EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING
Revised for
ACCESS TO APPRENTICESHIP

MATHEMATICS SKILLS
INTERPRETATION OF GRAPHS

AN ACADEMIC SKILLS MANUAL
for
The Construction Trades: Mechanical Systems

This trade group includes the following trades:
Electrician (Construction, Maintenance & Industrial),
Network Cabling Specialist,
Plumber, Refrigeration & Air Conditioning Mechanic,
Sprinkler &Fire Protection, and Steamfitter,

Workplace Support Services Branch
Ontario Ministry of Training, Colleges and Universities

Revised 2011

In preparing these Academic Skills Manuals we have used passages, diagrams and questions similar to those an apprentice might find in a text, guide or trade manual.

This trade related material is not intended to instruct you in your trade. It is used only to demonstrate how understanding an academic skill will help you find and use the information you need.

MATHEMATICS SKILLS
INTERPRETATION OF GRAPHS

An academic skill required for the study of the Construction Trades: Mechanical Systems

INTRODUCTION

Tables and graphs present facts in a way that makes it easy to find and interpret the information. Some of the meters and testing equipment you use on the job to test circuitry show information in a graph form. When this information is presented in a visual form on a graph, the relationship is easy to visualize or interpret.

For example, the OMNI*Scanner* might be used to measure and verify that cable links for certain installations meet the necessary requirements. The hard copy record of a test that compares attenuation (loss of signal due to distance) in decibels at different frequencies up to 100 MHz is shown as a line graph. The graph illustrates the relationship between the frequency of the signal and any loss of signal for the cable being tested.

This skill manual looks at tables and graphs, including the following topics:

- Tables
- The co-ordinate system
- Line graphs

TABLES

Usually the information, or *data*, presented in a graph is first organized into a table. In a table, the data is arranged in rows and columns so they can be easily referred to.

Table 1 lists the attenuation (loss of signal) of a cable over different frequencies. All electromagnetic signals lose strength as they get further away from their source. This lose is measured in decibels. Since attenuation is a loss of signal, it is given in negative values. If 0 dB is the starting measurement (no loss), then -2 dB is a small loss, while −30 is a larger loss.

TABLE 1: Attenuation compared to frequency

Frequency (MHz)	Attenuation (db)
0	0
10	-5
20	-18
30	-22
40	-26
50	-30
60	-32
70	-36
80	-38
90	-40
100	-42

GRAPHS

A graph is a diagram that is used to show the changes of quantities in relation to each other.

> **Example:** A graph could be used to show the relationship between the heat values of different fuels in Table1.

THE CO-ORDINATE SYSTEM

A ***grid*** system is used to locate points on a graph. *A **grid** consists of a horizontal line crossed by a vertical line.*

