MATHEMATICS OF MERCHANDISING

FOURTH EDITION

A.P. KNEIDER

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A. P. Kneider

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Preface

This workbook outlines the basic mathematics involved in the operation of the retail enterprise and has been designed to supplement the fundamental course in retail merchandising and/or buying. The book is also intended to be used by employees and management trainees, who, through self-instruction, may better understand the principles and techniques of the mathematical concepts involved in the operation of retail stores.

After more than 30 years of teaching retailing and marketing to college and university students, the author has concluded that students are quicker to comprehend concepts when unnecessary and complicated calculations are avoided. With this in mind, the author's primary intention has been to provide the student or trainee with an understanding of the mathematical concepts of retailing without complicated arithmetical calculations. The application of computer technology and electronic calculators has simplified the mechanics of problem-solving situations throughout this book. Consequently, complicated and tedious calculations can be solved quickly by computer programs readily available to the retailer. However, an understanding of the concepts is essential to the successful operation of the retail store.

The problem situations presented in this book demonstrate practical situations that retail store personnel must address. Merchandise managers, buyers, store managers, merchandise controllers, and independent merchants are faced with decisions that require mathematical computations. An understanding of the concepts presented is more important to decision makers than is the mathematical computation.

This workbook has been designed to facilitate the instructor's presentation of the material to achieve maximum understanding of the concepts. The author's classroom experience has revealed that the method of presentation used in this book reduces the amount of confusion encountered in solving business problems mathematically.

To accomplish the established objectives, this edition has been divided into six parts. Part I begins with an introduction and discussion of the terms of purchase that the merchant or buyer negotiates with suppliers in the acquisition of merchandise for the store. An understanding of this section is essential to obtaining the best discounts and transportation terms in order to acquire the merchandise inventory at the best price.

Part II explores the understanding of individual markup and the planning and calculation of average markups for the retail store. Since the retailer normally is not able to obtain the same profitability on all merchandise carried in the store, the overall planning of markup is essential to the success of the operation. Part III continues the discussion of the differences between the markup with which the store begins (the initial markup) and the markup finally realized in maintained markup and gross margin. In this discussion, the effect of markdowns and other reductions on the store's overall markup is examined.

Part IV examines the two methods of inventory valuation retail stores use in establishing the value of the closing inventory in its accountability of profit. Consequently, this section explores both the cost method and the retail method of inventory valuation.

Part V identifies and explains the planning and control functions of the retail enterprise. A complete understanding of this section of the book is important in planning sales, inventory, and buying and in reaching predetermined objectives.

Finally, Part VI explores the fundamentals of measuring a retail operation's performance through financial statements and basic financial ratios.

Each of these parts is divided into chapters, which discuss the various components of the concepts. To facilitate the presentation of the material, each chapter is divided into three areas:

1. *Sample Example.* Problem types are introduced with sample examples that the instructor may solve with the students. A fully explained solution to the sample problem is given with each example. Students, employees, and management trainees consequently can use the book as a self-instruction manual.
2. *Problem.* After each sample example, a problem is presented for the student to solve in the presence of the instructor or at his or her own pace. The answer to the problem is provided.
3. *Summary problems.* At the end of the chapter a group of summary problems is presented to allow the students and trainees to examine their understanding of the concepts presented. The answers to these problems are also given to allow the students to check the accuracy of their answers.
4. *Answers.* The answers to the problems students are asked to solve have been placed at the end of the book to permit easy access for checking the solution.

The student will also note that a series of Review Problems is presented after each group of two or three chapters. These problems have been presented without workspace after each question. The purpose of these Review Problems is to ensure that the student or trainee has grasped the concepts presented in each part of the workbook and to assist in the preparation for written tests. The student is asked to solve these problems without referring back to individual chapters and examples; this ensures that the solutions are understood rather than memorized. In addition, the author has attempted to bring together some of the concepts presented in the chapters into one problem or group of problems.

Instructors are encouraged to supplement workbook assignments with additional merchandising theory to relate the concepts to actual retailing experiences. Various charts and exhibits are provided to help instructors and students understand the concepts presented.

