Subject: *Quality Engineering*

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Overview (Lecture the 1st)

- Definition of Quality
- Indicators of Quality
- Historical perspective / performance - VOC
- Deming's quality principles
- Plotting graphs (scatter method) and Spreadsheet calculations

Definition

Of the many meanings of the word “quality,” two are of critical importance to managing for quality:

1. “Quality” means those features of products which meet customer needs and thereby provide customer satisfaction. In this sense, the meaning of quality is oriented to income. The purpose of such higher quality is to provide greater customer satisfaction and, one hopes, to increase income. However, providing more and/or better quality features usually requires an investment and hence usually involves increases in costs. Higher quality in this sense usually “costs more.”

Definition

2. “Quality” means freedom from deficiencies—freedom from errors that require doing work over again (rework) or that result in field failures, customer dissatisfaction, customer claims, and so on. In this sense, the meaning of quality is oriented to costs, and higher quality usually “costs less.”

“Quality engineering” is Discipline that deals with the analysis of a manufacturing system at all stages, to improve the quality of the production process and of its output

Quality engineering focuses on making sure that goods and services are designed, developed, and made to meet or exceed consumers’ expectations and requirements

Quality engineers design and monitor the quality of processes. They work in a variety of industries and play a vital role in correcting or fixing defects

Indicators of Quality

1. Performance – primary operating characteristics
2. Time – time waiting for service, time waiting on queue, time to complete the service and etc
3. Reliability – extend of failure free operation
4. Durability – amount of use until replacement
5. Consistency - match with documentation
6. Serviceability – resolution of problems and complaints
7. Personal interface – punctuality, courtesy and professionalism
8. *Harmlessness – health, safety, environment*

The definitions of "quality" include certain key words that themselves require definition.

* Product: The output of any process. To many economists, products include both goods and services. However, under popular usage, "product" often means goods only.
* Product feature: A property possessed by goods or services that is intended to meet customer needs.
* Customer: Anyone who is affected by the product or by the process used to produce the product. Customers may be external or internal.
* Customer satisfaction: A state of affairs in which customers feel that their expectations have been met by the product features.
* Deficiency: Any fault (defect or error) that impairs a product's fitness for use. Deficiencies take such forms as office errors, factory scrap, power outages, failures to meet delivery dates, and inoperable goods.
* Customer dissatisfaction: A state of affairs in which deficiencies (in goods or services) result in customer annoyance, complaints, claims, and so on.

Historical basis - VOC

A fourth and widely used basis for setting quality goals has been historical performance; i.e., goals are based on past performance. Sometimes this is tightened up to stimulate improvement. For some products and processes, the historical basis is an aid to needed stability. In other cases, notably those involving chronically high costs of poor quality, the historical basis helps to perpetuate a chronically wasteful performance. During the goal-setting process, the management team should be on the alert for such misuse of the historical basis.

Lessons learned are based on experience that is derived from prior historical events. These events become lessons learned only after analysis—"retrospective analysis."

With the huge range of products on the market today, manufacturers must provide top-quality products that consumers want. They must also provide them at competitive prices.

Companies can make sure they take into account the '***voice of the customer***' through the effective use of quality engineering methods and tools.

Deming's quality principles

William Edwards Deming (October 14, 1900 – December 20, 1993) was an American engineer, statistician, professor, author, lecturer, and management consultant. Deming is best known for his work in Japan after WWII, particularly his work with the leaders of Japanese industry. That work began in August 1950 at the Hakone Convention Center in Tokyo, when Deming delivered a speech on what he called "Statistical Product Quality Administration"

14 Principles

1. "Constancy of Purpose" towards Product and Service Improvement

Deming believed that businesses should also innovate, conduct research, and continually improve product design. Customer's needs should come first when making business decisions. After all, without customers, no business can survive. Since customer needs change over time, it's up to businesses to prepare for new challenges, and whatever we do, the goal of continually doing it better should be foremost in our minds

2. Adopt a New Philosophy

Staff should be inspired to support quality rather than needing to be forced to do so. Deming encourages us to treat quality management as a strategic priority that leads to the fulfillment of customer needs. Deming suggested practical interventions including proper training for staff, full management support when help is needed, proper supervision, and planning for management continuity

Deming's quality principles

3. Build Quality In – You Can't Inspect it In

He encouraged businesses to stop depending on inspections to get quality. He pointed out that inspections can miss defects, that they are costly, and that they don't improve quality because all they can do is find poor quality. improving processes to eliminate errors is far better and less costly than trying to correct errors after they have already occurred.