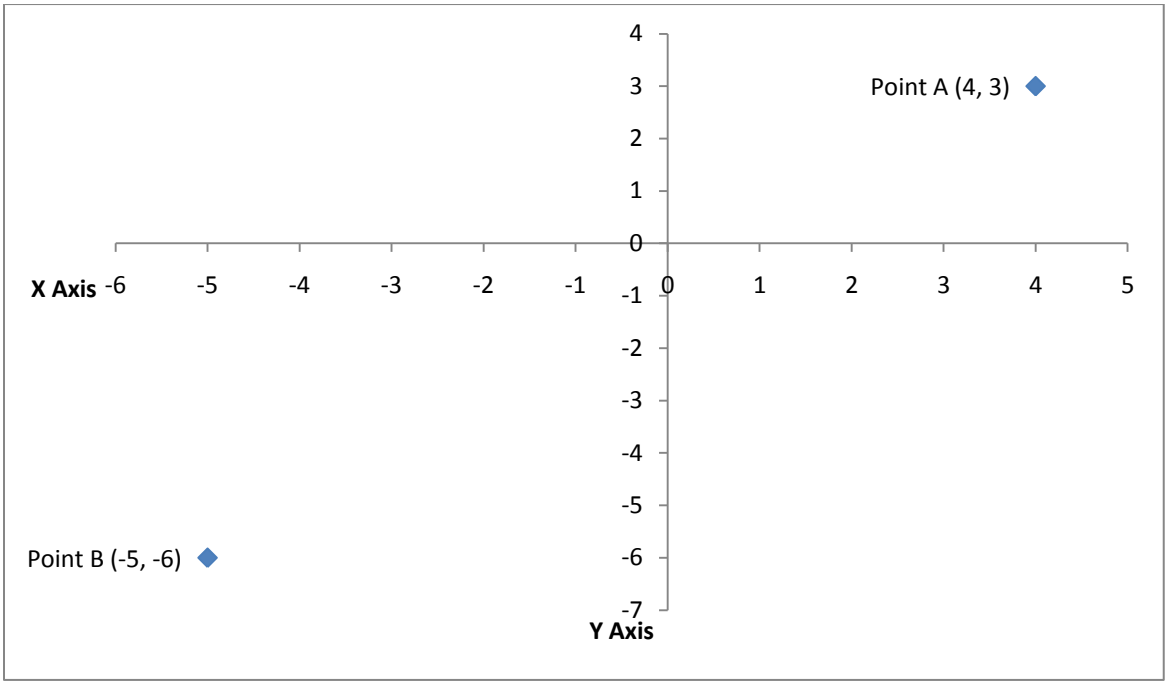
Graph 1, below, shows a grid.

- The horizontal line is called the ***x-axis***.
- The vertical line is called the ***y-axis.***
- The x-axis represents one set of measurements and the y-axis represents another set.

The x- and y-axis each have a ***scale***, *a graduated series of numbers that include the measurements of the quantities used on the graph.*

The point where the x and y-axis cross, called the point of intersection or the ***origin***, usually has the value of 0.

- Numbers to the right of 0 on the x-axis are positive, while numbers to the left of the origin are negative.
- Numbers above 0 on the y-axis are positive, while numbers below the origin are negative.



GRAPH 1: A grid with an X axis and a Y axis

Often only positive quantities are shown on a graph.

- A graph like this will not show negative numbers.
- The y-axis will be at the left hand side and the x-axis is at the bottom of the graph.

Points on a grid

A vertical line can be drawn from any point on the x-axis to meet a horizontal line drawn from any point on the y-axis. *Where the two lines meet, a **point** is formed on the grid.*

- A point can be formed at every place where a vertical line from the x-axis crosses a horizontal line extending from the y-axis,.

Coordinates

Every point has two ***coordinates*** *that describe where, on the graph, each point is*:

- The first coordinate shows the measurement on the x-axis.
- The second shows the measurement on the y-axis.
- Point coordinates are listed inside brackets.

Example: Look back to Graph 1. Point A on the graph is listed as Point A (4, 3).

1. If you look down to the x axis below Point A, you will see the point is directly above 4 on the axis.
   - 4 is the x coordinate.
2. If you look across to the Y axis you will see that Point G is directly across from the 3.
   - 3 is the y coordinate.

Point A (4,3) is the point where 4 is the x co-ordinate and 5 is the y co-ordinate.

Plotting points on a grid

In general, the information that is used to form the points on a grid comes from a table. The table will list two sets of numbers or measurements in a way that shows the connection between them.

Table 2 lists related x and y values. This table can be used to plot points on a grid.