It is hoped that the students will find the appendixes to the workbook useful in understanding the material presented. Appendix A reviews basic arithmetical calculations to ensure an understanding of the fundamentals. Appendix B provides the student with a table of fractional equivalents for selected percentages that will facilitate the calculations required. A summary of the various formulae that have been developed and used throughout the workbook to solve the problems have been included in Appendix C. Appendix D provides the reader with a summary of selected merchandising and operating data used by department and specialty stores in planning retail operations.

The answers to the problems presented have been included at the end of the book. ***Students should note that their answers may vary slightly from those presented in the workbook. These differences are generally due to the use of different methods of rounding off fractional portions of whole numbers and decimals. Students and instructors are asked to use their judgment regarding these variances. In the answers, the author has taken the calculations to three decimal places and rounded these to two decimal places. In the calculation of stock turnover, the industry practice is to take the calculation to two decimal places and round this to one. In this context, the author has also followed industry practice.***

The author wishes to express his thanks to his past and present students, who, perhaps unknowingly, have helped the author determine the most effective means of presenting these mathematical concepts. This workbook is dedicated to all of these students.

A. P. Kneider,
Toronto, Ontario,
Canada

Contents

Part I

TERMS OF PURCHASE

VOCATIONAL APPLICATION

The material in this section examines those areas of buying that all independent store owners, buyers, managers and other retail employees buying merchandise for resale in a retail operation need to understand. The fundamental aspects of negotiating terms and the conditions of purchasing merchandise and/or services are vital elements of retailing strategy. These elements will establish a sound relationship between the suppliers and the merchant.

Merchandising is said to be the process of acquiring the right merchandise, at the right price, in the right quantity, at the right time, and in the right place. In this retailing activity of purchasing merchandise for resale, retailers are constantly in the process of negotiating with suppliers for buying terms that will improve the profitability of the firm.

Consequently, an important aspect of the buying function of retailers involves the terms under which the goods are purchased. Frequently, these terms include a discount or other conditions that will induce the buyers to place orders with specific suppliers. It should be noted that these terms, which are negotiated between buyer and seller, may vary depending upon market conditions and will also vary from one trade to another. The standard terms of purchase that are found in the merchandising of shoes may in fact be significantly different from those negotiated between a hardware merchant and his supplier.

It is possible to combine rates of discount, dating, and other conditions into a wide variety of buying terms, but no attempt will be made here to discuss all the possible combinations. Only those terms and elements of the terms that occur with some frequency will be discussed. In our democratic system, the vendor may offer any terms he or she wishes to a retailer, provided that such terms do not violate any statute of law and do not prove detrimental to the public's interest.[1]

[1]Students who wish to investigate further the legal implications of granting terms of purchase should analyze the Robinson-Patman Act in the United States and the Combines Investigations Act in Canada. Both Acts prohibit the seller from offering discriminatory terms to buyers.

For purposes of our discussion of the various terms of purchase available to the retailer, Part I of this book has been divided into trade discounts, cash discounts and dating, and shipping terms. The student will observe that these aspects of the buying function of retail stores are vital in negotiating the profitable acquisition of merchandise.

The terms of purchase that have been negotiated between buyer and seller are defined on the purchase order and subsequently appear on the invoice that is received upon delivery of the goods to the store. The invoice confirms the following three areas of terms of purchase that need to be negotiated:

1. Trade discount
2. Cash discount and dating
3. Shipping terms.

When buyers place orders with suppliers after negotiating terms of sale, it is always advantageous to utilize the store's own order forms rather than use those supplied by the vendor. In this way the buyer is able to standardize the order system and provide the retailer with order forms that will be uniform in size and numbered and consequently easily filed. An example of such an order form is given in Fig. 1.1. This order form is made in triplicate, with the original going to the vendor, the duplicate to the retailer's office for processing, and the third to the department responsible for writing the order or the receiving room, and it is used to check the goods as they arrive.

The remainder of Part I explores the variations in each of these elements outlining the terms of the purchase.

COLONY DEPARTMENT STORES,

PURCHASE ORDER

RETAIL SALES TAX PERMIT 98130776
GST #46397

R 187089

Store No. | Store Event

Div. No.

SHOW ALL ABOVE NOS. ON ALL INVOICES, CASES, PACKING SLIPS, BILLS OF LADING AND CORRESPONDENCE

STREET ADDRESS _____ Ship to above address unless otherwise stated

CITY & PROVINCE _____

SOURCE NAME & ADDRESS _____

Date of order | Ship on.