4. Use Single Suppliers for Any Item

Businesses should build long-term relationships with suppliers. Focus on one supplier for each input, and there is greater motivation for the supplier to meet your business's needs and even go the extra mile. Suppliers can become part of your never-ending drive towards improvement, but to do so, there must be a stable relationship characterized by trust.

5. Improve Processes Constantly. Improve Them Forever

By improving productivity and training its staff so that they're able to deliver their best, a business also improves its profits. The temptation to adopt a short-term fix is good, but why if we can fix flaws in our business processes permanently.

Deming's quality principles

6. Use On-The-Job Training

Expenses + time loss. You don't need to know all the details of how to do every job, you do need to understand what people do, and what obstacles to quality your team members face. If people know where they fit into a team, and how the team's results depend on their work, they are far more likely to care about the results they achieve.

7. Use Leadership Skill

You don't just talk and expect others to "do," you listen, you understand, and you act. You create an environment in which people can realize their potential. You motivate them to want to do their best, and they deliver their best.

8. Drive out Fear

Were you ever a junior employee who was scared of the boss? Perhaps you had a teacher at school who terrified you. Could you deliver your best under these conditions? some of your best quality and process improvement suggestions come from the coalface – but if you don't have open lines of communication, you're never going to hear those suggestions. Never hide problems or mistakes in your job.

Deming's quality principles

9. Break Down the Barriers Between Departments

When people work as a team, they can achieve more than they would on their own. Although your company will have departments, they can't work in isolation. If product designers never work with production, and if production doesn't work with sales, your organization is never going to reach its potential.

10. Ditch Slogans and Communicate With Individuals

Slogans sound so nifty, but do they have any real effect? "We put the customer first" is a typical example. It sounds great, but what is its practical meaning? How does it apply to every worker in your internal value chain? Use tools like ***Fishbone Diagrams*** to help you get down to root causes before you suggest solutions.

11. Quotas are Incompatible With Quality in Production

High production targets make quality suffer. For instance, if you are production line worker and you get paid per piece, you will finish as many pieces as possible. You are working as fast as you can, but are you working as well as you can? When you set a numerical target, are you encouraging people to take ***shortcuts*** that will affect quality? if you want to set a numerical goal, be very sure you know how your business can reach it. Without a plan and a method, numbers are meaningless.

Deming's quality principles

12. Remove Barriers that Prevent Teams From Feeling Proud of Their Work

Taking pride in one's work is essential to quality and process improvement. It's natural that some workers will acquire skills faster than others, and it's natural that they will get better results than their counterparts. While it's great to recognize achievements, the rest of the team should never feel judged or be made to feel that they are valued less than others are.

13. Encourage Education and Self-Improvement

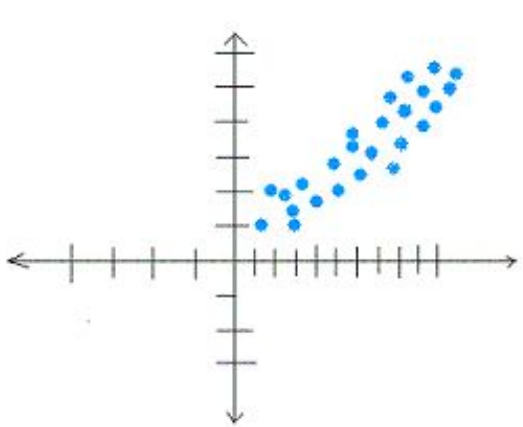
Your business isn't always going to stay the same, and the new skills your employees gain could prove helpful in the longer-term. As a part of self-improvement motivation can play the major role, and what is more important which type of motivation will you use ***Intrinsic*** / ***extrinsic,*** ***positive*** / ***negative*** motivation.

