SPREADSHEET SOFTWARE FOR ENGINEERING: AN APPLIED GUIDE



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Spreadsheet software for engineering: an applied guide

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Detailed Licensing

Detailed Licensing

Licensing

*A detailed breakdown of this resource's licensing can be found in **Back Matter/Detailed Licensing**.*

CHAPTER OVERVIEW

1: Overview of Microsoft Excel and Google Sheets

Spreadsheets are **essential tools** for **processing, analyzing, and communicating data**, making them invaluable in **engineering environments**. They are widely used in **academic settings**, such as **labs and grade calculations**, and in **professional fields**, including **accounting and engineering**, where efficient data processing is critical. In the workplace, **accurate data management** is crucial, as companies rely on **data-driven decision-making** to optimize operations and solve complex problems.

Whether consciously or not, you will encounter **spreadsheets** throughout your **academic and professional career**, reinforcing their importance across various disciplines.

This guide explores how spreadsheets serve as a **powerful data processing tool**, covering essential **engineering functions**, **formatting techniques**, and strategies for creating **visually informative charts** that enhance data interpretation.

1.1: Text and Numbers in Microsoft Excel

1.2: Microsoft Excel Basics

1.3: Google Sheets Basics

1.4: Text and Numbers in Google Sheets

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1.1: Text and Numbers in Microsoft Excel

Learning Objectives

By the end of this section, you will be able to:

- Explain the basics of data and data analysis
- Enter and format numeric data in a worksheet cell
- Use the Text and General formats for cell data
- Use the commands in the Page Layout and Review tabs

WorldCorp receives many orders every day, and they rely on databases for recording all data. Large corporations like WorldCorp also keep an inventory of direct materials for manufacturing. These materials, such as bolts and screws, come from many suppliers on multiple orders. They need to store all this inventory information in the accounting system. Finished products—the products that the company packages for shipping and sells—are built with various components and parts, and they record a list of all this information for every item that is manufactured. When a client places an order from a sales agent, these transactions are recorded in a customer relationship management (CRM) database. Although many large corporations use Oracle or SAP databases, many other software companies furnish solutions to big, medium, and small organizations. Medium-sized companies may use Microsoft Access and/or Microsoft Dynamics for their database purposes and for the financial accounting. Organizations of all sizes can utilize Microsoft Excel.

Here, you will learn some of the basic sales order database capabilities in Excel. For WorldCorp, Excel is an appropriate tool to gather, organize, and analyze information within the smaller business units such as by region or product line. The company-wide information might be stored in another type of program suited for large corporations, but at the business-unit level, Excel can be a powerful tool to feed into the corporate information database.

Data Fundamentals

For the purpose of spreadsheet programs, data can be textual (such as a product description) or numerical (such as a price per unit), and it represents what an organization has determined is valuable. If you decide to compare the prices of oranges at different grocery stores, then you are researching and creating data. You can write your data on paper, but a more efficient and common method today for capturing and storing data is with computers. Data is collected primarily to use later in data analysis, a scientific discipline that uses mathematical and statistical tools to measure trends. For example, a company could track the sales trends of three locations over the span of a few months. Watching the data could reveal slumps in sales, which could trigger the company to introduce a corrective action.

There are different kinds of data that businesses like to collect from their clients. Demographic data can segment a growing list of clients so that a company can give them better service based on their likes or dislikes. Financial and accounting data can keep track of a business's sales, unit costs, overhead costs, and so on. In addition to client data, machines are constantly generating data related to their performance. All manufacturing plants have machines that output data to computers for engineers and managers to analyze.

Excel can manage many types of datasets but works better when the dataset is relatively small. Access databases are appropriate for large sets of data or data that will continue to grow. There are other industrial-sized data storage and analysis solutions like SAP and Oracle, as well as others that might work better for larger data files. Programs such as Sage and QuickBooks that are specific to accounting and finance provide additional features for financial analysis that are not offered in Excel.

Entering and Formatting Numeric Data in a Worksheet Cell

The information made of numerals that Excel reads like a calculator to perform mathematical equations is called numeric data. There are many purposes of numerical values in spreadsheets. The numbers can represent quantities, currency, dates, time stamps, percentages, and more. Table 9.1 summarizes the numerical values Excel uses.

Table 9.1: Numerical Values in Excel

Type of Numerical Value	Description
Number	Data has two decimal places by default, but you can add or remove them, depending on what your needs are. It accepts negative numbers as well. You can add a thousands separator.
Currency	Data has two decimal places by default. It accepts negative numbers and will display them within parentheses or with a negative sign in red or black font. The thousands separator is turned on by default. A zero is displayed with two decimal places. Excel adds the appropriate currency symbol preceding the number, and the numbers are aligned to the right with no spaces to the edges.
Accounting	Data has two decimal places by default. It accepts negative numbers and will display in parentheses only. The thousands separator is given. The zeros are displayed as "-". Excel adds a currency symbol aligned to the left. The difference between Currency and Accounting is that with the Accounting format, all currency symbols are aligned.
Date	Data is displayed in the American format by default (i.e., month/day/year). There are options to change the location or to change the format to one of many different choices, such as day/month/year or year/month/day.
Time	Data uses the 24-hour clock or AM/PM format by default.
Percentage	Data analyzes the portion of a whole and the data is displayed as a percentage with the % symbol and no decimal points by default.
Fraction	Data analyzes the portion of a whole and displays the values as in the percentages. You can convert a fraction to a percentage before entering data.
Scientific	Data can be shortened numbers written in exponential form. To shorten a number, display the first digit, add a decimal point, and then list the next two digits. Then, add "E" and the number of zeros the whole number contains. For example, 644362623 would be 6.44E+9. These truncated forms of numbers are commonly used in all sorts of sciences.

Mac Tip

Percentages are shown with two decimal points by default.

You can choose the type of numerical value appropriate for your data on the Home tab. Figure 9.10 shows the drop-down menu in the Number command group where you can choose the type of numerical data you have. You can also access more details about the number type by selecting the arrow in the lower-right corner of the Number command group. This will open up the Format Cells dialog box that allows you to specify many more types of number formatting, including the number of decimal places. If you're starting from a blank worksheet, you can plan in your mind what kind of values your tables will contain, so that you can design them to be informative and display logical information. You can even do this prewrite of the table on a piece of paper, or as you go through the process of designing the document in Excel.

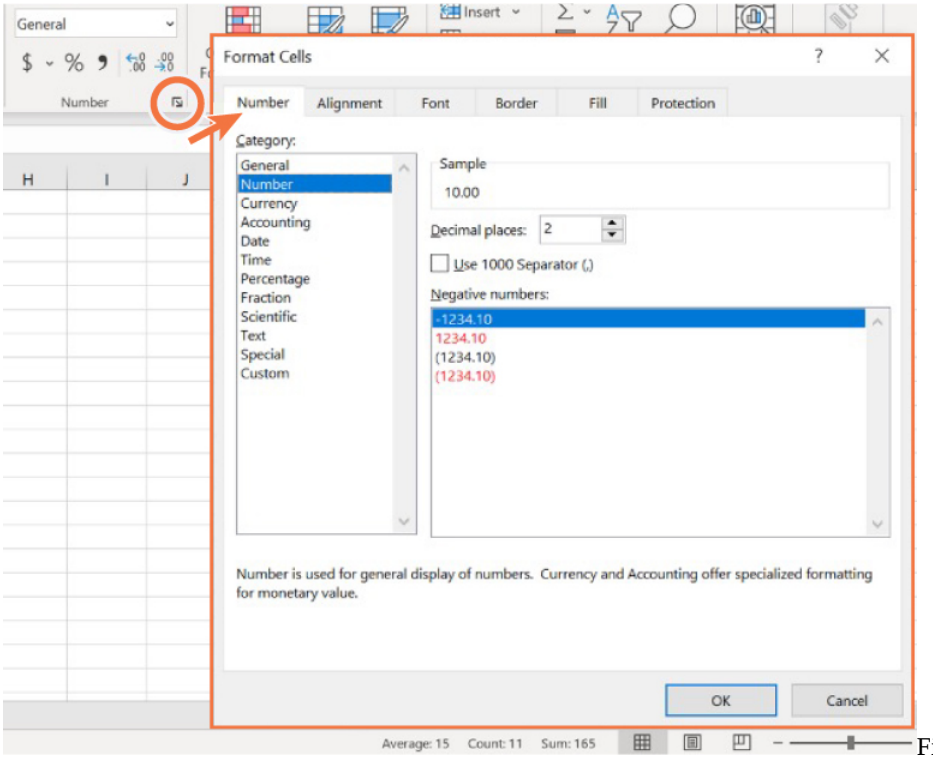


Figure 9.10: You can format numbers on the Home tab. The Number command group contains several buttons for commonly used formats and a drop-down menu. The drop-down menu contains an expanded list of common number formats. More options are available in the Format Cells dialog box. (Used with permission from Microsoft)

The Format Cells dialog box allows you to choose the category and formatting for your cell, based on the data. For example, you can determine the number of decimal places you want to show with your Accounting data. You can also use the Custom formatting category. There are numerous complicated formatting options in the Custom category, such as combining a date with a time, but you can also design your own by modifying an existing one to meet your needs.

Say a sales report table contains a set of orders and the name of the salesperson who fulfilled them. This worksheet contains a variety of types of data: dates, text, general, number, accounting, and more. In order to determine the type of data, click on the cell, and check the drop-down menu in the Number command group. Figure 9.11 shows that cell A2 is a Date. You can convert any number to currency by selecting a cell and then clicking on the "$" button on the Home tab.

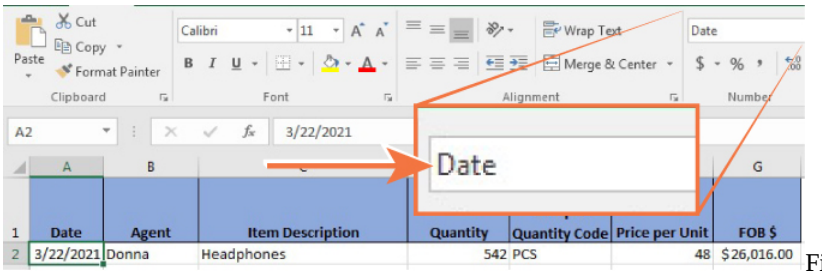


Figure 9.11: When a worksheet has multiple types of data, make sure to format it as the most appropriate type. Column A is formatted as a Date. (Used with permission from Microsoft)

Figure 9.12a shows a summary of the sales figures of all agents. You will notice that the first row is shaded blue and the text is bolded. This is an effective way to differentiate the headings for each column, often referred to as the column header, title row, or header row. More about formatting cells will be covered in Formatting and Templates in Excel. For now, to make the header row stand out, you can highlight (select) the row and use the commands in the Font command group on the Home tab to change the formatting, such as bolding, shading (fill), or text color.

Figure 9.12a includes a column for each agent's percentage of the FOB $ total, but by default, Excel formats cell contents as General, so it displays the calculation as a decimal number. You can format it as a Percentage by selecting the cell and changing the

number format in the drop-down menu or by clicking on the button in the Number command group. We can use the same process to display the next cell as a fraction. Figure 9.12b shows the finished table.

Agent	Quantity Total	FOB $ Total	Percentage	Fraction
Donna	759	$ 43,850.00	0.2197	0.2197
Robert	2680	$ 46,847.00	0.2347	0.2347
Cheryl	3865	$ 108,929.00	0.5457	0.5457
		$ 199,626.00		

(a)

Agent	Quantity Total	FOB $ Total	Percentage	Fraction
Donna	759	$ 43,850.00	21.97%	2/9
Robert	2680	$ 46,847.00	23.47%	1/4
Cheryl	3865	$ 108,929.00	54.57%	5/9
		$ 199,626.00		

(b)

Figure 9.12: By default, Excel formats cells as General, so formatting may require adjustment for numbers to display properly. (a) The unformatted table shows percentages and fractions as decimals. You can choose the Percentage format for the cells in the Percentage column. You can choose the Fraction format for the cells in the Fraction column. (b) The formatted table displays the percentages and fractions correctly. (Used with permission from Microsoft)

Using the Text and General Cell Formats

When your worksheet uses text data, which is information made up of words, letters, numerals, or a combination of those things, you can use the General or the Text cell format. For example, say you have salespersons' names in Text format, and item descriptions in the General format. In a blank worksheet, you can enter your data using the default General format, and Excel will automatically format it according to the type of data you're entering. For example, if you type a date in a cell formatted as General, Excel will identify it as a date and reformat it accordingly. If Excel detects a number or text, it will remain in the General format. General formatting is flexible and can accommodate numbers or text. Because Excel may automatically change the format of your cell contents if you leave the format as General, consider formatting all numbers as Number or Accounting, as appropriate.

If you format your words or letters as Text, then Excel will not try to autoformat them. Figure 9.13 compares the same data formatted as Text and formatted as Number. The Text format is flexible in that it can store numbers, letters, symbols, and words.

Text	Number
0126438796	126438796
0054735474	54735474
0005643573	5643573
=4*5	20

Figure 9.13: Numbers can be stored as text data to retain symbols or leading zeros, which are regularly used in some government reports, identification numbers, and some phone numbers. (Used with permission from Microsoft)

You are not restricted to the autoformatting that occurs when you type your data into a cell with General formatting. If you enter a number using the General format (Figure 9.14a), but you want the number to display as currency, for example, simply select the cell or column and then choose Currency from the Number command group's drop-down menu (Figure 9.14b). Excel will automatically add the currency symbol and two decimal places. All cells in a new workbook are by default set to General format, but you can design your tables with the correct format for your purpose.

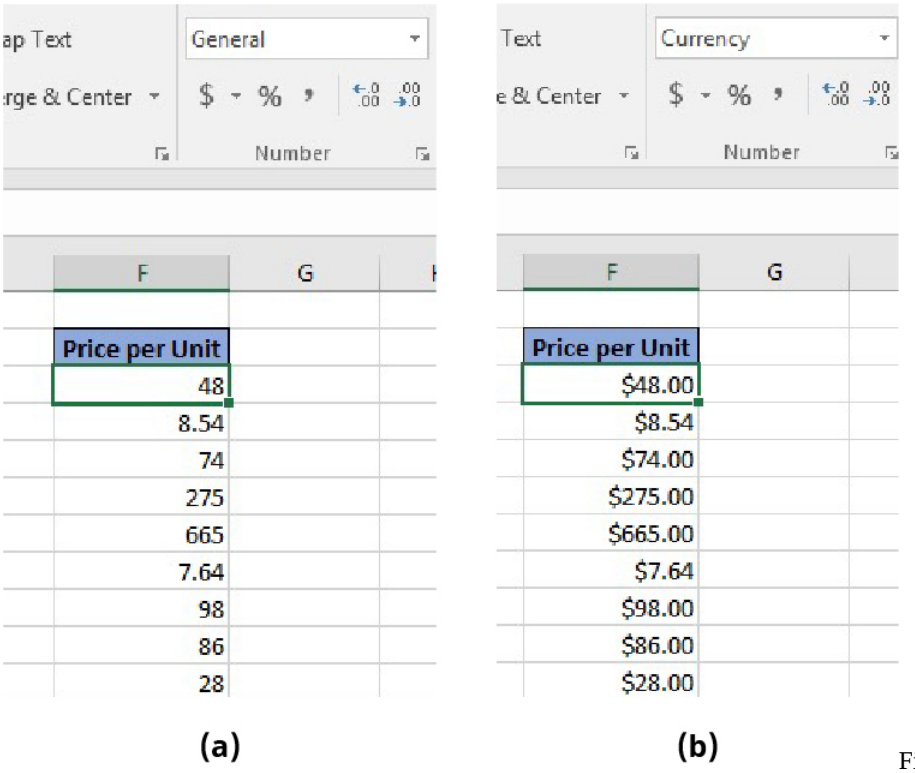


Figure 9.14: The default formatting for cell data is (a) General, but if you change it to (b) Currency, Excel will add two decimal places and a currency symbol. (Used with permission from Microsoft)

Page Layout and Review Tabs

The Page Layout tab (Figure 9.15) lets the user control the page setup for printing, such as the paper size, the vertical or horizontal orientation, and the print margins. It also contains the settings for arranging graphical objects on a worksheet. One of the most useful commands here is the Breaks drop-down menu, where you can insert page breaks, just like in Microsoft Word, so that when you print your worksheet, the page breaks occur where you want them to.

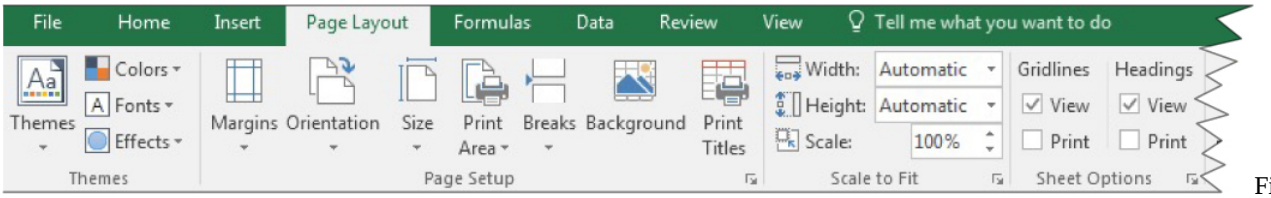


Figure 9.15: The Page Layout tab includes commands for page setup and manipulation of objects. (Used with permission from Microsoft)

The Review tab contains the commands for adding and reviewing comments and activating the track-changes tool, as shown in Figure 9.16. It also has password protection options, where you can restrict others' editing capabilities when you are collaborating on the same project. The spell checker and thesaurus tools are also included in the Review tab. Your Review tab might look somewhat different based on the version of Excel that you are using. If these commands are not included on your ribbon, you can add those using the process outlined in Essentials of Business Software Applications for Business.

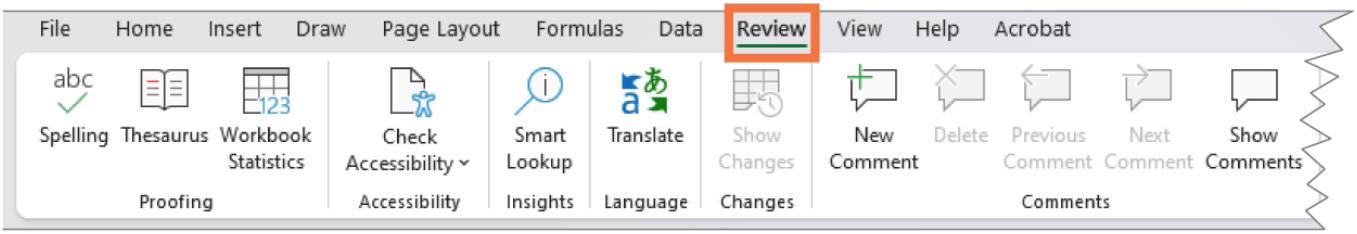


Figure 9.16: The Review tab lets you manage comments, sharing settings, and spelling tools. (Used with permission from Microsoft)

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1.2: Microsoft Excel Basics

Learning Objectives

By the end of this section, you will be able to:

- Identify common uses for Excel spreadsheets
- Use basic features of Excel
- Describe the essential functions of each tab on the ribbon
- Differentiate between worksheets and workbooks
- Create worksheets and navigate existing files
- Print a workbook and a worksheet

WorldCorp sells many consumer electronics, including tablets, HD antennas, headphones, and TVs. The Portland location is in a port city, so it can dispatch orders anywhere in the world, but most of its orders go to the northern United States and Canada. As you receive more and more orders from clients, you need a spreadsheet or database to keep all data flowing so that the warehouse knows where the shipment will be sent, what products are in the order, and how much the total shipment costs. This data, in turn, can be added to the financial statements in the accounting system, which will help the senior managers analyze the sales results of the company. Microsoft Excel is a powerful tool that can be used for creating sales order tables.

Common Uses of Spreadsheets

Excel is a spreadsheet software application type that has rows and columns in a grid pattern. A cell is the intersection of a row and a column, and it looks like a rectangle. You can enter data into the cells to design tables and graphs and perform data analysis. A workbook is a file that contains at least one worksheet, which is a tab within a workbook where you can input data and design tables and graphs that use the data (Figure 9.2). The terms *worksheet* and *spreadsheet* are interchangeable, but Excel uses the *worksheet* terminology.

A workbook may contain several worksheets, similar to taking a hard copy of a set of data and adding it to another hard copy in a file folder. One benefit of using a workbook is that the worksheets within it can communicate with each other. Having multiple worksheets in one workbook gives you flexibility in organizing and analyzing your data. Data analysis grows in complexity as a business grows. Even a simple accounting system for a small business designed in Excel will require many sheets, and each worksheet can feed or receive data from other worksheets. One workbook can contain all of these worksheets together, as in a manila file folder.

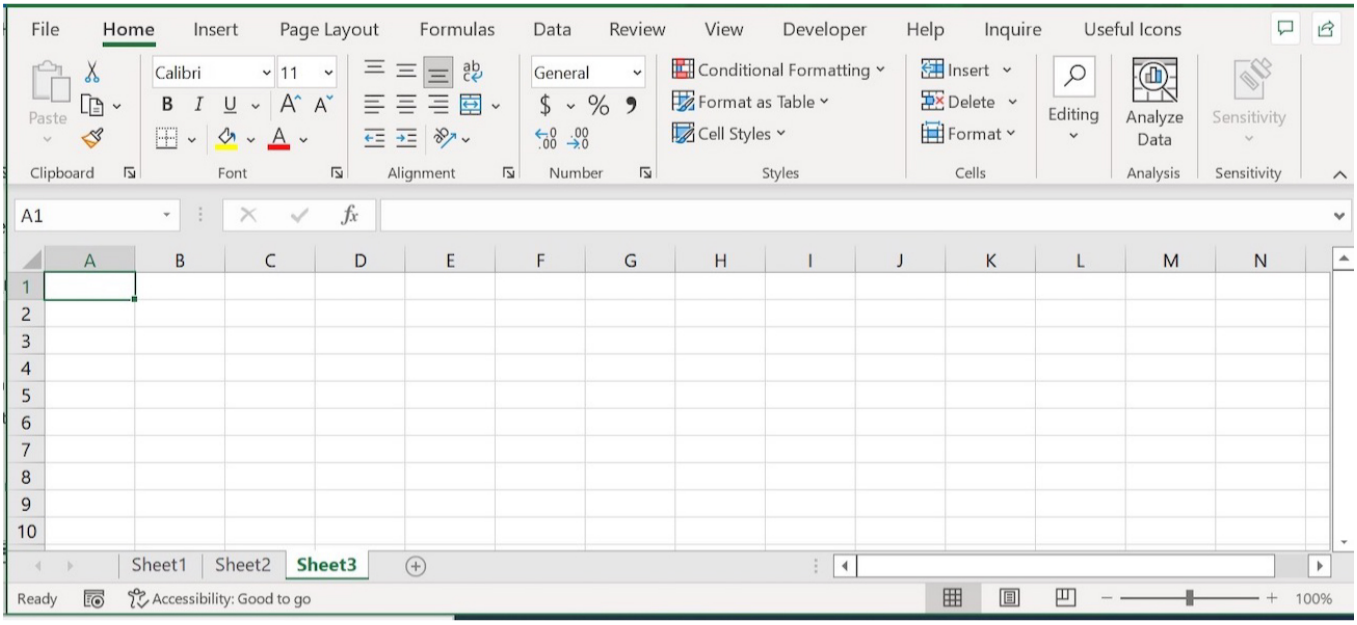


Figure 9.2: An Excel workbook contains individual worksheets made up of cells. (Used with permission from Microsoft)

The cells are named based on their location. For example, the upper-left cell is in column A and row 1, so Excel designates its address relative to the other cells in the worksheet, or its cell reference, as A1. You can use these cell references to perform operations that use either formulas or functions. A formula is a mathematical operation that may use constants or cell references, or a combination of constants and cell references. All formulas must begin with "=." For example, you can calculate 4 + 4 by typing "=4+4" in a cell, or you can add the contents of cell A1 and 4 by typing "=A1+4" or typing "=" and then clicking on cell A1 and then completing the formula.

A function is a mathematical or analytical operation that uses words instead of mathematical operators. All functions must also begin with "=" in Excel. For example, to calculate 4 + 4, you can type "=sum(4,4)." Excel can do the calculations for you just as you would using a calculator. Excel's formulas and functions can take the place of a calculator.

One use for spreadsheets is to create a monthly food budget. You can keep track of how much you spend on groceries by category and on eating out at restaurants. You could list it by the type of product (i.e., milk) and by restaurant. Over time, you can use these numbers to determine your average cost for groceries and for eating out, and you will then be able to predict what you will spend on groceries. This tracking can serve as a control on your budget and will help you save money in the long run. You can use a similar process for all your personal finance and family expenses to enable you to create a budget that works for your situation by tracking expenses.

In business, the same principles apply. If you can track business sales, you will be able to allocate the money more effectively. In other words, by having a better accounting system and dispatching of orders, a manager will be able to see where money is being generated. If the manager realizes that a certain product is generating a higher profit, then the manager can allocate resources to increase the sales of that product. For example, the company could increase the unit production and hire more sales agents to sell that product, which in turn will increase distribution venues, such as corporate retail clients that sell the products in their stores. Not only that, the company may also increase the marketing and advertisement expenses of these products, to gain new clients. All of these actions stemmed from the tracking of sales and analyzing what products sell the most units. In all these layers of actions, there will be many worksheets tracking data, such as an order-dispatching spreadsheet or the unit cost manufacturing sheets.

Link to Learning

Mallory is an Australian website that offers career advice and tips to recent college grads or high-school students about to enter the job market. Read the article that discusses different ways businesses use Excel to learn more.

Basic Features

The most salient Excel feature is the arrangement of cells in columns and rows. The appearance of Excel is similar to graph paper. You can easily customize the width or height to fit words or numbers in the cells. To navigate through the cells in the spreadsheet, you can click on the cell and then use the Enter or Return key to move down to the next row, use the Tab key to move to the next column, or use the arrows on your keyboard to move around the worksheet.

Spreadsheets are designed for data analysis. Each cell has its own integrated calculators that automatically compute the result when you type in a formula or function. Another major benefit to Excel is that you can quickly and easily copy an equation into other cells, so that you do not have to retype it. Excel has many other features that can save you time over using a calculator.

To demonstrate how efficient Excel can be in organizing and analyzing data, let's look at an order-dispatching spreadsheet (Figure 9.3). Each row represents one order, and each column represents a different characteristic of the order, identified by the labels in the top row (called the headers), with the data separated into different cells.

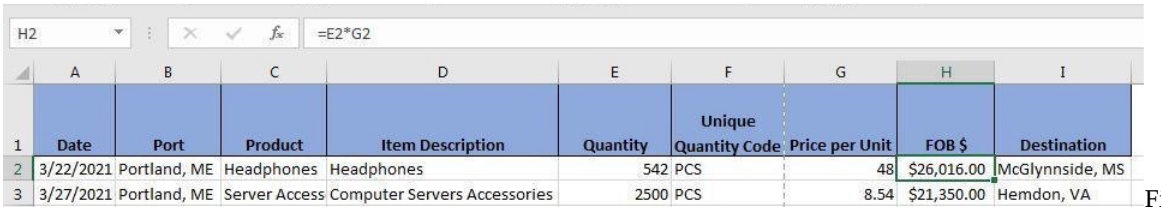
A1

	A	B	C	D	E	F	G	H	I
1	Date	Port	Product	Item Description	Quantity	Unique Quantity Code	Price per Unit	FOB $	Destination
2	3/22/2021	Portland, ME	Headphones	Headphones	542	PCS	48	$26,016.00	McGlynnside, MS
3	3/27/2021	Portland, ME	Server Access	Computer Servers Accessories	2500	PCS	8.54	$21,350.00	Hemdon, VA
4	3/29/2021	Portland, ME	Tablets	Tablets 7in	143	PCS	74	$10,582.00	Norristown, PA
5	3/21/2021	Portland, ME	TVs	LCD TVs 32in and 45in	53	PCS	275	$14,575.00	Charleston, WV
6	3/17/2021	Portland, ME	TVs	LED TVs, 55in and 65in	97	PCS	665	$64,505.00	Metaire, LA
7	3/15/2021	Portland, ME	Phone Access	Cellular Phone Accessories	3000	PCS	7.64	$22,920.00	Hemdon, VA
8	3/10/2021	Portland, ME	Stereos	Home Stereo Systems	74	PCS	98	$7,252.00	Charleston, WV
9	3/7/2021	Portland, ME	Media Players	Blu-Ray Players	127	PCS	86	$10,922.00	Metaire, LA
10	3/5/2021	Portland, ME	Antennas	HDTV Antennas	768	PCS	28	$21,504.00	McGlynnside, MS
11	3/1/2021	Portland, ME	Antennas	HDTV Antennas	453	PCS	28	$12,684.00	Norristown, PA
12	2/28/2021	Portland, ME	Media Players	Blu-Ray Players	241	PCS	86	$20,726.00	Hemdon, VA
13	2/25/2021	Portland, ME	Stereos	Home Stereo Systems	99	PCS	98	$9,702.00	Charleston, WV
14	2/22/2021	Portland, ME	Tablets	Tablets 7in	241	PCS	74	$17,834.00	Metaire, LA
15	2/20/2021	Portland, ME	Headphones	Headphones	753	PCS	48	$36,144.00	McGlynnside, MS
16	2/17/2021	Portland, ME	Headphones	Headphones	235	PCS	48	$11,280.00	Norristown, PA
17	2/18/2021	Portland, ME	TVs	LED TVs, 55in and 65in	87	PCS	665	$57,855.00	Hemdon, VA
18	2/14/2021	Portland, ME	Antennas	HDTV Antennas	214	PCS	28	$5,992.00	Charleston, WV

Figure 9.3: Separating data by columns makes it easier to analyze and perform calculations with the data. (Used with permission from Microsoft)

Separating the data by columns serves multiple purposes. First, it allows a user to organize the information by any one or more of the columns. For example, you could organize the data by date, as shown in Figure 9.3 or by destination. You can also keep different types of data, such as item description (column D) and price per unit (column G), separated. That way, if the price per unit changed, it could be updated quickly and easily. Further, if they were combined in a single column, you would be unable to use formulas to do calculations, because Excel cannot perform calculations when there are both letters and numbers in a cell. Excel recognizes numerals for calculations but cannot perform calculations with words or letters, just as a calculator cannot calculate letters. Another benefit of separating data into categories by column is that each column can later become a graph and help the user visually analyze the information.

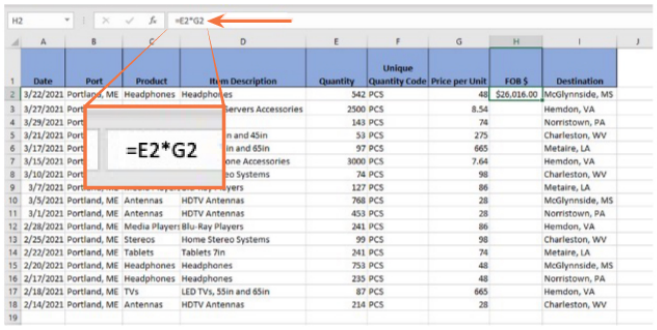
The data in column E and column G in Figure 9.3 are not linked to other columns; in other words, they do not contain formulas or functions but are raw quantities entered into the spreadsheet. Column H, however, is a quantity based on the data in columns E and G. The FOB $ is the number of products (column E) multiplied by the price per unit (column G). The formula is displayed at the top of the Excel worksheet in the Formula Bar, which is next to the "f_x" symbol. You can see in the Formula Bar in Figure 9.4 that the formula is "=E2*G2," yet the cell displays the result of the multiplication. The "*" is the mathematical symbol Excel uses for multiplication. This simple multiplication formula shows how Excel calculates numbers.



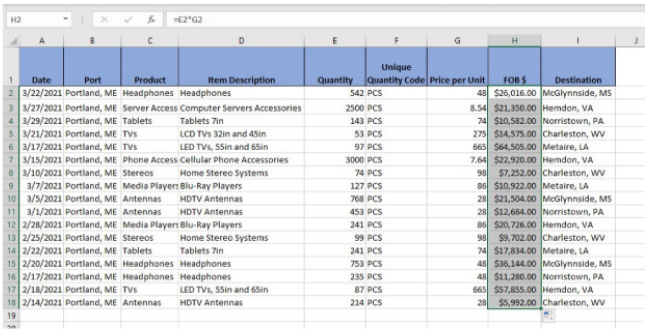
	A	B	C	D	E	F	G	H	I
1	Date	Port	Product	Item Description	Quantity	Unique Quantity Code	Price per Unit	FOB $	Destination
2	3/22/2021	Portland, ME	Headphones	Headphones	542	PCS	48	$26,016.00	McGlynnside, MS
3	3/27/2021	Portland, ME	Server Access	Computer Servers Accessories	2500	PCS	8.54	$21,350.00	Hemdon, VA

Figure 9.4: Clicking on a cell reveals the formula above the headers in the Formula Bar, while the result of the calculation shows in the cell. (Used with permission from Microsoft)

In order to apply this calculation to the rest of the data, you can repeat the formula in other cells in the same column. In Figure 9.5a, all data has been removed from column H, except for the first cell, which contains our formula "=E2*G2." The easiest way to repeat the formula is to use AutoFill. Place the cursor on the lower-right corner of the cell, until the cursor changes to a black cross. Then, click and drag the cross to the end of your column of data, which copies the formula into each cell. Figure 9.5b shows the result of dragging the formula from H2 to H18. AutoFill is also a useful feature for repeating text. The text could be a static value, such as when you enter multiple orders that contain the same item, or a time value, such as months of the year or days of the week. You can simply type in "January" and then use AutoFill to drag across or down to fill in the rest of the months. This method works for dates, days of the week, other text such as Quarter 1 and Quarter 2, and nearly any pattern of numbers (i.e., odd numbers or counting by 5). When using AutoFill for a pattern of numbers or text you want to repeat, you need to select enough of the pattern so that Excel can recognize the repetition. For example, if you want to generate a list of numbers counting up by 5, you will need to select at least the cells that contain 5 and 10 so that Excel understands you want to increase the value in each row in the AutoFill by 5.



(a)



(b)

Figure 9.5: The AutoFill feature is useful to get the results without retyping or copying and pasting the formula. (a) Column H is empty, except for the first cell, which contains the formula, as seen in the Formula Bar. Clicking and dragging the formula to the end of the column automatically applies the same formula to subsequent rows. (b) By dragging the formula down the column using the AutoFill feature (small black cross sign in the lower-right corner of a cell), the values are calculated for each row. (Used with permission from Microsoft)

Mac Tip

On a Mac, you can simply double-click on the cross, and the formula will copy down the column to the last row that contains data.

The Ribbon

As you recall from Essentials of Software Applications for Business, Excel's interface includes a ribbon of commands, grouped into categories that are similar across Microsoft Office programs. The Home tab for Excel (Figure 9.6a) has commands such as conditional formatting and inserting/deleting columns or cells. The Insert tab (Figure 9.6b) includes inserting a chart or equation, which is not included on the Insert tab of other programs such as Microsoft Word. The Formulas (Figure 9.6c) and Data (Figure 9.6d) tabs are specific to Excel. These tabs include commands for analyzing data in various ways.