Authorized Signature _____

DETACH AT PERFORATION BEFORE MAILING

Write Clearly

THIS SECTION FOR RETAIL USE ONLY. NOT TO BE SENT TO SUPPLIER

SHIPPING INSTRUCTIONS	INSURANCE OR DECLARED VALUE	Shipment Complete ☐ Partial ☐

TERMS	TRADE DISCOUNT	F.O.B.	TRANSPORTATION ALLOWANCE

Colony Stock No.	Mfg. Stock No.	Description	Size → Color →	Order Quantity	Buying Unit	Cost Price	Unit Selling	Selling Unit	Markup

CANADIAN SUPPLIERS –

MAIL INVOICE SAME DAY MERCHANDISE SHIPPED ALONG WITH SHIPPING RECEIPT DIRECT TO RETAIL STORE SHOWN ABOVE

UNITED STATES SUPPLIERS –

DO NOT MAIL M.A. INVOICES DIRECT TO RETAIL STORES. REFER TO ATTACHED INSTRUCTION SHEET "HOW TO COMPLETE CANADIAN CUSTOMS FORM M.A."

TOTAL SELLING

$ | ¢

FIG. 1.1 The Purchase Order

Chapter 1

Trade Discounts

Some sources of supply prefer to establish the prices at which the retailer may sell the merchandise. In the trade, these prices are referred to as the **suggested list price (SLP), suggested retail price (SRP), recommended selling price (RSP),** or **manufacturer's list price (MLP).** Some countries and some sections of certain countries have made it illegal for the supplier to dictate the price at which goods **must** be sold by the retailers. The law prohibiting such practices is known as the **resale price maintenance law.** As a result, in countries, states, or provinces where resale price maintenance (RPM) is illegal, we almost always find the term *suggested* or *recommended* list price on the manufacturer's price list. Although resale price maintenance is illegal in some parts of the United States and Canada, in some cases manufacturers have, through moral suasion and other techniques, been able to convince retailers that the merchandise should be sold at the retail price suggested.

Consequently, for those suppliers who operate from a suggested selling price, the method of determining the price the retailer will pay for merchandise requires the establishment of a discount. It should be obvious that this will not be required by suppliers who quote wholesale prices rather than selling prices to potential retail buyers.

When the suggested list price is quoted, the price the retailer pays for the merchandise is determined by deducting from the list price a certain percentage called a ***trade discount.*** The resultant price, or price that the retailer pays for the merchandise, is known as the ***net price.*** It is this net price that becomes known as the merchant's ***cost price*** for the item.

Consider, for example, the merchant's cost for a crystal vase:

	Suggested List Price	$ 90.00
−	Trade Discount, 60%	54.00
=	Net Price, 40%	$ 36.00

In this case, the retailer will pay the supplier $36.00 (net price) for the crystal vase, after receiving a trade discount of 60%.

▶ Suggested List Price − Trade Discount = Net Price (Cost Price)

Trade discounts are used in much of the retail industry. The actual percentage discount offered to the retailer, however, varies among the different trades in the industry and with respect to the quantities purchased. Wholesalers are normally offered larger trade discounts from the manufacturer than are retailers, and by the same token, large retail chain and department store organizations may be offered a larger trade discount than are smaller independent retailers. The legality of offering different discounts on the basis of size has been challenged, but no clear-cut ruling has emerged.

In some cases, the manufacturer may offer the retailer a discount of more than one percentage. For example, a retailer may be offered a discount of 40% off the suggested retail price or may be given discounts of 25%, 10% and 5% off the list price. Although the offering of these three discounts does sum to 40%, the manner in which the three discounts are applied does not give the same net price to the retailer.

Example 1

Suggested List Price	$100.00
− Trade Discount, 40%	40.00
= Net Price, 60%	$ 60.00

Example 2

Suggested List Price	$100.00
− Trade Discount, 25%	25.00
= Net Price, First	$ 75.00
− Trade Discount, 10%	7.50
= Net Price, Second	$ 67.50
− Trade Discount, 5%	3.38
= Net Price, Third	$ 64.12

Since each discount in the series is taken from the preceding net amount, it can be seen that the resulting net price is not the same in both examples and, consequently, that the series discount of 25%, 10%, 5% is not the same as a trade discount of 40% (as one might expect by simply summing the three discounts). This series discount in fact provides for a total discount of only 35.88% ($25.00 + $7.50 + $3.38)/($100.00).

