EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING
Revised for
ACCESS TO APPRENTICESHIP

MATHEMATICS SKILLS
INTERPRETATION OF TABLES AND GRAPHS

AN ACADEMIC SKILLS MANUAL
for
The Construction Trades (Structures)

This trade group includes the following trades:
Drywall & Acoustical Applicator, General Carpenter,
Mason (Brick & Stone and Restoration), Reinforcing Rod Worker, Roofer,
Terrazzo, Tile & Marble Mechanic

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 TABLES AND GRAPHS

An academic skill required for the study of the Construction Trades (Structures)

INTRODUCTION

Graphs present facts visually, making it easier to find and interpret information. You can actually see the relationship between different quantities, rather than having to analyse numbers.

In construction, you will be constantly referring to a specialized type of graph – the blueprint. Although we don't usually refer to a blueprint as a graph, computer blueprints or graphics are based on the ***Cartesian coordinate system***. The Cartesian coordinate system uses a ***grid*** system to locate points on a graph. It is the basis of mathematical graphs.

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

- Tables
- The co-ordinate system
- Graphing a linear relationship
- Blueprint drawings as points on a grid
- Bar graphs

TABLES

Usually the information, or *data*, presented in a graph is first organized into a table. A table lists two sets of numbers or measurements in a way that shows the connection between them. The data is arranged in rows and columns.

In your work you will have to hoist loads safely. If you are using a swivel to attach the load to the rigging, you will need to check that the swivel will be strong enough to support the load. Table 1 shows the safe working load that different diameters of swivels can support. For each size of swivel, the maximum load that can be lifted is listed.

TABLE 1: Safe working load for different diameters of forged alloy steel swivels

Diameter in inches	Max. safe working load in pounds
1/4	850
5/16	1250
3/8	2250
1/2	3600
3/4	7200
7/8	10,000
1 1/8	15,200

A table can also show the relationship between two quantities in a formula. For example, the formula for the area of a circle is:

$$\text{Area} = \pi r^2$$

In this formula:

- One quantity in the formula, area, varies as the length of the radius changes. and
- For every value of radius in the formula, there is one value of area, found by multiplying π (3.14) times the radius squared.

Table 2 compares area with different values of radius.

TABLE 2: Value of area as the radius changes

Radius	Area (πr^2)
2 cm	12.6 cm^2
3 cm	28.3 cm^2
4 cm	50.2 cm^2
5 cm	78.5 cm^2
6 cm	113.0 cm^2

Instead of a specific formula such as that for area of a circle, you can have a general equation such as $y = 2x + 3$. *This equation, called a* ***function,*** *relates the value of y to every different value of x from 1 to 4.*

- To find values for y, you substitute different values of x in the equation and solve for y.

TABLE 3: Value of x and y for the equation
y = 2x + 3

x	y (2x + 3)
1	(2x1 + 3) = 5
2	(2x2 + 3) = 7
3	(2x3 + 3) = 9

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 diameter s of swivels and safe working loads 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.*

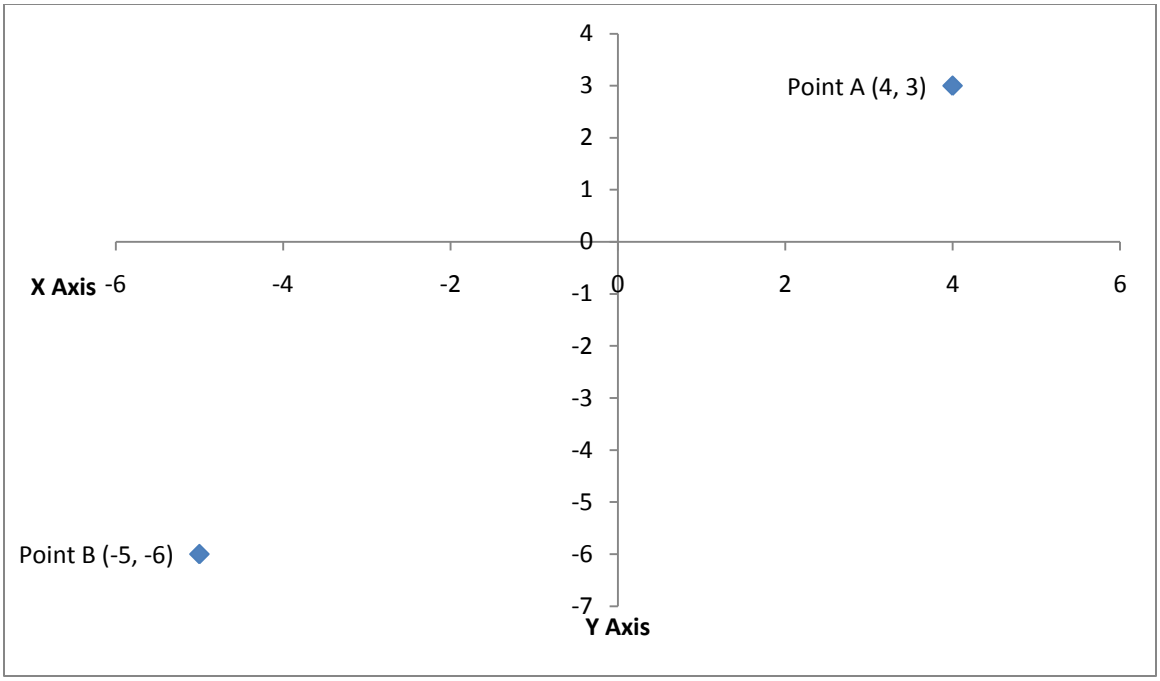
Graph 1, below, shows a grid.

