

# Cracking the Code



## Student Resource: What are Barcodes?

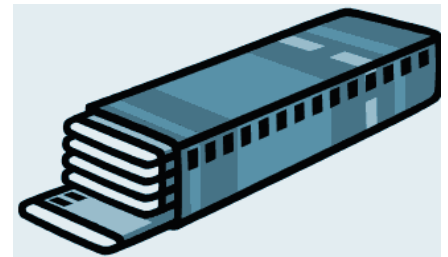
### ◆ Computer Barcodes

Thirty years ago marked the launch of the Universal Product Code (UPC) -- or the "barcode. At the time, food distribution and sales systems lead the way encouraged by potential savings in having to affix pricing labels to every product in every grocery store. It took cooperation between food manufacturers and grocery chains to support the required engineering and technology to develop an automated check-out system. The results were amazing! In addition to automatically ensuring that no pricing errors were made by clerks, automated check-out counters have now completely eliminated the need for humans to check out at some grocery, home goods, and home improvement stores. The barcode has had a huge impact on retail, manufacturing systems, and distribution of products all over the world. In addition, the little black and white lines have established a computerized database tracking buying habits, sales preferences, and pricing preferences for consumers everywhere. The barcode has boosted the odds that a new product will meet the needs of society, and dramatically increased the accuracy of inventories.



### ◆ History

The first barcodes were used at a supermarket in Troy, OH, in 1974, and the scanners that read the barcode were considered large, loud, and clumsy. The very first item scanned was a pack of Wrigley's Juicy Fruit chewing gum. This was simply by chance, as the first customer (whose name now lost to history...) pulled a pack of Juicy Fruit from the rack! That historic pack of now very stale gum can be viewed on display at the Smithsonian Institution's National Museum of American History in Washington DC!



Now scanners are small, hand held, unobtrusive, quiet, and quick; they are used everywhere from stores and post offices -- to hospitals -- and by researchers and engineers in remote locations all over the world.

### ◆ What's New?

Recently, advances have been made in providing medicine instructions and blood transfusion accuracy by attaching bar coding systems to these items as well. Dry cleaners are applying barcodes to make sure that clothing is returned to the right customer, and banking system codes allow customers to "swipe and go" --- purchasing gasoline, food, and even meals at restaurants at lightning speed.



## ◆ How Does it Work?

Most product UPC codes have twelve digits. The first six numbers define the manufacturer or vendor of the product. Every product that the vendor sells will have the same first six numbers. The next five digits are specific to the product itself. And, the last number is a special digit called the "check digit" that is a double check to make sure that the UPC for the code is correct. This "check digit" has a mathematical formula it follows to confirm that the product is accurately checked. Here's how it works:

Let's use the UPC code for Heinz 57 Ketchup Tomato (14 oz).  
The code is 013000001243.



Step One: Add the digits in the odd positions together:

$$0 + 3 + 0 + 0 + 1 + 4 = 8$$

Step Two: Multiply the answer in Step One by 3:

$$8 \times 3 = 24$$

Step Three: Add the digits in the even positions (except for the 12th digit):

$$1 + 0 + 0 + 0 + 2 = 3$$

Step Four: Add the answer from Step Three to the answer from Step Two:

$$3 + 24 = 27$$

Step Five: Add the check digit (in this case 3) to the answer from Step Four (27):

$$3 + 27 = 30$$

Step Six: This check digit must be a multiple of ten to be accurate, and the first digit of the answer (a multiple of ten) is used as the check digit.

Each time that a UPC is read by a barcode scanner, this calculation is automatically performed. If the check digit is different than the one that is calculated, then the computer knows that there is something wrong with the UPC.

## ◆ How Do Barcode Readers Work?

Because computers cannot read barcodes, they require an adapter called a "Barcode Reader" kit to scan products. The kit usually consists of a scanner, a decoder, and a cable that connects to a computer, cash register, or other computer embedded product. The scanner "reads" the barcodes -- looking at both the black lines and the size and spacing of blank space between bars. The decoder checks the number through the method above, and transmits the corresponding information about the item to the computer in text format. Depending upon the application, the information might be the price of a product, the expiration date of medicine, or blood types for a transfusion.

## ◆ How Are Engineers Involved?

Products, such as barcode readers, are originally designed and then continually improved by computer engineers, software engineers, electrical engineers, and others who work in teams to solve problems through engineered products. Products often go through a redesign process after launch to meet consumer needs. For example, barcode readers are now available in pen form, wireless forms, and can be built to withstand harsh environments -- the original designs were engineered for use in climate controlled grocery stores.