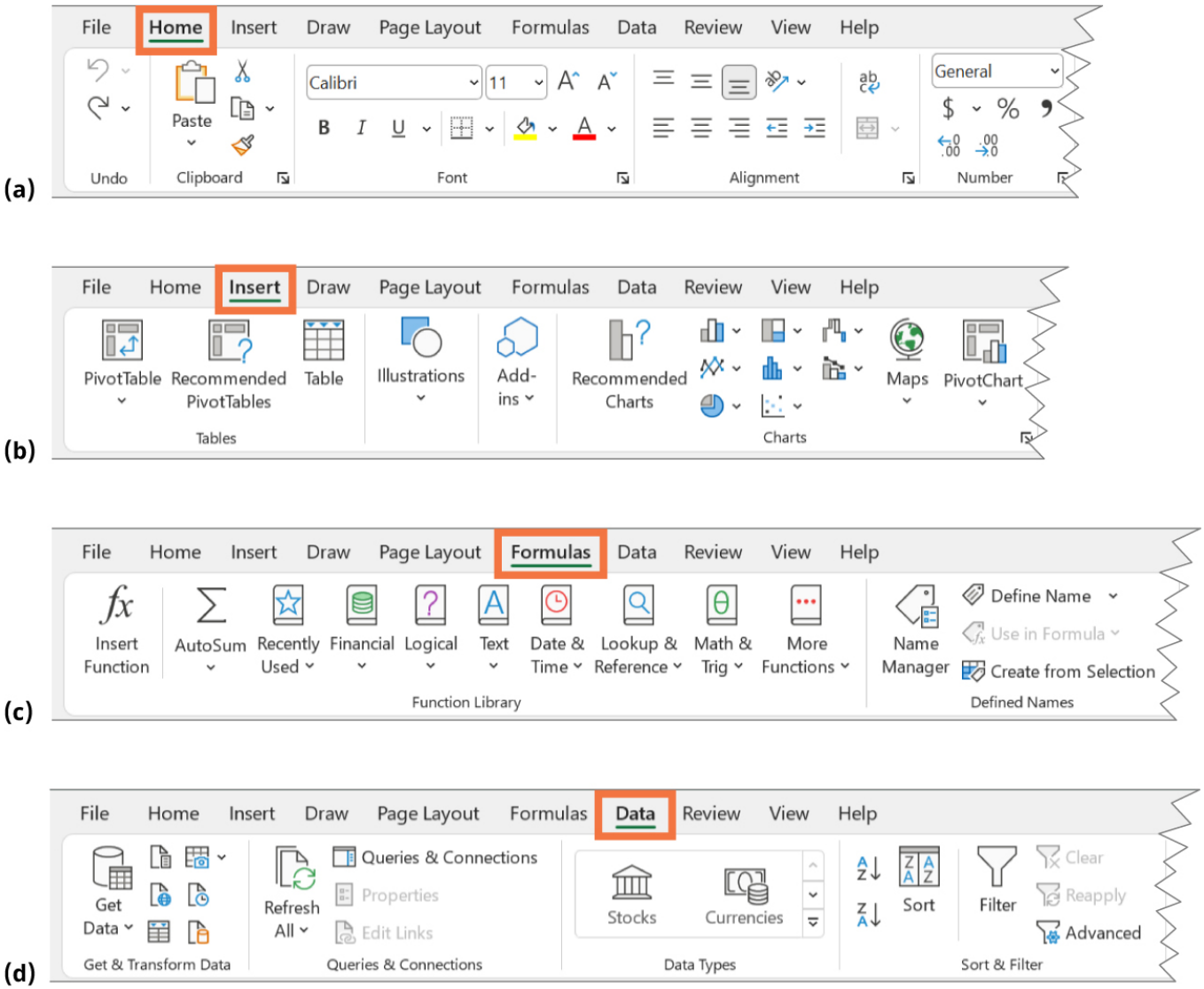


Figure 9.6: The Excel interface uses a ribbon to organize commands into tabs, which include (a) the Home tab and (b) the Insert tab, which are similar to other Office programs. The Excel ribbon also includes tabs specific to Excel, including (c) the Formulas tab, and (d) the Data tab. (Used with permission from Microsoft)

Creating Worksheets and Navigating Existing Files

Now that you understand how to navigate a worksheet, let's see how to apply this skill. Suppose you need to build sales figures of different retail store locations. Each location will have its own worksheet, and then you'll add one more sheet to total the sales figures and make a comparison using a table. Figure 9.7a gives the data for location X. You will need to use the copy-and-paste method to use this table to make the table for location Y. In the copy-and-paste method, copy text or objects by typing Ctrl+C (or right-click to Copy or use the Clipboard command group on the Home tab), and then typing Ctrl+V to paste the text or object in the new area. To use this procedure in this workbook, follow these steps:

1. Highlight the table, as shown in Figure 9.7a.
2. Press Ctrl+C to copy the table.
3. Create a new sheet by clicking on the circled plus sign at the bottom of the worksheet.
4. Click on cell A1.
5. Press Ctrl+V to paste the table into your new sheet.

This process copies the table exactly, so you will need to change the data so that it reflects the sales figures of location Y using the sales figures received from the finance department.

Mac Tip

Macs use a Command key, whereas PCs use a Ctrl (control) key. These keyboard shortcuts on a Mac are Command+C to copy and Command+V to paste. Mac also uses Ctrl+click to bring up the right-click menu Windows uses.

Data that you provide or that is provided to you is often raw data, and designing a worksheet or even a workbook helps to organize it. Replace the data from location X with the data from location Y and change the location, as shown in Figure 9.7b. Using the copy-and-paste procedure saves time when dealing with the same or similar scenarios because it eliminates the need to create a new table from scratch. Note, however, that this process works with cells that contain numbers and not formulas; copying and pasting tables with formulas requires additional work after the initial copy and paste to retain the correct formulas and cell references.

	A	B	C	D
1	Model	Inches	Price	Units Sold
2	E-900s	32	$ 170.00	8752
3	E-900m	42	$ 380.00	10563
4	E-900l	55	$ 550.00	9543
5	E-900xl	65	$ 780.00	4326
6				
7	Location	X		

(a)

	A	B	C	D
1	Model	Inches	Price	Units Sold
2	E-900s	32	$ 170.00	6576
3	E-900m	42	$ 380.00	8757
4	E-900l	55	$ 550.00	5643
5	E-900xl	65	$ 780.00	2867
6				
7	Location	Y		

(b)

Figure 9.7: The copy-and-paste process makes it easy to create multiple tables that are similar to each other. Start with a formatted data table for location X. (a) Highlight (select) the table and copy it. Notice the dotted line around the selection to show that it has been copied. (b) Paste the table in a new worksheet and update it with the data for location Y. (Used with permission from Microsoft)

Now, replicate the steps for location Z: copy and paste the table, and then retype the real data. Next, focus on creating the final sheet that displays the totals. In the workbook, this would be “Sheet 4.” Because the summary table needs to be a similar structure to the other tables, you can copy and paste the same table here, but you will need to modify Column D so that it adds up the units sold in each location. However, the summary table will need to use the data from Sheets 1, 2, and 3.

To calculate the totals, you need an addition formula. Follow the same process used previously to insert a formula. First, in cell D2, type “=,” which tells Excel that a formula or a function is being entered. Next, click on the tab for Sheet 1 and then on cell D2 in that sheet (Figure 9.8a). Then, type the operator (in this case +), and then repeat the process for the appropriate cells in Sheets 2 and 3. When finished, press Enter, and Excel will display the total in the cell. Notice in the syntax that Excel has inserted “Sheet1!” before the cell designation in the first part of the formula. This tells Excel that it needs to use the contents of cell D2 in Sheet 1 for that portion of the calculation. The next element is “Sheet2!D2,” which is cell D2 in Sheet 2.

D2 =Sheet1!D2

	A	B	C	D	E
1	Model	Inches	Price	Units Sold	
2	E-900s	32	$ 170.00	8752	
3	E-900m	42	$ 380.00	10563	
4	E-900l	55	$ 550.00	9543	
5	E-900xl	65	$ 780.00	4326	
6					
7	Location	X			
8					

(a)

J2

	A	B	C	D
1	Model	Inches	Price	Units Sold
2	E-900s	32	$ 170.00	25186
3	E-900m	42	$ 380.00	30562
4	E-900l	55	$ 550.00	25719
5	E-900xl	65	$ 780.00	12661
6				
7	All three locations			
8				

(b)

Figure 9.8: Excel allows formulas to reference data appearing on any worksheet in the workbook. To create a total of the number of units sold at each location, begin the equation with an equals sign. (a) Then, click on the relevant cell in the first worksheet. Insert

the mathematical operator and click on another cell you want in the formula. The formula shows the references to other worksheets. AutoFill can complete the table with formulas that reference the relevant cells. (b) The completed table uses data from other worksheets. (Used with permission from Microsoft)

Now that the formula is in place for cell D2, use the AutoFill feature to apply the formula to subsequent rows. Highlight cell D2, click on the cross, and drag it to the bottom of the table. If you then click on cell D3, for example, you will see that the formula has been repeated but references cells D3 in the other sheets. Figure 9.8b shows the completed table.

This summary table can be very useful. In addition to providing a straightforward list of the totals, you could create graphs using this data and have a visual representation of sales trends. This is a simple scenario assumption; in the real-world sales totals, you would have much more than just five TV models. Imagine adding all the unit and dollar sale figures of three Best Buy locations in a given city; there would be hundreds of different products. You will learn increased complexity that will help in analyzing real-world problems such as this as your knowledge of Excel grows. The sorting and filtering feature is covered in Data Tables and Ranges, where you will learn how to set up a condition and a criterion to hide or show values for analysis.

Printing Worksheets

Excel offers two options for printing: either printing each worksheet separately or printing the whole workbook. To do either, first go to the File tab, and then click on Print (Figure 9.9). The default is to print only the currently opened worksheet, so we'll do that first. Choose the number of copies you want for this page, then choose the correct printer. There are other options for printing, include changing the size of the paper, changing vertical or horizontal orientation of the paper, adjusting the margins, and regulating the scaling (i.e., zooming in or not while printing). Once you have chosen your settings, click on the Print icon, and Sheet 1 will come out of the printer. Different printers might have different options for you to choose from.

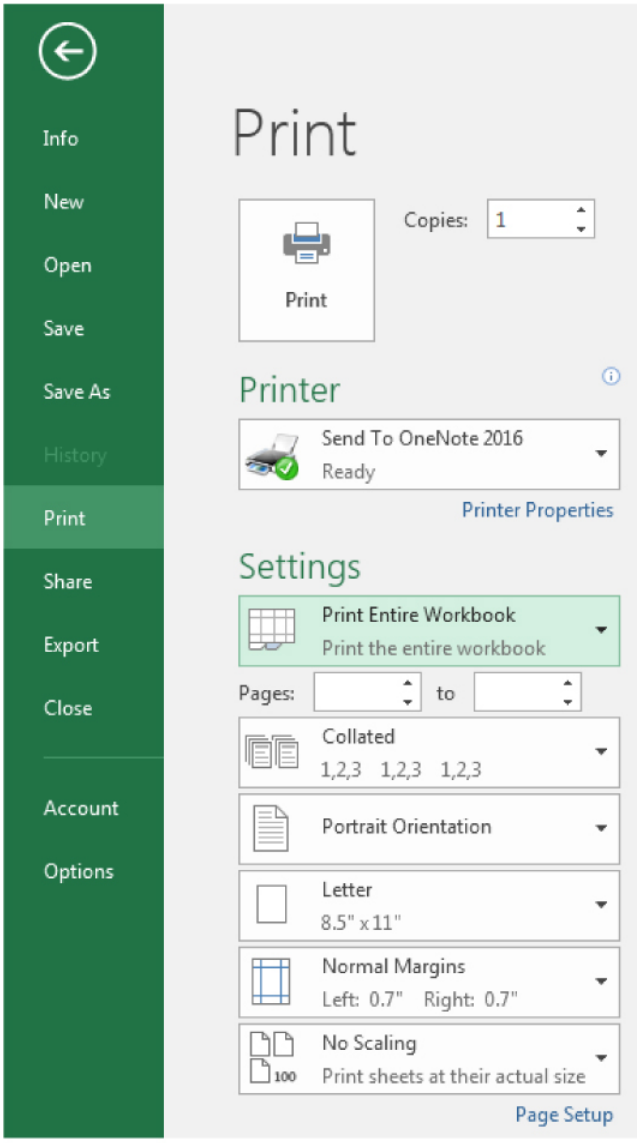


Figure 9.9: The options for printing are on the File tab. Click on Print. To print only a worksheet, leave the default selection of Print Active Sheets and make any necessary changes to the options. To print the whole workbook, select Print Entire Workbook from the first menu in the Settings. On a Mac, the steps are the same, but the appearance will differ slightly. (Used with permission from Microsoft)

It is important to note that, when constructing spreadsheets, what you see on the computer screen is rarely how it looks when you actually print the workbook. When you have large spreadsheets with multiple rows or columns, they may not always fit within the bounds of the printed page. When you print the document, the result could be columns of data split oddly across several pages. Be sure to preview the printed version prior to printing. When you select Print, you will see the print preview on the right of the screen. Double-check that the columns and rows are displayed in the way you would like them to print. If not, you can change the margins of the worksheet or insert a page break as appropriate to print a final, professional workbook. More will be covered about formatting the worksheets and workbook in Formatting and Templates in Excel.

Mac Tip

You can get to the Print menu with Command+P, but you can also use the File tab at the top of the window. There is a separate menu in the File menu to set your print area, and you can select which worksheets to print from the Print menu.

If you want to print all the sheets in the workbook, select Print Entire Workbook from the drop-down menu under Settings (Figure 9.9). Then, click on the Print icon, and this time all the worksheets will be printed (including any blank worksheets that are in the

workbook), instead of individual worksheets.

Real-World Application - Using Excel for Personal Finance

Excel is a powerful tool for business; however, it can also be a very useful tool for managing personal finances. You can set up Excel to manage all your personal finances, link bank accounts and other financial documents, help with managing documentation for income taxes, and perform many other personal finance tasks. Excel has all the features needed to set up a budget and manage personal and projected income, track expenditures, and analyze investments and other personal revenue trends. You will want to organize your financial information into separate functional worksheets within your budget workbook to ensure you keep your finances organized from the start. For instance, consider keeping separate worksheets to record income, expenditures, savings, and investments. You can start small as you grow in your comfort level in using Excel to record your financial transactions; for instance, you might want to start with a weekly or monthly expenditure sheet to track what you spend your money on, then move into savings and tracking interest accrued. This disciplined approach will ensure data is recorded in a timely manner, reducing the potential for missed information and errors, ultimately helping you maximize your dollars. What's more, there are a number of free templates available online and through Microsoft to help set up your budget workbook with little effort.

What software or other tools do you use now to help you track your budget? Do a Google or template search in Excel and identify a budget template you might adopt. Once you find one you like, set up your monthly budget.

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1.3: Google Sheets Basics

Learning Objectives

By the end of this section, you will be able to:

- Identify common uses and basic features of Google Sheets
- Describe the essential functions of each command group on the toolbar
- Create a worksheet in Google Sheets
- Open an existing workbook in Google Sheets
- Print a Google Sheets file

Google Sheets is another spreadsheet application that has much of the same functionality as Microsoft Excel. They have similar GUIs, in that they use window menus and a toolbar. Excel has the ribbon, which has wide tabs filled with commands. Sheets only has one toolbar menu, although its button commands grow over time as the product is updated. Sheets contains all the same basic features as Excel, but Excel is more robust with regard to higher-level tools.

Common Uses and Basic Features

Sheets serves the same basic purposes as Excel and can be used for most of the same purposes that any spreadsheet could serve. Google Workspace is a web-based service and does not have desktop versions like Microsoft Office. Because of this, there are some limitations to the functionality of Sheets compared with Excel. To access Sheets, you need to have internet access and a Gmail account.

The basic features are the same as any other spreadsheet program. Similar to Excel, Sheets has rows and columns in an interface that does calculations for the user. It has automated features like autofill and easy copying of formatting. You can create all tables you've created in Excel in Sheets, including your order-dispatching worksheets or sales reports. Sheets also requires you to separate the values in each column so that the spreadsheet can read the numbers and calculate the desired result. Words and letters should be separated from numbers in order for spreadsheets to use the numbers for calculations. Sheets doesn't have the same library of functions that you can find in Excel. On its own, Sheets may not be able to handle in-depth analysis like Excel can.

The Toolbar Overview

Sheets does not have any ribbon tabs like Excel. Instead, the toolbar is composed of menus and commands. The menu options are similar to those you see in Excel in the ribbon tabs. The menus are as follows: File, Edit, View, Insert, Format, Data, Tools, and Extensions. To view the contents in the menu, simply hover over the menu title with your cursor. The File and Edit menus are similar to those for Google Docs, as covered in Essentials of Google Workspace. The View menu gives the user the ability to freeze and group cells together. Inserting and deleting cells can be accessed in the Insert menu. The data and text can be formatted using the commands contained in the Format menu. The Data menu includes commands similar to the Data tab in Excel that are useful for analyzing data in a spreadsheet. The Tools menu is like the Review tab in Excel with spelling and grammar checking commands. Advanced features are in the Extensions menu.

The toolbar is called the action bar, and it mostly remains static, yet sometimes it adds functions based on usage. Figure 9.39 shows the toolbar. In addition to the menus, the toolbar includes buttons for the more frequently used commands for easy access. These commands can be accessed through the menus, but here they are available with one click. You will notice there is some similarity in the look of the icons in Sheets and Excel. The first two commands are Undo and Redo, then Print, and Paint format. After that, you see the Zoom drop-down menu, the Format as currency, Format as percent, Decrease decimal places or Increase decimal places, and more formats. Next are the menus for the font type and size, font formatting, border lines, alignment, text wrapping, and text rotation. The last group includes linking, commenting, and adding a graph, filter, or function.



Figure 9.39: The toolbar in Sheets has one row of commands. (Google Sheets is a trademark of Google LLC.)

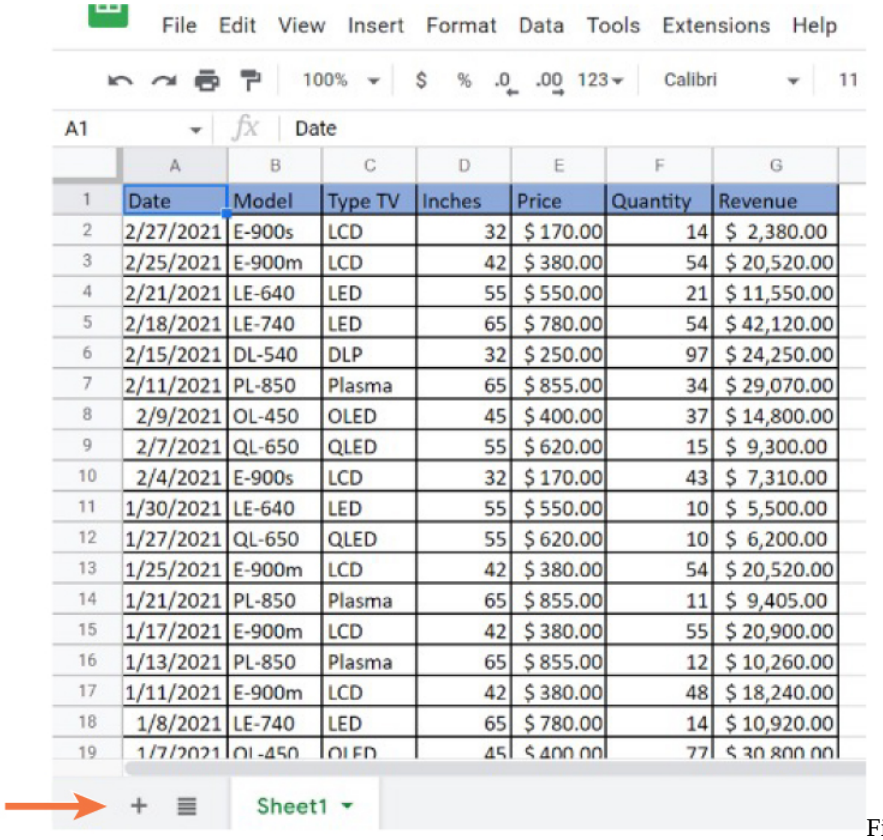
Mac Tip

On a Mac, the Google Sheets action bar shows the menu, like on a PC. However, rather than simply hovering, you will need to click on the menu title to see its contents.

Creating Sheets

Figure 9.40 shows a finished sales report, much like an Excel worksheet. As in Excel, when you open Sheets, there is only one worksheet, called "Sheet1." To add another sheet, you can click on the plus sign at the bottom left. This will add another sheet called "Sheet2." Let's walk through the steps to create this table in Sheets. Let's assume that you have handwritten invoices of a set of orders, and you want to enter these invoices in Excel or Sheets. The receipt-block pads are customized with a unique receipt number, your company logo, contact data, and other business information. These were popular before small and medium businesses started to use computerized receipts, yet you may still see these handwritten receipts sometimes. In such a case, after the sale has occurred, you need to input the data into Excel or Sheets.

The first step in re-creating the table in Figure 9.40 is to insert and format the headers in a blank worksheet. Then, select the first 20 rows below the headers, since the table has 20 rows of data (Figure 9.41), click on the Borders drop-down menu, and choose All Borders. Next, change the format type for each column based on the contents of the column (Figure 9.42). For cells A2 to A21, use the Date format under the More Formats drop-down menu. Format cells B2 to B21 and C2 to C21 as Plain Text. You can leave cells D2 to D21 as Automatic or change them to Plain Text. Format cells E2 to E21 and G2 to G21 as Accounting. Automatic as a format type is the equivalent of "General" in Excel. To select two columns that are not contiguous, select the first one, in this case E, then press Ctrl on the keyboard, and select G. This is called the Ctrl+Select process. For column F, you can leave it as Automatic or format it as a number. Now, you are ready to do the data entry of the manual invoicing. You will format the header after entering the data.



	A	B	C	D	E	F	G
1	Date	Model	Type TV	Inches	Price	Quantity	Revenue
2	2/27/2021	E-900s	LCD	32	$ 170.00	14	$ 2,380.00
3	2/25/2021	E-900m	LCD	42	$ 380.00	54	$ 20,520.00
4	2/21/2021	LE-640	LED	55	$ 550.00	21	$ 11,550.00
5	2/18/2021	LE-740	LED	65	$ 780.00	54	$ 42,120.00
6	2/15/2021	DL-540	DLP	32	$ 250.00	97	$ 24,250.00
7	2/11/2021	PL-850	Plasma	65	$ 855.00	34	$ 29,070.00
8	2/9/2021	OL-450	OLED	45	$ 400.00	37	$ 14,800.00
9	2/7/2021	QL-650	QLED	55	$ 620.00	15	$ 9,300.00
10	2/4/2021	E-900s	LCD	32	$ 170.00	43	$ 7,310.00
11	1/30/2021	LE-640	LED	55	$ 550.00	10	$ 5,500.00
12	1/27/2021	QL-650	QLED	55	$ 620.00	10	$ 6,200.00
13	1/25/2021	E-900m	LCD	42	$ 380.00	54	$ 20,520.00
14	1/21/2021	PL-850	Plasma	65	$ 855.00	11	$ 9,405.00
15	1/17/2021	E-900m	LCD	42	$ 380.00	55	$ 20,900.00
16	1/13/2021	PL-850	Plasma	65	$ 855.00	12	$ 10,260.00
17	1/11/2021	E-900m	LCD	42	$ 380.00	48	$ 18,240.00
18	1/8/2021	LE-740	LED	65	$ 780.00	14	$ 10,920.00
19	1/7/2021	OL-450	OLED	45	$ 400.00	77	$ 30,800.00

Figure 9.40: Formatting a normal sales report table in Sheets is similar to formatting in Excel. The table contains different types of data. First, create the headers. (Google Sheets is a trademark of Google LLC.)

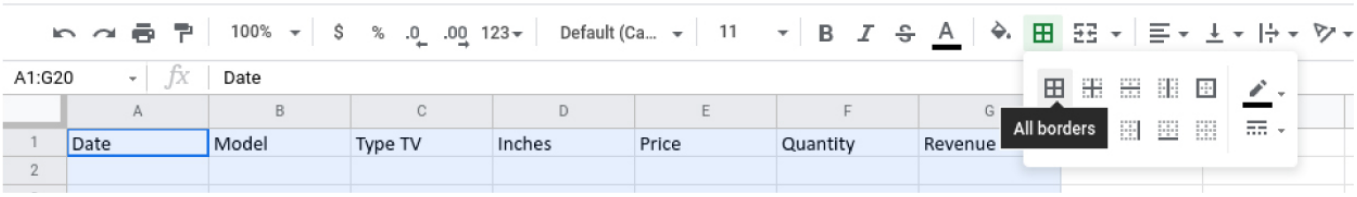


Figure 9.41: Then, highlight the cells you will be filling in to add borders. (Google Sheets is a trademark of Google LLC.)

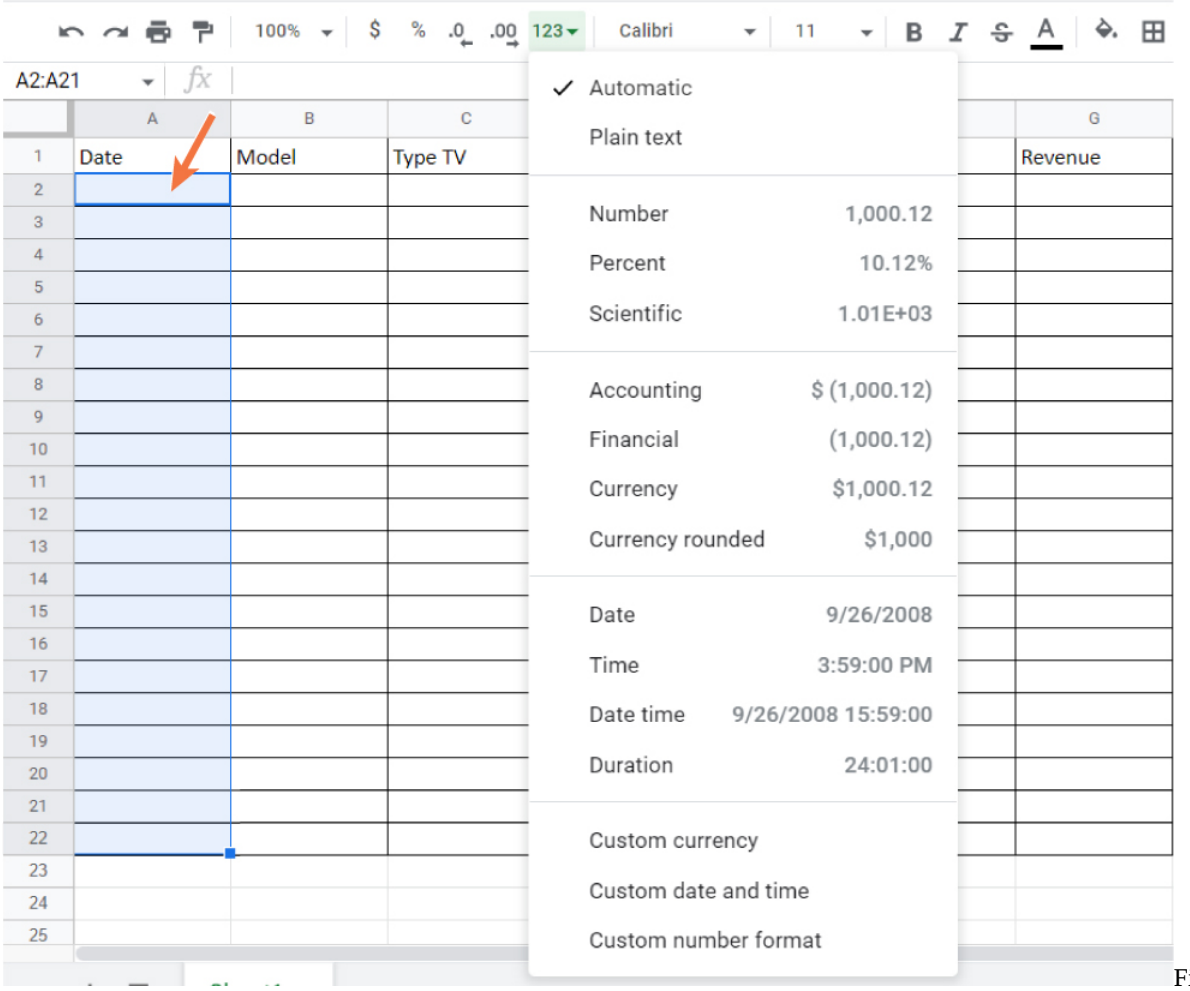


Figure 9.42: Format each column according to the type of data it will contain. The first column is a date, so you can choose Date from the menu. The next two columns can be formatted as plain text. Columns E and G can be formatted as Accounting. You can use Ctrl+Select to format both of them at the same time. (Google Sheets is a trademark of Google LLC.)

Next, enter the data in row 2, and follow the same steps for subsequent rows. The first several columns only require typing in data from the data source. The first order was placed on February 27, 2021, for 14 model E-900s 32-inch LCD TVs for $170 each. First, enter the date as 02-27-21 (Figure 9.43a). Because we selected the format in advance, it will automatically be formatted to the desired format of 02/27/2021. Fill in the rest of the data from the order across the row (Figure 9.43b). The price is already in accounting format, so you do not need to type the currency symbol. The Revenue, column G, is the product of the price and the quantity, so type in a formula, “=E2*F2” (Figure 9.43b).

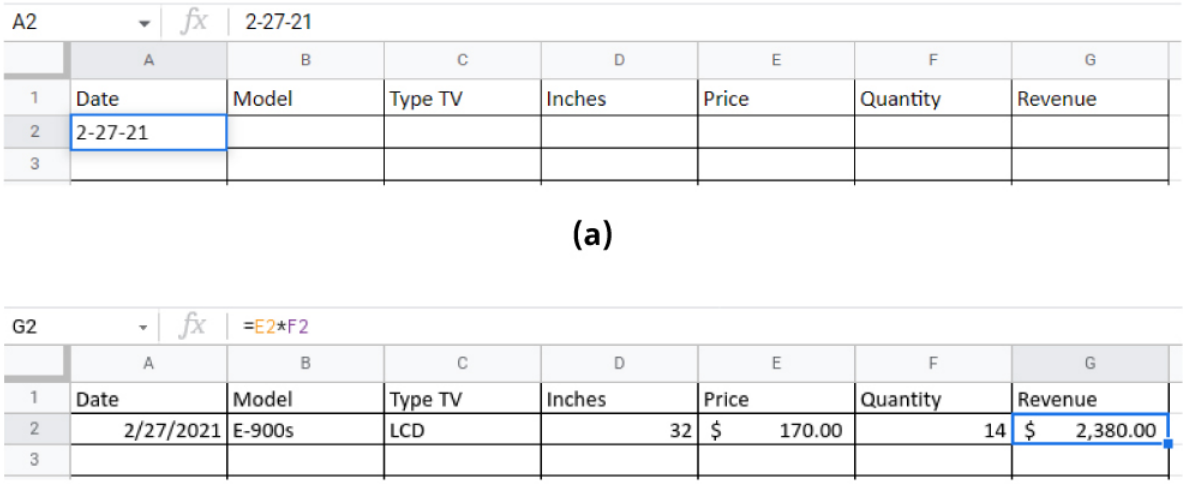


Figure 9.43: First, populate the first row of the table. (a) The date should automatically be formatted as month/day/year. The rest of the data can be copied from the order. (b) The revenue cell needs a formula so that it calculates the product of the price and the quantity. Notice the date is formatted correctly once you press Enter or navigate to another cell. (Google Sheets is a trademark of Google LLC.)

Now that the first row is finished, you will adjust the width of each column to accommodate the data so it looks like the original table. Place your cursor on the edge of column A, and the cursor will change to an arrow (Figure 9.44a), then double-click it. The column automatically adjusts to the width of the contents. To do this with a single action, highlight the entire table and then double-click between any two columns. This will apply the AutoFit function to all columns you have selected (highlighted). When you do this for all columns, the columns all have different widths (Figure 9.44b). Finally, to format the header row, select the whole row and click on the Fill color command, choosing a similar color, as shown in Figure 9.45.

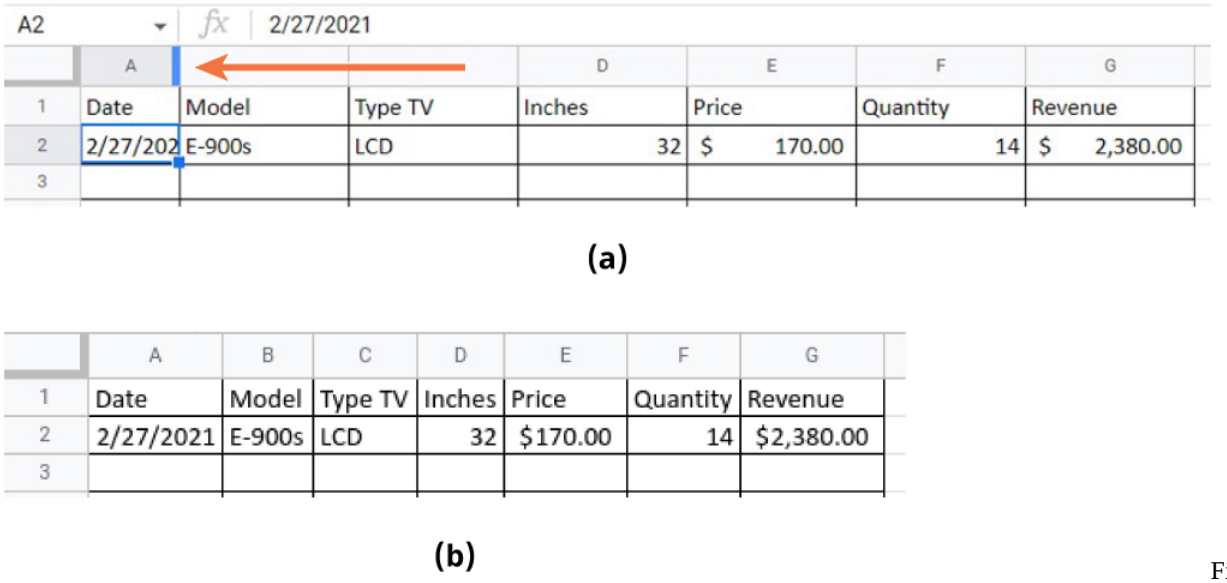


Figure 9.44: After entering a row of data, you can do the final formatting of the table. (a) Double-click at the edge of a column to change the width automatically. (b) Repeat this process for all columns. (Google Sheets is a trademark of Google LLC.)