14. Make Transformation Everybody's Job

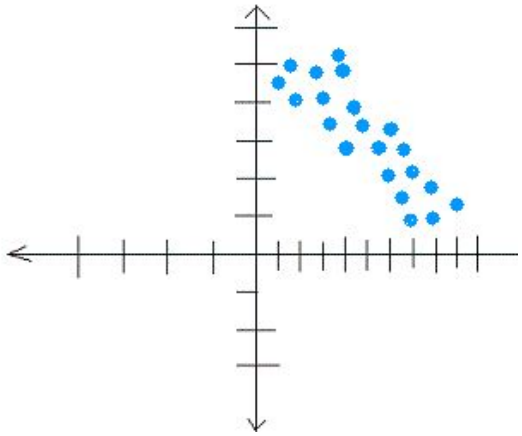
We can ask people to help us think about how we can change processes to improve the quality of their outputs. And since each step in a process impacts on subsequent ones, preparing for transformation becomes everybody's job

Plotting graphs (scatter method)

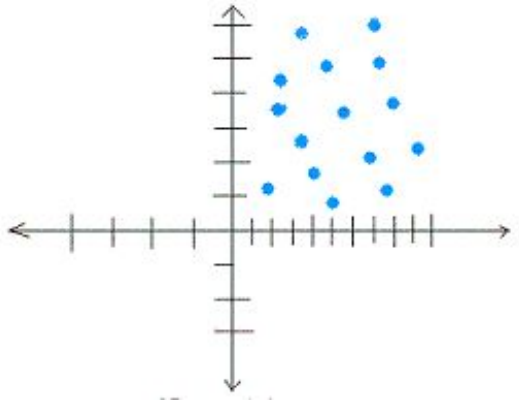
Scatter plots are used when you want to show the relationship between two variables. Scatter plots are sometimes called correlation plots because they show how two variables are correlated. There are three types of correlation:



Positive



Negative



No correlation

Plotting graphs (scatter method)

Microsoft Excel is a tool which has many uses, the most common of which are performing calculations and plotting graphs.

When you open *Microsoft Excel* you will see a grid. Each box in the grid is called a cell. Each cell has an "address" made up of a letter indicating the column the cell is in and a number indicating the row the cell is in. For example, the upper left cell is A1.

The first step in doing a spreadsheet calculation or making a graph is entering the data.

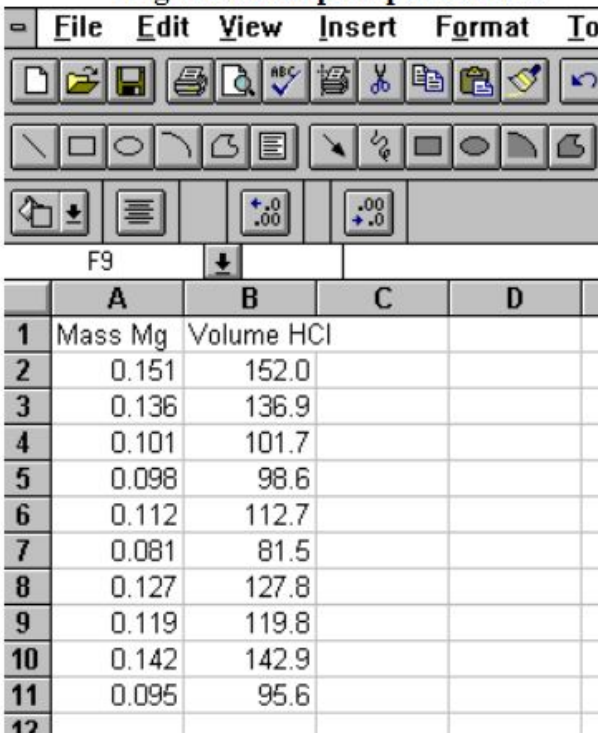
For example, if we did an experiment reacting several different samples of magnesium metal with hydrochloric acid, we might want to set up a spreadsheet containing the **moles of magnesium** and **volume of hydrochloric acid** used. We would create a spreadsheet that looks like figure 1.

Plotting graphs (scatter method)

Each number in column A contains a mass of magnesium used in the experiment, and each number in column B contains the volume of HCl with which the mass in column A reacted.

The x data **always** goes on the left of the y data.