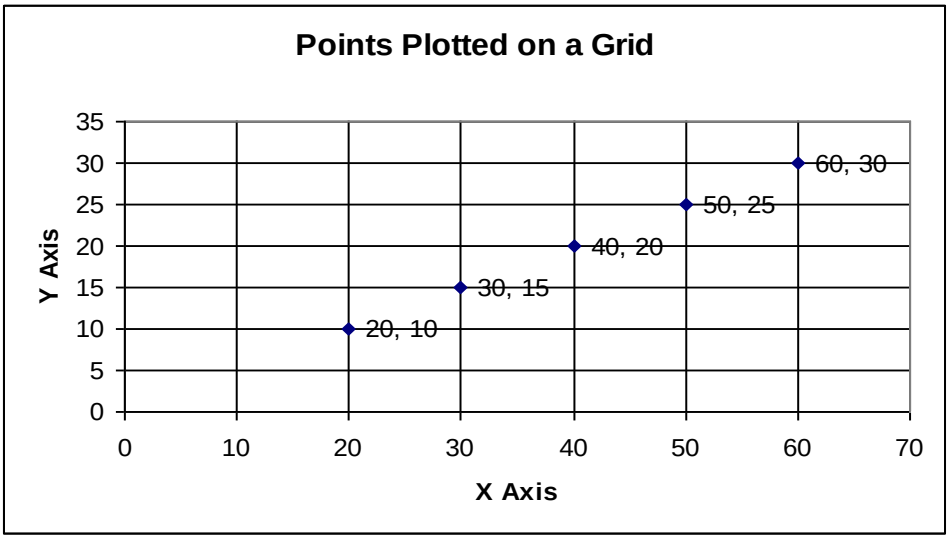
TABLE 2: List of x and y values

x value	y value
20	10
30	15
40	20
50	25
60	30

The points on Table 2 can be plotted on a grid with an x and y-axis, as shown on Graph 2 below.

To make the data in Table 2 into a graph:

1. We assign each axis numbers that are in the range of the information on the table.
   - X values in the table start at 20 end at 60,
     - So the x axis will start at 0 but it must include that range of values.
   - Y values range between 10 and 30
     - The Y axis also starts at 0 and must include that range of values.
2. We put a point on the grid each place where the y value and the x value meet.
   - We put a point on the grid where the x value, 20, meets the y value, 10.
   - The next point goes where x = 30, y = 15.
   - Another point goes where x = 40, y = 20, and so on.
3. The result is Graph 2, below.



GRAPH 2 Points Plotted on a Grid

The grid in Graph 2 shows the horizontal x-axis and the vertical y-axis. The x and y scales are simple number intervals without any units such as centimeters or feet.

- Notice that the y scale is smaller or closer together than the x scale on the graph.
- Also note that only positive values are shown in this graph.

The points are plotted on the grid like this: Look at the third point on Graph 2. It has an x coordinate of 40 and a y coordinate of 20. It is named as point A (40, 20).

Finding Points on a Grid

To locate a point on a grid, use the x and y numbers listed in the co-ordinate pair for that point.

- The order of the numbers is important.
- The first number gives the x coordinate. The second number is the y coordinate.

To find the point (30,45) on Graph 2:

1. Draw a vertical line extending up from the number 30 on the x-axis.
2. Then draw a horizontal line extending over from the number 45 on the y-axis.
3. The point (30,45), is where the two lines meet.
4. Note that this point has no relation to the other points on the graph.

GRAPHING A LINEAR RELATIONSHIP

Graphs are often used to show a relationship between two quantities, such as the relationship between the numbers of hours required to charge a battery and the voltage required. If a line is drawn connecting the points, the graph is called a ***line graph***.

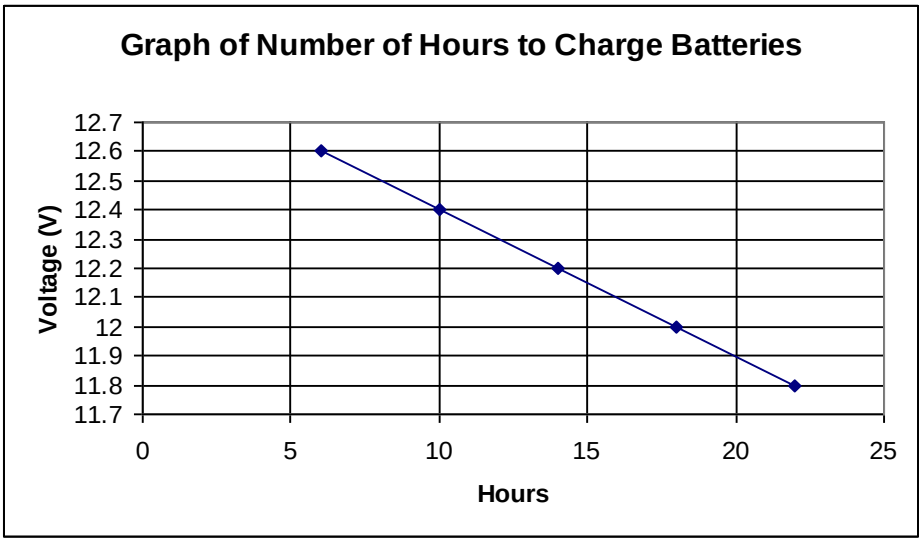
To graph the relationship between the open circuit voltage of a battery and the hours required to charge it using a 10 amp charger, follow these steps:

1. List the voltage of different batteries and the hours required to recharge each battery.
   - Table 5 lists the measurements.

TABLE 5: Number of hours to charge batteries with a 10 amp charger

hours to charge	open circuit voltage
6	12.6 V
10	12.4 V
14	12.2 V
18	12.0 V
22	11.8 V

2. The number of hours forms the scale on the x-axis.
   - The time scale goes from 6 to 22 hours.
3. The voltage measurements form the scale on the y-axis.
   - The voltage scale goes from 11.8 V to 12.6 V.
4. Use the quantities listed in the table to form the points on Graph 3.
5. Draw a line to link the points.



GRAPH 3: Number of Hours to Charge Batteries

When you look at Graph 3, you can see that the higher the voltage of a battery, the less time that is required to charge it, using a 10 amp charger

*When the points are joined, a straight line is formed. If a straight line results when the points plotted on a graph are joined, a **linear relationship** exists between the two quantities.*

Graphs with Curved Lines

Some of the graphs in your work will form a curved line

For example, if you plot and join the points from Table 1, the line drawn will not be a straight line. We will use Graph 4 to plot the points from Table 1 and then draw a line to join them.

TABLE 1: Attenuation compared to frequency

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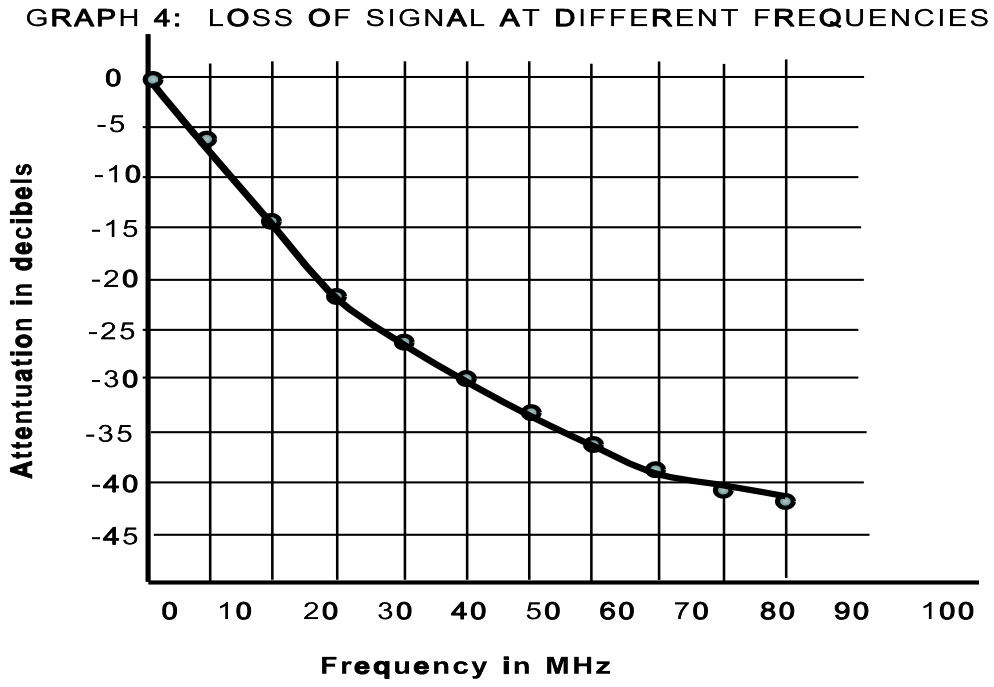
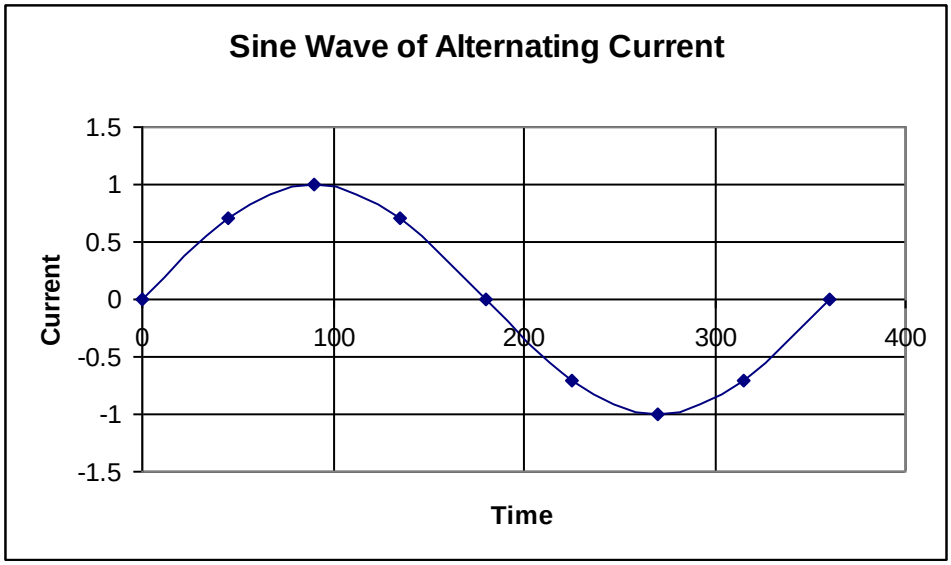
60	-32
70	-36
80	-38
90	-40
100	-42