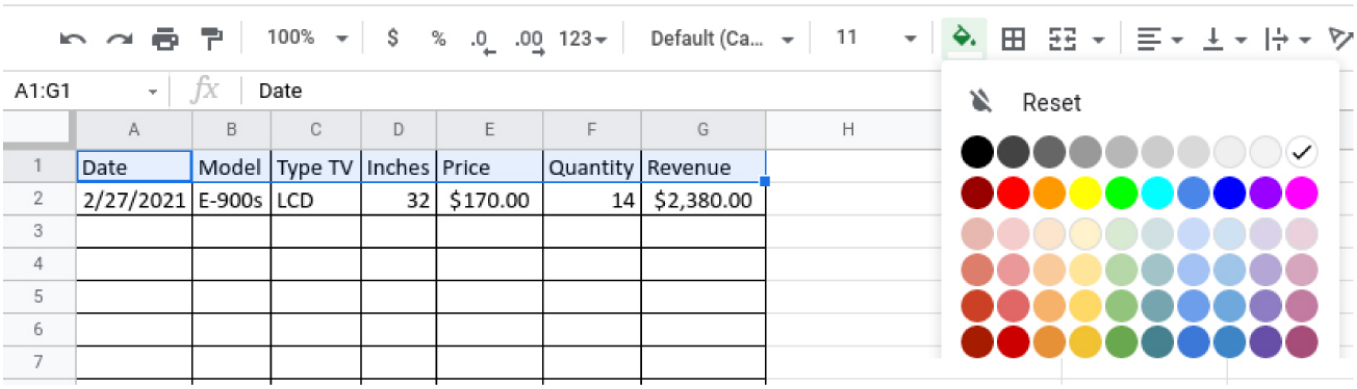


Figure 9.45: You can change the white fill color of the header row to match the original table by choosing blue from the Fill color command. (Google Sheets is a trademark of Google LLC.)

Navigating Existing Sheets

To open existing sheets, you start from Google Drive. Sign into your Drive account, then browse through your files to look for the existing workbooks. Double-click on an existing Sheets file, and it will open in a new browser tab. Figure 9.46 shows several files in Google Drive. You will need to recognize the icon for Sheets to know which are workbooks. The icon for Sheets is green. Sheets can also open Excel files. To browse for the saved Excel files not found in your Google Drive, choose Upload.

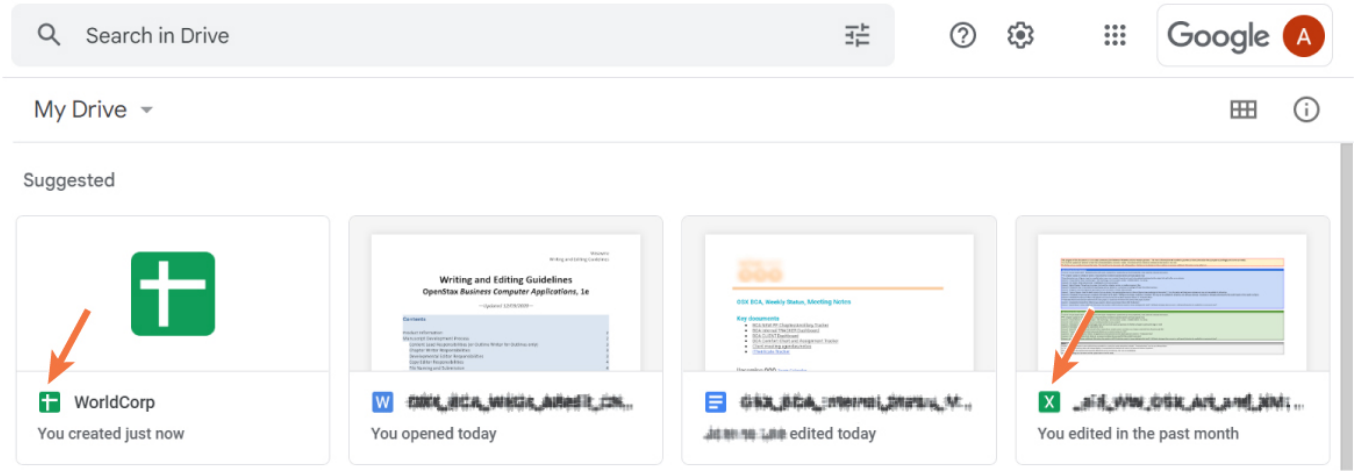


Figure 9.46: To open a Sheets file from Google Drive, you need to recognize the icon for spreadsheets. The first arrow points to an Excel file, and the second arrow points to a Sheets file. Sheets can open both types. (Google Sheets is a trademark of Google LLC.)

Spotlight on Ethics - Maintaining Accountability with Version History

In order to open Docs or Sheets, you will need to create or log in to your Google account. Every time you make a change to a file, Google Workspace uses your username to track it. If multiple people have been given access to open or edit the file, Google tracks these changes. You can review the changes different collaborators in your company make to a file using the Version History feature located near the bottom of the File menu. Version history is tracked from file creation. If a user has editing privileges for a document, they can see the version history. You can also filter changes by date to see what users changed on a specific date. You can check what changes any coworker made in the document. Having access to the version history of the document protects the integrity of collaborating with others by establishing accountability. Changes to the file cannot be made without other collaborators knowing that changes have been made. This allows transparency of information flow between collaborators. This can become important in tracking down errors in the file and can guide you if you need to revert to an earlier version of a document. It is also an important feature that helps collaboration when the individuals are not in the same location.

Printing Sheets

The process for printing worksheets in Sheets is the same as it is in Excel. Choose Print from the File menu (Figure 9.47a). The dialog box that opens (Figure 9.47b) lets you choose the print settings, such as page setup, range of pages to print, and zoom level, just like in Excel. The Print dialog box allows you to adjust the margins and add page breaks to make sure the spreadsheet prints as you would like. To adjust the margins, choose the Margins menu from the right side of the display. To add page breaks, choose Set Custom Page Breaks and move the lines to the desired location for the page breaks. Then, choose Confirm Breaks in the upper-right corner. You can also choose to print the active worksheet or the whole workbook. The whole workbook choice is shown in Figure 9.47b. When you click Next, Sheets will generate a preview of the file you are printing. Typically, your printer is listed as the default destination for printing. Choose the down arrow to choose your printer if it is not automatically listed. You can also generate a .pdf file, which you can save and then download from the browser into your computer. You can then open the .pdf file in Adobe Acrobat or any other .pdf viewer, such as Microsoft Edge, and print it there.

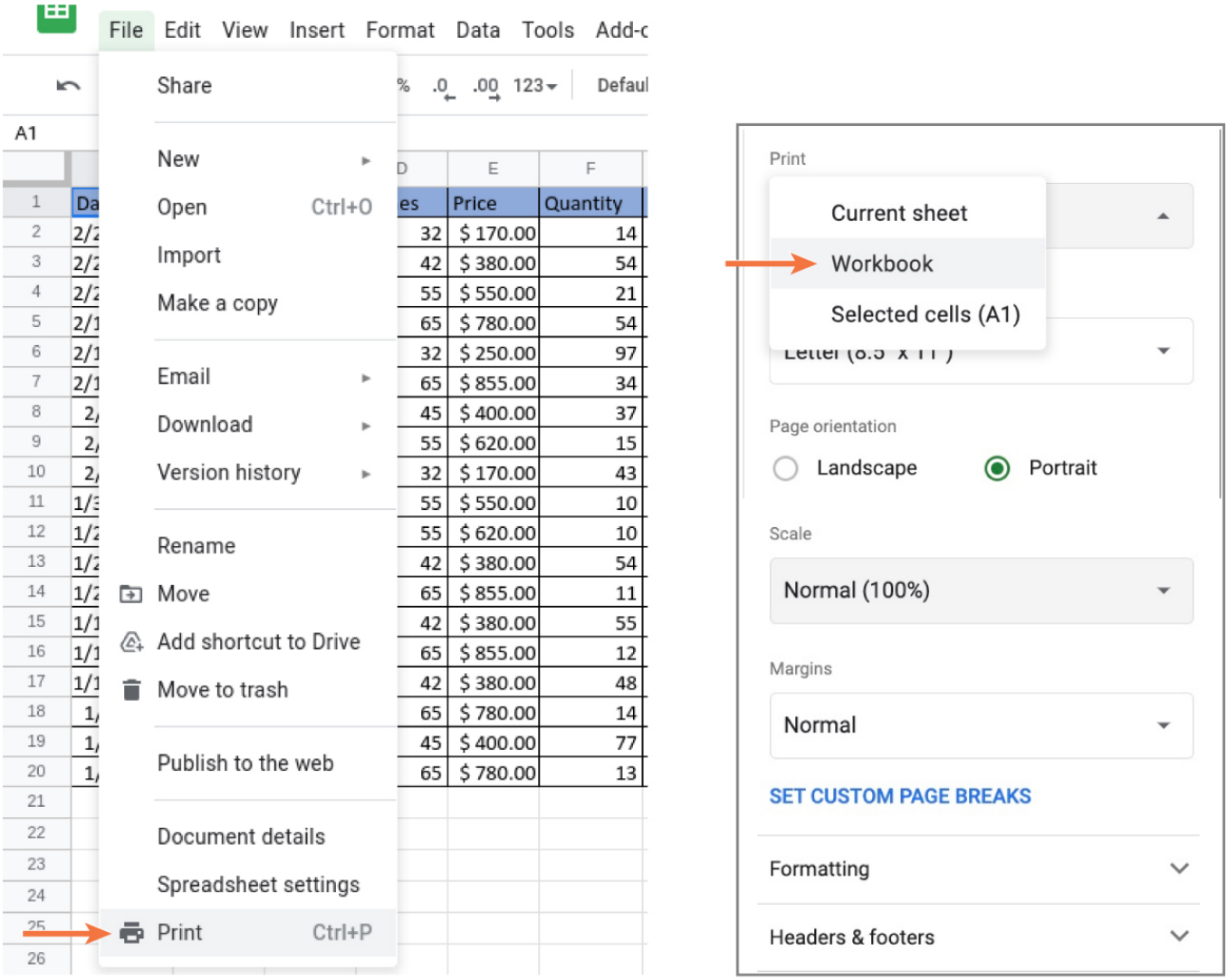


Figure 9.47: Printing from Sheets is similar to printing from Excel. (a) Select Print from the File menu. You can print the current sheet. (b) You can also print the entire workbook. Choose your printer from the Destination drop-down menu or save the file as a .pdf. (Google Sheets is a trademark of Google LLC.)

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1.4: Text and Numbers in Google Sheets

Learning Objectives

By the end of this section, you will be able to:

- Use the insert and copy-and-paste functions in Google Sheets
- Enter numeric and text data in a Sheets cell
- Create basic graphs from numeric and text data
- Use page layout and review features

There is a great need for text and numeric data in databases. For example, in WorldCorp's database, the client's surnames and given names are in two separate text data columns. The address, city, and state are each in their own text columns, too. The zip code and telephone may be in text format. This is because these values are numerical, but they are not used to perform any calculations. They are instead providing information about the client. Order quantity may be a number, and total dollar value per client is in accounting format. Sheets can handle large datasets in a similar manner to Excel. The cell formatting in Sheets is similar to that of Excel. Sometimes it is more a matter of company and/or personal preference. Some companies may be used to using Sheets for collaboration and information sharing, or a user might prefer the Sheets GUI over Excel. One drawback of Sheets is that it offers fewer options for charts and graphs than Excel.

Using the Copy-and-Paste and Insert Functions

Before learning to design and build a table from a blank worksheet, you need to understand how to use formatting from an existing table, as with Excel. Say a table to be copied to a new blank worksheet. Follow the same basic procedure as with Excel. First, select the table (Figure 9.48), then choose Copy from the Edit menu or press Ctrl+C on the keyboard. Next, go to the new worksheet and choose Paste from the Edit menu or press Ctrl+V. There will be are a few minor differences between your new table and the original. For example, the column widths of the original were adjusted to their contents, whereas in the pasted table, all columns have the same width. To adjust the widths, you can double-click on the edges of the header row between two columns you want to adjust.

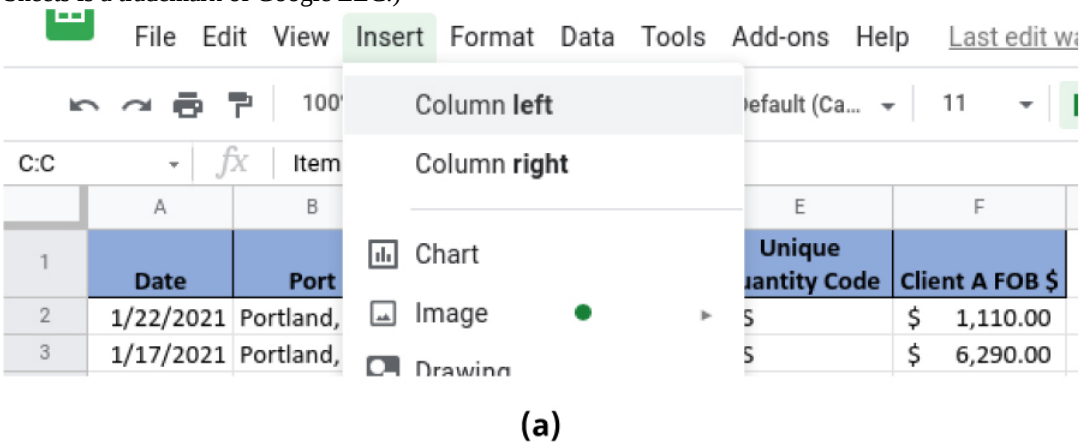
Mac Tip

As in Excel, Mac uses the Command key instead of the Control key, so the shortcut for copy is Command+C and the shortcut for paste is Command+V.

You have now created a new table using the formatting of an existing table, but the table isn't exactly what we need. Your manager asks you to add a new column between existing columns for the destination. To do this, first click on the top of column C to highlight the whole column, because you will insert the new column to its left. Then, click on the Insert menu to select Column Left (Figure 9.49a), which will insert a blank column (Figure 9.49b) where you can input your new data.

	A	B	C	D	E	F
1	Date	Port	Item Description	Quantity	Unique Quantity Code	Client A FOB $
2	1/22/2021	Portland, ME	Tablets 7"	15	PCS	$ 1,110.00
3	1/17/2021	Portland, ME	Tablets 7"	85	PCS	$ 6,290.00
4	1/15/2021	Portland, ME	Tablets 7"	110	PCS	$ 8,140.00
5	1/13/2021	Portland, ME	Tablets 7"	76	PCS	$ 5,624.00
6	1/8/2021	Portland, ME	Tablets 7"	22	PCS	$ 1,628.00
7	1/5/2021	Portland, ME	Tablets 7"	15	PCS	$ 1,110.00
8	1/3/2021	Portland, ME	Tablets 7"	15	PCS	$ 1,110.00
9	12/28/2020	Portland, ME	Tablets 7"	62	PCS	$ 4,588.00
10	12/20/2020	Portland, ME	Tablets 7"	46	PCS	$ 3,404.00
11						

Figure 9.48: Using the formatting of an existing table can make it easier to create a new one. The table being copied has formatted headers and cells. First, highlight the table and copy it. Then, paste it into the new workbook. Since the columns are all the same size, they need to be resized. (Google Sheets is a trademark of Google LLC.)



(a)

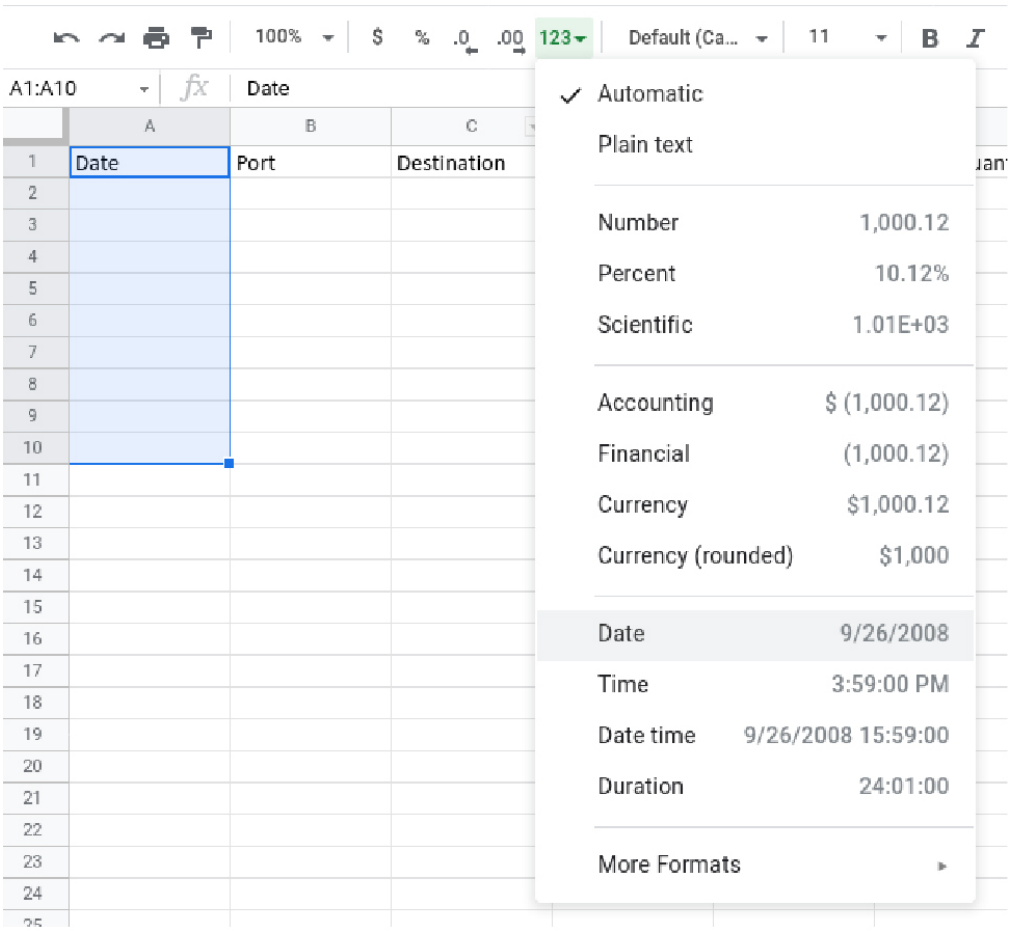
	A	B	C	D	E	F	G
1	Date	Port		Item Description	Quantity	Unique Quantity Code	Client A FOB $
2	1/22/2021	Portland, ME		Tablets 7"	15	PCS	$1,110.00
3	1/17/2021	Portland, ME		Tablets 7"	85	PCS	$6,290.00

(b)

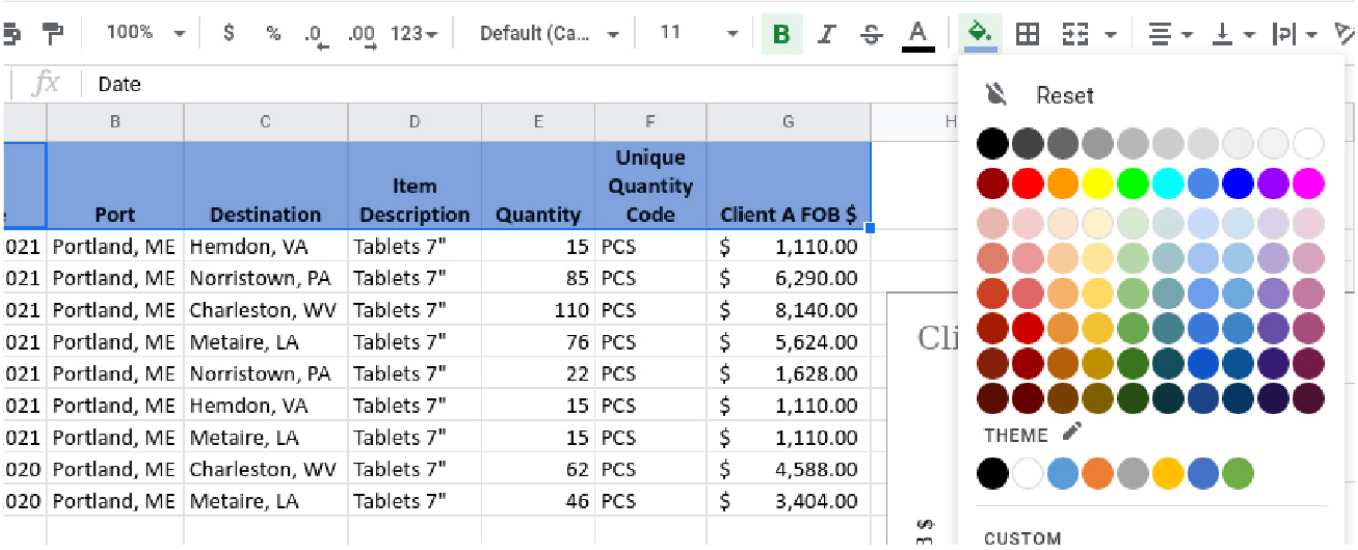
Figure 9.49: (a) Insert a column to the left of the item description. (b) The empty column keeps the visual formatting in the header. Then, you can enter the data in the new column. (Google Sheets is a trademark of Google LLC.)

Working with Numeric and Text Data in a Sheets Cell

Copying the formatting from an existing table is helpful, but it is not always an option. In some cases, you will need to create a table from scratch. The first step is to establish the headers in the first row (Figure 9.50a). Based on the headers, you can then choose the most appropriate format for the data (Figure 9.50b).



(a)



	Port	Destination	Item Description	Quantity	Unique Quantity Code	Client A FOB $
021	Portland, ME	Hemdon, VA	Tablets 7"	15	PCS	$ 1,110.00
021	Portland, ME	Norristown, PA	Tablets 7"	85	PCS	$ 6,290.00
021	Portland, ME	Charleston, WV	Tablets 7"	110	PCS	$ 8,140.00
021	Portland, ME	Metaire, LA	Tablets 7"	76	PCS	$ 5,624.00
021	Portland, ME	Norristown, PA	Tablets 7"	22	PCS	$ 1,628.00
021	Portland, ME	Hemdon, VA	Tablets 7"	15	PCS	$ 1,110.00
021	Portland, ME	Metaire, LA	Tablets 7"	15	PCS	$ 1,110.00
020	Portland, ME	Charleston, WV	Tablets 7"	62	PCS	$ 4,588.00
020	Portland, ME	Metaire, LA	Tablets 7"	46	PCS	$ 3,404.00

(b)

Figure 9.50: Creating a table from scratch requires many steps. First, enter your headers in the first row. (a) Then, format each column for the type of data it will contain. Adjust the column width when necessary. Format your header row by bolding and centering the content. (b) Finally, add the background fill from the custom color menu. (Google Sheets is a trademark of Google LLC.)

The format types Sheets uses are similar to the ones Excel uses. Table 9.3 compares the formats between Sheets and Excel. The names differ slightly, but many mean almost the same thing. There are minor differences like the order the format types appear in the menu, and there are some formats that are unique to Sheets. Sheets has the Financial, Currency rounded, Date time, and Duration formats that are not available in Excel.

Table 9.3: Data Formats in Google Sheets Compared with Excel

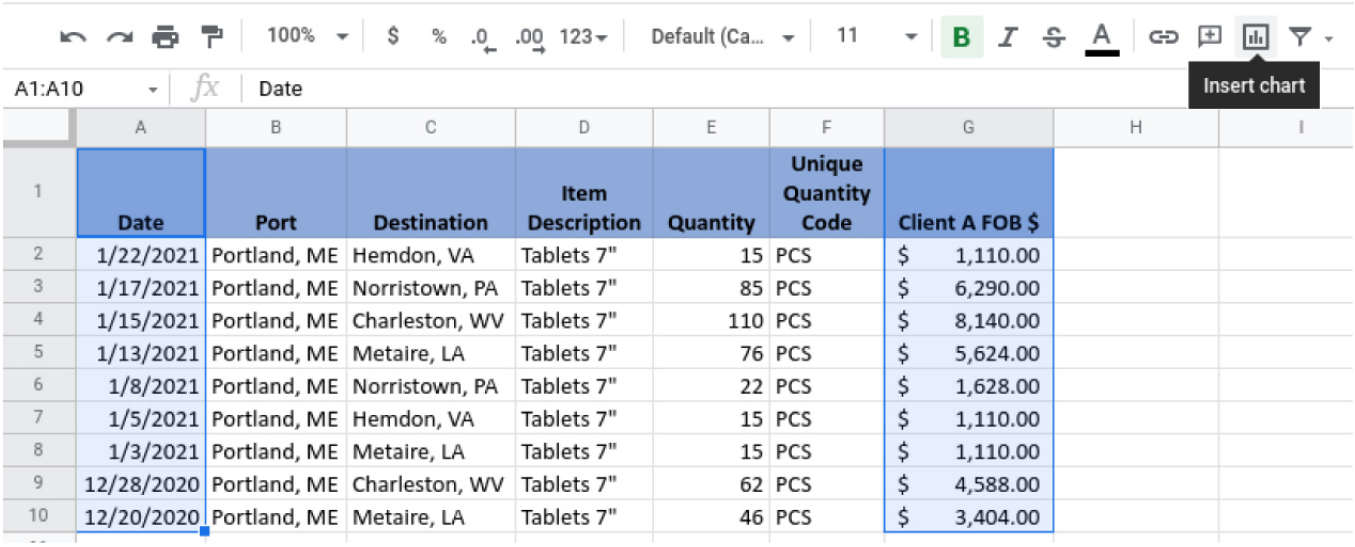
Type of Numerical Value	Difference Compared to Excel
Number	Same as Excel
Percentage	Same as Excel
Scientific	Same as Excel
Accounting	Same as Excel
Financial	Similar to Accounting, but without the currency symbol
Currency	Same as Excel
Currency rounded	Similar to Currency, but with no decimals
Date	Same as Excel
Time	Same as Excel
Date time	Similar to Date and Time but together in one cell
Duration	Unique to Sheets; a new way to measure time

Once you have your headers in place, you can apply the appropriate format to the cells below. Select all of column A and go to the More formats drop-down menu, and use the Date format (Figure 9.50a). You can set the next three columns as Plain Text and leave columns E and F as Automatic format. Set column G as Accounting. Then, you can fill in the table by adding each order. With all of the data entered, you can make any final formatting changes. First, adjust the width of the columns by double-clicking at the edge of each column. Next, drag the edge of column F to make it narrower so that the header has one word per line. Then, center align and apply bold font on all headers. Finally, apply the background color from the Custom set of colors, which shows recently used colors (Figure 9.50b).

Using Numeric and Text Data to Create Basic Graphs

To create a chart or graph in Sheets, the process is slightly different from Excel. First, select the data as you would do when creating a graph or chart in Excel. Then, go to the Insert menu and choose Chart. The chart will appear on the screen in the spreadsheet you have created. Google will analyze the type of data and choose the chart that seems appropriate for the data you have selected. The Chart Editor window will appear to the right. Here, you can adjust the type of chart you want to use and customize the chart with titles and other formatting options. Use the sales report created in Figure 9.50b to make a graph that compares the FOB $ to the Date. In other words, it will show the amount of money traded on each day. Sheets analyzes the data before creating the graph and will manipulate the data to be chronological, if necessary. It will also use its built-in artificial intelligence to choose the type of graph most appropriate for the data. You can override the graph type Sheets selects if there is one you feel is more appropriate. PivotTables/Charts goes into more detail about creating graphs and charts.

To create a basic graph, first select the columns you want to compare (Figure 9.51), using the Ctrl key to select two noncontiguous columns. Then, click on Insert Chart, and Sheets will create the graph it determines is the most appropriate. You can change the type of graph if you prefer a different type. Using the Chart Type drop-down menu, you can choose a different layout (Figure 9.52). Two other options for this data are a bar chart with the chronological order inversed, and an area chart, which is similar to the line chart. When choosing any chart option, Sheets will automatically reorder the dates.



	A	B	C	D	E	F	G
1	Date	Port	Destination	Item Description	Quantity	Unique Quantity Code	Client A FOB $
2	1/22/2021	Portland, ME	Hemdon, VA	Tablets 7"	15	PCS	$ 1,110.00
3	1/17/2021	Portland, ME	Norristown, PA	Tablets 7"	85	PCS	$ 6,290.00
4	1/15/2021	Portland, ME	Charleston, WV	Tablets 7"	110	PCS	$ 8,140.00
5	1/13/2021	Portland, ME	Metaire, LA	Tablets 7"	76	PCS	$ 5,624.00
6	1/8/2021	Portland, ME	Norristown, PA	Tablets 7"	22	PCS	$ 1,628.00
7	1/5/2021	Portland, ME	Hemdon, VA	Tablets 7"	15	PCS	$ 1,110.00
8	1/3/2021	Portland, ME	Metaire, LA	Tablets 7"	15	PCS	$ 1,110.00
9	12/28/2020	Portland, ME	Charleston, WV	Tablets 7"	62	PCS	$ 4,588.00
10	12/20/2020	Portland, ME	Metaire, LA	Tablets 7"	46	PCS	$ 3,404.00

Figure 9.51: Creating graphs in Sheets is simple because of the built-in analysis the application performs. First, choose the columns you want to compare and click on Insert Chart. Sheets automatically chose a line chart for the data. (Google Sheets is a trademark of Google LLC.)

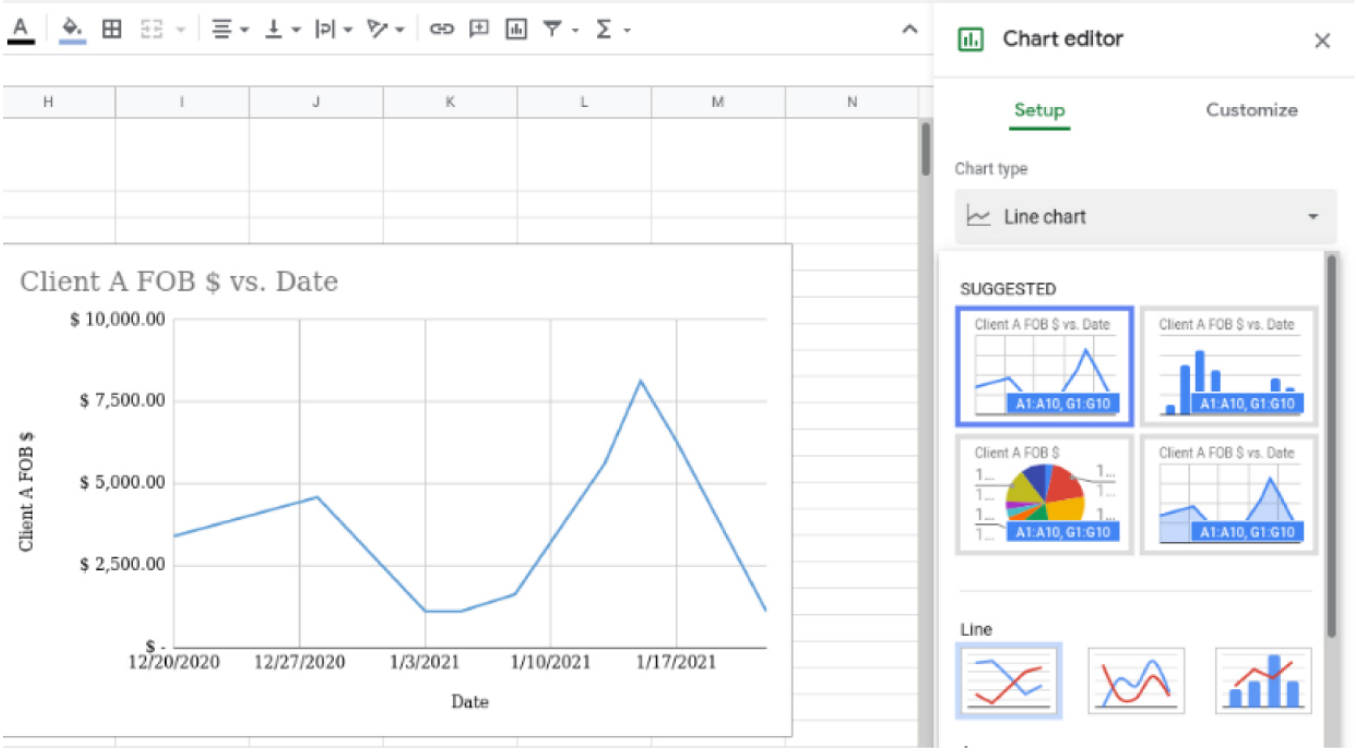


Figure 9.52: The Chart Editor sidebar gives other options for the type of chart. Another option for this set of data is a bar chart. (Google Sheets is a trademark of Google LLC.)

Link to Learning

The help forums for Sheets contain a short introduction to all the types of graphs you can build. They describe the use of each of the graphs, previews, and short step-by-step instructions. Go to Google's support page on the different graph types to learn more.

Page Layout and Review Menus

Sheets does not have menus that directly compare to the Page Layout and Review tabs in Excel, but it does have many of the same features. One feature Sheets does not have is Page Setup. The items in the Page Setup command group such as margins and page orientation are managed in the Print Setting in Google. Similar to the Themes command group in Excel, Sheets has a Theme option found in the Format menu (Figure 9.53). Excel's Page Layout tab also has the Background command that allows you to choose an image for the background of your worksheet. This feature is partly available in Sheets in the Insert menu, which allows you to insert an "Image in cell" or "Image over cells" (Figure 9.54a). The result of placing an image in a cell is shown in Figure 9.54b. The inserted image (either in a cell or over cells) sits on top of the information in the cells, unlike in Excel, where the image is in the background. The other functions, like moving an object forward or backward, adding gridlines, or scaling settings, are partly available in Sheets. You can insert objects such as Google Draw files, Google Forms, charts, and images into the worksheets, but moving them around may be more cumbersome and less robust compared with Excel.