- 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 such as Table 1, 2 or 3. The table will list two sets of numbers or measurements in a way that shows the connection between them.

Look at Table 4 which lists values for x and y. This table does not give an equation or formula, it only lists a series of values. We will look at how this table can be used to plot the points on a grid.

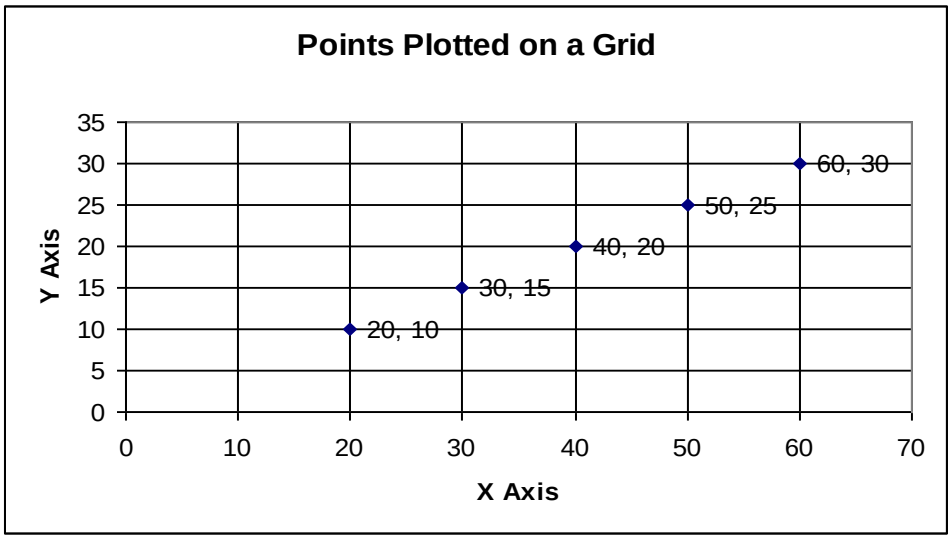
TABLE 4: List of x and y values

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

These points can be plotted on a grid with an x and y-axis, as shown on Graph 1.

To make the data in Table 4 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***.

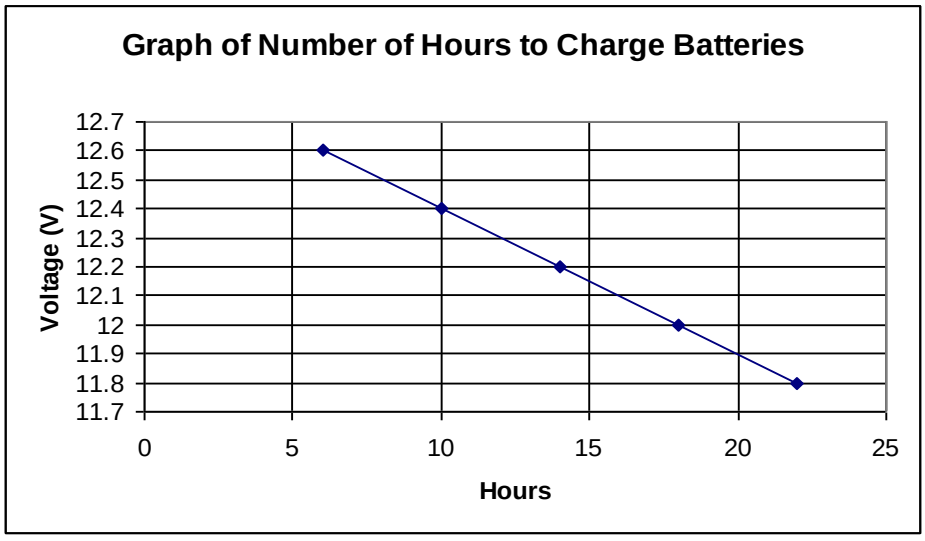
To graph the relationship between the open circuit voltage of a battery and the hours required to charge it using a 10 amp charger, follow these steps:

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.*

BLUEPRINT DRAWING AS POINTS ON A GRID

You can think of a two dimensional blueprint or working drawing as a series of points drawn on a grid.