Figure 1: Simple Spreadsheet



	A	B	C	D
1	Mass Mg	Volume HCl		
2	0.151	152.0		
3	0.136	136.9		
4	0.101	101.7		
5	0.098	98.6		
6	0.112	112.7		
7	0.081	81.5		
8	0.127	127.8		
9	0.119	119.8		
10	0.142	142.9		
11	0.095	95.6		

Some Symbols used in Excel "operations"

- It is very important to use the "=" sign. The "=" sign tells the spreadsheet program that the information that follows is a formula and the values for the selected cells using that formula should be computed.
- The "^" symbol means "raised to the power of...", the "*" means "multiplied by...", and the "a2:a11" means the range of cells A2 through A11.
- Range (:)
- Negation of operand (-7)
- Exponentiation (^)
- Multiplication and division (* and /)
- Addition and subtraction (+ and -)

Simple Spreadsheet Calculations

In order to convert from grams of magnesium to moles of magnesium, equation 1 would be used:

Moles Mg = Mass Mg (grams) / Molecular Weight Mg

Equation 1

where the molecular weight of magnesium is 24.305 g/mol.

This calculation can easily be done with a calculator, however, for large data sets, a spreadsheet is much faster.

A step wise procedure for using **Microsoft Excel** to do such calculations is given on next slides:

Table 1

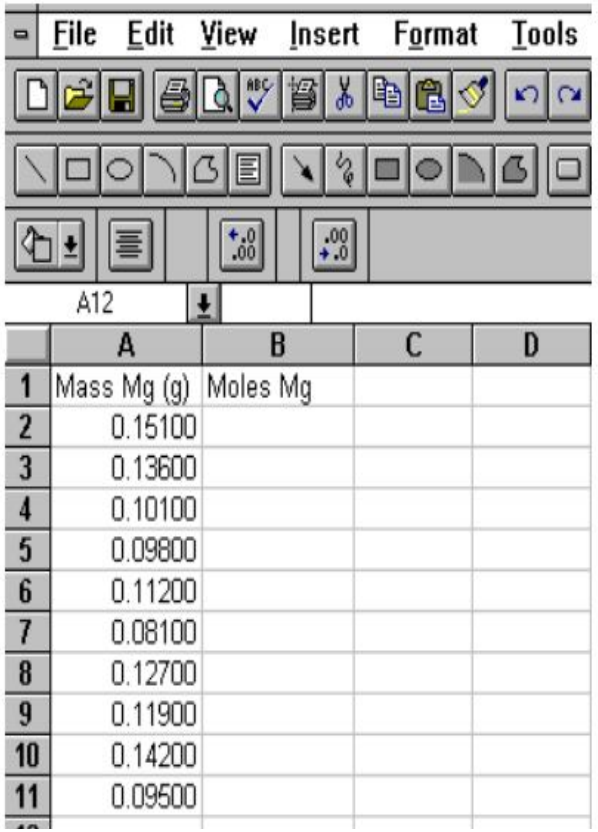
trial number	mass of magnesium (grams)
1	0.151
2	0.136
3	0.101
4	0.098
5	0.112
6	0.081
7	0.127
8	0.119
9	0.142
10	0.095

Simple Spreadsheet Calculations

1. Enter the data for the mass of magnesium shown in table 1 into rows 2 through 11 of column A. Row 1 should contain a data label of "Mass Mg (g)" to identify what the numbers in the spreadsheet represent. Cell B1 (i.e., column B, row 1) should contain the label "Moles Mg" which is what we want to calculate (figure 2)

2. Place the mouse cursor (represented as a "fat" "+" sign) on cell B2 (i.e., column B, row 2), click and hold the left mouse button, drag the pointer to cell B11, and release the mouse button. Cells B2 through B11 should be highlighted.