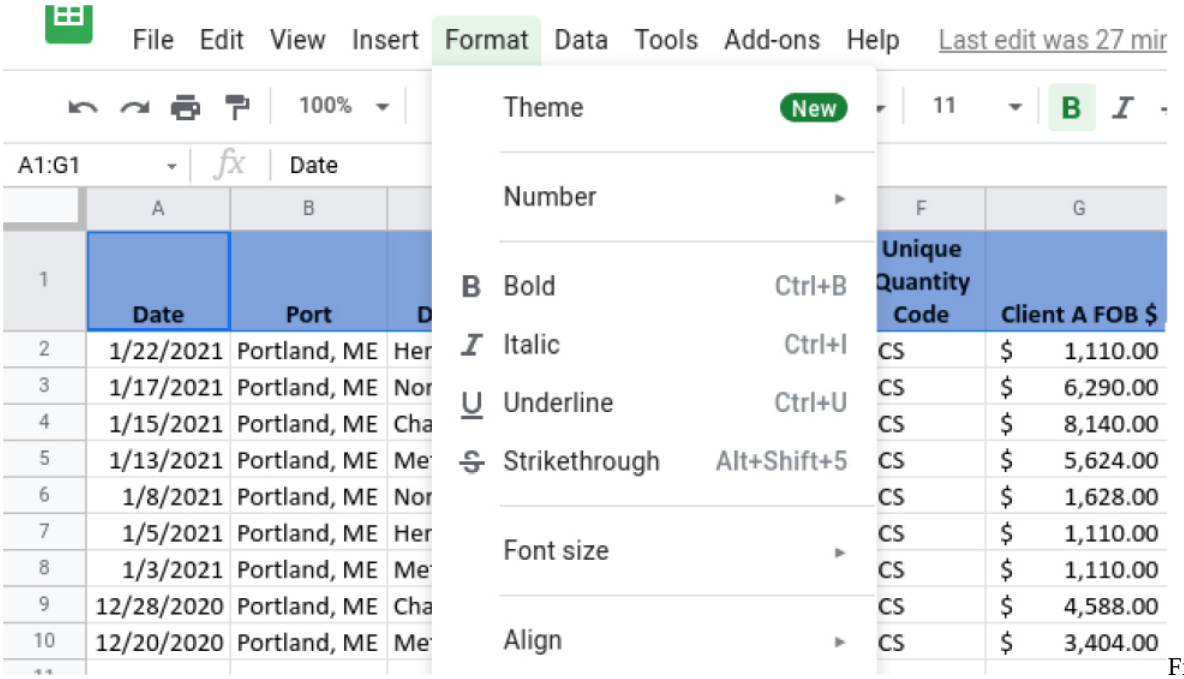
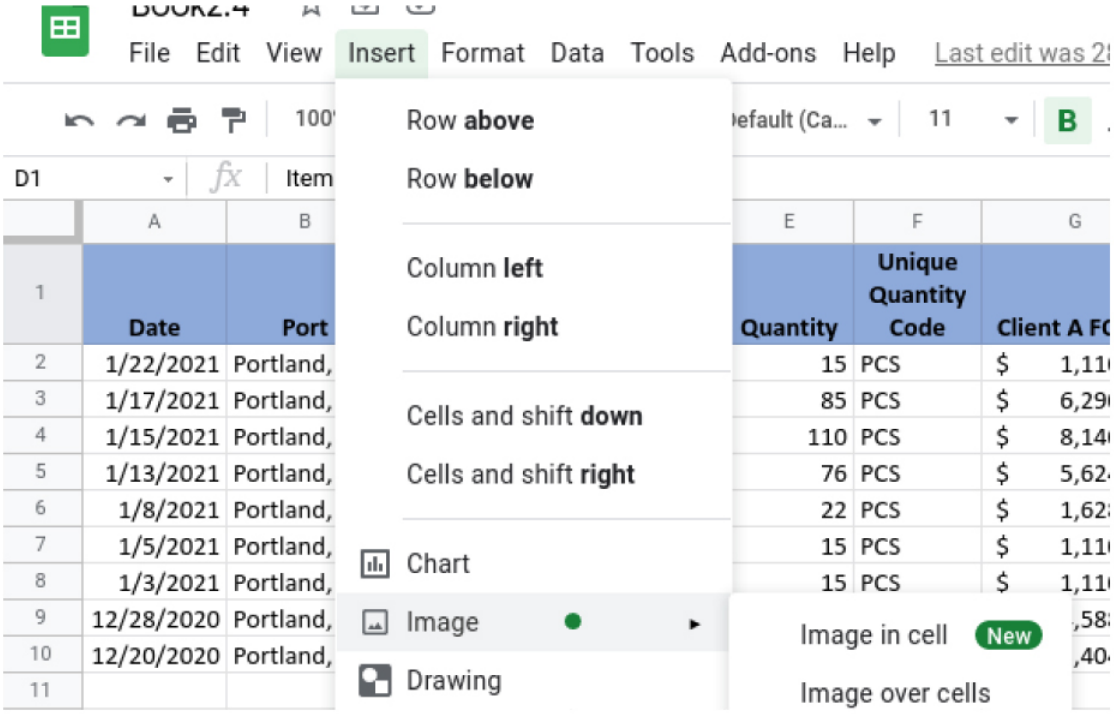
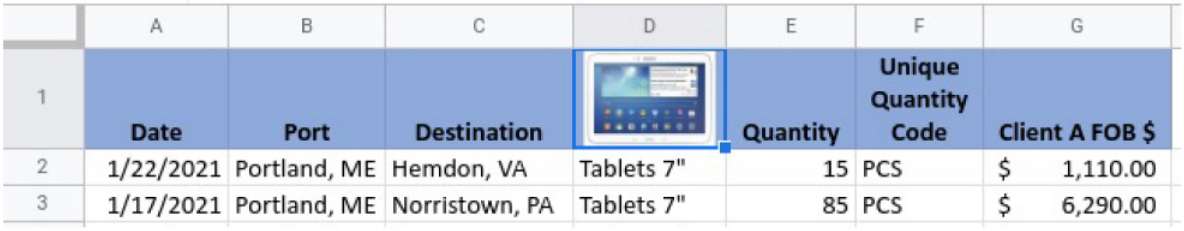


Figure 9.53: Page layout features in Sheets differ somewhat from those in Excel. Themes are used to set a color scheme and/or font type for your spreadsheet. (Google Sheets is a trademark of Google LLC.)



(a)



(b)

Figure 9.54: (a) You can insert an image in a single cell or over all of the cells in a worksheet. (b) Inserting an image in a single cell fills the cell with the image. (Google Sheets is a trademark of Google LLC.)

The review features in Sheets differ somewhat from the Review tab commands in Excel. Sheets allows you to insert a comment (Figure 9.55) and view all the comments on the document by clicking on the Comment History button on the top. The Tools menu in Sheets has a spelling and grammar check (Figure 9.56).

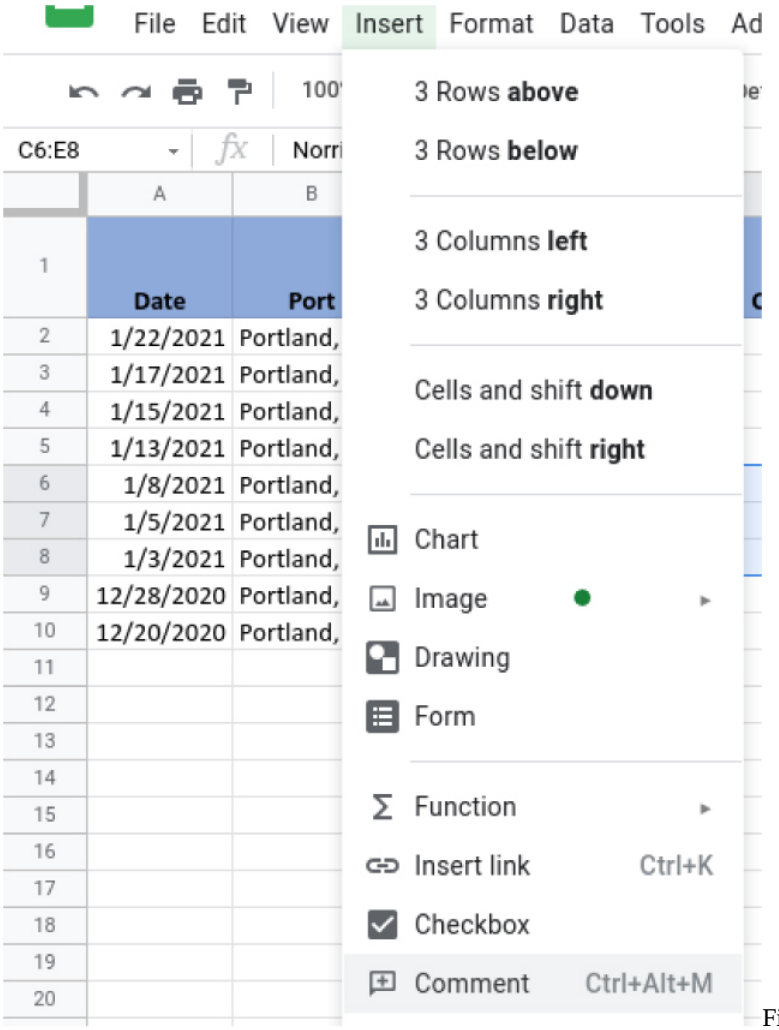


Figure 9.55: Some review features in Sheets are similar to those of Excel. Comments are available in the Insert menu. You can also review all comments in a workbook. (Google Sheets is a trademark of Google LLC.)

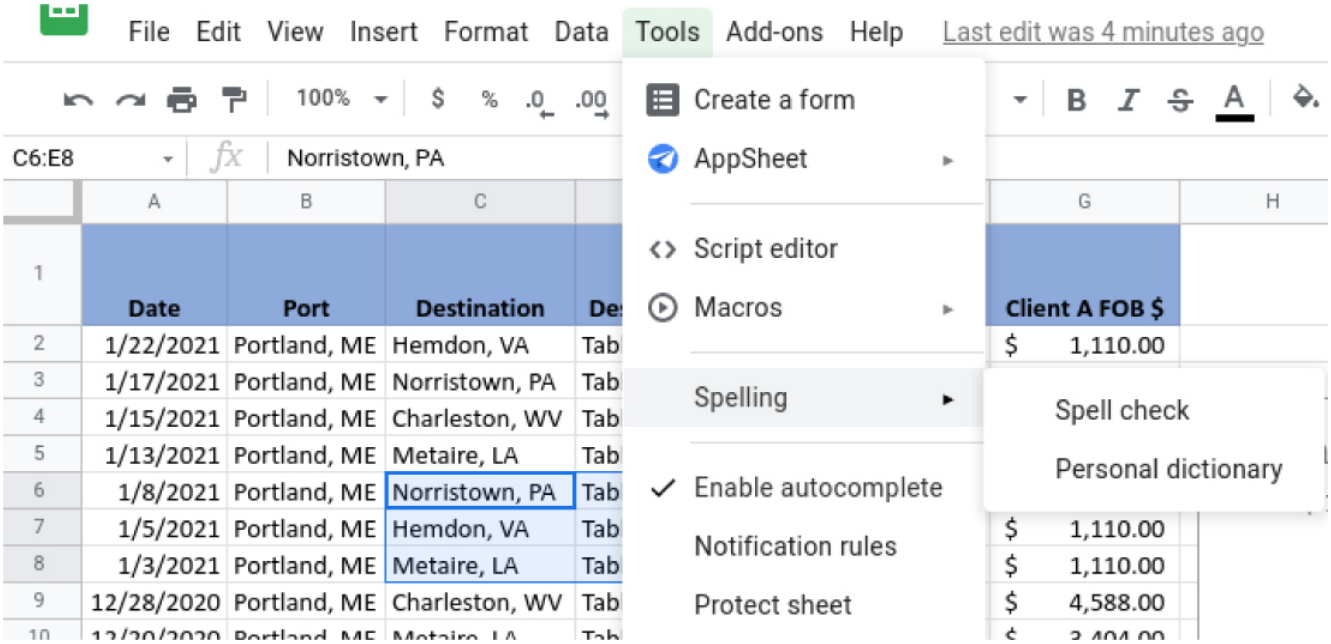


Figure 9.56: The spelling and grammar check are in the Tools menu. (Google Sheets is a trademark of Google LLC.)

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CHAPTER OVERVIEW

2: Formatting in Microsoft Excel and Google Sheets

2.1: Formatting and Templates in Microsoft Excel
2.2: Formatting and Templates in Google Sheets

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2.1: Formatting and Templates in Microsoft Excel

Learning Objectives

By the end of this section, you will be able to:

- Format and manipulate a cell or group of cells
- Design column and row headers
- Use conditional formatting
- Work with templates to format worksheets

At WorldCorp, there is so much data that it is impossible to look at it all at once. For example, on a long worksheet with several hundred or thousand orders, you might want to see only orders over a certain value. In the previous sections, you learned how to organize the information in a spreadsheet and analyze the data using some basic calculations. These calculations provide the information needed to present the data to other entities in the corporation, but it might not yet be formatted in a professional manner. You may want to ensure the data meets certain criteria; you might want to add additional formatting to highlight certain trends in the data or group the data in a different way to show meaningful differences. With the skills you learned in the previous sections and those to follow, you can create a meaningful report and analysis of the data to effectively communicate company performance. This report can be utilized to measure company progress toward strategic goals or to compare WorldCorp to their competitors.

Formatting Cells

We've discussed formatting cells according to their contents, such as number, percentage, or text, but formatting extends to the visual presentation of a worksheet. In this context, formatting involves applying colors, font types, and borders to cells for styling purposes. It can make a presentation more visually appealing or distinct from other presentations. Another important reason for formatting is to increase the readability and comprehension of data. Formatting can be applied to text and numbers, to cell backgrounds, or to cell borders. It is important to remember that sometimes additional formatting may not be necessary. The goal is to have a professional presentation of the information. Too much formatting such as bright colors or distracting fonts does not enhance the presentation of the information. It is advisable to stick to simple formatting that is not distracting and is in line with company standards for your corporation.

Using Color and Fonts

Colors and fonts can be used to highlight specific parts of a worksheet such as the header row or the total row and to indicate the end of a table. Highlighting values that are outside of a certain range or to show trends in a dataset can also be useful. In accounting, the convention is to have negative numbers in red font and positive numbers in black font. These uses of colors and fonts provide meaningful information to the user at a glance.

In Figure 9.27a, the current header row is gray with white font. Suppose your manager wants to follow the color scheme of the company and wants the header row to be highlighted with a blue cell fill and a larger font. To change the fill color of the cells, first select the cells you want to change (Figure 9.27a) and then click on the paint bucket in the Font command group on the Home tab. The drop-down arrow next to the bucket allows you to choose from many preset colors, or you can create your own by clicking on More Colors. For this table, click on the blue fill box in the middle of the fifth column of colors. Now that the background is blue, the white font is harder to read, so you should change it to a darker color. To change the color of the font, select the cells and click on the text icon next to the paint bucket. You can change the font by clicking on the Font drop-down menu and the size by clicking on the adjacent Font Size drop-down menu (Figure 9.27b). You can also change the formatting of individual cells, but it saves time to highlight all of the header cells and format them at the same time.

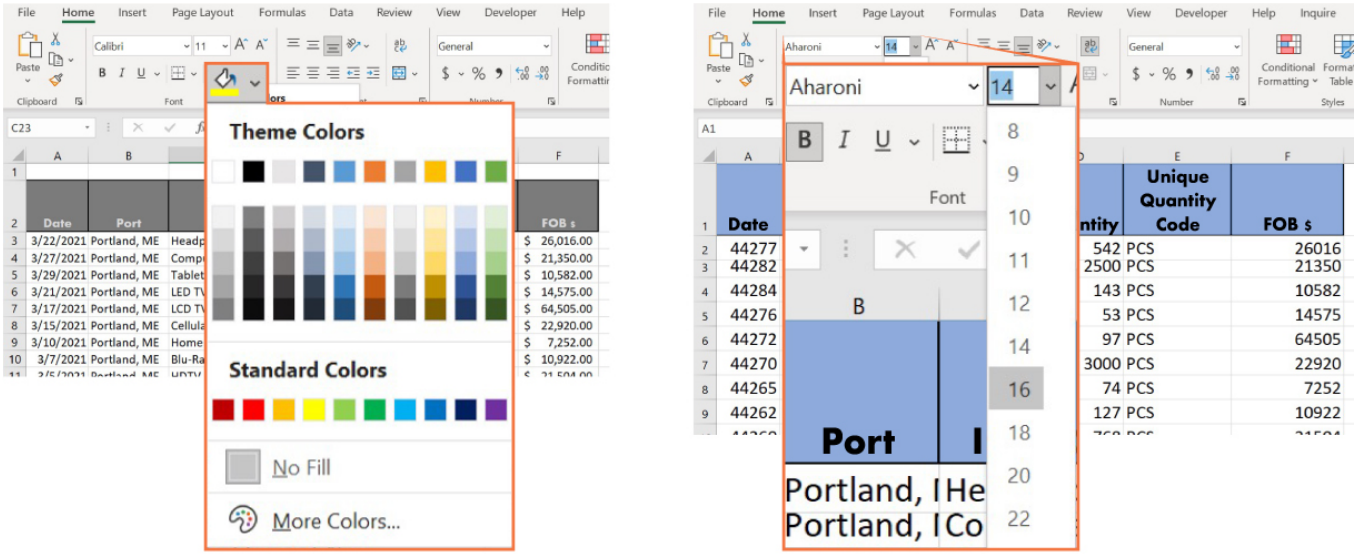
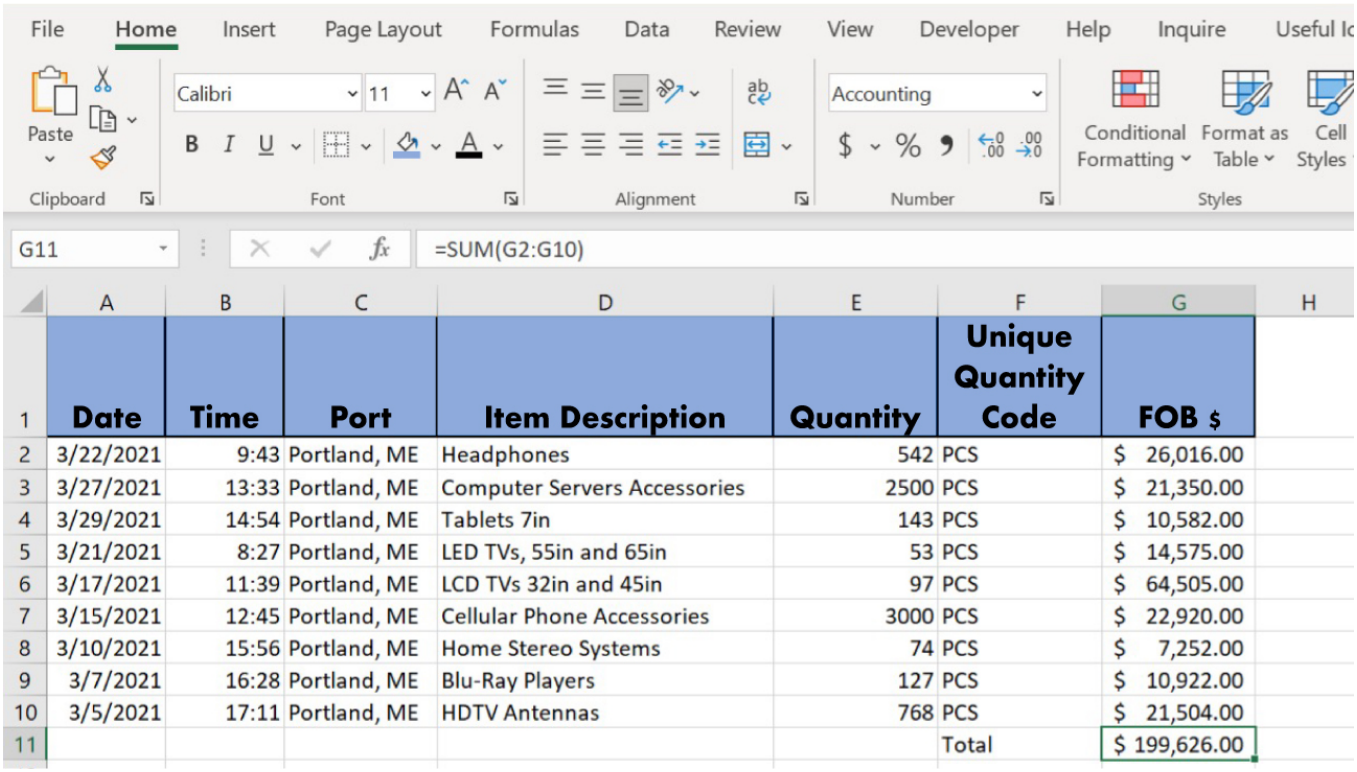


Figure 9.27: You can easily change the cell fill color, font type, and text color. (a) Select the paint bucket from the Home tab to change the color of the background fill. A drop-down menu gives you many options or you can define your own color using More Colors. The new background fill color is more visually appealing, but the text does not stand out as it would in a different color. (b) Font size, type, and color can also be changed using the commands in the Font command group. (Used with permission from Microsoft)

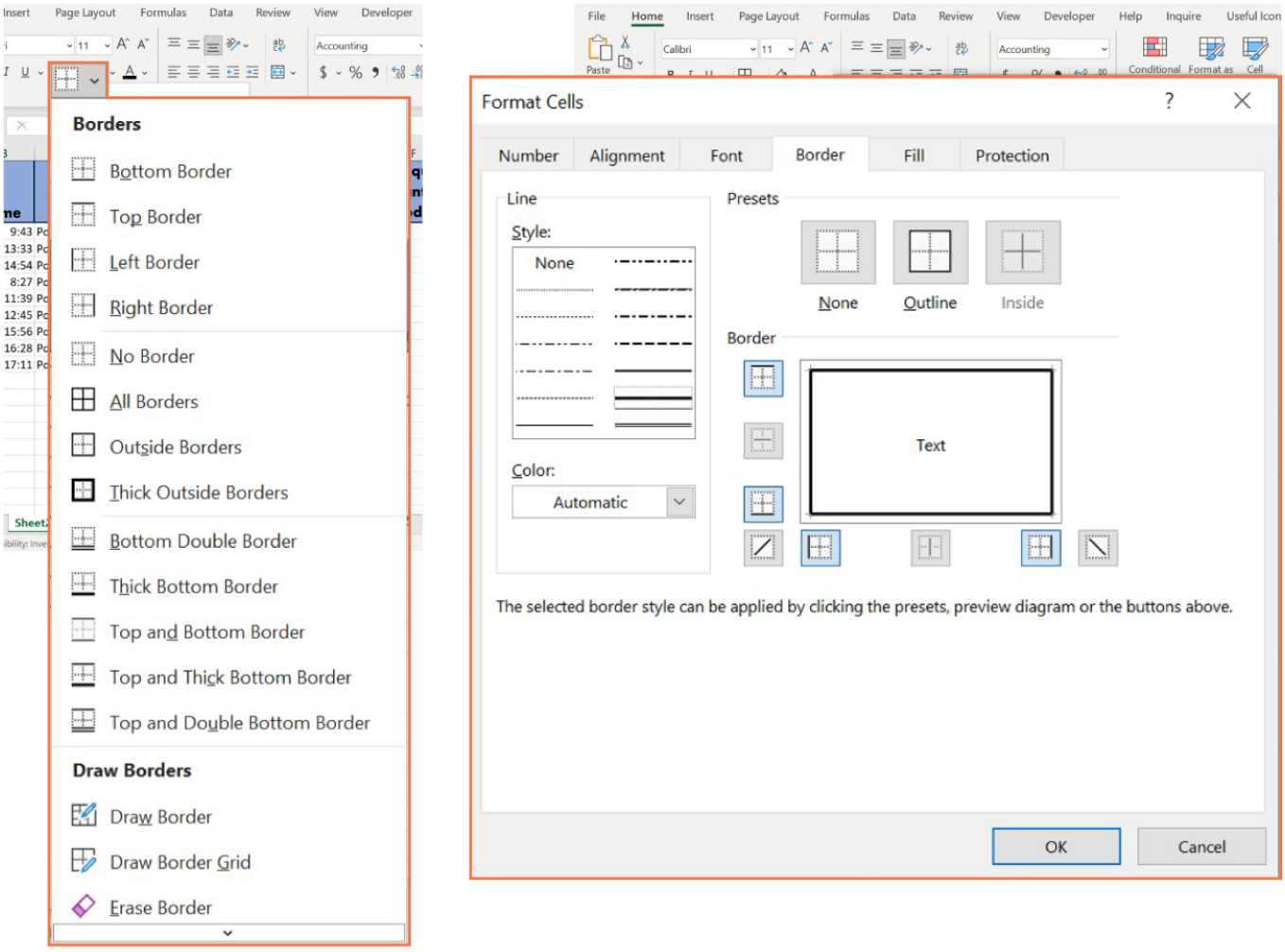
Borders

The default style in Excel is for gridlines to be visible in order to distinguish one cell from another when viewed on the screen. However, there may be times when that distinction could be clearer, or you want to divide groups of columns or rows. You can use borders to make these distinctions. Let's assume you would like to put a border around the total cell. To add this border, first select the cell or cells where you want to add a border (Figure 9.28). Then, from the Home tab, in the Font command group, you will find the Border command drop-down menu. You can also access this by right-clicking after you selected the cells and choosing Format Cells and then the Borders tab (Figure 9.29a). By selecting the down arrow of the Border command, you can choose the appropriate border for the cell or cells. You can change the border style and color. First, select the style and thickness of the outline, change the color if you want it to be a color other than black, then apply it on the preview on the right by clicking on each border (Figure 9.29b). You can choose multiple styles of borders or leave cells without borders, such as if you wanted a border around your table but not within the rows and columns. More border options are available by choosing More Borders at the bottom of the list. This will bring up the Format Cells dialog box, Borders tab. Make sure your header row is now formatted consistently.



	A	B	C	D	E	F	G	H
1	**Date**	**Time**	**Port**	**Item Description**	**Quantity**	**Unique Quantity Code**	**FOB $**	
2	3/22/2021	9:43	Portland, ME	Headphones	542	PCS	$ 26,016.00	
3	3/27/2021	13:33	Portland, ME	Computer Servers Accessories	2500	PCS	$ 21,350.00	
4	3/29/2021	14:54	Portland, ME	Tablets 7in	143	PCS	$ 10,582.00	
5	3/21/2021	8:27	Portland, ME	LED TVs, 55in and 65in	53	PCS	$ 14,575.00	
6	3/17/2021	11:39	Portland, ME	LCD TVs 32in and 45in	97	PCS	$ 64,505.00	
7	3/15/2021	12:45	Portland, ME	Cellular Phone Accessories	3000	PCS	$ 22,920.00	
8	3/10/2021	15:56	Portland, ME	Home Stereo Systems	74	PCS	$ 7,252.00	
9	3/7/2021	16:28	Portland, ME	Blu-Ray Players	127	PCS	$ 10,922.00	
10	3/5/2021	17:11	Portland, ME	HDTV Antennas	768	PCS	$ 21,504.00	
11						Total	$ 199,626.00	

Figure 9.28: To add borders, select the cells you want to add a border to. (Used with permission from Microsoft)



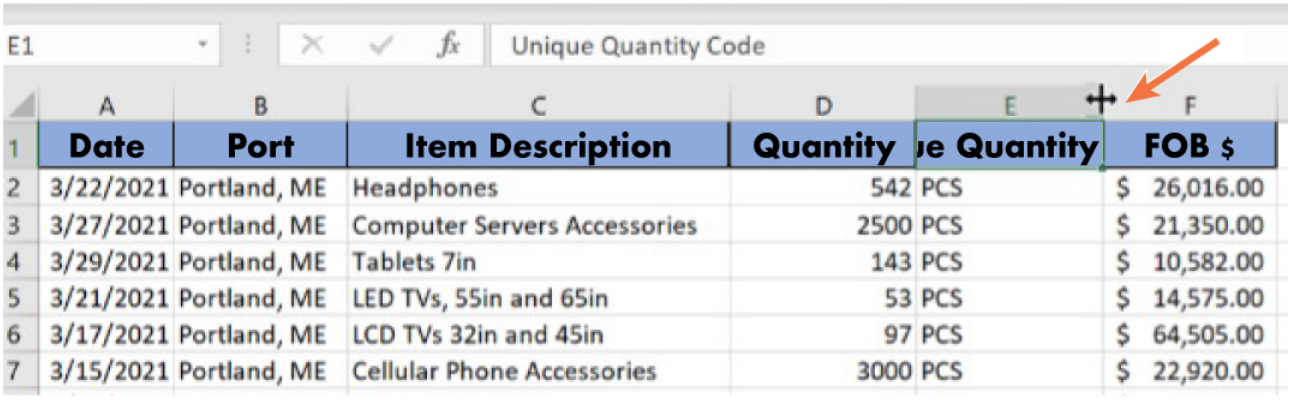
(a) **(b)**

Figure 9.29: (a) You can use the Borders command drop-down menu or right-click and choose Format Cells. (b) You can select various thickness levels of the border around the cell. (Used with permission from Microsoft)

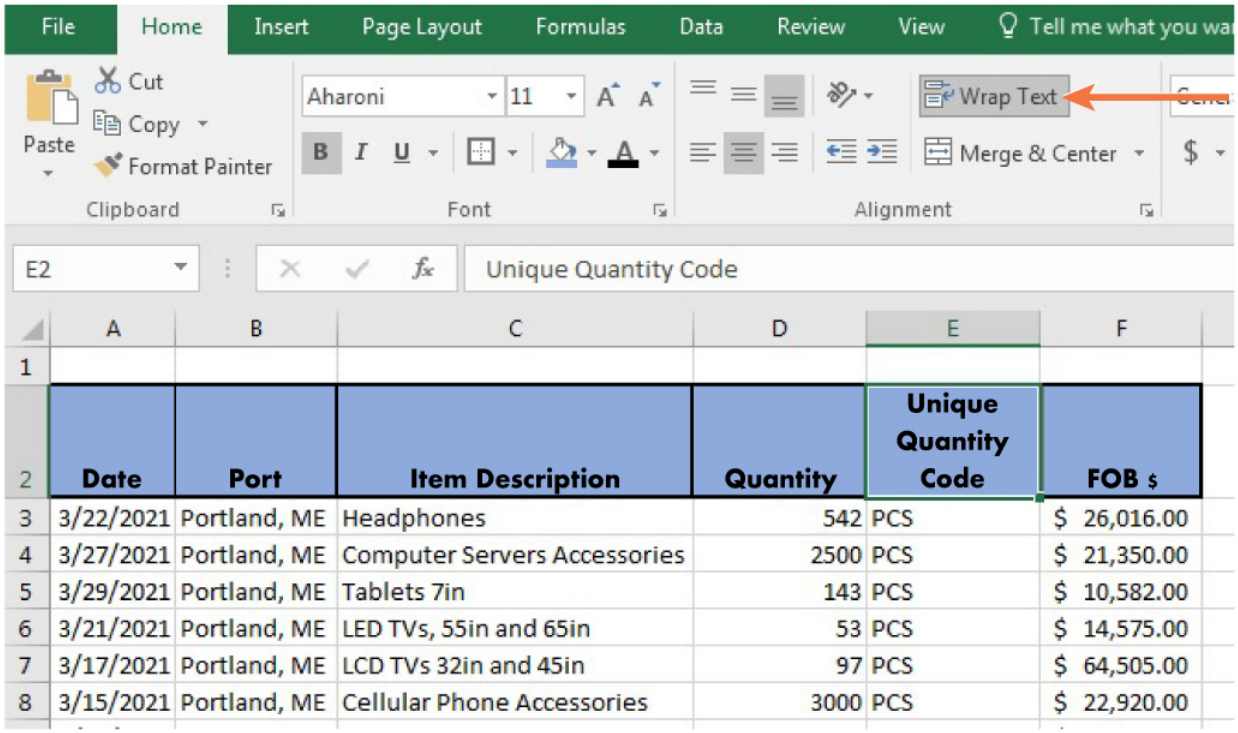
Wrapping Text

When you are working with text that is long, you can extend the width of your columns to fit it all in. One way is to do it manually. Hover over the line between two columns. The cursor will change to a black vertical line with opposite arrows. Click on this line and drag the column to your preferred width. You can also use the AutoFit command to automatically size the columns to fit the data contained in that column (Figure 9.30a). To AutoFit the columns, hover over the line between the columns, as you would to do it manually. Then, double-click on the line, and the column will adjust to the width of the contents. For example, to automatically size column E to the appropriate size for the data in the column, double-click on the line between the D and F columns at the top of the spreadsheet.

Sometimes, the text is so long that the whole width of the column is not visible on your screen; other times, you may not want a column to take up most of the width of your table. In those cases, the text is cut off. In Figure 9.30a, the header for column E is too long to fit in the cell. To fix this, select the cell, then on the Home tab, click on Wrap Text. The Wrap Text feature arranges the text in a cell so that it extends onto another line and increases the height of the row (Figure 9.30b).



(a)



(b)

Figure 9.30: Text wrapping can make long text fit in a column. (a) The header for column E is too long for the width of the column. Double-click or click and drag the line between columns to widen or narrow a column. The Wrap Text feature allows you to see text that is cut off. (b) Text wrapping changes the height of a row to accommodate long text. (Used with permission from Microsoft)

Merging Cells

Borders provided one method of grouping content in a table, but there are other ways to show that some rows or columns of data should be grouped together. The merge feature combines the content from two or more cells. When merging, the content and formatting of the first cell supersedes the content and formatting of the others. Merging cells can increase the readability of the tables. Figure 9.31a shows a row added above the header row to group some of the columns together to identify important sales order information to the port dispatchers. The first two columns tell the port dispatchers when the order was placed, so you want the cell that says “When” to span both columns. First, add “When” to the first cell. Then, select both cells over the columns you want the header to span and click on Merge & Center on the Home tab. Figure 9.31b shows the merged and centered cells. This can be repeated with cells E3 and F3. You can also merge content within a table. At the bottom, merge cell A14 with cells B14, C14,

D14, E14, and F14, to make the Total row more readable. Now that the merging is complete, you can format the border outlines. Format the top row, making sure all cell contents are centered and have borders, and add borders to the bottom row to highlight the totals. Figure 9.31c shows the completed table.

	A	B	C	D	E	F	G
1							
2							
3	When		Where	What	How many		How much
4	**Date**	**Time**	**Port**	**Item Description**	**Quantity**	**Unique Quantity Code**	**FOB $**
5	3/22/2021	9:43	Portland, ME	Headphones	542	PCS	$ 26,016.00
6	3/27/2021	13:33	Portland, ME	Computer Servers Accessories	2500	PCS	$ 21,350.00
7	3/29/2021	14:54	Portland, ME	Tablets 7in	143	PCS	$ 10,582.00
8	3/21/2021	8:27	Portland, ME	LED TVs, 55in and 65in	53	PCS	$ 14,575.00
9	3/17/2021	11:39	Portland, ME	LCD TVs 32in and 45in	97	PCS	$ 64,505.00
10	3/15/2021	12:45	Portland, ME	Cellular Phone Accessories	3000	PCS	$ 22,920.00
11	3/10/2021	15:56	Portland, ME	Home Stereo Systems	74	PCS	$ 7,252.00
12	3/7/2021	16:28	Portland, ME	Blu-Ray Players	127	PCS	$ 10,922.00
13	3/5/2021	17:11	Portland, ME	HDTV Antennas	768	PCS	$ 21,504.00
14	Total						$199,626.00

(a)

	E	F	G
1			
2			
3	How many		How much
4	**Quantity**	**Unique Quantity Code**	**FOB $**
5	542	PCS	$ 26,016.00
6	2500	PCS	$ 21,350.00
7	143	PCS	$ 10,582.00
8	53	PCS	$ 14,575.00
9	97	PCS	$ 64,505.00
10	3000	PCS	$ 22,920.00
11	74	PCS	$ 7,252.00
12	127	PCS	$ 10,922.00
13	768	PCS	$ 21,504.00
14			$199,626.00

(b)

	A	B	C	D	E	F	G
1						**Unique Quantity Code**	
2							
3	When		Where	What	How		**FOB $**
4	**Date**	**Time**	**Port**	**Item Description**	**Quantity**	**Unique Quantity Code**	**FOB $**
5	3/22/2021	9:43	Portland, ME	Headphones	542	PCS	$ 26,016.00
6	3/27/2021	13:33	Portland, ME	Computer Servers Accessories	2500	PCS	$ 21,350.00
7	3/29/2021	14:54	Portland, ME	Tablets 7in	143	PCS	$ 10,582.00
8	3/21/2021	8:27	Portland, ME	LED TVs, 55in and 65in	53	PCS	$ 14,575.00
9	3/17/2021	11:39	Portland, ME	LCD TVs 32in and 45in	97	PCS	$ 64,505.00
10	3/15/2021	12:45	Portland, ME	Cellular Phone Accessories	3000	PCS	$ 22,920.00
11	3/10/2021	15:56	Portland, ME	Home Stereo Systems	74	PCS	$ 7,252.00
12	3/7/2021	16:28	Portland, ME	Blu-Ray Players	127	PCS	$ 10,922.00
13	3/5/2021	17:11	Portland, ME	HDTV Antennas	768	PCS	$ 21,504.00
14				Total			$ 199,626.00

(c)

Figure 9.31: Merging cells is useful for presentation and readability purposes. You can (a) group columns by adding a row above the header row, merge and center cells to create a new label above the date and time, (b) merge and center cells to group the quantity and the code, and merge cells next to the total to create a more readable total. You can also add borders. (c) The final table is clear and readable. (Used with permission from Microsoft)

Link to Learning

Did you know that you can embed Excel objects and components into other Microsoft applications? You can insert all or parts of an Excel worksheet into your presentations and documents, saving time from re-creating the same content in these applications. Embedding content also helps ensure that the content provided in your document or presentation is accurate, as changes in Excel will update in these files as well. Visit this Microsoft page that shows how to embed Excel content in PowerPoint to learn more.