Manufacturers and other suppliers have attempted to use series discounts with various market conditions or on the basis of the bargaining power of large retailers. The retailer may have been offered a discount of 25% on the first order placed with the supplier and offered the additional discounts as a result of subsequent placings or reordering from the same supplier. Thus, series discounts suppliers have used to encourage repeat buying and to establish some loyalty among the retail clients.

In addition, trade discounts may be used when suppliers sell merchandise to retailers through catalogs, in which the vendor illustrates and describes the items carried and states the suggested retail prices of these items. The vendor encloses a separate sheet in the catalog which tells the merchant that the goods will cost him or her a certain percentage off list price. Since it takes months to compile and mail a catalog, the prices of some or all of the items in the catalog may change. If the supplier had to issue a new catalog with every price change, he or she would soon eliminate any profit. To deal with price fluctuations, therefore, the supplier simply mails additional discount notices to buyers.

DEFINITIONS

List Price. This price is referred to as the manufacturer's suggested retail price and is in fact the price or dollar amount to which the trade discount is applied in order to obtain the retailer's net (cost) price.

Trade Discount. This discount represents the dealer's discount from the suggested list price of the manufacturer or supplier and is offered to both the wholesalers and retailers. When the buyer is offered a cash discount for early payment of the invoice, **the trade discount is always taken before the cash discount.**

Series Discount. This discount represents the manufacturer's offering of more than one trade discount to a purchaser and is normally quoted in a fashion similar to 25%, 10%, 5%. As noted earlier, each discount in the series discount is taken from the preceding net amount before applying the next discount.

Single-Discount Equivalent. This discount represents the equivalent of the series discount that is offered and is expressed as a single percentage. As noted earlier, the single-discount equivalent of the series discount of 25%, 10%, 5% was calculated to be 35.88%. The purpose of obtaining the single-discount equivalent is to allow the buyer to compare his or her purchasing power within the trade and to allow for the planning of markup and profit.

Net Price. The net price represents the resultant figure after applying the trade discounts to the list price. It represents the retailer's cost price or the price that the buyer must pay for the merchandise that is being acquired for resale to the consumer.

On Percentage. This percentage represents the complement of the single-discount equivalent and is used to determine the net price when a series discount is used. The application of the on percentage to the suggested list price will immediately provide the net price to the buyer. Therefore,

▶ On Percentage = 100% − Single Discount Equivalent%

Quantity Discounts. These represent a discount in dollars or in percentage on the basis that the buyer will purchase a given quantity of merchandise. While it is not usual for a buyer to be offered a trade discount and a quantity discount on the same purchase, if this occurs, the trade discount is taken before the quantity discount. In addition, if the same invoice should also include a cash discount, then the cash discount is taken after the quantity discount. Quantity discounts are normally allowed to retailers on the basis of purchases that are concentrated with a supplier over a period of time, such as a season or year.

The following, then, expresses the order in which each of the discounts is taken in reference to the suggested list price in order to arrive at the net price:

(1)		SUGGESTED LIST PRICE
(2)	−	Trade Discount
(3)	−	Quantity Discount
(4)	−	Cash Discount
(5)	=	NET PRICE

Cumulative Discounts. These are discounts which vendors use to encourage customer loyalty. They are figured at the end of the period and are graded according to the total

amount of the purchases that the retailer has made for the period. They do not oblige the retailer to order heavily, but they tend to make him or her direct as much business as possible to a single supplier in the process of developing what are termed "key" sources of supply.

Therefore, we note that

1. **Trade discounts** are **given** to everyone in a certain category,
2. **Quantity discounts** and **cumulative discounts** are **given** to everyone who buys in sufficient quantities,
3. **Cash discounts** are **offered** to those who pay their invoices in a shorter time frame than custom dictates.

Example 1 **Finding the Net Price when a Trade Discount Is Given**

The manufacturer of a line of bone china figurines has a suggested list price for each figurine of $200.00. If the buyer is offered a trade discount of 40%, what will be the buyer's net price?

Solution By definition, the net price will be 60% of the list price since the buyer is offered a trade discount of 40%.