Example: If you were making a rectangular box, you might have a blueprint showing three rectangular pieces:

- the top,
- the long side,
- and the short side.

Any of the rectangular pieces can be drawn as a series of points on a grid.

Graphs are created by drawing programs to generate working drawings and blueprints. The actual program for creating computer designed blueprints is, of course, very complex. However, it is based on the same grid system that simple graphs use.

Example: A CADD (computer-aided drafting and design) drawing is based on these principles.

- Every line on the drawing is defined by the relevant points.
- If the computer is given the needed information, such as the center point of a circle and the radius, it can draw that circle.

Example: CADD can also generate three dimensional diagrams using a third axis, the z-axis.

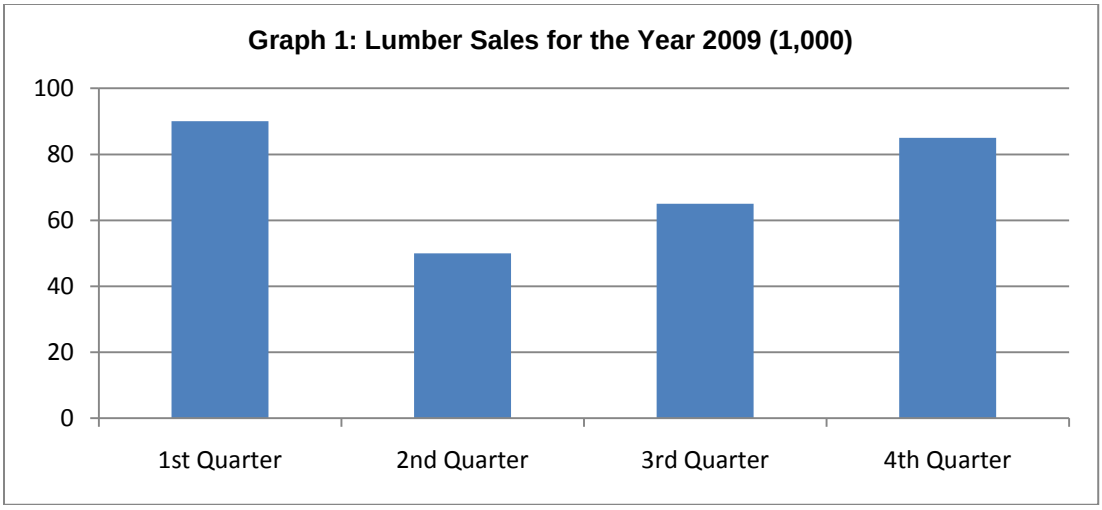
- The z-axis extends upwards and downwards at right angles from the point of origin.
- A point in a three dimensional diagram is named by the x, y, and z coordinates.

BAR GRAPHS

Bar graphs are used to compare related information or show trends. In a vertical bar graph like the one on this page, the scale of the quantities is written along the vertical left hand side, sometimes called the y-axis. The items being compared are written along the bottom of the graph, sometimes called the x-axis.