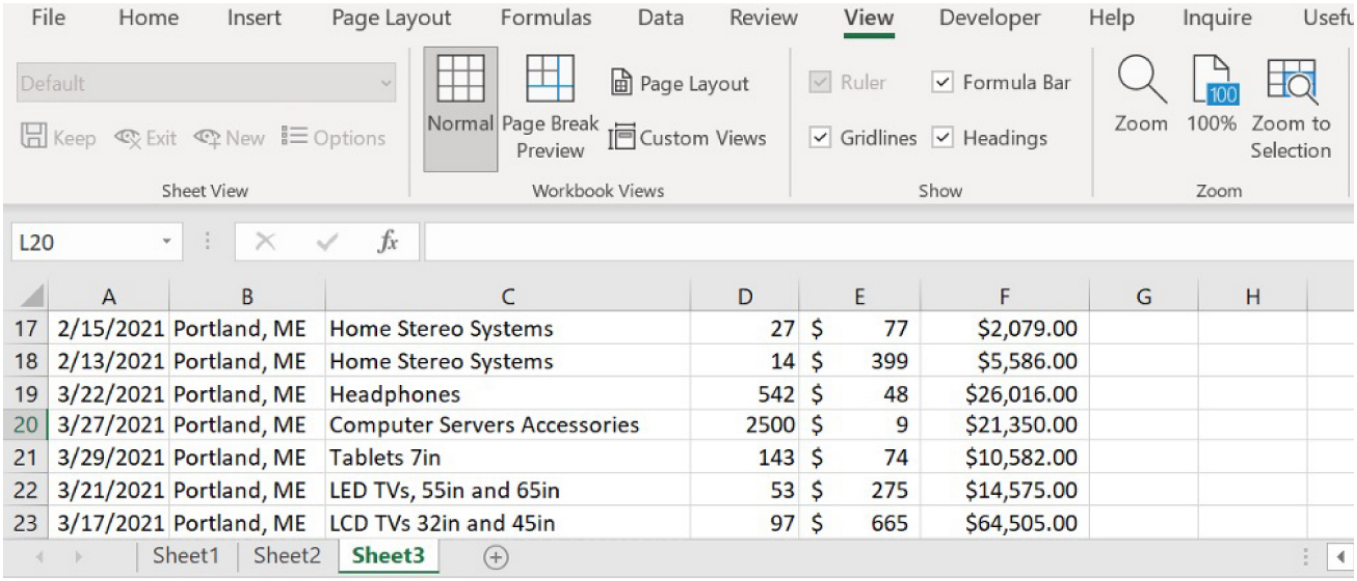
Working with Columns and Rows

The label added to tables at the top of a column or to the left of a row to make the data understandable is called a header. You've already learned to type words at the top of a column and format cells so that the headers look different from the rest of the table. Fonts can be bolded or centered, and background colors or shading applied. You can also freeze columns and rows so that the

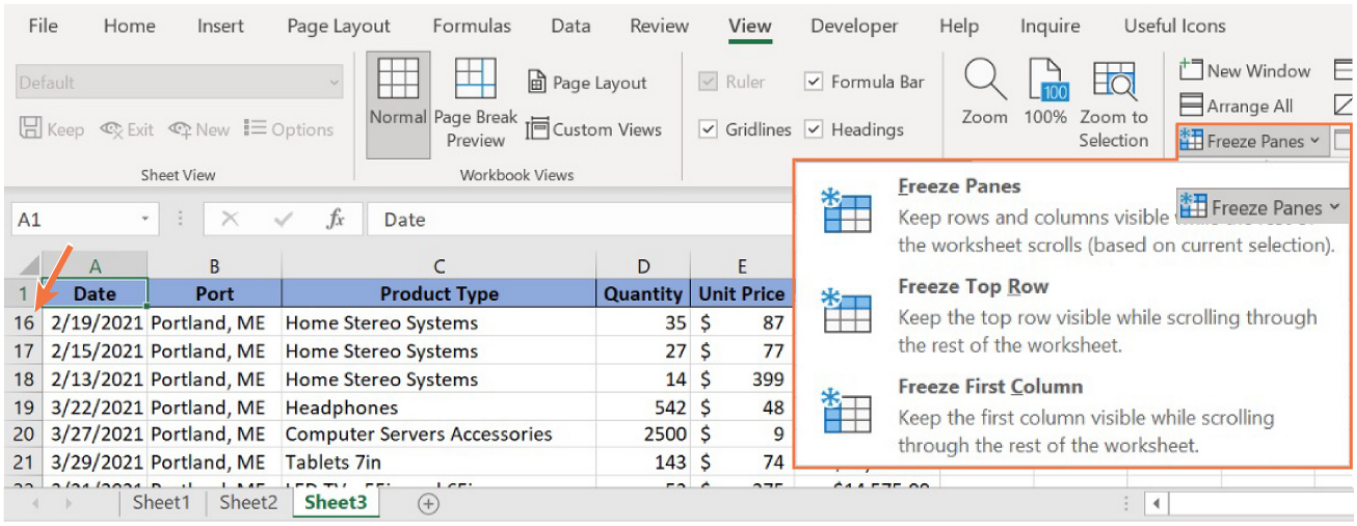
viewer of the document can see the header even if the document extends beyond the screen. Hiding rows and columns can also be useful for reducing the size of a worksheet.

Freezing Columns and Rows

When you have a large set of data, you will need to scroll beyond the edges of your screen to see all of it. You will need to be able to look at the data in each column or row but scrolling can take the header row or column off the screen. To ensure that the column or row headers are visible, you can use a command called Freeze Panes, which fixes the headers on the screen while allowing users to scroll through the rest of the data. The table in Figure 9.32a extends beyond row 22. As you scroll down through the data, notice that you can no longer see the column headers, so you will want to freeze the header row so that you can still see the column headers when you scroll down through the data. Figure 9.32b shows the choices in the Freeze Panes command on the View tab. You can freeze the top row, the first column, or both. For this data, freeze the top row so that scrolling down will keep the column headers in view. Figure 9.32b shows a line below the top row that indicates that the row is frozen. You are not limited to only freezing a header row or column. Excel allows you to use Freeze Panes anywhere in the spreadsheet. Just click on a cell and then on Freeze Panes, and it will freeze everything above and to the left of it.



(a)



(b)

Figure 9.32: Using the Freezing Panes command keeps headers visible when data extends off the screen. (a) Before the header row is frozen, scrolling down removes the header from view. (b) The Freeze Panes options are found on the View tab. Clicking on Freeze Panes allows for freezing the top row, first column, or both. Freezing the header row shows a line that indicates the row is frozen and keeps it in view while scrolling. (Used with permission from Microsoft)

Mac Tip

On a Mac, Excel uses icons for many of the drop-down menus that appear in the Windows version. The Freeze tool, for example, is always visible at the top of your active workbook.

Link to Learning

Go Skills is a company that offers a variety of free or paid online courses. Go to their website to review presentation tips for Excel tables and learn more.

Hiding Columns and Rows

Sometimes when working with data, information may be irrelevant for one use but cannot be deleted. This could be important when formatting spreadsheets for various users or when performing calculations. A user might not need to see all the data that goes into the formula but needs to see the final result of the formula. For example, in Figure 9.32a, column B contains the name of the port, but all of the visible data for the port is the same. If the port of Portland, Maine, is working with this data, they won't need to see the column that contains the port name. Additionally, the workers at the port won't need to know the price per unit. To make the table more usable for these workers, you can use the Hide command, which temporarily removes designated rows or columns from view. To hide a row or column, click on the row or column designation (the number to the left of the row header or the letter above the column header) to select the whole row or column, then right-click and select Hide from the menu (column B in Figure 9.33a). The result is shown in Figure 9.33b. To unhide a column, select the two columns that surround the hidden column, right-click, and select Unhide (Figure 9.34a). The column appears again, as shown in Figure 9.34b.

You can tell when a row or column is hidden by looking at the header, where you can see that letters or numbers are missing and there are two lines between the column or row designations. For example, we can see in Figure 9.33b that the header row goes from column A to column C. B is hidden and is not shown as a header. It is important to watch for that when you are using a spreadsheet that you did not create.



Figure 9.33: Using the Hide command makes rows/columns temporarily not visible in a table. (a) Right-click on the column and select Hide. (b) When columns are hidden, double lines and skipped letters are indicated in the letter designation header. (Used with permission from Microsoft)

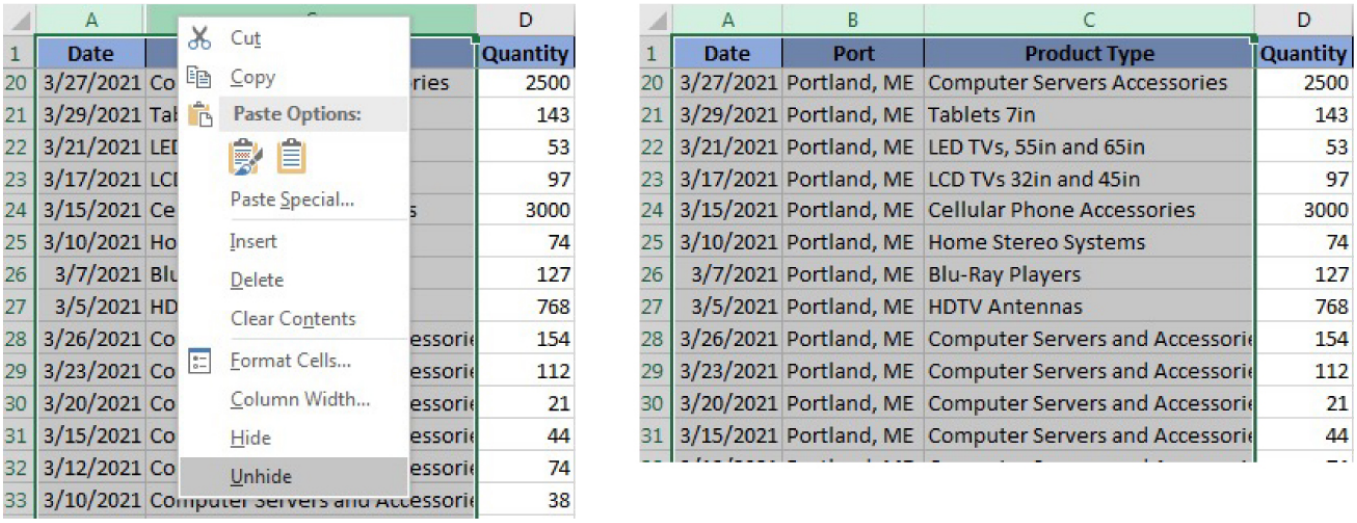


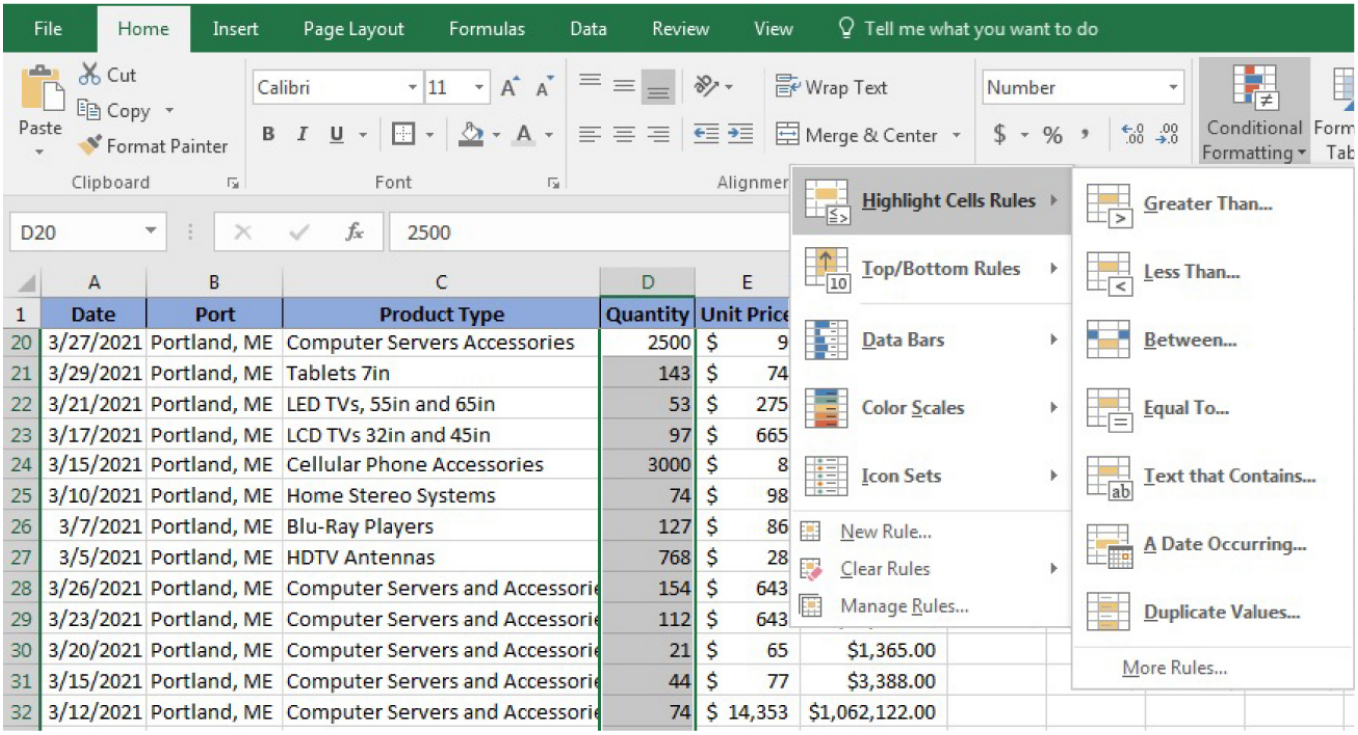
Figure 9.34: (a) To reveal the columns again, select the two columns on either side of the hidden one, right-click, and select Unhide. (b) All columns are visible again. (Used with permission from Microsoft)

Mac Tip

To access the Hide function, hold the Control key and click on the column.

Conditional Formatting

All of the formatting you have learned about so far has involved manually configuring individual cells or groups of cells. Excel has additional formatting features that can save you the time of manual formatting. One of these features, conditional formatting, analyzes the cell contents and applies certain preset designs or layouts based on the content. One example is to change the color of the font if the data is above or below a certain threshold (Figure 9.35). Conditional formatting is not turned on by default, so you will need to apply and customize it. Click on the drop-down menu next to Conditional Formatting on the Home tab and choose the formatting you want to use. You can set up the parameters using the dialog box shown in Figure 9.36a. Figure 9.36b shows another example of conditional formatting: highlighting the top ten FOB $ values.



	A	B	C	D	E		
1	Date	Port	Product Type	Quantity	Unit Price		
20	3/27/2021	Portland, ME	Computer Servers Accessories	2500	$ 9		
21	3/29/2021	Portland, ME	Tablets 7in	143	$ 74		
22	3/21/2021	Portland, ME	LED TVs, 55in and 65in	53	$ 275		
23	3/17/2021	Portland, ME	LCD TVs 32in and 45in	97	$ 665		
24	3/15/2021	Portland, ME	Cellular Phone Accessories	3000	$ 8		
25	3/10/2021	Portland, ME	Home Stereo Systems	74	$ 98		
26	3/7/2021	Portland, ME	Blu-Ray Players	127	$ 86		
27	3/5/2021	Portland, ME	HDTV Antennas	768	$ 28		
28	3/26/2021	Portland, ME	Computer Servers and Accessorie	154	$ 643		
29	3/23/2021	Portland, ME	Computer Servers and Accessorie	112	$ 643		
30	3/20/2021	Portland, ME	Computer Servers and Accessorie	21	$ 65	$1,365.00	
31	3/15/2021	Portland, ME	Computer Servers and Accessorie	44	$ 77	$3,388.00	
32	3/12/2021	Portland, ME	Computer Servers and Accessorie	74	$ 14,353	$1,062,122.00	

Figure 9.35: Conditional formatting automatically applies designated formatting to values that meet a certain criterion. The Conditional Formatting drop-down menu lists several commonly used choices. (Used with permission from Microsoft)

(a) Cells (2500, 3000) highlighted Red Fill with Dark Red Text (Figure 9.36: (a) The dialog box allows you to set the parameters. (b) There are numerous preset conditional formatting choices. (Used with permission from Microsoft)

Real-World Application - Excel in the Construction Industry

The construction industry in the United States employs nearly ten million people and contributes over $1 trillion to the economy in structures built each year.[1] Excel can manage all the information needed to share among the various entities involved in a construction project. From building a small home garden shed to constructing an office complex, Excel can help manage the overall progress of a construction project. Excel can be helpful when estimating costs for construction projects to submit bids for particular projects. Items that can be summarized, tracked, and analyzed in Excel include order tracking, calculating needed quantities of materials such as lumber or piping, and payroll. Even for the small construction management company, Excel can be used to effectively manage a large construction project to keep the project on time and within budget. There are many templates available to help set up a construction project from start to finish.

What are some other industries where Excel could be a useful tool?

Working with Templates

As in the other Office applications, Excel has built-in and online templates. Microsoft has their own online templates for Office, but many other websites offer free Excel templates. Templates are blank, formatted workbooks that you populate with your own data. Microsoft provides some built-in templates. Figure 9.37 shows the selection of a sales report, which has five sheets. This sales report has an order ledger, called “Sales Data,” with the product name, customer code, and quarterly sales figures. The template comes with a few lines of generic data. The other sheets use the data you enter on the first sheet. The second sheet uses the sales data but organizes it by product. The third sheet organizes the same data by customer. The fourth sheet filters the data to show the top 10 products, and the fifth sheet filters the data to show the top 10 customers. You should be able to find a similar template in your version of Excel, but there are many other sales reports templates available. The template library is frequently updated by Microsoft, so the versions you see might look a bit different than what we have shown here. The functionality will be similar, but the colors and the layout could vary.

Sales Report
Company Name

By Product | By Customer | Top 10 Products | Top 10 Customers

Product	Customer	Qtr 1	Qtr 2	Qtr 3	Qtr 4
Alice Mutton	ANTON	$ -	$ 702.00	$ -	$ -
Alice Mutton	BERGS	$ 312.00	$ -	$ -	$ -
Alice Mutton	BOLID	$ -	$ -	$ -	$ 1,170.0
Alice Mutton	BOTTM	$ 1,170.00	$ -	$ -	$ -
Alice Mutton	ERNSH	$ 1,123.20	$ -	$ -	$ 2,607.1
Alice Mutton	GODOS	$ -	$ 280.80	$ -	$ -
Alice Mutton	HUNGC	$ 62.40	$ -	$ -	$ -
Alice Mutton	PICCO	$ -	$ 1,560.00	$ 936.00	$ -
Alice Mutton	RATTC	$ -	$ 592.80	$ -	$ -
Alice Mutton	REGGC	$ -	$ -	$ -	$ 741.0
Alice Mutton	SAVEA	$ -	$ -	$ 3,900.00	$ 789.7
Alice Mutton	SEVES	$ -	$ 877.50	$ -	$ -

Sales Data | By Product | By Customer | Top 10 Products | Top 10 Customers

Figure 9.37: Templates are preformatted and predesigned tables. You can find the templates by clicking on File and New. A sales report has formatting and formulas preset so that all you need to do is enter your data. (Used with permission from Microsoft)

Figure 9.38 shows a product price list downloaded from http://templates.office.com that has columns for a product inventory number, product name, product description, retail price, and volume-selling price. This sort of price list is an information sheet for potential business clients who are considering products from you. These templates are modifiable, so you can update the header with your company's information. You can also add more products or change the headers.

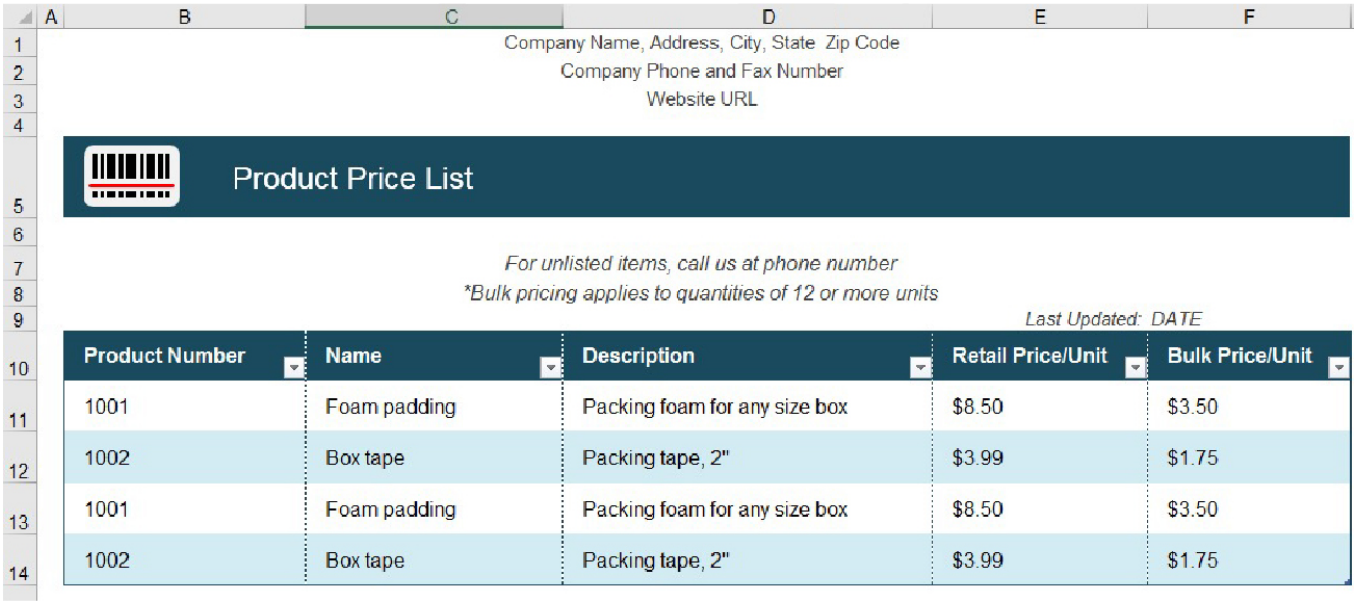


Figure 9.38: Although templates come with their own formatting, you can customize them based on your needs. (Used with permission from Microsoft)

Spotlight on Ethics - Ethical Considerations in Using Templates

Templates are a wonderful resource and can save time and money in creating spreadsheets and workbooks in Excel. Templates can come with preset formatting and formulas, with little more to do than enter your own data. There are many templates available online, but you must choose one carefully. You will need to consider the purpose of the template you are using, company policy regarding branding, the version of the software you are using, as well as copyright and licensing of the template itself prior to using it for business purposes. For instance, perhaps you are using a template to create an invoice to provide clients. The template may hold a license that allows you to use the template for commercial use so long as you do not resell the template itself, or the license might prohibit commercial use altogether, restricting its use to nonprofit activities only. If that is the case, you should not use the template for business purposes as it may place the business at risk of litigation. It is always best to carefully read the user agreement and license of a template prior to implementing it.

Where might you find a template's licensing and permissible usage information? How can you be sure you are permitted to use a template in the manner in which you intend?

Footnotes

- 1Ken Simonson. "Construction Data." *Associated General Contractors of America*.

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2.2: Formatting and Templates in Google Sheets

Learning Objectives

By the end of this section, you will be able to:

- Format and manipulate a cell or group of cells
- Design column and row header
- Use conditional formatting
- Work with templates to format worksheets

Google Sheets has the same formatting features that Microsoft Excel does. The cell formatting of fonts and shading of cells is part of everyday use when making headers. Text wrapping is also a feature in Sheets. Like Excel, there are numerous Sheets templates available online and within the application. All of these features make Sheets a valuable spreadsheet application for WorldCorp.

Formatting Cells

Sheets has the same functionality for formatting cells as Excel does. For example, you can use contrasting color combinations to make text easier to read. The main difference in formatting cells between Sheets and Excel is the location of the tools.

Using Color and Fonts

The tables in Figure 9.57 have the standard blue headers we've been using. Starting with these tables, we will apply formatting changes. First, let's change the font of the headers and the body of the tables. Click on the header row and choose Courier New from the Font drop-down box (Figure 9.71a). Next, change the color of the font. Since the headers are still selected after the font change, go to the action bar and click on the Text color command. Select dark orange (last option in the third column from the left) as the text color. You can then change the background color to a lighter blue using the Fill color command on the action bar (Figure 9.71b). In this case, changing the color of the background or the color of the font can make the column headers stand out more and is more visually appealing.

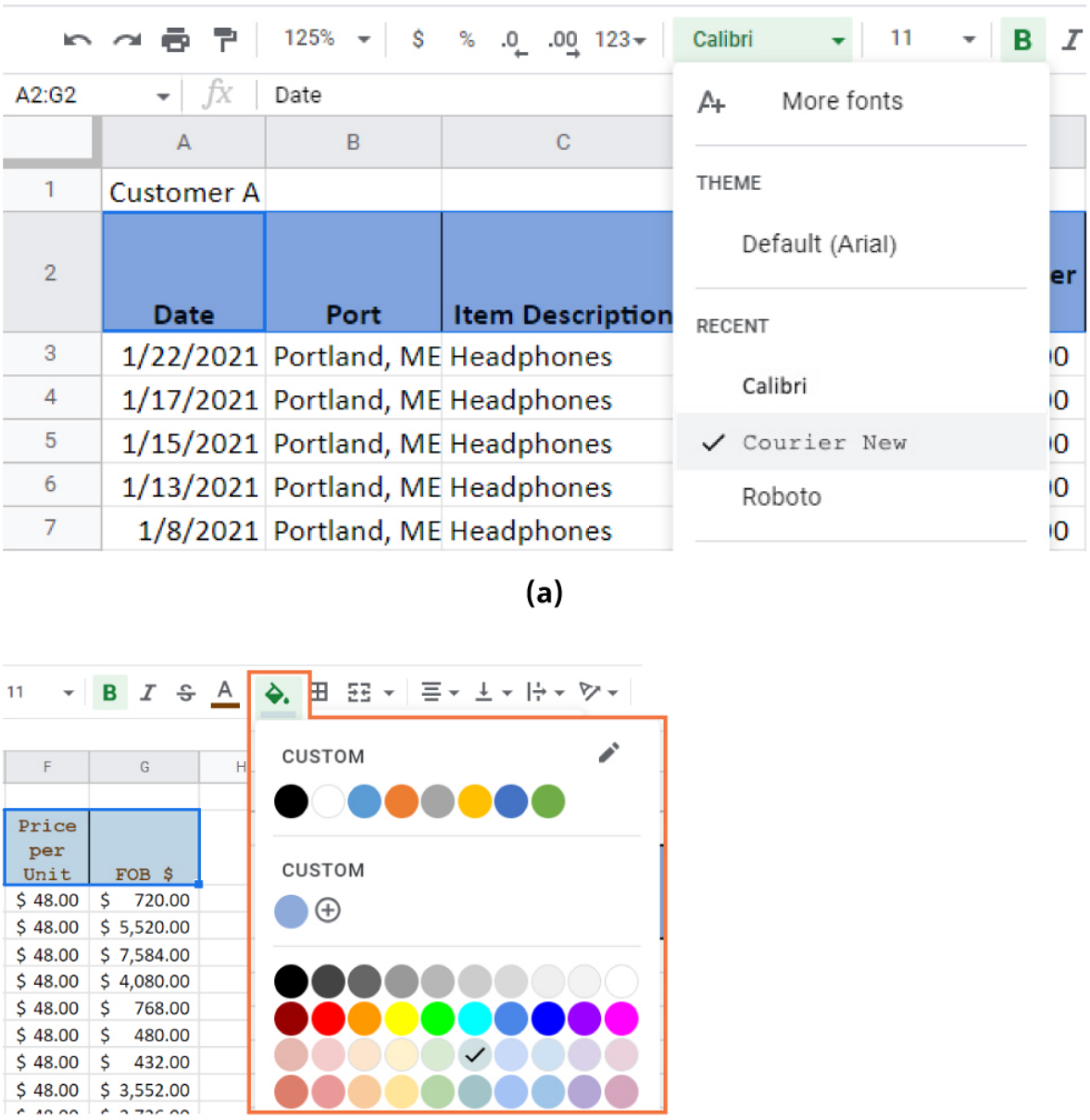


Figure 9.71: In Sheets, you can format headers by (a) changing the font, changing the color of the font, and (b) changing the cell background color, just as in Excel. (Google Sheets is a trademark of Google LLC.)

Borders

The Borders command lets users modify the borders on each cell. Using the same table, let's change the thickness of the borders around the headers to differentiate them from the body. You will also add an outside border for the body of the table. First, select the headers and click on the Borders command on the action bar, then click on the Border style drop-down menu and select the third thickest (Figure 9.72a). To apply the thicker border, click on the command for All borders (Figure 9.72b).

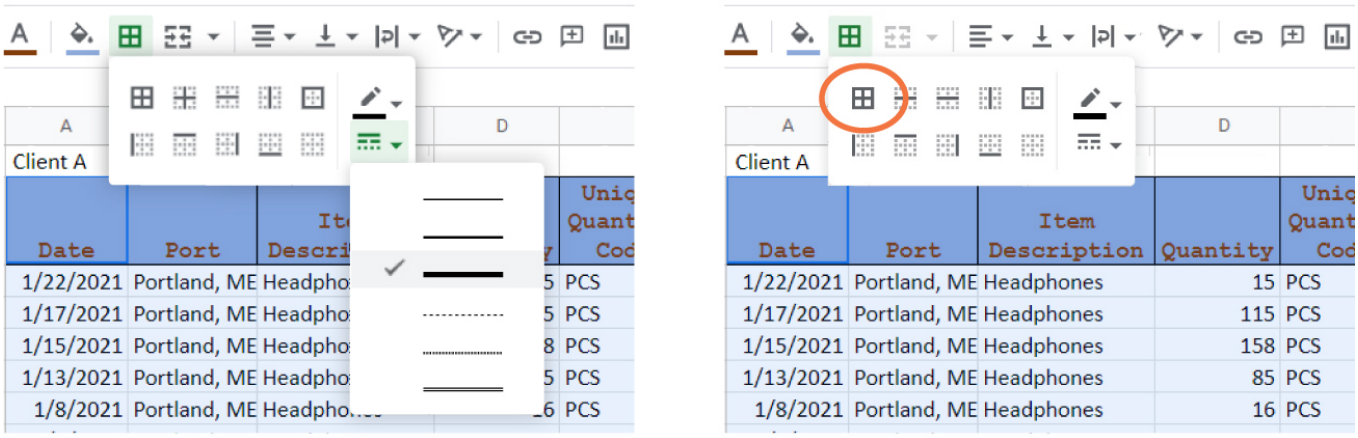
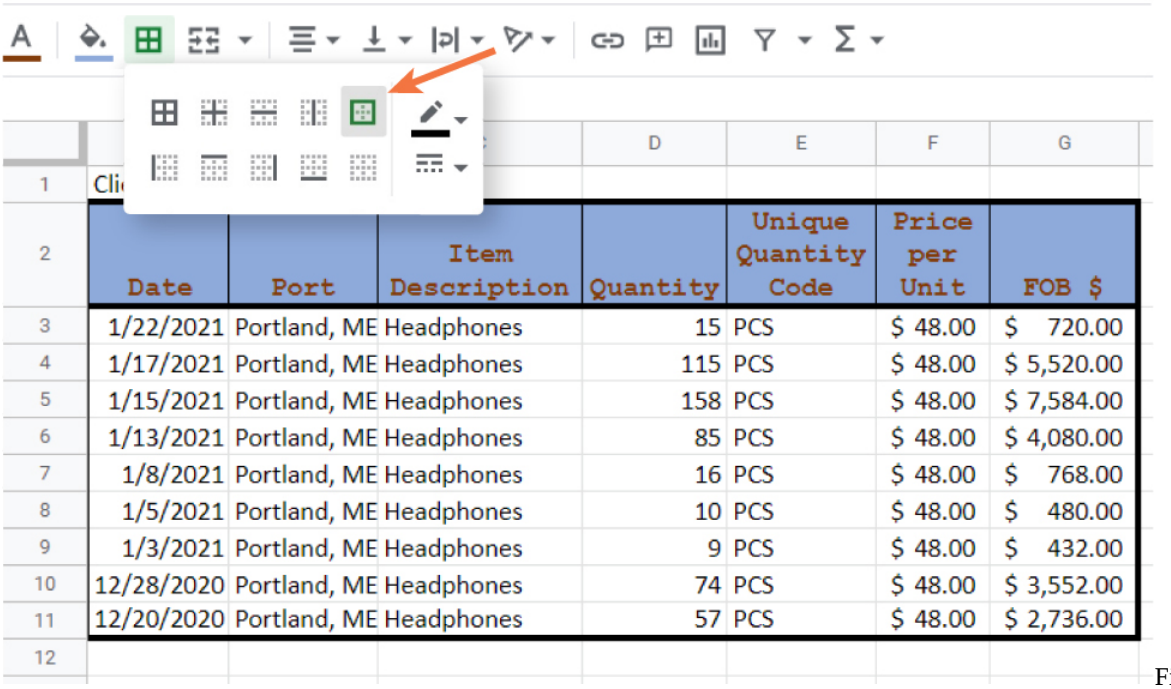


Figure 9.72: You can change the borders from the action bar. Click on the Borders command and choose Border style. (a) There are several border styles to choose from in the list. (b) After choosing the style, apply it to all borders. (Google Sheets is a trademark of Google LLC.)

For the border around the table body, repeat the same first step, selecting the third thickest. Then, instead of applying it to all borders, choose the Outer borders option (Figure 9.73).