Figure 2: Setup for Spreadsheet Calculation



Simple Spreadsheet Calculations

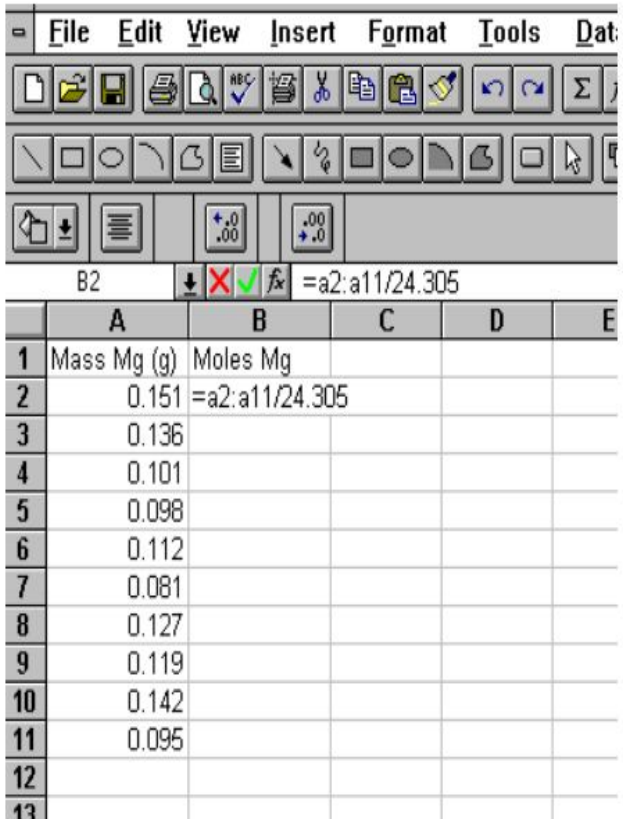
3. Next we have the spreadsheet program calculate the value for moles of magnesium for each row of data. Type the following exactly as it appears (shown in figure 3 - DO NOT hit "enter" when finished!):

=a2:a11/24.305

This is the same equation as ***equation 1***, but it is entered symbolically so that the spreadsheet can understand it

4. Simultaneously press and hold the CTRL, SHIFT, and ENTER (or RETURN) keys on the keyboard and the numerical values of moles of magnesium will be computed and automatically entered into cells B2 through B11.

Figure 3: Entering an Equation for a Spreadsheet Calculation



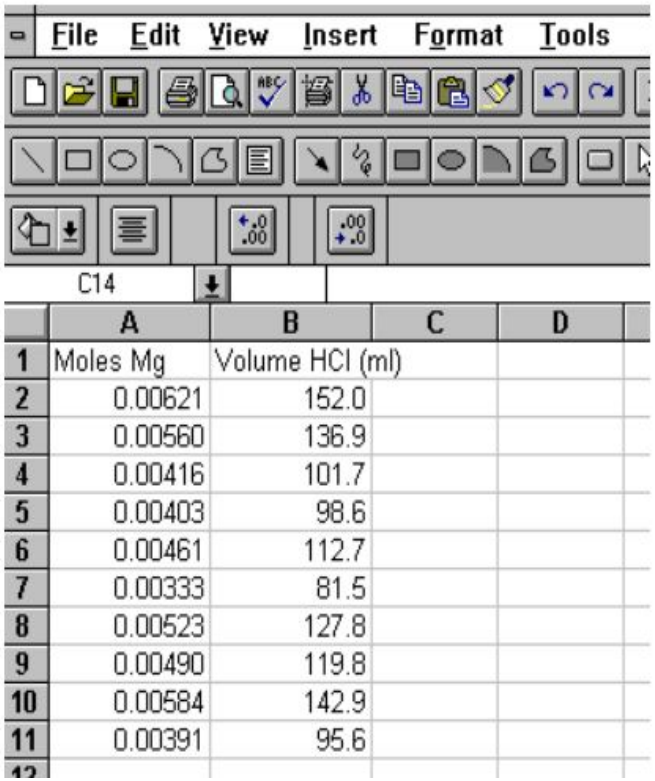
	A	B	C	D	E
1	Mass Mg (g)	Moles Mg			
2	0.151	=a2:a11/24.305			
3	0.136				
4	0.101				
5	0.098				
6	0.112				
7	0.081				
8	0.127				
9	0.119				
10	0.142				
11	0.095				
12					
13					

Plotting an X-Y Data Set and SCATTER Graph

1. The first step in creating a graph using Microsoft Excel is entering the data. The data should be in two adjacent columns with the x data in the left column. The columns should be labeled in row one in order to identify what the numbers in the spreadsheet represent.(figure 4).

2. Position the cursor on the first X value (i.e., at the top of the column containing the x values, or "Moles of Mg" values), hold down the left mouse button and drag the mouse cursor to the bottom Y value (i.e., at the bottom of the column containing the y values, or "Volume of HCl" values). All of the X-Y values should now be highlighted (figure 4).