Sine Wave

The current in power lines is supplied as an alternating current. This current moves in one direction, stops and then moves in the opposite direction. One cycle of alternating current can be graphed. The form of the graph is called a sine wave.



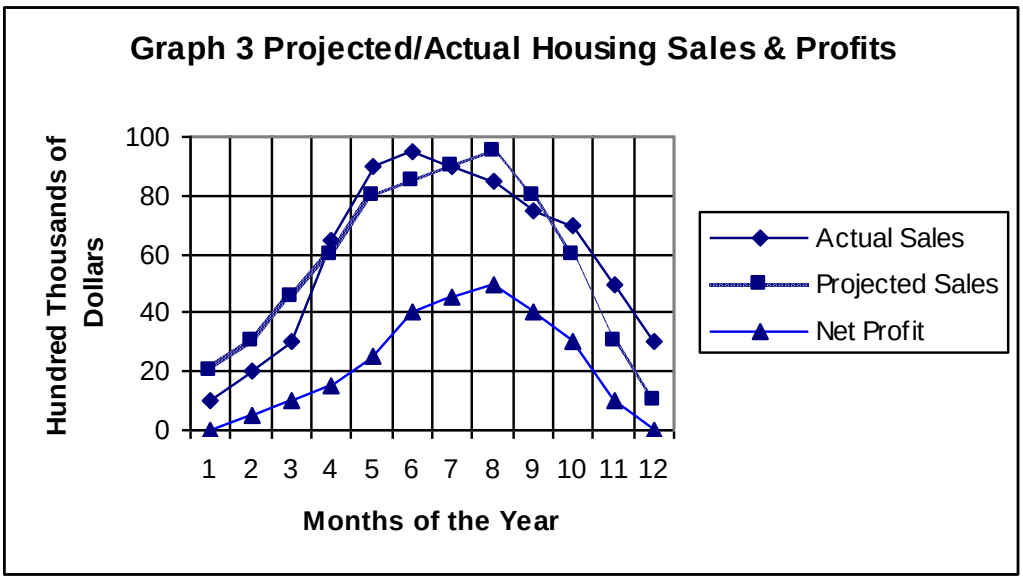
GRAPH 5 Sine Wave of Alternating Current

In Graph 5:

- The scale of the x-axis is the time it takes to make a complete cycle.
- The scale of the y-axis is the amount of current.
  - When the current is moving forward, the scale is positive.
  - When the current is moving in the reverse direction, the scale is negative.
- The graph does not show exact numbers for the current and time scale:
  - The current is calculated at thirteen successive time intervals.
  - It shows how the amount, and direction of the current changes through one cycle. (The actual time for one cycle is incredibly fast.)