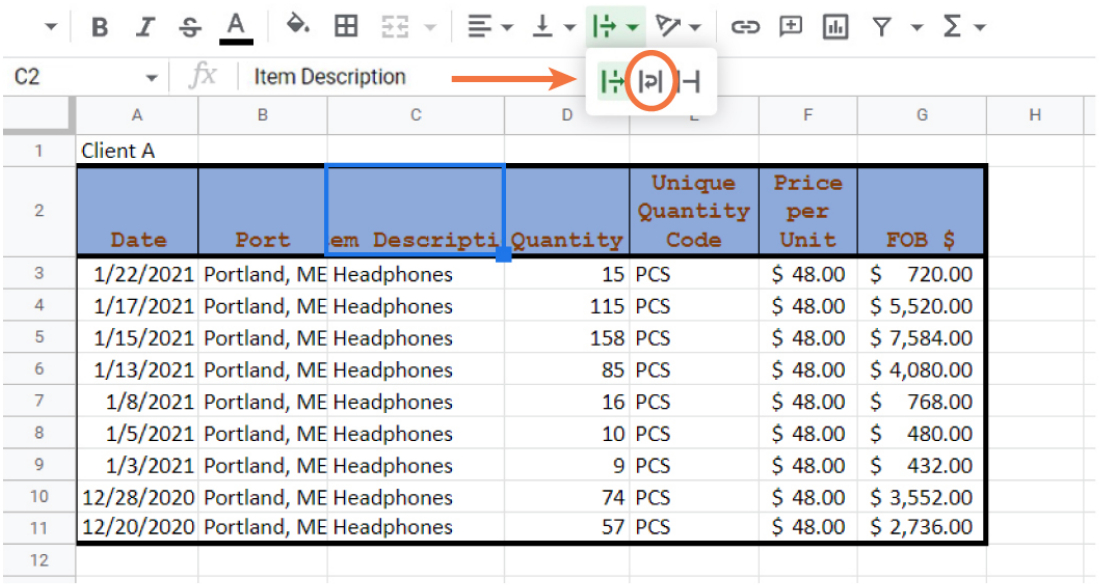


Date	Port	Item Description	Quantity	Unique Quantity Code	Price per Unit	FOB $
1/22/2021	Portland, ME	Headphones	15	PCS	$ 48.00	$ 720.00
1/17/2021	Portland, ME	Headphones	115	PCS	$ 48.00	$ 5,520.00
1/15/2021	Portland, ME	Headphones	158	PCS	$ 48.00	$ 7,584.00
1/13/2021	Portland, ME	Headphones	85	PCS	$ 48.00	$ 4,080.00
1/8/2021	Portland, ME	Headphones	16	PCS	$ 48.00	$ 768.00
1/5/2021	Portland, ME	Headphones	10	PCS	$ 48.00	$ 480.00
1/3/2021	Portland, ME	Headphones	9	PCS	$ 48.00	$ 432.00
12/28/2020	Portland, ME	Headphones	74	PCS	$ 48.00	$ 3,552.00
12/20/2020	Portland, ME	Headphones	57	PCS	$ 48.00	$ 2,736.00

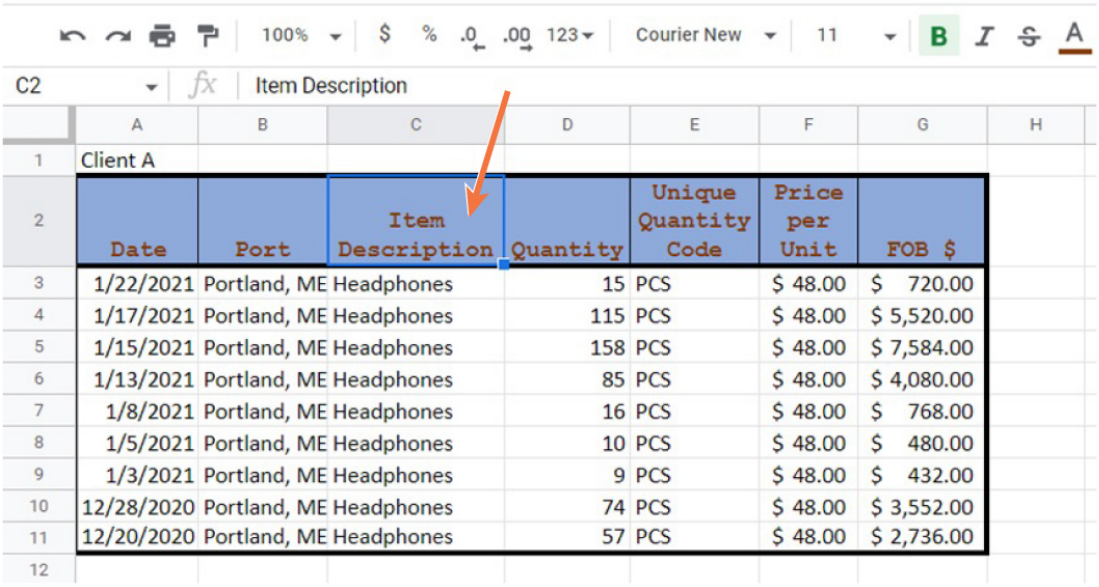
Figure 9.73: The header borders are formatted, and the same styling can be used to add a border to the outside of the table. Click on the Borders command, choose the border style, and then apply it to the outer borders. The final table looks neat and professional with borders. (Google Sheets is a trademark of Google LLC.)

Wrapping Text

You may have noticed that because you changed the font, the header in column C does not fit the width of the column. This is easily fixed by using the Text wrapping command on the action bar. First, select cell C2, then click the Text wrapping command, and select the middle command for Wrap (Figure 9.74a). Now all of the text is visible, as seen in Figure 9.74b. If the text is still a little tight, widen the column slightly by hovering over the edge of the column until the cursor changes to a double arrow, then drag the edge of the column to the right to accommodate the text.



(a)



(b)

Figure 9.74: When the text does not fit in a cell, one option is to wrap the text. (a) Select the cell and use the Wrap command. (b) The text should automatically fit in the cell. (Google Sheets is a trademark of Google LLC.)

Merging Cells

As with Excel, Sheets allows cell merging. This enables information to be grouped to make it more readable for the user. For example, the Merge cells command could group sales agents by region. To use this function, first select the cells you would like to merge. Then, use the Merge cells tool in the action bar, as shown in Figure 9.75. You have several options with the tool: Merge all, Merge vertically (working with rows), Merge horizontally (working with columns), and Unmerge.

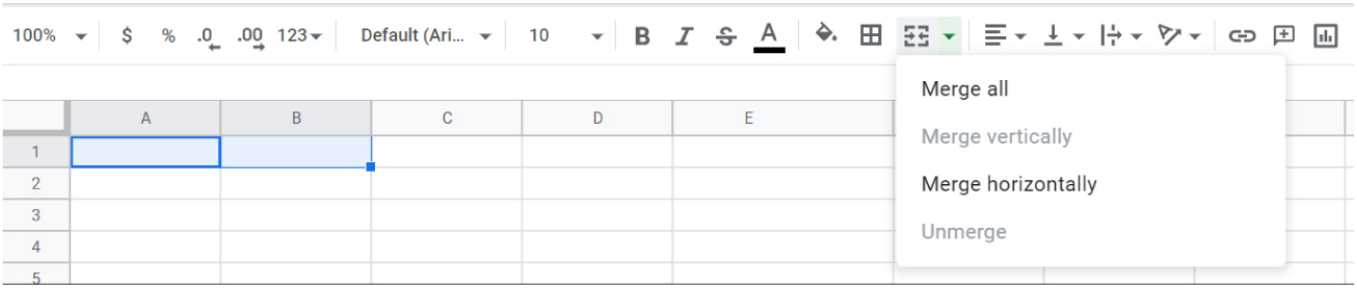
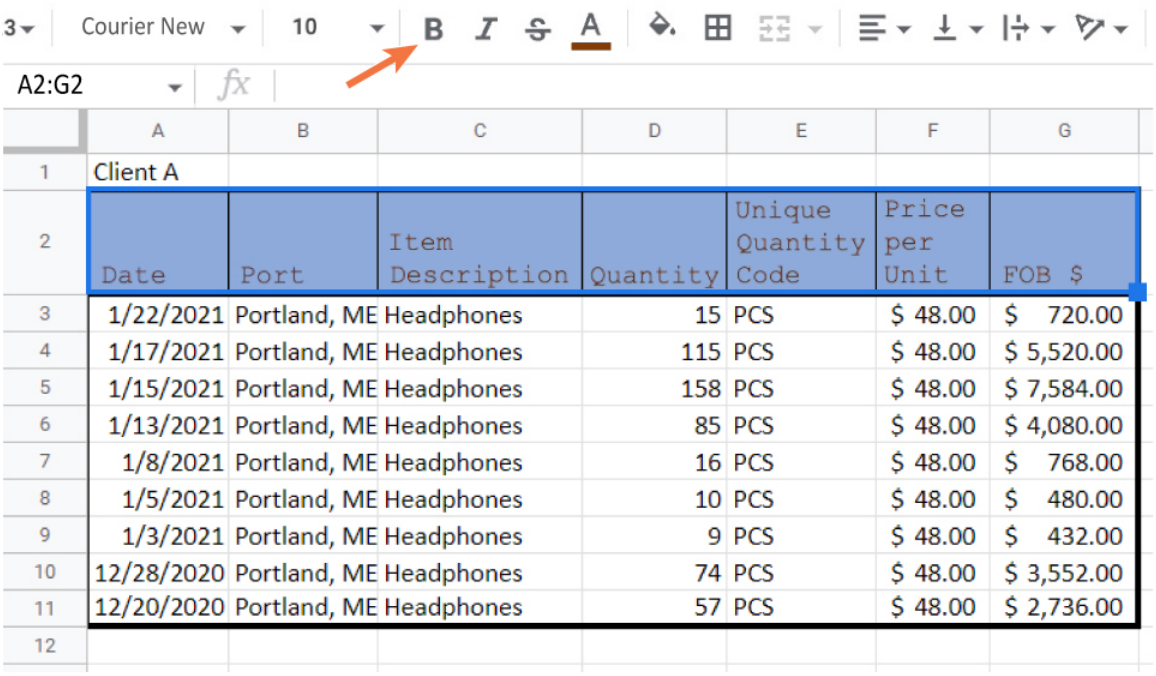


Figure 9.75: The Merge cells tool is found on the action bar. First, select the cells to be merged, then select the Merge cells tool. (Google Sheets is a trademark of Google LLC.)

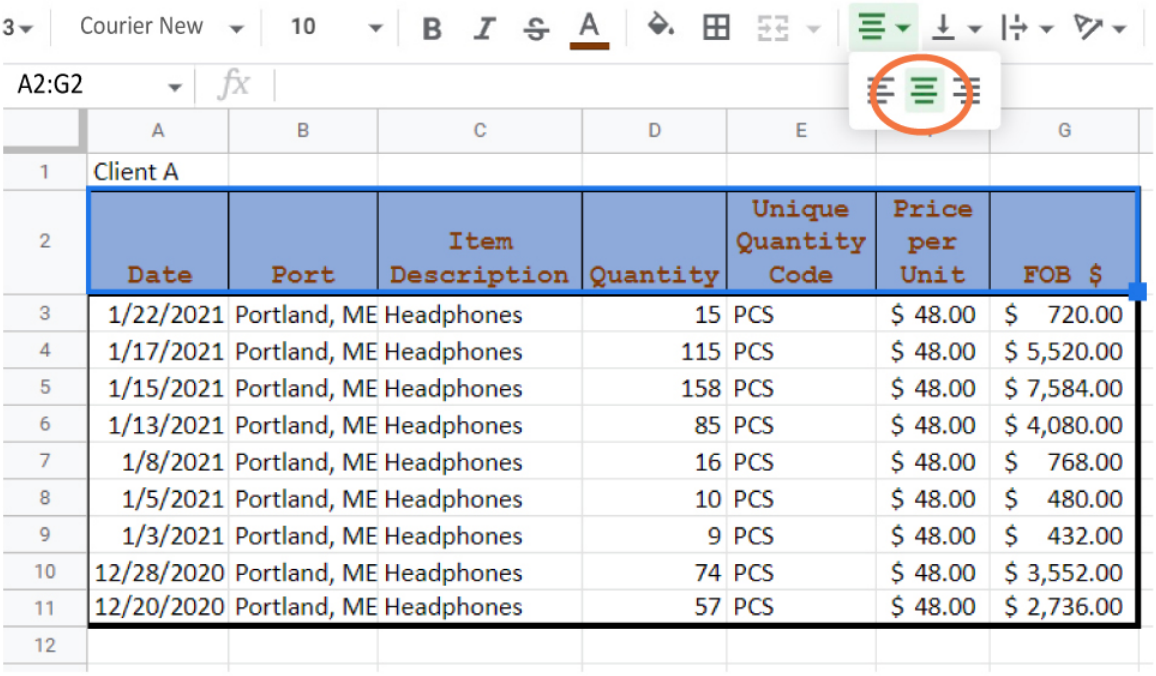
Designing Column and Row Headers

You have learned how to change the font, font color, background color, and width for header styling. Header text can be bolded and centered to make them easier to read, and background colors can be applied and changed. Figure 9.76 shows the formatting applied to cell B2 in the header. The font is bold and the text is centered.



	A	B	C	D	E	F	G
1	Client A						
2	Date	Port	Item Description	Quantity	Unique Quantity Code	Price per Unit	FOB $
3	1/22/2021	Portland, ME	Headphones	15	PCS	$ 48.00	$ 720.00
4	1/17/2021	Portland, ME	Headphones	115	PCS	$ 48.00	$ 5,520.00
5	1/15/2021	Portland, ME	Headphones	158	PCS	$ 48.00	$ 7,584.00
6	1/13/2021	Portland, ME	Headphones	85	PCS	$ 48.00	$ 4,080.00
7	1/8/2021	Portland, ME	Headphones	16	PCS	$ 48.00	$ 768.00
8	1/5/2021	Portland, ME	Headphones	10	PCS	$ 48.00	$ 480.00
9	1/3/2021	Portland, ME	Headphones	9	PCS	$ 48.00	$ 432.00
10	12/28/2020	Portland, ME	Headphones	74	PCS	$ 48.00	$ 3,552.00
11	12/20/2020	Portland, ME	Headphones	57	PCS	$ 48.00	$ 2,736.00
12							

(a)



	A	B	C	D	E	G
1	Client A					
2	Date	Port	Item Description	Quantity	Unique Quantity Code	Price per Unit	FOB $
3	1/22/2021	Portland, ME	Headphones	15	PCS	$ 48.00	$ 720.00
4	1/17/2021	Portland, ME	Headphones	115	PCS	$ 48.00	$ 5,520.00
5	1/15/2021	Portland, ME	Headphones	158	PCS	$ 48.00	$ 7,584.00
6	1/13/2021	Portland, ME	Headphones	85	PCS	$ 48.00	$ 4,080.00
7	1/8/2021	Portland, ME	Headphones	16	PCS	$ 48.00	$ 768.00
8	1/5/2021	Portland, ME	Headphones	10	PCS	$ 48.00	$ 480.00
9	1/3/2021	Portland, ME	Headphones	9	PCS	$ 48.00	$ 432.00
10	12/28/2020	Portland, ME	Headphones	74	PCS	$ 48.00	$ 3,552.00
11	12/20/2020	Portland, ME	Headphones	57	PCS	$ 48.00	$ 2,736.00
12							

(b)

Figure 9.76: Most professionally designed tables (a) use bold font on the headers and (b) are center aligned. (Google Sheets is a trademark of Google LLC.)

Freezing Columns and Rows

Freezing columns and rows is useful when the data in your sheet does not fit the available viewing space. In Sheets, you can freeze panes anywhere in the worksheet, but it's certainly most useful to freeze column and row headers. First, select the row that you

want to freeze, then select Freeze from the View menu and choose Up to current row. Sheets freezes that row and all rows above it, as shown in Figure 9.77.

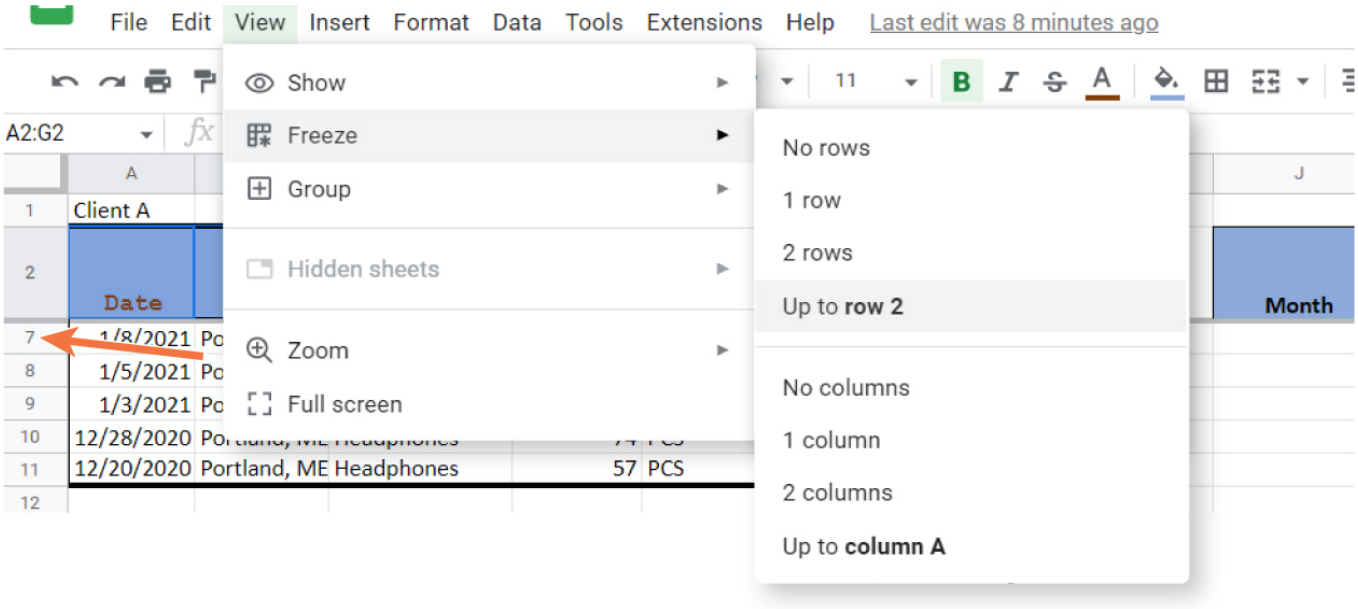
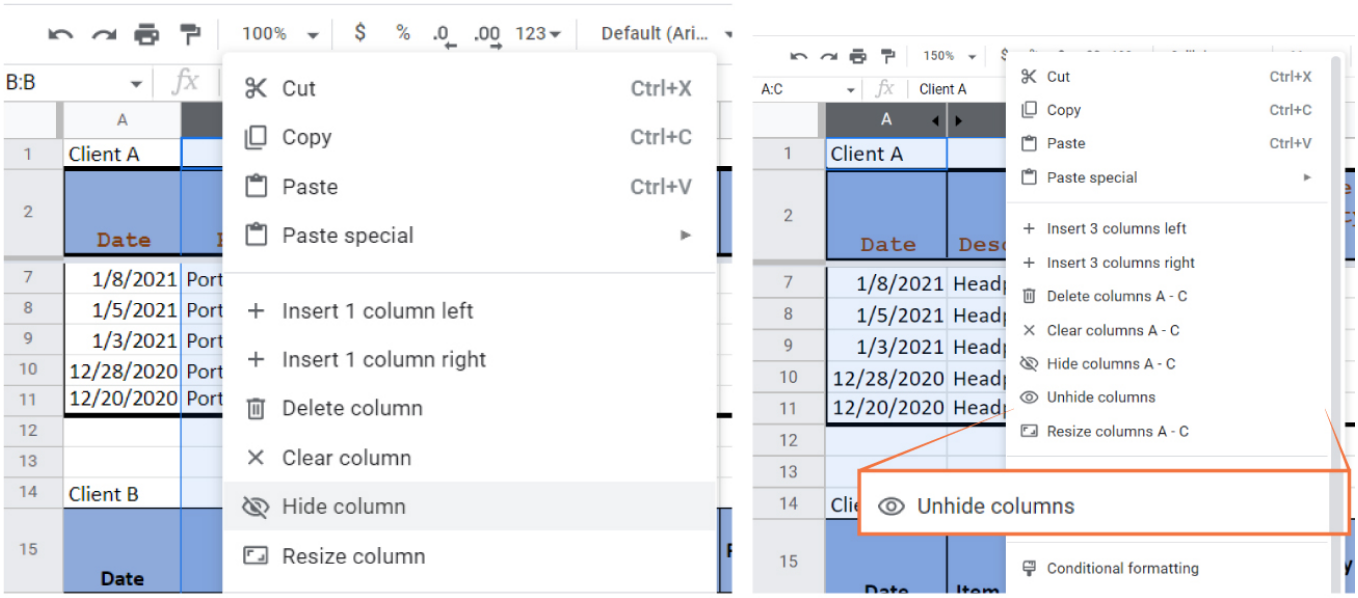


Figure 9.77: You can freeze panes anywhere on a sheet. Click on the row that you want to freeze and freeze up to that row. That row freezes, and you can scroll through the data below it. (Google Sheets is a trademark of Google LLC.)

Hiding Columns and Rows

Sheets also supports hiding columns and rows. Select the row or column you want to hide. Right-click and then click on Hide row or Hide column (Figure 9.78a). To unhide it, select the two on either side of the hidden row or column, right-click and click on Unhide rows or Unhide columns (Figure 9.78b), or click on one of the two small arrows in the header.



(a) (b)

Figure 9.78: Hiding and unhiding columns in Sheets is similar to the process in Excel. (a) Select the column you want to hide, right-click, and click on Hide column. (b) To unhide, select the columns on either side of the hidden column, right-click, and click on Unhide columns. (Google Sheets is a trademark of Google LLC.)

Conditional Formatting

Conditional formatting allows us to apply preset formatting to data that meets certain criteria. You can find the conditional formatting feature in Sheets on the Format menu (Figure 9.79). First, select the cells to format, and then choose the conditional formatting feature. A sidebar opens where you can set up the conditional formatting. In this example, the conditions are set so that Sheets will highlight in the default color any cells in the range G2:G11 that have values greater than 999. The table updates instantly (Figure 9.80).

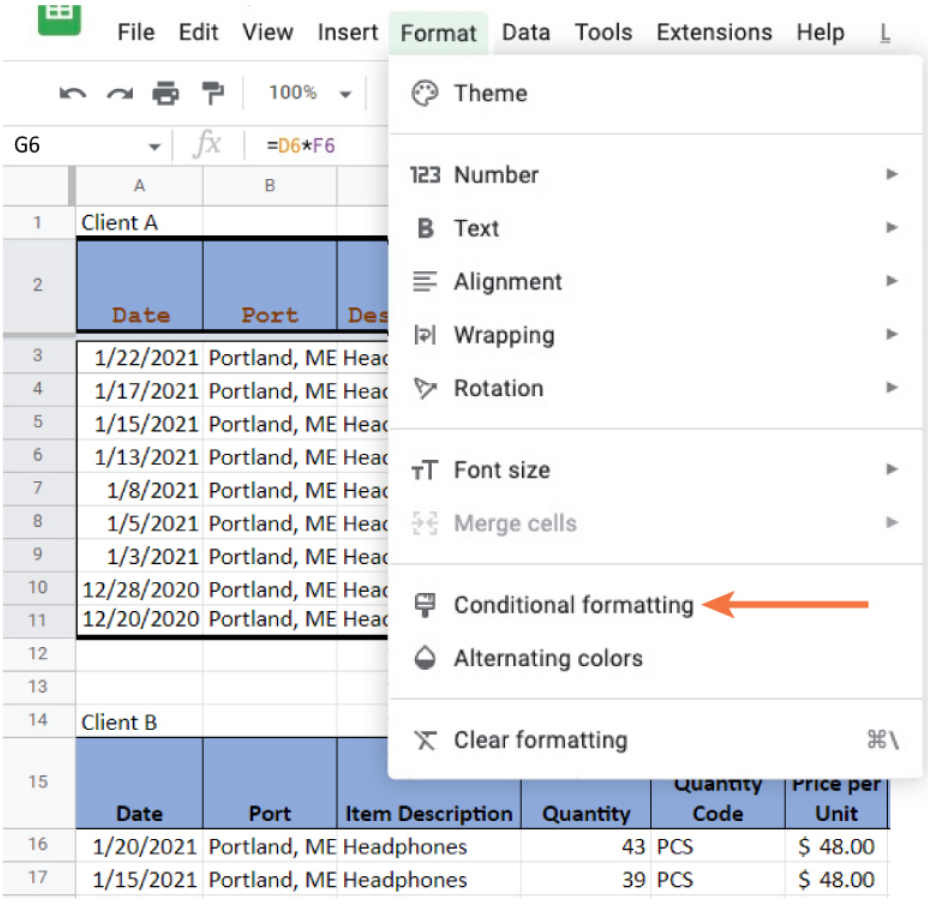


Figure 9.79: In Sheets, you can set up conditional formatting as in Excel. Conditional formatting is in the Format menu. The sidebar opens up to set the criteria. (Google Sheets is a trademark of Google LLC.)

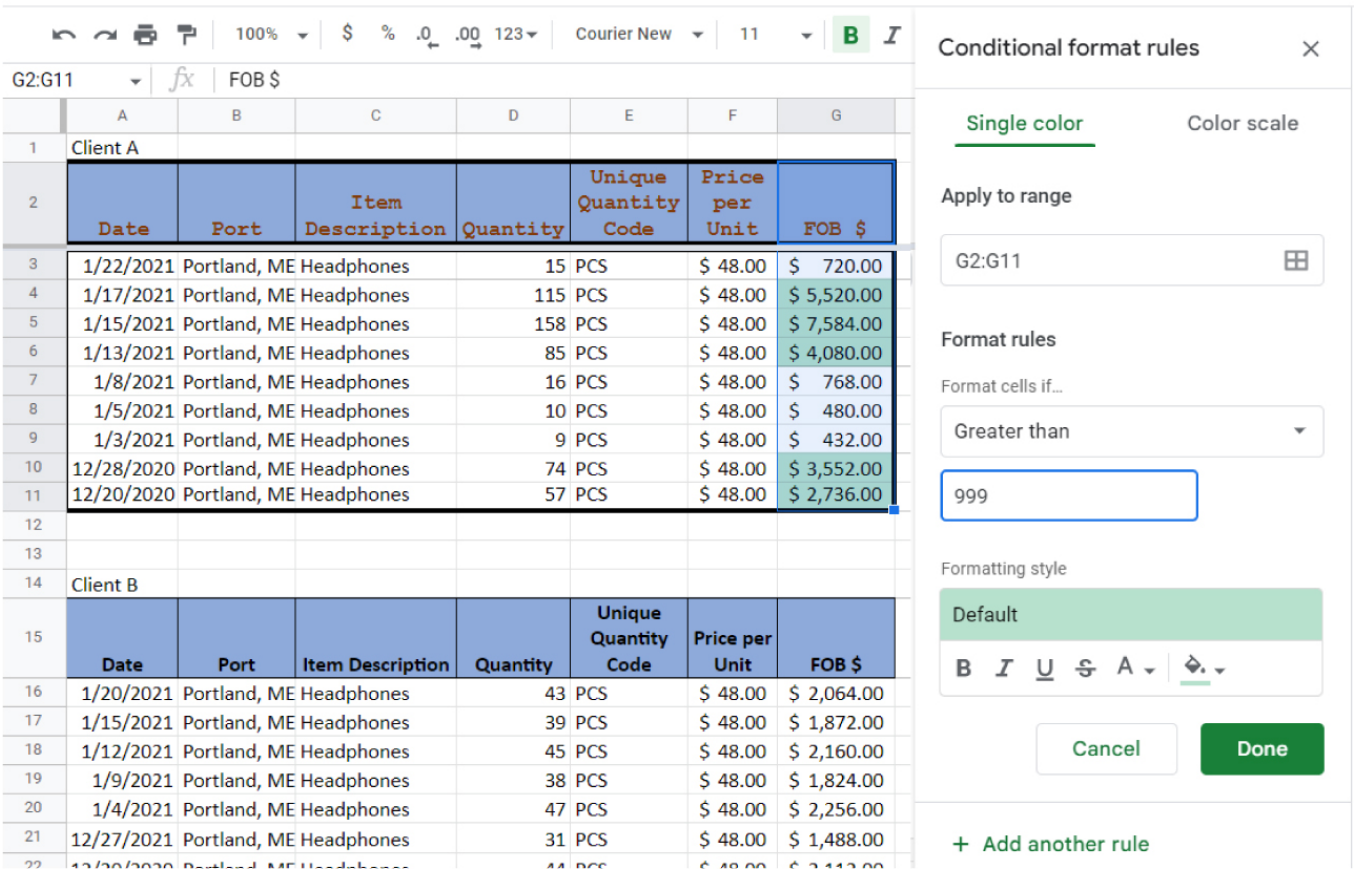


Figure 9.80: When the criteria are set, the table instantly updates. (Google Sheets is a trademark of Google LLC.)

Working with Templates

Sheets offers many templates on the Welcome screen (Figure 9.81). If you do not find what you are looking for in this screen, you can search for other online templates, but you have to use certain criteria. You need to use the Google search engine, and type "X template site:https://docs.google.com." For example, if you are looking for business budget reports, you would type "business budget report template site:https://docs.google.com." Searching in this manner will give you results from other Google Docs users' Google Drive accounts, meaning that they are sharing their templates with other users and they are available for use and not protected or restricted. This also means that the templates have been formatted for Sheets and not for Excel. In some cases, importing Excel files into Sheets can alter the formatting.

When you find the one you want to use, click on it, and a little ball will appear in the middle while you wait for the document to open. You can then edit the document that was generated using the template to customize it for your needs (Figure 9.82).

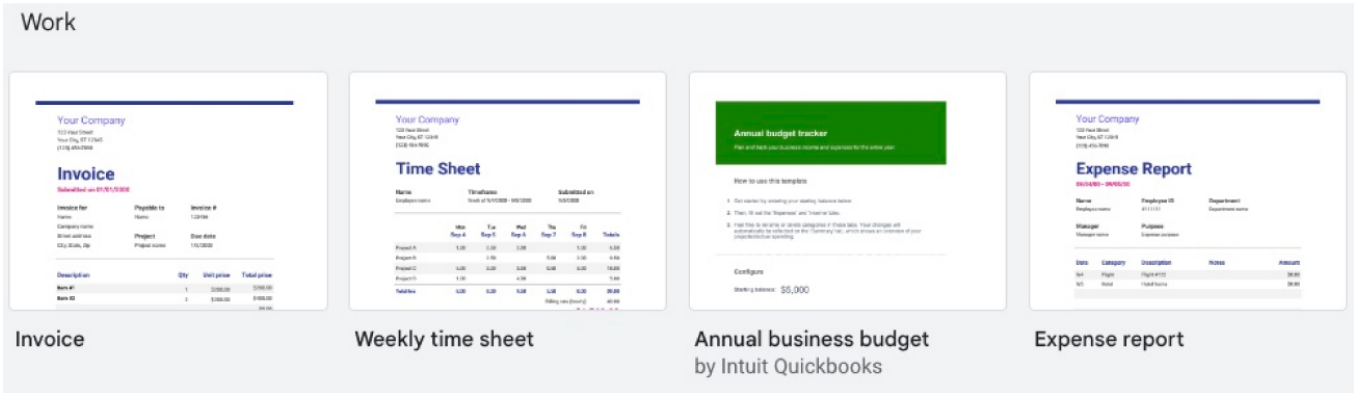


Figure 9.81: Sheets templates are available on the Welcome screen. (Google Sheets is a trademark of Google LLC.)

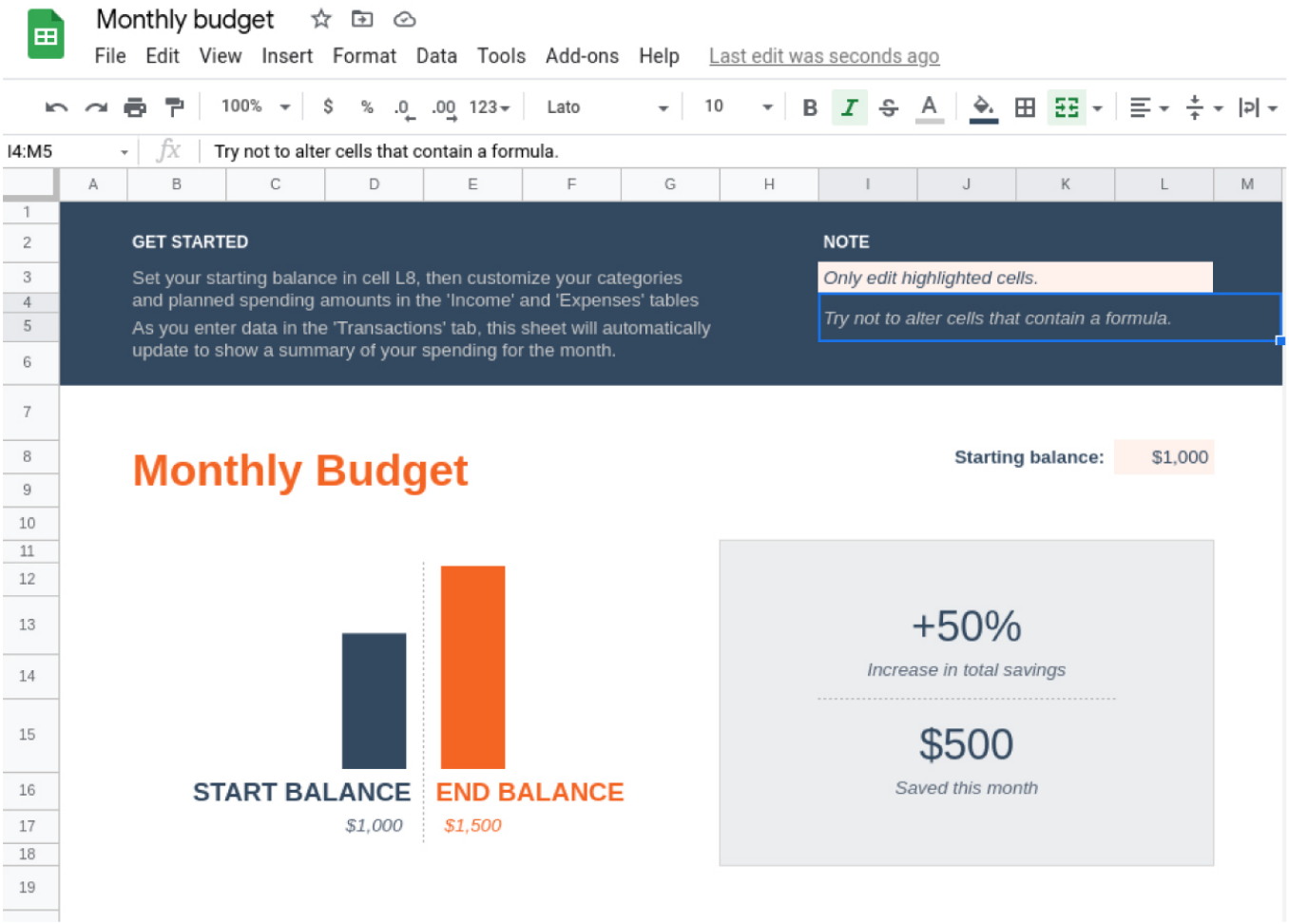


Figure 9.82: Sheet templates are also available online from other users. (Google Sheets is a trademark of Google LLC.)