Figure 4: X and Y data

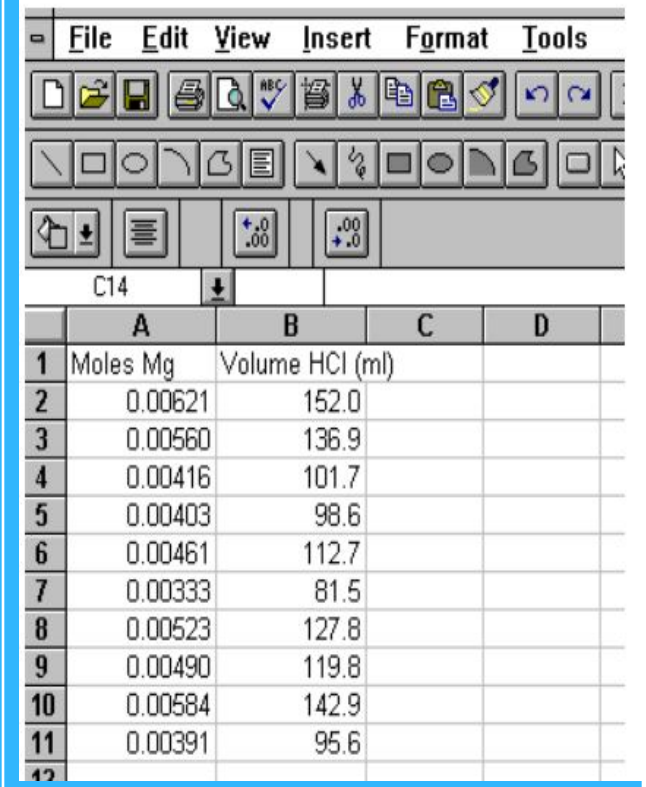


	A	B	C	D
1	Moles Mg	Volume HCl (ml)		
2	0.00621	152.0		
3	0.00560	136.9		
4	0.00416	101.7		
5	0.00403	98.6		
6	0.00461	112.7		
7	0.00333	81.5		
8	0.00523	127.8		
9	0.00490	119.8		
10	0.00584	142.9		
11	0.00391	95.6		

Plotting an X-Y Data Set and SCATTER Graph

3. Click on Insert at the top left of the toolbar.
4. Click on Chart
5. Click on the box labeled XY (Scatter).
6. Click on Next >.
7. Click on the X-Y pattern without lines (Format Option 1).
8. Click on Next >; a reduced version of your graph will appear.
9. Click on Next >.
10. Click in the rectangular box labeled "Chart Title" and type in a title for the graph (e.g., "Volume of HCl vs. Moles Mg).
11. Click separately on the boxes labeled "Category (X)" and "Value (Y)" and type a label for the X axis (e.g., Moles Mg) and the Y axis (e.g., Volume HCl (mL)).

Figure 4: X and Y data



	A	B	C	D
1	Moles Mg	Volume HCl (ml)		
2	0.00621	152.0		
3	0.00560	136.9		
4	0.00416	101.7		
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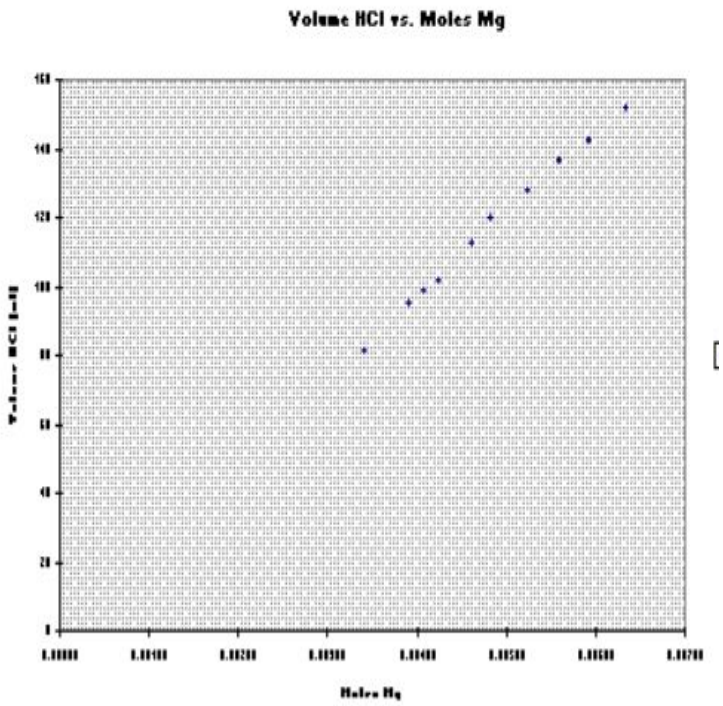
9	0.00490	119.8		
10	0.00584	142.9		
11	0.00391	95.6		

