$7	**Not Binding**	19
$B$4	Activity level Product X	0	$B$4>=0	**Binding**	0
$C$4	Activity level Product Y	73.08	$C$4>=0	**Not Binding**	73.08

Status of variables in solution.

Solving the Algebraic Problem 6: Reading the Solver Reports (b).

- The sensitivity report shows possible adjustments to the solution.

Microsoft Excel 9.0 Sensitivity Report
Worksheet: [Ch 11 PP Example.xls] Sheet1
Report Created: Date:Time
Adjustable Cells

Cell	Name	Final Value	Reduced Gradient	
$B$4	Activity level Product X	0	-0.24	<== Required amount to reduce
$C$4	Activity level Product Y	73.08	0.00	<== costs to enter the solution.

Constraints

Cell	Name	Final Value	Lagrange Multiplier	
$D$5	Constraint 1 Resource Use	4312.00	0.03	<== Upper amount limit that could
$D$6	Constraint 2 Resource Use	1096.27	0.00	<== be paid for these resources
$D$7	Constraint 3 Resource Use	0.00	0.00	<== to improve the solution.

<= Commonly known as the
<= "Shadow Price."

Solving the Algebraic Problem 6: Reading the Solver Reports (c).

- The limits report shows the amount of movement allowed in the cell values within the constraint levels.

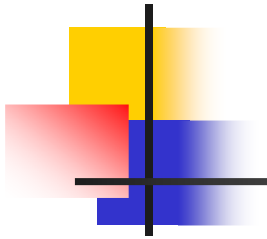
Microsoft Excel 9.0 Limits Report
Worksheet: [Ch 11 PP Example.xls] Sheet1
Report Created: Date:Time

	Target		
	Cell	Name	Value
	$D$8	Total Dollar Contribution Resource Use	$133.01

	Adjustable			Lower	Target	Upper	Target
	Cell	Name	Value	Limit	Result	Limit	Result
	$B$4	Activity level Product X	0	0	133.01	0	133.01
	$C$4	Activity level Product Y	73.08	0.00	0.00	73.08	133.01

Movement allowed in these values whilst still satisfying the constraints.

Linear Programming: Summary



- Use when an optimum solution is required, from constrained resources.
- Express the objective function and the constraints as linear equations.
- Solve using either the graphical method, or a computerized model.
- Interpret the results.
- Consider the sensitivity of the results.
- Make a decision.

THE END