Link to Learning

It is not always easy to present data in an appealing and interesting way. Following a few simple steps and best practices in formatting Sheets can ensure you are able to get your message across, while also engaging your audience. Check out these best practices for presenting data to learn more.

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CHAPTER OVERVIEW

3: Hands on exercises for spreadsheet functions

3.1: Essential Spreadsheet functions for Engineers

3.2: Intermediate Spreadsheet functions for Engineers

3.3: Advanced Functions Overview

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3.1: Essential Spreadsheet functions for Engineers

By the end of this tutorial, you will be able to:

- Apply professional formatting to make spreadsheets readable and organized
- Create dropdown menus for controlled data entry
- Perform basic mathematical operations using cell references
- Use rounding functions to control decimal precision
- Build IF statements for conditional logic
- Apply SUM functions for automatic calculations
- Combine multiple functions to create automated scoring systems

Understanding the Scenario

You're creating a digital scoring system for an engineering student contest at NC State. Students earn points in four categories, and your spreadsheet will automatically calculate their total score and determine if they win a T-shirt or consolation prize.

Scoring Rules:

- **Completed Credit Hours:** >60 credits = 2 points, ≤60 credits = 0 points
- **Current Semester Load:** Total credits ÷ 6, rounded to nearest whole number
- **Club Participation:** 0.5 points per club
- **Professor Office Hours:** Know ≥1 professor's office hours = 2 points, otherwise 0 points
- **Prize Threshold:** ≥4 total points = T-shirt, <4 points = consolation prize

Part 1: Setting Up Your Workspace and Basic Formatting

Understanding Spreadsheet Structure

Rows: Numbered horizontally (1, 2, 3, 4...)
Columns: Lettered vertically (A, B, C... Z, AA, AB...)
Cells: Individual boxes identified by column + row (A1, B2, C3...)

Definition: Cells

Cells can be formatted in many ways:

- **Changing text size** for readability (Figure 1, section 1)
- **Changing colors for better organization** (Figure 1, section 2)
- **Changing border color and thickness** to define sections (Figure 1, section 3)
- **Merging** cells to combine content (Figure 1, section 4)
- **Text rotation** to adjust orientation (Figure 1, section 4)
- **Text wrapping** to display long content neatly (Figure 1, section 4)
- **Vertical alignment** for better positioning (Figure 1, section 4)

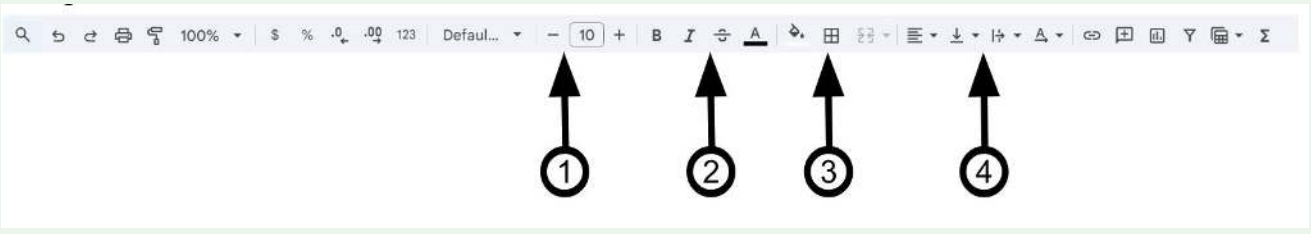


Figure 1. Formatting tools in the Google Sheets taskbar. The text size (1) can be adjusted directly from the taskbar. Various text formatting options (2), such as bold, italics, and strike through, are also available. The toolbar includes cell formatting options (3), allowing users to modify borders, change background colors, and merge cells. On the right side of the taskbar, advanced text options (4) enable users to adjust text wrapping, alignment, and angle for improved readability.

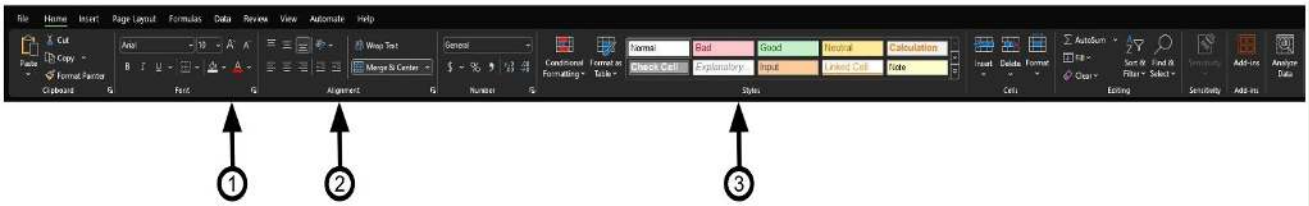


Figure 2. The Microsoft Excel taskbar. The taskbar allows users to modify text and cell formatting (1), such as font style and cell color. It also provides options to adjust text alignment (2) for improved readability and apply document styles (3) for a consistent appearance.

Step-by-Step: Creating the Contest Scorer Layout

1. **Open your spreadsheet software** (Excel or Google Sheets)
2. **Create the header section:**
   - **Click on cell A1**
   - **Type:** `NC State Engineering Contest Scorer`
3. **Merge cells for a professional header:**

In Google Sheets:

   - **Select cells A1 through E1** (click A1, hold Shift, click E1)
   - **Go to Format menu → Merge cells → Merge horizontally**

In Excel:

   - **Select cells A1 through E1**
   - **Go to Home tab → Merge & Center** button
4. **Format the header:**
   - **With A1 still selected, increase font size:**
     - Google Sheets: Click font size dropdown → Select **14** or **16**
     - Excel: Click font size dropdown → Select **14** or **16**
   - **Make it bold:** Click the **B** button
   - **Center the text:** Click center alignment button

Creating the Data Entry Structure

5. **Set up category labels in row 3:**
   - **A2:** `Student Name`
   - **B2:** `Completed Credits`
   - **C2:** `Current Semester Credits`
   - **D2:** `Number of Clubs`
   - **E2:** `Knows Office Hours?`
6. **Format the category headers:**
   - **Select cells A3:E3**
   - **Make bold** (click B button)
   - **Add background color:**
     - Google Sheets: Click fill color icon → Choose light blue or gray
     - Excel: Click fill color dropdown → Choose light blue or gray
7. **Adjust column widths for readability:**
   - **Hover over the line between column headers** (e.g., between A and B)
   - **When cursor changes to resize arrow, drag** to make columns wider
   - **Make columns wide enough** to see full category names

✅ **Check Your Progress:** You should now have a professional-looking header and clearly labeled categories.

Example 3.1.1

	A	B	C	D	E
1	NC State Engineering Contest Scorer				
2	**Student Name**	**Completed Credits**	**Current Semester Credits**	**Number of Clubs**	**Knows Office Hours?**
3					

Figure 3. Scorer after applying formatting modifications

Part 2: Creating Dropdown Menus

Why Use Dropdowns?

Dropdowns prevent typing errors and ensure consistent data entry. For "yes/no" questions, they eliminate variations like "Y," "YES," "yes," "Yeah," etc.

Step-by-Step: Creating a Yes/No Dropdown

1. **Click on cell E3** (under "Knows Office Hours?")

In Google Sheets:

2. **Go to Insert menu → Dropdown**
3. **In the dropdown options panel** (appears on right):
   - **First option:** Type `Yes`
   - **Click "Add item"**
   - **Second option:** Type `No`
4. **Click "Done"**

In Excel:

2. **Go to Data tab → Data Validation**
3. **In the "Allow" dropdown:** Select **List**
4. **In the "Source" field:** Type `Yes,No` (exactly like this, with comma)
5. **Click OK**

Testing Your Dropdown

Click on cell E3 and verify you see a dropdown arrow. Click it to confirm "Yes" and "No" options appear.

Example 3.1.1

In this example, the dropdown menu in the **Simple Scorer** reflects the binary nature of the office hours question—students either **know** or **don't know**.

Solution

	A	B	C	D	E	F
1	NC State Engineering Contest Scorer					
2	**Student Name**	**Completed Credits**	**Current Semester Credits**	**Number of Clubs**	**Knows Office Hours?**	
3						
4						
5						
6						
7						
8						

Figure 4. The image shows a dropdown menu within a simple scorer. The cell designated for the dropdown is highlighted in blue, while the menu used to add options is highlighted in green. In Google Sheets, dropdowns are created through the "Insert" menu, while in Microsoft Excel, they are set up using the "Data Validation" tool.

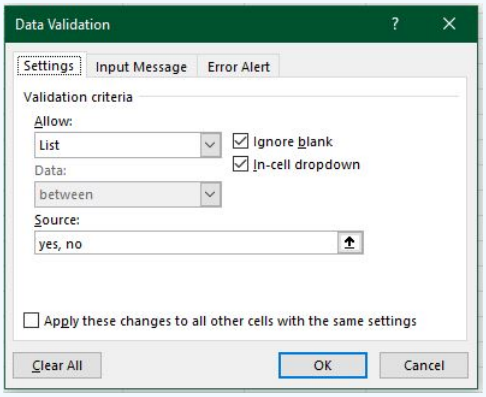


Figure 5. The data validation menu in Microsoft Excel is configured to allow only "Yes" or "No" responses, ensuring consistent and controlled data entry.

Part 3: Basic Mathematical Operations

Understanding Formula Basics

Key Rule: All formulas start with an equals sign (=)
Cell References: Use cell addresses (like B4) instead of typing numbers
Basic Operators: + (add), - (subtract), * (multiply), / (divide)

Step-by-Step: Setting Up Sample Data

First, let's add a sample student to practice with:

1. **Enter sample data in row 3:**
   - **A3:** `Alex Johnson`
   - **B3:** `75` (completed credits)
   - **C3:** `18` (current semester credits)
   - **D3:** `3` (number of clubs)
   - **E3:** Select `Yes` from dropdown

Creating Score Calculation Columns

2. **Add scoring column headers in row 2:**
   - **F3:** `Credits Score`
   - **G3:** `Semester Score`
   - **H3:** `Club Score`
   - **I3:** `Office Hours Score`
   - **J3:** `Total Score`
   - **K3:** `Prize`
3. **Format these headers** the same way as before (bold, background color).

Example 3.1.1

You can copy the format by selecting on the cell that has the format that you want, and then clicking on  (for google slides) or 

in excel, then select the cells that you want to apply the formatting in.

Solution

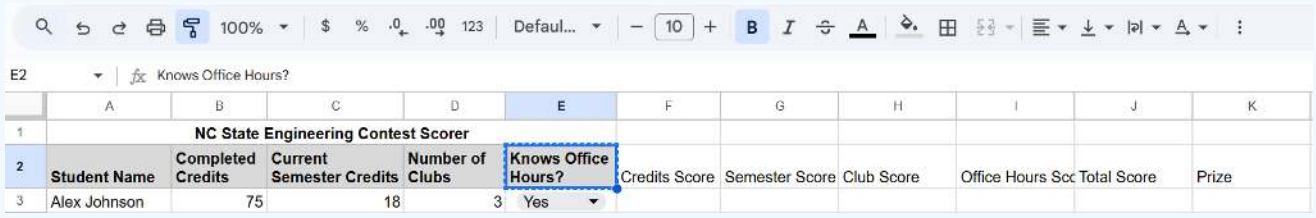


Figure 6. Selecting the cell with the format you want and clicking 

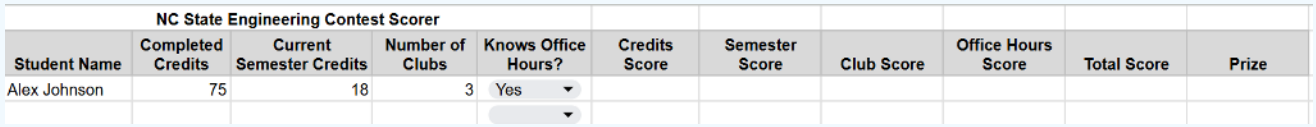


Figure 7. Spreadsheet after you applied the same formatting.

Step-by-Step: Mathematical Formulas

Club Score Calculation (0.5 points per club)

4. **Click on cell H3**
5. **Type this formula exactly:** `=D3*0.5`
6. **Press Enter**

What this does: Takes the number in D3 (number of clubs) and multiplies by 0.5

Expected result: You should see `1.5` (since 3 clubs × 0.5 = 1.5 points)

Understanding Cell Highlighting

When you type `=D3`, notice that:

- **D3 gets highlighted** (usually with a colored border)
- **This shows which cell** the formula references
- **If you reference multiple cells,** each gets a different color

Part 4: Rounding Functions

Understanding Rounding Functions

- **ROUND**: Rounds to a specified number of digits.
- **ROUNDUP**: Rounds up to the nearest integer.
- **ROUNDDOWN**: Rounds down to the nearest integer.

Step-by-Step: Semester Score with Rounding

For the semester score, we divide current credits by 6 and round to the nearest whole number.

1. **Click on cell G3**
2. **Type this formula:** `=ROUND(C3/6,0)`
3. **Press Enter**

Breaking down the formula:

- `C4/6` = 18 ÷ 6 = 3
- `ROUND(...,0)` = round to 0 decimal places (whole number)
- **Result:** 3 points

Testing Different Rounding Functions

4. **Try these in empty cells to see the difference:**
   - **Empty cell:** `=ROUND(2.7,0)` → Result: 3
   - **Another empty cell:** `=ROUNDUP(2.1)` → Result: 3
   - **Another empty cell:** `=ROUNDDOWN(2.9)` → Result: 2

✅ **Understanding Check:** Change C3 to 17 nd watch G4 automatically update. With 17 credits: 17÷6 = 2.83, which rounds to 3.

Part 5: IF Statements - Making Decisions

Understanding IF Statement Logic

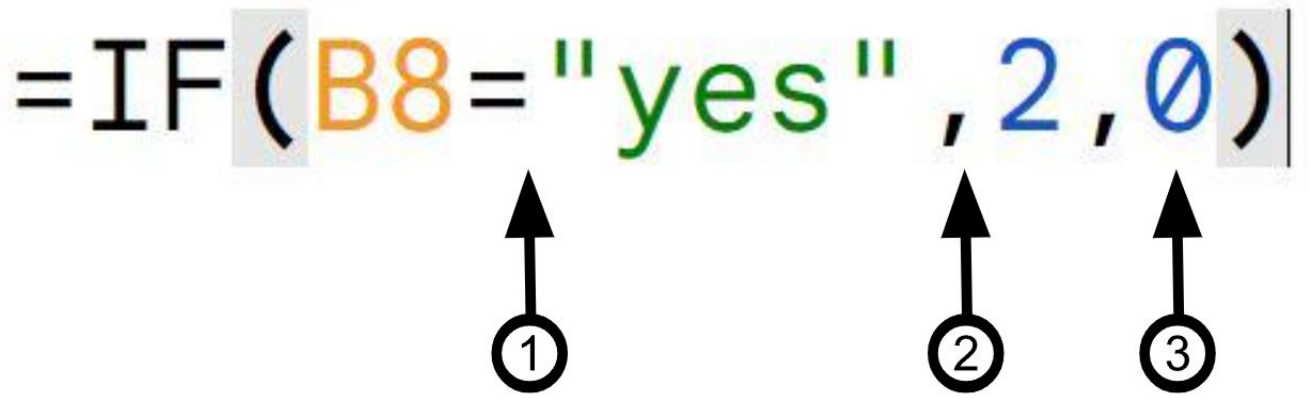


Figure 8. Components of an IF statement in spreadsheet software. The **condition (1)** is the Boolean expression that determines which output is returned and must evaluate to either true or false. The **output if true (2)** specifies the result or operation that occurs when the condition is true. The **output if false (3)** defines what happens when the condition is false and can also be replaced by an ELSE statement, which is covered in intermediate resources.

The condition must be something that's either TRUE or FALSE:

- `B4>60` (is B4 greater than 60?)
- `E4="Yes"` (does E4 exactly equal "Yes"?)
- `A1=A2` (is A1 equal to A2?)

> **Note**
>
> A boolean is something that is either true or false, it is often a comparison between an input value and a reference value

Step-by-Step: Credits Score (IF Statement)

Students get 2 points if they have more than 60 completed credits, otherwise 0 points.

1. **Click on cell F3**
2. **Type this formula exactly:** `=IF(B3>60,2,0)`
3. **Press Enter**

Breaking down the formula:

- **Condition:** `B4>60` (Is the value in B4 greater than 60?)
- **If TRUE:** `2` (award 2 points)
- **If FALSE:** `0` (award 0 points)
- **Since B4 contains 75:** 75 > 60 is TRUE, so result is 2

Step-by-Step: Office Hours Score (Text Comparison)

Students get 2 points if they selected "Yes" for knowing office hours.

4. **Click on cell I3**
5. **Type this formula exactly:** `=IF(E3="Yes",2,0)`
6. **Press Enter**

Important notes about text comparisons:

- **Text must be in quotes:** `"Yes"` not `Yes`
- **Case sensitive:** `"Yes"` ≠ `"yes"` ≠ `"YES"`
- **Must match exactly:** `"Yes"` ≠ `"Yes "` (extra space)

✅ **Test Your IF Statement:** Change the dropdown in E4 to "No" and watch I4 automatically change from 2 to 0.

Part 6: SUM Function - Adding It All Up

Understanding SUM Function

Syntax: `=SUM(range)` or `=SUM(cell1,cell2,cell3...)`

Range examples:

- `SUM(F4:I4)` = Add all cells from F4 to I4
- `SUM(A1,C3,E5)` = Add specific cells A1, C3, and E5

Step-by-Step: Total Score Calculation

1. **Click on cell J3**
2. **Type this formula:** `=SUM(F3:I3)`
3. **Press Enter**

What this does: Adds the values in F3 + G3 + H3 + I3

Expected result: 2 + 3 + 1.5 + 2 = 8.5 points

Alternative SUM Methods

You could also write this as:

- `=F3+G3+H3+I3` (manual addition)
- `=SUM(F3,G3,H3,I3)` (listing each cell)

Why use SUM(F3:I3)? It's easier to read and less likely to have typos.

Part 7: Combining Functions - Advanced IF with SUM

The Prize Decision Logic

Students get a T-shirt if their total score is 4 or higher, otherwise a consolation prize.

Step-by-Step: Prize Determination

1. **Click on cell K3**
2. **Type this formula:** `=IF(J3>=4,"T-shirt","Consolation Prize")`
3. **Press Enter**

Breaking down this complex formula:

- **Condition:** J3 `>=4` (Is the total score 4 or greater?)
- **If TRUE:** `"T-shirt"`
- **If FALSE:** `"Consolation Prize"`

Expected result: Since our total is 8.5, which is ≥4, the result should be "T-shirt"

Understanding the ≥ Symbol

≥ means "greater than or equal to"

- >=4 means 4, 5, 6, 7, 8... all qualify
- >4 would mean only 5, 6, 7, 8... qualify (4 wouldn't be enough)

✅ **Test the Logic:** Change some scores to make the total less than 4 and verify the prize changes to "Consolation Prize"

	A	B	C	D	E	F	G	H	I	J	K
1	NC State Engineering Contest Scorer										
2	Student Name	Completed Credits	Current Semester Credits	Number of Clubs	Knows Office Hours?	Credits Score	Semester Score	Club Score	Office Hours Score	Total Score	Prize
3	Alex Johnson	75	18	3	Yes	2	3	1.5	2	8.5	T-shirt
4	Sam Garcia	59	12	0	No	0	2	0	0	2	Consolation Prize

Figure 9. Functional scorer for further use

Conclusion

By creating a basic spreadsheet, we can efficiently track and calculate student scores and prizes for a contest. Instead of manually computing results each time, the spreadsheet automates the process by allowing quick updates to key categories.

In engineering, spreadsheets are widely used to analyze and manage large datasets. They offer a **fast and organized** way to process information with minimal setup. Compared to coding in software like **MATLAB**, spreadsheets require less initial configuration, reducing the risk of errors. Learning to design spreadsheets that dynamically update based on changing inputs will make data processing **more efficient** and help streamline your work as an engineer.

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3.2: Intermediate Spreadsheet functions for Engineers

By the end of this tutorial, you will be able to:

- Organize data across multiple spreadsheet pages
- Create dynamic dropdown menus from data ranges
- Use VLOOKUP and HLOOKUP to retrieve data automatically
- Build nested IF statements for complex decision logic
- Apply AND/OR functions for multiple conditions
- Implement conditional formatting for visual data analysis

Understanding the Scenario

You're building a grade calculator that helps students determine what final exam score they need to achieve an A in their courses. The tool must handle different grading policies and automatically adjust calculations based on user selections.

We will walk you through the process indicating you several features as well.

Part 1: Working with multiple Pages

Separating data improves organization and reduces errors. To rename a page, double click the tab.

In our grade calculator, we will use two tabs (Figure 1).

- **Page 1 (Calculator):** User inputs and calculations
- **Page 2 (Weights):** Course weight configurations (protected from accidental changes)



Figure 1. By organizing data into pages, we can effectively separate information into separated sources.

Step-by-Step: Creating and Managing Pages

In Google Sheets:

1. **Open your starter file**
2. **Right-click on the sheet tab** at the bottom (currently says "Sheet1")
3. **Select "Rename"** and type `Calculator`
4. **Right-click in the empty space** next to the Calculator tab
5. **Select "Insert sheet"**
6. **Name the new sheet** `Weights`

In Excel:

1. **Open your starter file**
2. **Right-click on the Sheet1 tab** at the bottom
3. **Select "Rename"** and type `Calculator`
4. **Right-click next to the Calculator tab**
5. **Select "Insert..." → Worksheet → OK**
6. **Rename the new sheet** to `Weights`

Setting Up the Weights Page

Switch to the Weights page and enter this data as example or your data if you want.

A	B	C	D	
Class	Exam 1	Exam 2	Exam 3	Final Exam
Chemistry 101	0.20	0.20	0.30	0.15
Physics 205	0.25	0.25	0.25	0.15
Math 241	0.35	0.35	0.20	0

Add more columns if you have more categories

E	F	G
Homework	Extra Credit	Policy
0.15	0.05	Keep Lowest
0.10	0.05	Replace with Final
0.08	0.02	Replace with Average

Part 2: Creating Dynamic Dropdown Menus

Set up the calculator page

In the "Calculator page", replicate this model presented in Figure 2.

	A	B	C	D	E	F	G
1	Class	Category	Grade	Weight	contribution	grade total	
2		Exam 1					
3	Does your Lowest exam grade get dropped?	Exam 2					
4		Exam 3					
5		Final exam					
6		Homework					
7		Extra Credit					
8		Lowest Exam grade					
9							
10							
11	Input the grades you received for each category below out of 100. The final grade calculator works even with a 0 in for the final						
12	Class	Exam 1	Exam 2	Exam 3	Homework	Final Exam	Extra Credit
13							
14							
15							
16							

Figure 2. Structure of the calculator page

Understanding Dropdown from Range

Instead of manually typing dropdown options, we'll create them from our data range. This makes the dropdown automatically update if we add new classes.

Step-by-Step: Creating the Dropdown

Switch to the Calculator page

In Google Sheets:

1. **Click on cell A2** (where you want the dropdown)
2. **Go to Insert menu → Dropdown**

3. **Select "Dropdown (from range)"**
4. **In the range field, type:** `Weights!A2:A4`
   - `Weights!` tells it to look in the Weights sheet
   - `A2:A4` is the range containing our class names
5. **Click "Done"**

In Excel:

1. **Click on cell A2**
2. **Go to Data tab → Data Validation**
3. **In the "Allow" dropdown, select "List"**
4. **In the Source field, type:** `=Weights!$A$2:$A$4`
5. **Click OK**

Part 3: VLOOKUP - Retrieving Data Automatically

Understanding VLOOKUP

VLOOKUP searches for a value in the first column of a table and returns a corresponding value from another column. Think of it like looking up someone's phone number in a directory.

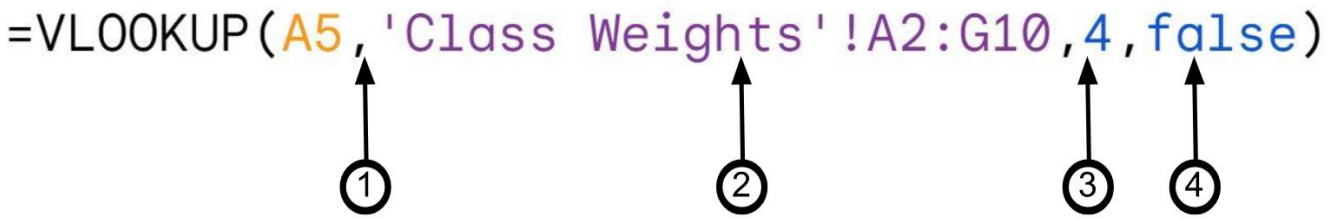


Figure 3. This chart illustrates the components of the VLOOKUP and HLOOKUP functions. The search key (1) is the word, phrase, or value the function references. The range (2) defines the dataset the function searches through. The index (3) specifies the column or row from which the function retrieves a matching value. The sort type (4) determines whether the data is sorted, with "FALSE" recommended if unsure.

Step-by-Step: Setting Up VLOOKUP

Goal: Automatically populate exam weights based on the selected class.

1. **In cell D2** (Exam 1 weight), type this formula exactly:

```
=VLOOKUP(A2,Weights!A:G,2,FALSE)
```

2. **Press Enter**
3. **Let's break down this formula:**
   - `A2` = Search for the value in A2 (selected class)
   - `Weights!A:G` = Look in columns A through G of the Weights sheet
   - `2` = Return the value from column 2 (Exam 1 weights)
   - `FALSE` = Find exact match only
4. **Copy this formula to other cells:**
   - **Cell D6** (Exam 2): `=VLOOKUP(A2,Weights!A:G,3,FALSE)`
   - **Cell D7** (Final Exam): `=VLOOKUP(A2,Weights!A:G,4,FALSE)`
   - **Cell D8** (Homework): `=VLOOKUP(A2,Weights!A:G,5,FALSE)`

Now, do the same for the Grade column using the second table in the "Calculator page"

Troubleshooting VLOOKUP

Getting #N/A error?

- Check that the dropdown value exactly matches the spelling in the Weights sheet
- Verify your range includes the lookup column (column A)

Getting wrong values?

- Count your columns carefully (A=1, B=2, C=3, etc.)
- Make sure you're using FALSE for exact match
-

Example 3.2.1

VLOOKUP is used in the calculator to retrieve the grade for each category, as shown in the figure below. The search key (highlighted in yellow) is A2, and the range (highlighted in purple) is B13:G16.

Based on the search key, VLOOKUP retrieves the corresponding value from the third column, which contains the Exam 2 scores. This function remains effective even if data is added or removed, as long as the search key's name stays in the first column of the specified range.

Solution

```
=VLOOKUP(A2,Weights!A:G,2,FALSE)
```

	A	B	C	D	E	F	G
1	Class	Category	Grade	Weight	contribution	grade total	
2	Chemistry 101	Exam 1	100	0.1	10	75	
3	Does your Lowest exam grade get dropped?	Exam 2	100	0.1	10		
4	Keep Lowest	Exam 3	100	0.1	10		
5		Final exam	50	0.5	25		
6		Homework	100	0.2	20		
7		Extra Credit					
8		Lowest Exam grade					
9							
10							
11	Input the grades you received for each category below out of 100. The final grade calculator works even with a 0 in for the final						
12	Class	Exam 1	Exam 2	Exam 3	Homework	Final Exam	Extra Credit
13	Chemistry 101	100	100	100	100	50	
14	Physics 205	20	65	72	100	65	
15	Math 241	30	85	90	100	80	
16	Economics ...	100	95	80	100	100	

Figure 4. The VLOOKUP tool is used to retrieve information from the highlighted purple table that comes from the "Weights" page, allowing for efficient data lookup based on a specified search value.

Add another VLOOK UP for Cell A4, where you lcoate the policy of the class.

Part 4: Understanding Cell References

Reference Types Explained

Reference Type	Example	Behavior
Relative	`C7`	Changes when copied (C7 becomes C8, D7, etc.)
Absolute	`$C$7`	Always references C7, never changes
Mixed	`$C7` or `C$7`	Column OR row stays fixed
Cross-sheet	`Weights!C7`	References another sheet

> **Note**
>
> Functions are formatted the same in Google Sheets and Excel; cells will be referenced the same in both software.

When to Use Each Type

Use Relative References when:

- You want the formula to adjust as you copy it down or across
- Calculating running totals or similar patterns

Use Absolute References when:

- Referencing a constant value (like tax rate)
- Looking up from a fixed table

Practice Exercise

1. **In cell E2**, create a formula that multiplies the Exam 1 score (C13) by its weight (D22):

```
=B13*D2
```

2. **Copy this formula** to cells E3 and E4 for Exam 2 and Exam 3
3. **Notice how** the cell references automatically adjust

Understanding the Logic

Our grade calculator needs to handle three different policies for the lowest exam grade:

1. **Keep Lowest:** Use the actual lowest score
2. **Replace with Final:** Replace lowest with final exam score
3. **Replace with Average:** Replace lowest with average of other two exams

Therefore, we need to modify the way cells E2, E3, E4, and so on make the calculation

Step-by-Step: Building Nested IF

Goal: Create a formula that applies the correct policy based on the dropdown selection.

1. **In cell E2**, we'll create a formula to handle Exam 1 score:

```
=(IF(AND(C2=MIN($C$2:$C$4),A4="Replace with Final"),C5,IF(AND(C2=MIN($C$2:$C$4),A4="R
```

2. **Let's break this down step by step:**

Outermost IF:

- **Condition:** `AND(C2=MIN($C$2:$C$4),A4="Replace with Final")`
- **Translation:** "Is C2 the minimum grade AND is the policy 'Replace with Final'?"

- **If TRUE:** Use C5 (Final exam score)
- **If FALSE:** Move to next IF

Second IF:

- **Condition:** `IF(AND(C2=MIN($C$2:$C$4),A4="Replace with Average"),(C3+C4)/2,B13)`
- **Translation:** "Is C2 the minimum grade AND is the policy 'Replace with Average'?"
- **If TRUE:** Use `(C3+C4)/2` (average of other two exams)
- **If FALSE:** Use B6 (Keep Lowest)

> **Note**
>
> Check the use of absolute and relative cells. Be aware if they need to be modified

3. **Repeat for cells E3 and E4**, changing the respective cells.

Simplified Approach for Beginners

If the above seems complex, try building it step by step:

1. **Start with simple IF:**

```
=IF(B6=MIN(B6:D6),"This is lowest","Not lowest")
```

2. **Add policy check:**

```
=IF(AND(B6=MIN(B6:D6),VLOOKUP(A5,Weights!A:G,7,FALSE)="Replace with Final"),"Repla
```

3. **Replace text with actual calculations**

✅ **Test Your Nested IF:** Try different policy selections and verify the calculations change correctly.

> **? Exercise 3.2.1**
>
> The final formulas should look like this:
>
> **Answer**
>
> For exam 1:
>
> ```
> =(IF(AND(C2=MIN($C$2:$C$4),$A$4="Replace with Final"),$C$5,IF(AND(C2=MIN($C$2:$C$4),A4="Replace with Average"),(C3+C4)/2,B13)))*D2
> ```
>
> For exam 2:
>
> ```
> =(IF(AND(C3=MIN($C$2:$C$4),$A$4="Replace with Final"),C5,IF(AND(C3=MIN($C$2:$C$4),A4="Replace with Average"),(C2+C4)/2,C13)))*D3
> ```
>
> For exam 3:
>
> ```
> =(IF(AND(C4=MIN($C$2:$C$4),$A$4="Replace with Final"),C5,IF(AND(C4=MIN($C$2:$C$4),$A$4="Replace with Average"),(C2+C3)/2,D13)))*D4
> ```

Part 6: AND/OR Functions

Understanding Logic Functions

AND Function: Returns TRUE only if ALL conditions are met

```
=AND(condition1, condition2, condition3)
```

OR Function: Returns TRUE if ANY condition is met

```
=OR(condition1, condition2, condition3)
```

Practice Examples

Example 1 - Checking Multiple Conditions:

```
=AND(B6>90, C6>90, D6>90)
```

Returns TRUE only if all three exam scores are above 90.

Example 2 - Flexible Conditions:

```
=OR(B6>95, C6>95, D6>95)
```

Returns TRUE if ANY exam score is above 95.

Real Application in Our Calculator

In our nested IF statement, we used AND to check two conditions simultaneously:

1. Is this the lowest score?
2. Is the correct policy selected?

Both must be true for the replacement to occur.

Part 7: Putting it all together

Grade total calculation

Sum all values in row E and place the formula in cell F2.

	A	B	C	D	E	F	G
1	Class	Category	Grade	Weight	contribution	grade total	
2	Chemistry 101	Exam 1	100	0.1	10	75	
3	Does your Lowest exam grade get dropped?	Exam 2	100	0.1	10		
4	Keep Lowest	Exam 3	100	0.1	10		
5		Final exam	50	0.5	25		
6		Homework	100	0.2	20		
7		Extra Credit					
8		Lowest Exam grade					
9							
10							
11	Input the grades you received for each category below out of 100. The final grade calculator works even with a 0 in for the final						
12	Class	Exam 1	Exam 2	Exam 3	Homework	Final Exam	Extra Credit
13	Chemistry 101	100	100	100	100	50	
14	Physics 205	20	65	72	100	65	
15	Math 241	30	85	90	100	80	
16	Economics ...	100	95	80	100	100	

Make sure to change the values and test that the spreasheet is working as intended!

Conclusion

In this chapter, we explored practical functions for referencing and analyzing large datasets. The focus was on **data manipulation and visualization**, demonstrating how **lookup functions** and **nested IF statements** can extend beyond the limitations of a single dataset or a basic IF/ELSE statement.

As an engineer, it is essential to understand how to **import and process external spreadsheets**. Many datasets are provided in spreadsheet format and can be imported as **individual pages** within a workbook. Once imported, these datasets can be **easily searched and analyzed** without the need for manual review.

The ultimate goal of using a **spreadsheet editor** is to **streamline** your engineering workflow, making data processing more efficient and automated.

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3.3: Advanced Functions Overview

By the end of this tutorial, you will be able to:

- Use CONVERT functions for accurate unit conversions
- Import external data files into spreadsheet workbooks
- Apply INDEX-MATCH for flexible data lookup (superior to VLOOKUP)
- Implement multi-criteria INDEX-MATCH searches
- Solve real engineering problems using integrated spreadsheet tools

Understanding the Engineering Problem

You are designing a steam engine intended for operation in mountainous terrain, where maintaining optimal boiler pressure is critical for performance. The boiler must operate at a pressure of 1500 kPa to effectively power the steam engine.

To ensure continuous operation, you must determine the required fuel input to maintain steam production. The system processes 1000 kg/h of water, which enters at 78°F and atmospheric pressure. The boiler operates with an efficiency of 80%, and the steam produced is a saturated vapor upon reaching the boiler. The available fuel is lignite coal, with a heat capacity of 15 MJ/kg. The goal is to calculate the necessary mass flow rate of lignite coal to sustain engine operation.