Plotting an X-Y Data Set and SCATTER Graph

12. Click on As New Sheet. This will instruct the program to plot the data on a separate sheet labeled "Chart1".
13. Click on Next >.
14. Click on Finish. At this point you will have created an X-Y plot of the data which should look like figure 5.

Figure 5: X-Y Plot of Experimental Data



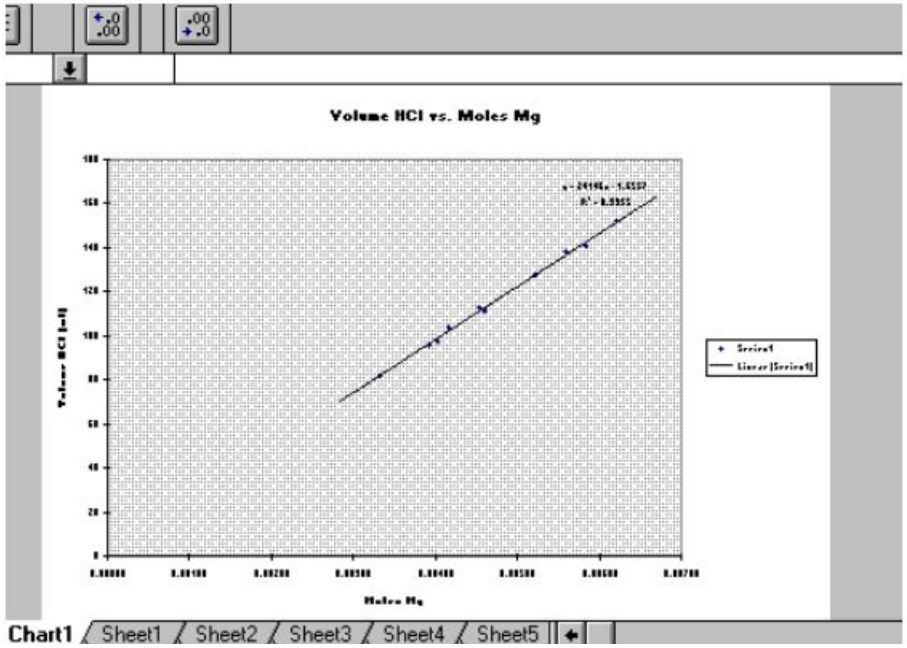
Plotting an X-Y Data Set and SCATTER Graph

1. Be sure you are on the worksheet which contains the chart you wish to work with.
2. Move the mouse cursor to any data point and press the left mouse button. All of the data points should now be highlighted. Now, while the mouse cursor is still on any one of the highlighted data points, press the right mouse button, and click on Add Trendline from the menu that appears.
3. From within the "Trendline" window, click on the box with the type of fit you want (e.g., Linear).
4. Click on Options at the top of the "Trendline" window.
5. Click in the checkbox next to "Display Equation on Chart" and the checkbox next to "Display R-squared Value on Chart". Do not click on the checkbox next to "Set Intercept = 0".
6. Click OK. A line, an equation, and an R-squared value should appear on the graph as shown in figure 6 below.

Plotting an X-Y Data Set and SCATTER Graph

6. Click OK. A line, an equation, and an R-squared value should appear on the graph as shown in figure 6 below.

Figure 6: Plot of Data Including Trendline, Equation of Line, and R-Squared Value



Printing Data from Excel

To print your data sheet:

1. Click on **File** in the left-hand corner of the toolbar, and then click on **Page Setup....**

2. Click on "Header/Footer" at the top of the "Page Setup" window.

3. Click on **Custom Header....**

4. Click on the box labeled "Left Section" and type in (on two separate lines) your name and your section number.

5. Click on **OK**.

6. Click on **Print....**

7. Click on **OK**.

8. Retrieve your printout from the printer.