Therefore,

$$\$\ 200.00 \times 60\%$$
$$\$\ 200.00 \times .60 = \$\ 120.00$$

Problem 1 Determine the net price that a buyer will have to pay for a line of blankets that have a suggested list price of $75.00 if she is offered a trade discount of $33\frac{1}{3}\%$.

Example 2 **Finding the Net Price when a Series Discount Is Given**

Determine the net price on a line of pillowcases that will retail at $25.00 per pair if the linen buyer is given a series discount of 30%, 10%, 5%.

Solution

The net price for the pillowcases can be determined by applying the complements of the series discount to the suggested list price of the manufacturer.

Therefore,

$$\$\ 25.00 \times 70\% \times 90\% \times 95\% = \text{Net Price} = \$14.96$$

or

$$\$\ 25.00 \times 7/10 \times 9/10 \times 19/20 = \text{Net Price} = \$14.96$$

Thus, the net price of the pillowcases will be \$14.96 per pair.

Problem 2

A manufacturer offers a retailer a line of skis that have a suggested list price of \$360.00. In an effort to maintain good relations with the retailer, the buyer is offered a series discount of 30%, 20%, 10%. Find the net price of the skis if the buyer is offered the total series on this purchase.

Example 3 **Finding the Single-Discount Equivalent to a Series Discount**

Determine the single-discount equivalent to the series discount of 30%, 10%, 5% that has been offered to the linen buyer.

Solution

Let the list price equal 100%. Therefore,

$$\begin{aligned}\text{Net Price} &= 100\% \times 70\% \times 90\% \times 95\% \\ &= 100\% \times 7/10 \times 9/10 \times 19/20 \\ &= 59.85\%\end{aligned}$$

But

$$\text{List Price} - \text{Net Price} = \text{Single Discount Equivalent}$$

Therefore,

$$\begin{aligned}100\% - 59.85\% &= 40.15\% \\ \text{Single-Discount Equivalent} &= 40.15\%\end{aligned}$$

Problem 3 Calculate the single-discount equivalent of 30%, 20%, 5% which is offered to the ski buyer.

Example 4 **Finding the On Percentage of a Series Discount**

Find the on percentage of the series discount of 30%, 10%, 5% that was offered to the linen buyer in Example 3.

Solution By definition, the on percentage is the complement of the single-discount equivalent. The calculation is simply the difference between the single-discount equivalent and 100% (the list price).

$$\begin{aligned} \text{On Percentage} &= 100\% - 40.15\% \\ &= 59.85\% \end{aligned}$$

Problem 4 Determine the on percentage of the series discount 30%, 20%, 10% offered to the ski buyer.

Example 5 **Finding the List Price when the Net Price and Series Discount Are Given**

A furniture buyer is able to purchase a dining room set from a manufacturer for \$1,600 as a result of a series discount of 30%, 20%, 10%. Determine the price that the manufacturer would suggest as a retail selling price for the set.

Solution If we assume a list price of 100%,

$$\begin{aligned}\text{Net Price} &= 100\% \times 70\% \times 80\% \times 90\% \\ &= 50.4\%\end{aligned}$$

But, $\text{Net Price} = \$1{,}600$

Thus, $50.4\% = \$1{,}600$

and, $1\% = \$1{,}600/50.4 = \$31.75$

But, $\begin{aligned}\text{List Price} = 100\% &= 100 \times \text{Value of } 1\% \\ &= 100 \times \$31.75\end{aligned}$

Therefore, $\text{List Price} = \$3{,}175.00$

Problem 5 The same furniture buyer is able to purchase a less expensive dining room set from a different manufacturer that offers a series discount of 30%, 15%, 5%. After the series discount has been applied, the net price of the set is \$819.00. Determine the suggested retail price for the dining room set.

SUMMARY PROBLEMS

1. The suggested list price of a line of men's sweaters has been quoted to a buyer of men's apparel as $115.00, with a series discount of 30%, 20%, 15% offered. Determine the net price of these sweaters and the single-discount equivalent of this series discount.

2. A manufacturer of a line of hockey equipment has offered a series discount of 30%, 20% on a quality line of hockey sticks that will retail at $22.50. Find the net price of the hockey sticks to the store.

3. A furniture outlet was able to purchase a line of bedroom suites from a manufacturer at a net price of $1,606.50 after a series discount of 30%, 15%, 10%. Determine the suggested list price for one of these bedroom sets.