Additionally, the company is developing a range of boilers with operating pressures between 1.0 and 2.0 MPa, increasing in 0.1 MPa increments, and with efficiencies of 80%, 85%, and 90%. To assist in optimizing boiler design, a comprehensive analysis is needed to determine the required coal input for each configuration. A plot of coal consumption across all operating conditions will provide engineers with critical insights into the trade-offs between efficiency, pressure, and fuel consumption.

You have access to the following resources. You need to add the steam tables to your excel file in different pages:

Steam tables-[link here]

Lignite Coal Information-[link here]

Part 1: Setting Up Your Workspace and Importing Data

Start by adding the input information in your spreadsheet. It can look like this

	A	B
1	**Given Data**	
2	Inlet Temperature (°F)	78
3	Atmospheric Pressure (atm)	1
4	Water Flowrate (kg/h)	1000
5	Boiler Pressure (MPa)	1.5
6	Boiler Efficiency	0.8

Figure 1. Initial set up of your spreadsheet

Understanding Data Import Benefits

Why import steam tables?

- Eliminates manual data entry errors
- Provides comprehensive thermodynamic property data
- Enables automated lookup functions
- Saves time in engineering calculations

Step-by-Step: Importing Steam Tables

In Google Sheets:

1. **Open Google Sheets** and create a new spreadsheet
2. **Go to File menu → Import**
3. **Click "Upload"** tab
4. **Drag and drop** the downloaded steam tables file OR **Select a file from your device**
5. **Choose "Insert new sheet(s)"** (keeps original data structure)
6. **Click "Import data"**

In Excel:

1. **Open Excel** and create a new workbook
2. **Go to Data tab → Get Data → From File → From Workbook**
3. **Navigate to** your downloaded steam tables file
4. **Select the file** and click **Open**
5. **In the Navigator window:**
   - Check **"Select multiple items"**
   - Select all sheets you need (typically "Saturated Steam" and "Superheated Steam")
6. **Click "Load" → Load To... → Existing worksheet → New worksheet**

Verifying Your Import

✅ **Check Your Progress:** You should now have multiple sheets in your workbook:

- Sheet1 (your working sheet)
- about (Information about the steam tables) (you can erase this tab)
- Saturated Steam by Pressure (you will use this table)
- Saturated Steam by Temperature (you will use this table)
- Additional steam property sheets

Expected Data Structure from imported data:

- Temperature (°C) or Pressure
- Pressure (MPa) or Temperature (°C)
- Specific Volume for the liquid (m^3/kg)
- Specific Volume for the vapor (m^3/kg)
- Internal Energy for the liquid (kJ/kg)
- Internal Energy for the vapor (kJ/kg)
- Additional thermodynamic properties

> If you imported the data to google sheets, you need to change the function "Numbervalue" for "value" and drag it to apply to all values in the "saturated_by_pressure" and "saturated_by_temperature" sheets.

Part 2: Unit Conversion with CONVERT Function

Understanding the CONVERT Function

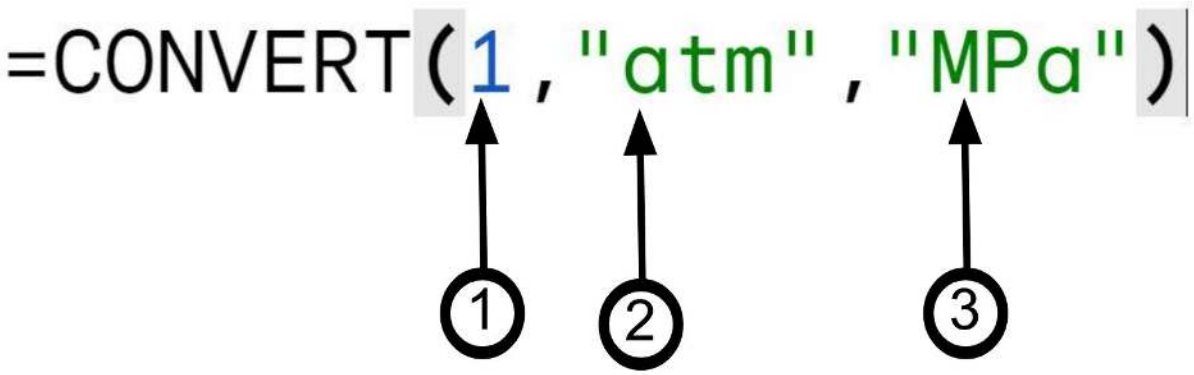


Figure 2. How to format the convert function in Google Sheets or Excel. The first input (1) is the amount of the first unit you are converting from. The second argument is the unit you are converting from (2), and the third is the unit you are converting to (3). Make sure to enter the abbreviations for the units correctly, as the arguments are coded for the correct capitalization and abbreviations.

Key Benefits:

- Eliminates conversion errors
- Handles complex unit systems
- Updates automatically with data changes
- Supports engineering units

Step-by-Step: Temperature Conversion

Problem: Convert inlet temperature from 78°F to Celsius for steam table lookup.

1. **Label and merge cells** D1 and E1 as "Converted and calculated data"
2. **In your main worksheet, cell D3:**
   - **Label:** `Inlet Temperature (°C)`
3. **In cell E3, type this formula:**

```
=CONVERT(B2,"F","C")
```

4. **Press Enter**

Expected Result: 25.56°C (approximately)

Step-by-Step: Pressure Conversion

Problem: Convert atmospheric pressure to MPa for consistency and calculate the operational pressure.

5. **In cell D3:**
   - **Label:** `Atmospheric Pressure (MPa)`
6. **In cell E3, type:**

```
=CONVERT(B3,"atm","MPa")
```

Breaking down this formula:

- `CONVERT(B3,"atm","MPa")` converts atmospheres to Mega Pascals
- **Result:** 0.10135 MPa

7. **In cell D4:**

- **Label:** `Operational Pressure (MPa)`

8. **In cell E4, type:**

```
=$B$5-E3
```

9. **Press Enter**

Expected Result: 1.4 (approximately)

Note

Common CONVERT Function Units

Unit Type	Abbreviations
Temperature	"C" (Celsius), "F" (Fahrenheit), "K" (Kelvin)
Pressure	"Pa" (Pascal), "atm" (atmosphere), "psi"
Energy	"J" (Joule), "cal" (calorie), "BTU"
Mass	"kg" (kilogram), "g" (gram), "lbm" (pound mass)
Length	"m" (meter), "ft" (feet), "in" (inches)

Part 3: INDEX-MATCH vs VLOOKUP

Definition: Why INDEX-MATCH is Superior to VLOOKUP

Feature	VLOOKUP	INDEX-MATCH
Search direction	Left to right only	Any direction
Column insertion	Breaks with new columns	Remains stable
Performance	Slower on large datasets	Faster
Flexibility	Limited	Highly flexible
Multi-criteria	Not possible	Easy to implement

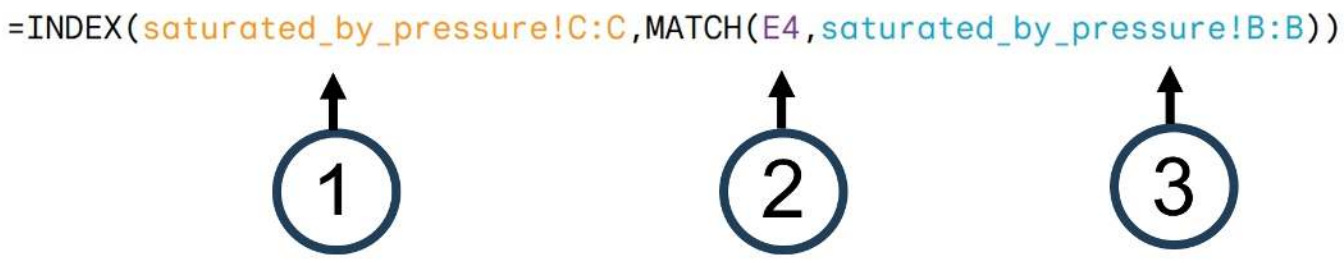


Figure 3. Basic formatting for the INDEX-MATCH function. The first step is to specify the data range to be returned (1), which determines the row or column from which values will be pulled. Next, the MATCH function is used with a search key (2), which is the value being located within the search range (3). If the search key is not found in the specified range, the function will return an error.

INDEX Syntax: `=INDEX(return_array, row_number)`
MATCH Syntax: `=MATCH(lookup_value, lookup_array, match_type)`

Combined: `=INDEX(return_array, MATCH(lookup_value, lookup_array))`

> **Note**
>
> Using `1` or not placing any argument instead of `0` finds the closest match ≤ lookup value.

Step-by-Step: Basic INDEX-MATCH Setup

Goal: Find the temperature and internal energy of steam and internal energy of water at inlet conditions.

1. **Label and Merge cells** G1 and H1 as "Extracted data"
2. **In cell G2:**
   - **Label:** `Steam temperature (°C)`
3. **In cell G3:**
   - **Label:** `Internal energy for steam (kJ/kg)`
4. **In cell G4:**
   - **Label:** `Internal energy for water (kJ/kg)`
5. **Set up your lookup data structure:**
   - **E2:** `25.56` (It will change if you change B2)
   - **E4:** `1.4` (It will change if you change B5 and/or B3)

> **Note**
>
> The tab "Saturated by pressure" allows you to find the properties when you know the pressure of the system (Like in the Operational Pressure), and the tab "Saturated by temperature" allows you to find the properties when you know the temperature of the system.
>
> In this scenario, we have both. We can evaluate the properties of the steam with the operational pressure and the properties of the inlet water with the inlet temperature

1. **Create basic INDEX-MATCH formula in H2:**

```
=INDEX('saturated_by_pressure'!C:C,MATCH(E4,'saturated_by_pressure'!B:B))
```

Breaking down this formula:

- `'saturated_by_pressure'!C:C` = Return array (Temperature)
- `MATCH(E4,'saturated_by_pressure'!B:B)` = Find row where pressure matches
- `E4` = Lookup value (1.4 MPa)
- `'saturated_by_pressure'!B:B` = Search array (Pressure column)

✅ **Verification:** Your result should be close to the internal energy of steam at 1.4MPa from steam tables.

Repeat the procedure to find the enthalpy of the steam (HS) (using the same array), and the enthalpy for water (change the array to 'saturated by temperature' and select the column for the liquid (HL))

	A	B	C	D	E	F	G	H
1	**Given Data**			**Converted data**			**Extracted data**	
2	Inlet Temperature (°F)	78		Inlet Temperature (°C)	26		Steam temperature (°C)	193
3	Atmospheric Pressure (atm)	1		Atmospheric Pressure (MPa)	0.1		Enthalpy for steam (kJ/kg)	2788
4	Water Flowrate (kg/h)	1000		Operational Pressure (MPa)	1.4		Entalphy for water (kJ/kg)	104.8
5	Boiler Pressure (MPa)	1.5						
6	Boiler Efficiency	0.8						

Figure 4. Spreadsheet after imputing the formulas to extract the information.

? Exercise 3.3.1

Your formulas should look like this.

Answer

```
=INDEX(saturated_by_pressure!J:J,MATCH(E4,saturated_by_pressure!B:B))
```

```
=INDEX(saturated_by_temperature!I:I,MATCH(E2,saturated_by_temperature!B:B))
```

Part 4: Building the Complete Thermodynamics Calculation

Understanding the Energy Balance

Heat Required: $Q = \dot{m} \times (h_2 - h_1) / \eta$

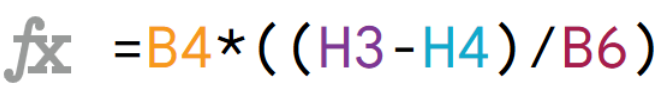
Where:

- **Q** = Heat input required (kJ/h)
- **$\dot{m}$** = Water flow rate (1000 kg/h)
- **h_2** = Enthalpy of saturated vapor at boiler pressure
- **h_1** = Enthalpy of inlet water
- **η** = Boiler efficiency (80%)

Step-by-Step: Calculating values

Goal: Find the amount of energy required to boil the indicated amount of water and how much coal do you need to so.

1. **Label and Merge cells** A9 and B9 as "Calculations"
2. **In cell A11:**
   - **Label:** Q `(kJ)`
3. **Add a new value in the given data table (A7 and B7):**
   - **Label:** `Coal specific heat (kJ/kg)`
   - **Value:** `15000`
4. **In cell A12:**
   - **Label:** `Amount of coal (kg)`
5. **Input the formula in B11**



Note

Be mindful of the parenthesis. They can be the difference between a correct and an incorrect value.

6. Calculate the amount of coal by dividing the amount of energy for the specific heat of coal.

	A	B	C	D	E	F	G	H
1	**Given Data**			**Converted data**			**Extracted data**	
2	Inlet Temperature (°F)	78		Inlet Temperature (°C)	26		Steam temperature (°C)	193
3	Atmospheric Pressure (atm)	1		Atmospheric Pressure (MPa)	0.1		Enthalpy for steam (kJ/kg)	2788
4	Water Flowrate (kg/h)	1000		Operational Pressure (MPa)	1.4		Entalphy for water (kJ/kg)	104.8
5	Boiler Pressure (MPa)	1.5						
6	Boiler Efficiency	0.8						
7	Coal specific heat (kJ/kg)	15000						
8								
9								
10	**Calculations**							
11	Q (kJ)	3354000						
12	Amount of coal (kg)	223.6						

Figure 5. Completed spreadsheet with target calculation obtained.

Conclusions

This chapter builds on previous functions and applies them in an **engineering context**. The problem presented is a **basic thermodynamics calculation** that can be solved manually with a calculator. Your spreadsheet can be used to evaluate the performance of the boiler with different efficiencies, inlet temperatures, water flow rates. The amount of coal will be updated correspondingly. You could also change the source of the energy!.

By using a **spreadsheet**, we can adjust system values and instantly update results, making it easier to explore different scenarios. This approach allows engineers to **simulate changes** without physically altering the system, significantly speeding up the **design and verification process**.

Spreadsheets also help **validate changes** at any stage of the engineering workflow. If modifications are needed later in the pipeline, a well-structured spreadsheet can quickly verify adjustments without unnecessary rework. Because of this, **spreadsheets are an invaluable tool for engineers**, improving efficiency and decision-making in complex calculations.

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CHAPTER OVERVIEW

4: Plotting and charting

One of the key functions of spreadsheet software is the ability to generate plots from aggregated data. To do this effectively, you need to be familiar with the charting functions available in your chosen software. Google Sheets and Microsoft Excel have different methods for creating charts, so understanding the capabilities and options of each is essential before starting.

All spreadsheet software provides several customization options for charts, including:

- Title and Axis Labels for clarity
- Chart Colors for better visualization
- Axis Labels and Scale Adjustments for accuracy
- Legend Formatting for readability

Charts are often used in presentations, textbooks, and quick reference guides, making customization crucial. For example, in a textbook, space constraints may require adjusting the axes to remove unnecessary blank space. In contrast, for a presentation, increasing label sizes can improve readability for the audience. Customizing charts based on their intended use ensures that data is clear, accessible, and effective in communication.

4.1: Why Is Plotting Important?

4.2: Formatting A Chart

4.3: How To Insert A Chart

4.4: Applied Example

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4.1: Why Is Plotting Important?

Why is plotting important?

Plotting allows engineers to generate reference figures for use in research and practical applications. Engineers frequently rely on complex reference tables and graphs created in spreadsheets to quickly identify material constraints and make informed design decisions. Without a clear understanding of how to create, interpret, and apply these visual tools, engineering challenges can become overwhelming. As future engineers, it is essential to develop skills in graph creation and analysis, as well as an awareness of the assumptions and limitations behind these figures.

In the example below (Figure 1), chemical engineers have developed a chart to assist in heat exchanger design. The chart plots heat transfer coefficients for different fin designs as a function of the material's flow characteristics. This table has been derived mathematically, and its proper use depends on understanding both the data source and the engineering context in which it applies. Misapplying this reference—such as using it for systems outside of heat exchangers—could result in incorrect component sizing, leading to a system that fails to perform as expected.

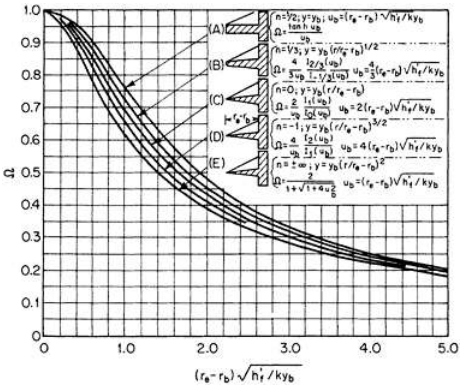


Figure 1. A chart was created for chemical engineers to quickly identify the effectiveness of various fins in a heat exchanger.

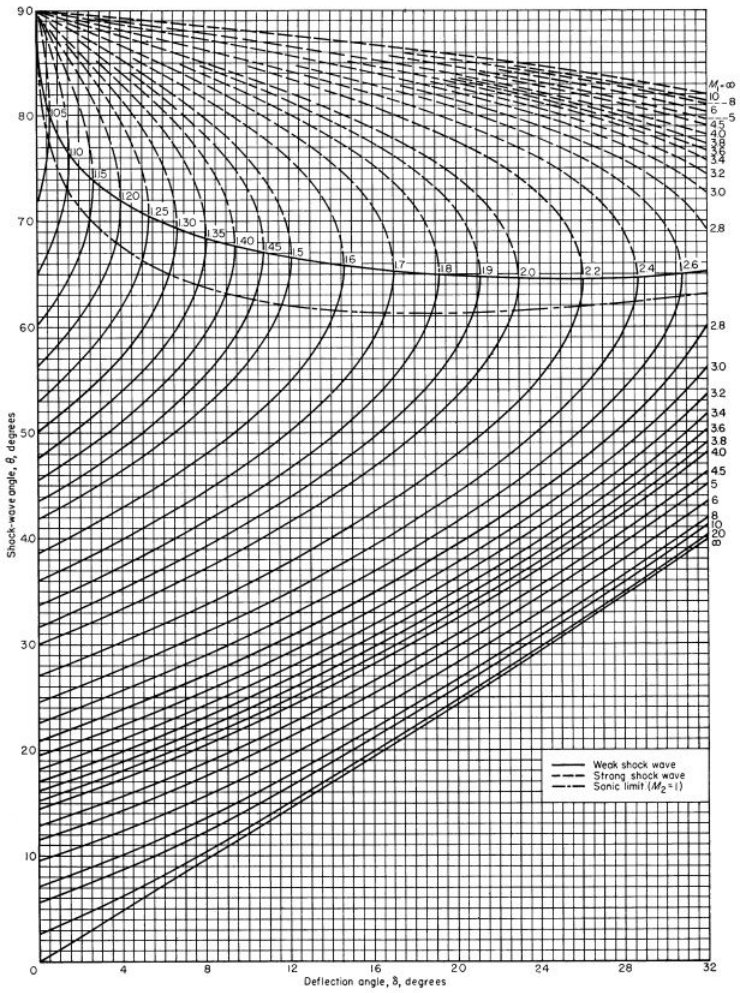


Figure 2. A chart created to assist Aerospace and Mechanical engineers in the NACA 1135 report to find the angle of a shockwave off of an oblique surface

References

(1) Green, D.; Perry, R. 11.1. THERMAL DESIGN of HEAT-TRANSFER EQUIPMENT. In *Perry's Chemical Engineers' Handbook, Eighth Edition*; Green, D., Perry, R., Eds.; McGraw Hill Companies, 2008.

(2) AMES RESEARCH STAFF. *EQUATIONS, TABLES, and CHARTS for COMPRESSIBLE FLOW*; 1953; pp. 46–47.

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4.2: Formatting A Chart

Formatting a chart

Before creating a chart, ensure that all necessary data is generated, organized, and easily accessible. In most spreadsheet software, charts require data from at least two ranges—one for the X-axis and one for the Y-axis. Properly labeling and processing these data ranges is essential to ensure that the chart is clear and readable for the intended audience. Key components of any chart include the title, axes, and legend. For more information on chart formatting in Microsoft Excel and Google Sheets, refer to How To Insert A Chart for labeled graphics.

Chart Title

The first decision in chart creation is whether a title is necessary. In some cases, such as poster presentations, a title may take up too much space and reduce readability. However, for a lab report or research paper, where readers must analyze significant amounts of data, a clear title is crucial.

If a title is used, it should quickly summarize the chart's trend. By convention, the Y-axis variable is listed first, followed by the X-axis variable. For example, based on previous examples, an appropriate title might be "Coal Consumption vs. Boiler Efficiency."

Axes and Scale

Once the title is established, focus on axis formatting. Most spreadsheet software allows you to customize the X and Y-axis labels, scale, and presentation. Always include units and ensure the labels are clear and concise for the audience. Additionally, text size should be large enough for easy readability, especially in presentations.

At this stage, consider how the data is visually represented. While gridlines can help provide a frame of reference in technical reports, they may reduce clarity in presentations. In such cases, using tick marks instead of a full grid can improve readability.

Balancing Accuracy and Readability

The goal of creating a chart is to effectively communicate trends in the data. However, ensuring that a chart remains as accurate as the raw dataset can be challenging. Charts are usually paired with additional context, which influences their formatting choices. The example below demonstrates how formatting enhances readability, making the chart easy to interpret and reference.

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4.3: How To Insert A Chart

How to Insert a Chart

Google sheets

In Google Sheets, you can insert a chart by navigating to the "Insert" menu in the main taskbar. After selecting "Insert," click "Chart" to add a blank chart to your spreadsheet.

The Chart Editor automatically opens when a chart is created, allowing you to choose and customize the chart type. If the Chart Editor is accidentally closed, you can reopen it by double-clicking on the chart. More details about the Google Sheets Chart Editor are provided below.

Microsoft Excel

In Microsoft Excel, you can add a chart using the main toolbar. Navigate to the "Insert" menu at the top and select the chart style you want to create. Clicking on a chart type will open a dropdown menu displaying specific styles related to your selection. Choose the desired style to insert a blank chart into your spreadsheet.

Once the chart is inserted, you must add data using the "Select Data" tool, located in the Chart Design menu. This menu only appears when a chart is highlighted or selected, allowing you to customize and input the necessary data for visualization.

Google Sheets chart formatting

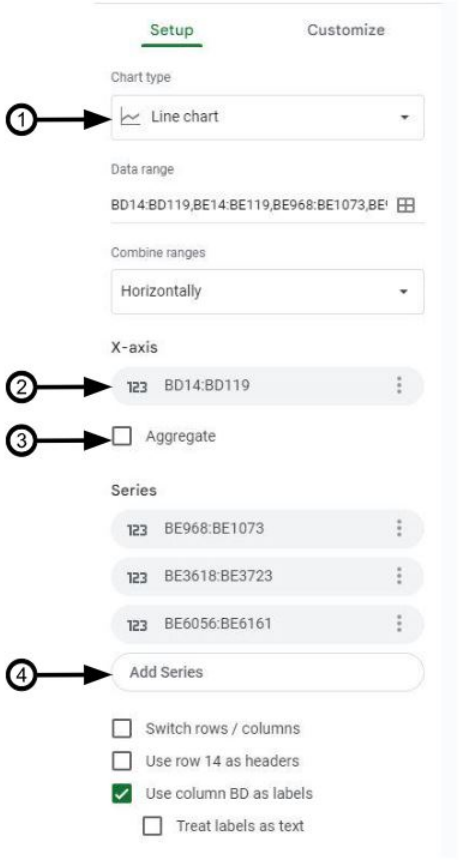


Figure 2. The chart setup menu in Google Sheets. The chart type menu (1) allows users to select the desired chart format. The X-axis series (2) sets the labels for the X-axis. The aggregate option (3) enables data aggregation, displaying an aggregate menu when checked. The series menu (4) allows users to add datasets to the Y-axis, with all added series being co-plotted on the same chart.

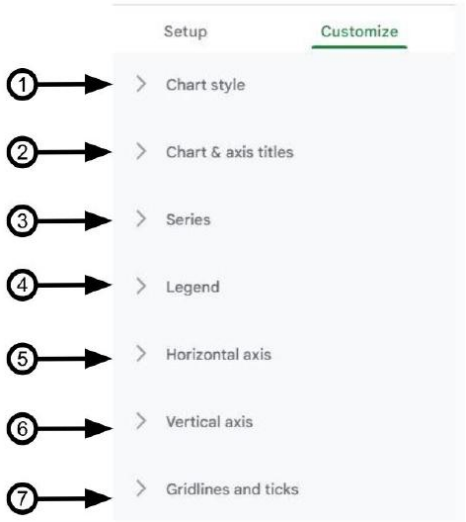


Figure 3. The Customize menu in Google Sheets allows users to modify various chart characteristics. The Style menu (1) adjusts global fonts, colors, and smoothing settings. The Axis and Title menu (2) customizes the title text, font, color, and size. The Series menu (3) enables changes to plotted points, including adding error bars, with options to modify settings for all series or a specific one. The Legend menu (4) controls the text and positioning of the legend. The Horizontal Axis menu (5) and Vertical Axis menu (6) allow adjustments to text settings and scale for their respective axes. The Grid Lines and Ticks menu (7) is used to add and format grid lines and tick marks for improved readability.

Microsoft Excel chart formatting

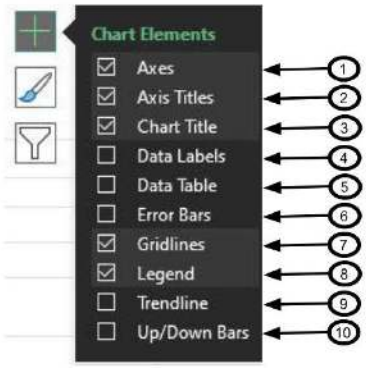


Figure 4. The Chart Elements toolbar in Microsoft Excel. After creating a plot, double-clicking on any element opens its corresponding Chart Element menu. The Axes menu (1) allows for editing displayed axes, while the Axis Titles menu (2) and Chart Title menu (3) customize axis labels and the overall chart title. The Data Labels menu (4) enables toggling visible data labels and adjusting their appearance, displaying specified points or values associated with data points. The Data Table menu (5) adds a table containing all plotted values, with the Error Bars menu (6) positioned below it, allowing error bars to be applied based on functions or another data series. The Gridlines menu (7) toggles Gridlines, while the Legend menu (8) controls the visibility and customization of the legend. The Trendline menu (9) adds a Trendline based on various selectable functions, and the Up/Down Bars menu (10) visually represents differences between data series.

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4.4: Applied Example

Creating Plots from Steam Tables

Outcome

Engineers working with water at various pressures often rely on steam tables to determine internal energy values. However, these tables can be complex and difficult to reference in the field. To simplify estimations, a quick-reference chart is needed to display internal energy values at different temperatures and pressures ranging from 0.01 MPa to 100 MPa on a logarithmic scale.

This chart will not replace steam tables or manual calculations but will serve as a supplementary tool for rapid approximations. To ensure comprehensive coverage, the dataset will include a temperature range of 50 K to 950 K and a pressure range of 0.1 MPa to 10 MPa, capturing critical thermodynamic behavior.

To enhance usability in field applications, the chart will feature clear titles, labeled axes with units, grid lines, and tick marks for easy interpretation. The title will follow standard conventions, with internal energy as a function of temperature, and will be displayed prominently for quick identification. The axes will be labeled with proper units, and major and minor tick marks will improve readability without overcrowding the chart.

The chart bounds will be optimized to highlight the most useful data, ensuring that engineers can quickly and accurately estimate internal energy values under different operating conditions.

Overview

To create an example graph from the spreadsheets, begin by importing the steam table found [here] and navigating to the **Compressed Liquid and Superheated Steam** page. This page organizes the steam tables by pressure and includes states such as **Saturated Liquid** and **Saturated Vapor**, which represent opposite ends of a liquid-vapor phase change and are critical in thermodynamic analysis.

To simplify the graphing process, it is necessary to plot only standard X (temperature) values. This requires creating a function that removes non-shared X values, as all values are tabulated in 5-degree Kelvin increments (and later 10 and 20) except for the two saturated states. A function using an IF statement can be implemented to filter out these two states. This function should then be applied to the entire dataset, ensuring that both temperature and pressure values remain consistent across all series. Once the table is refined, a quick validation step using conditional formatting helps highlight any unexpected values that do not conform to the 5-degree increment rule. Cross-checking with the original dataset further ensures that no extraneous data remains before proceeding to visualization.

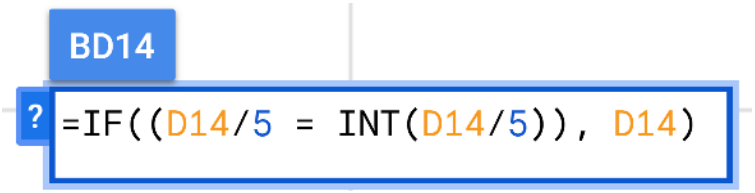


Figure 1. Function used to determine if the temperature is evenly divisible by 5. This function compares the raw temperature value divided by 5 to the rounded value using the INT function. If the values match, the new temperature value is set to the steam table temperature value, else it is FALSE.



Figure 2. Function used to determine whether the given pressure value should be plotted based on the temperature value. If the temperature value is not FALSE, the internal energy value from the steam tables is saved in the new column.

With the non-standard temperature values removed, a plot can be generated using a single X series. The following sections provide guidance for creating the same or similar charts in **Google Sheets** and **Microsoft Excel**. This method ensures clarity in visual representation and prevents unnecessary data clustering.

Creating a Plot in Google Sheets

To generate the desired figure in Google Sheets, begin by inserting a new chart through the Insert → Chart menu. Once the blank chart is inserted, navigate to the Setup menu and select Line Chart from the dropdown. In the Chart Setup menu, set the X-axis series to the modified temperature values, ensuring that the saturated values are removed. Multiple Y-axis series should be added by selecting all internal energy values corresponding to different pressures, allowing the temperature-internal energy values to be co-plotted effectively. To maintain continuity in the graph, enable the Plot Null Values option in the Chart Style menu.

Customizing the chart further enhances readability. Under the Customize menu, navigate to Chart & Axis Titles to input a Chart Title, Horizontal Axis Title, and Vertical Axis Title, adjusting text properties and fonts as needed. The legend, which is generated automatically, can be edited by double-clicking each series and renaming them to 0.1, 1, and 10 MPa respectively.

Adjusting the axis limits is the next step. Under the Horizontal Axis and Vertical Axis dropdowns, set the Horizontal Axis Min/Max to 50 and 750, and the Vertical Axis Min/Max to 0 and 4000. If these values do not apply correctly, ensure that the Allow Bounds to Hide Data setting is enabled. Finally, gridlines and spacing should be configured by enabling Major and Minor Ticks for both axes and setting Minor Line Thickness to 2px. Set the vertical axis to have steps of 1000 and one minor tick. Set the horizontal axis to have steps of 100 and one minor tick. If done correctly, the chart should match the reference figure and ensure consistent visualization.

Creating a Plot in Microsoft Excel

To create the plot in Microsoft Excel, begin by navigating to the Insert menu and selecting Scatter with Straight Lines from the Scatter Plot dropdown. It is important to avoid selecting a Line Chart, as this may prevent proper X-axis formatting. Once the blank chart is inserted, click Insert Data from the Chart Design menu and add the Y-series (internal energy values) alongside the X-data (temperature values). Properly naming the plotted values by pressure will aid in legend formatting, and if multiple series overlap, using the Chart Filters option can help isolate individual datasets for review.

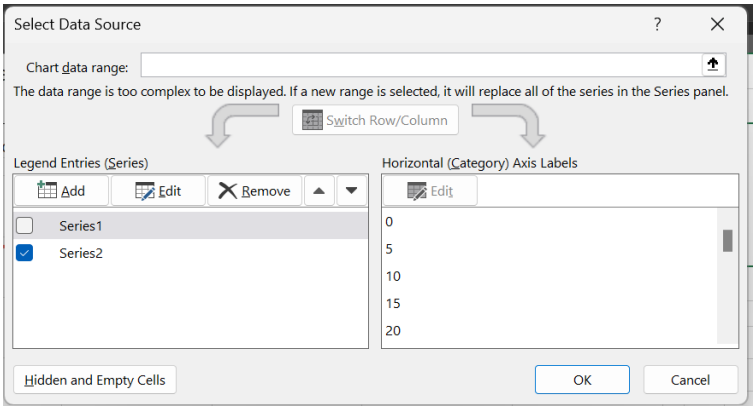


Figure 3. Data selection menu showing toggling options for co-plotting series.

The next step involves configuring the axis settings. By selecting the chart and clicking the + sign to open the Chart Elements menu, access the Axis → More Options settings. For the Vertical Axis, set the minimum value to 0, maximum to 4000, major units to 1000, and minor units to 500, ensuring that Major and Minor Tick Marks are set to Inside. Similarly, adjust the Horizontal Axis with a minimum of 50, maximum of 750, major units of 100, and minor units of 50, applying Inside tick marks as well.

Enabling gridlines further refines the chart. Within the Chart Elements menu, check the Gridlines box and expand its dropdown to enable Primary Major Horizontal and Primary Major Vertical gridlines. These settings align the gridlines with the major tick marks established earlier. Formatting the legend is the final step; checking the Legend box in the Chart Elements menu ensures that the

names assigned in the data selection step appear correctly. If needed, repositioning the legend can improve clarity, and disabling Data Labels removes unnecessary marks from the plotted series.

At this stage, the chart should closely match the provided figure. Verifying the axis limits, legend entries, and gridline placement ensures accuracy in the final visualization. Some changes may be present due to formatting limitations from each software.

Final result

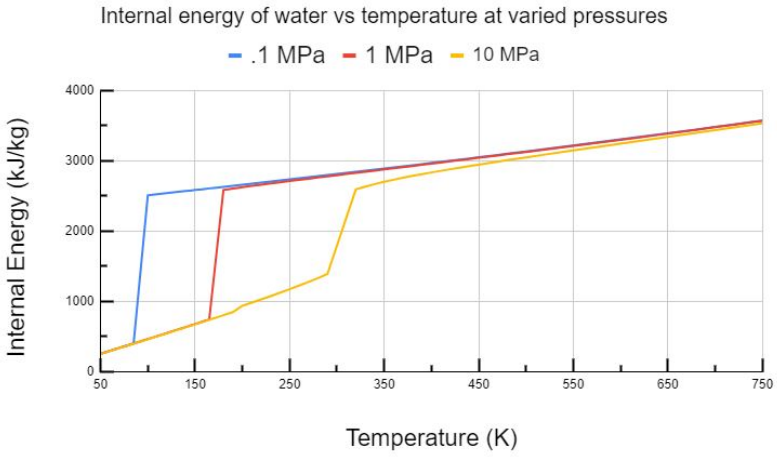


Figure 4. The internal energy of water plotted against temperature at various pressures, illustrating how internal energy changes with temperature under different pressure conditions.

Conclusion

By plotting water's internal energy against temperature, we created a quick-reference diagram that enables engineers to estimate internal energy values efficiently without performing manual calculations at different pressures. This approach saves time, reduces computational steps, and helps prevent errors in engineering applications.

Using pre-generated tables and graphs is a common practice in engineering, providing a reliable and accurate way to reference critical data. By utilizing these tools, engineers can ensure the values they use are both precise and error-free, improving decision-making and workflow efficiency.

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