Answer the questions based on the graphs shown. Answers are on the last page.

The three lines in the graph below represent a company's projected production (Δ), its actual production (■) and its net profit (◊) for each month of one year. Answer the following questions based on the graph below



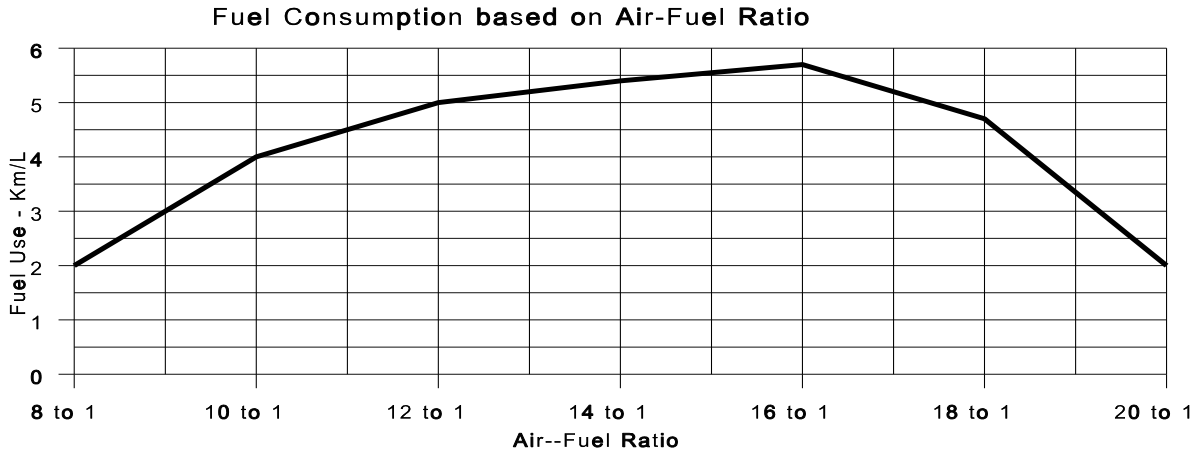
1. What month was the value of units produced the highest?

2. What month was the actual production the same as the projected production?

3. What month were profits the greatest?

4. Would you say that the company was fairly accurate in its prediction for the year?

5. In older vehicles with carburetors, the carburetor was set to regulate the amount of air admitted to the engine in a ratio with the amount of gasoline mixed with it. When the ratio is properly set, complete combustion takes place and the most economical fuel consumption occurs. Use the graph below to answer the questions on fuel consumption and air-fuel ratio.



a) What is the air-fuel ratio when the fuel consumption is 4 km/L? _____

b) What is the fuel consumption when the air-fuel ratio is 12? _____

c) At what air-fuel ratio is the gas consumption the most economical? (When do you get the most kilometers per liter of gas?) _____

d) At what two ratios is fuel consumption the least economical? _____ and _____

ANSWER PAGE

1. The value of units produced was the greatest in June.

2. The projected value was the same as the actual production in July.

3. Profits were greatest in August.

4. This question requires you to make a value judgement. The graph lines for the value of actual units produced and the projected value are close so it would be fair to say the company made an accurate prediction for the year.

5. a) Air-fuel ratio is **10 to 1** when the fuel consumption is 4 km/L.

   b) The fuel consumption is **5 km/L** when the air-fuel ratio is 12.

   c) Most economical consumption is at air-fuel ratio of **16 to 1**.

   d) Fuel consumption is least economical at the ratios of **8 to 1** and **20 to 1**.