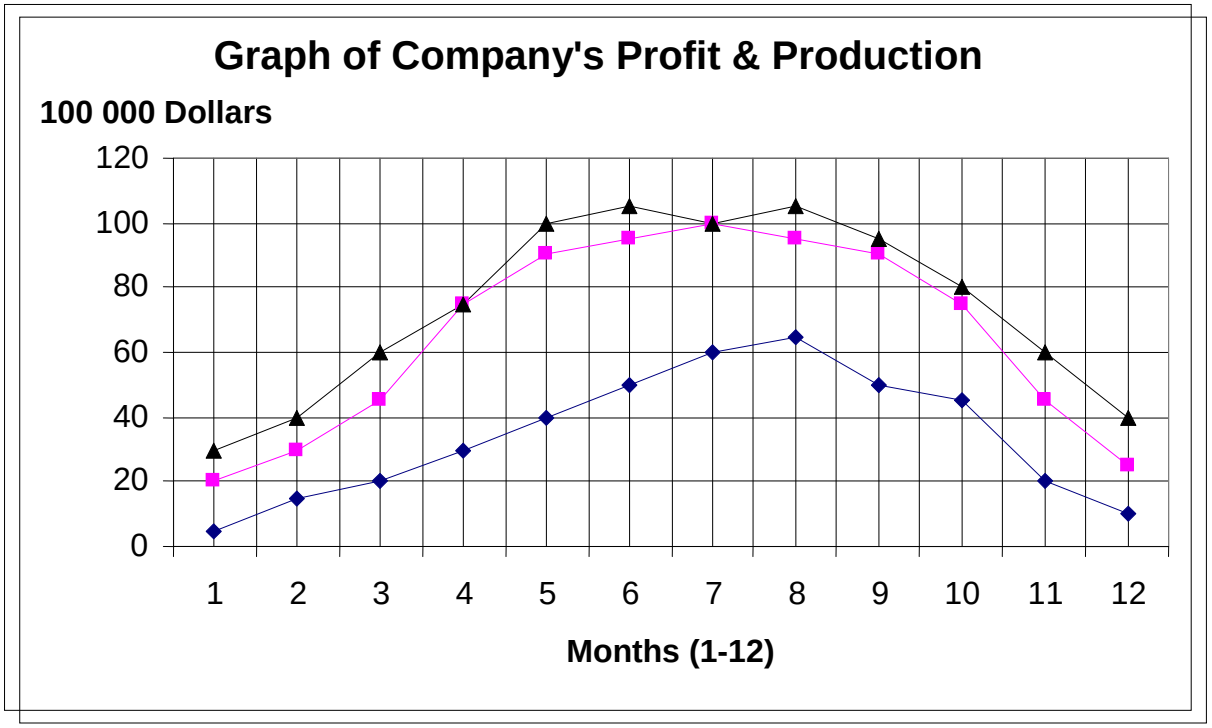
In the graph below, the scale on the left side represents the range of lumber sales, from 0 to 100. Multiply each number in the scale by $1000 to get its dollar value. The scale across the bottom represents the four quarters of the year. Looking at the bars, you quickly see that the greatest number of sales occurred in the first quarter and the least number occurred in the second quarter.

Bar graphs create an easy to understand visual picture, but they are limited in the amount of information they can present.


Graph 1: Lumber Sales for the Year 2009 (1,000)
100
80
60
40
20
0
1st Quarter
2nd Quarter
3rd Quarter
4th Quarter

Answer the questions based on the graphs which follow. 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.



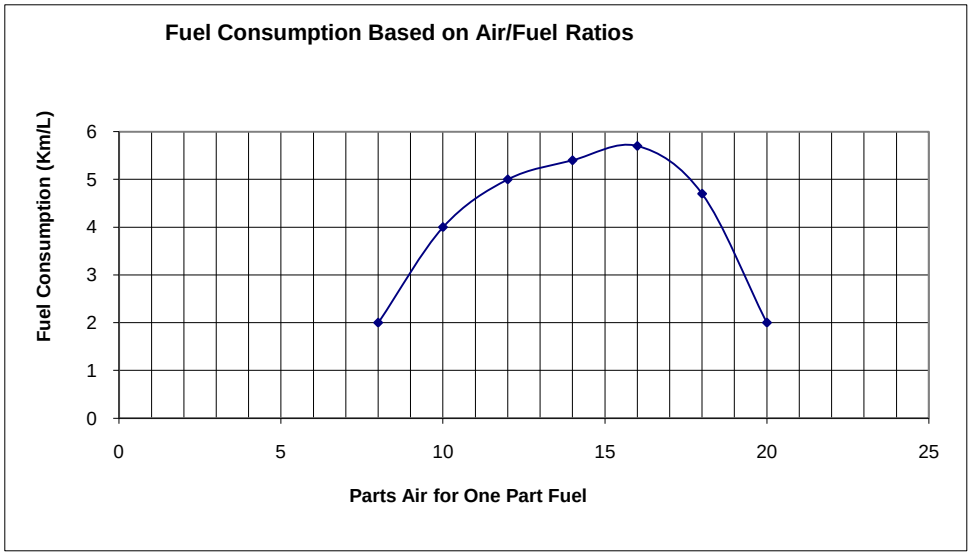
1. What month was the value of units produced the highest?

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

2. What month were profits the greatest?

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

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.



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

5. What is the fuel consumption when the air-fuel ratio is 12:1? _____

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

7. At what two ratios is fuel consumption the least economical? _____ and _____

ANSWER PAGE

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

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

6. The fuel consumption is **5 km/L** when the air-fuel ratio is 12:1.

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

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