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Preparatory Program

Part 1

**Financial Reporting, Planning,
Performance, and Control**

Manufacturing Input Variances Sample

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Editorial Notes

Throughout these materials, we have chosen particular language, spellings, structures and grammar in order to be consistent and comprehensible for all readers. HOCK study materials are used by candidates from countries throughout the world, and for many, English is a second language. We are aware that our choices may not always adhere to “formal” standards, but our efforts are focused on making the study process easy for all of our candidates. Nonetheless, we continue to welcome your meaningful corrections and ideas for creating better materials.

This material is designed exclusively to assist people in their exam preparation. No information in the material should be construed as authoritative business, accounting or consulting advice. Appropriate professionals should be consulted for such advice and consulting.

Note: On the Exam, you may be asked a question about a variance of any component of a budget. For example, you may be asked to calculate the variable costs flexible budget variance. To answer this question, calculate the difference between the actual and the flexible budget amounts of variable costs and determine whether the variance is favorable or unfavorable.

If a question does not say which line to use, use either the contribution margin line or the operating income line. If the question asks for the volume variance, the variances on the contribution margin line and the operating income lines will be exactly the same, so it does not matter which line you use. The variances on these two lines are the same because the volume variance is the difference between the static budget amount and the flexible budget amount. The only difference between the contribution margin line and the operating income line is fixed costs, and fixed costs are exactly the same in the flexible budget as they are in the static budget. Therefore, the volume variance for the contribution margin line will be exactly the same as the volume variance for the operating income line.

The detail variances that we will cover in the following pages give more information than can be obtained from just looking at a flexible budget variance report or a static budget variance report. The sales volume variance for a single-product firm like the one in the two example variance reports above can be explained by the fact that the actual level of sales was different from the budgeted level of sales. We do need to investigate the cause or causes of the sales volume variance, but we don't need any more variance detail to do that. A sales volume variance can be caused by the state of the economy, actions of competitors, production problems at the plant that prevented the company from manufacturing enough product to meet the demand, or any number of other things.

Flexible budget variances identify variances that are caused by something other than the different-than-expected sales volume. Flexible budget variances can be caused by multiple factors, and it is important to investigate what the factors are that caused them in order to determine what changes need to be made. Additional variance detail can be calculated to assist in this determination.

In a single-product firm, the flexible budget variance for revenue is fairly easy to investigate. A flexible budget variance for a revenue item is called a **selling price variance** because it is caused exclusively by differences between the actual selling price per unit and the budgeted selling price per unit. To investigate this variance, the company needs to find out why the price actually charged was different from the budgeted price. If the actual price was lower than the budgeted price per unit, the reason may be competitive pressure. If the actual price was higher than the budgeted price, the reason may be increased demand putting upward pressure on the price.

When a company sells more than one product, revenue variances can be caused by other factors as well as by different prices being charged than were budgeted. Variances can also arise when a different **mix** of products is sold than was budgeted. Further details are needed to determine the causes of variances for a multi-product firm. The company needs to determine how the product mix sold differed from the budgeted mix, which product or products were sold for prices that differed from their budgeted amounts, how the actual manufacturing costs compare with the budgeted costs for each product, how much contribution margin was lost or gained as a result of each difference, and why the actual sales volumes and prices were different from the budgeted volumes and prices.

Level 3 variances can give us more information about the causes of the variances.

Sales Variances

1)	Flexible budget variance	}	Level 2 variances
2)	Sales volume variance		
2a)	Quantity variance*	}	Level 3 variances
2b)	Mix variance*		

* These specific sales variances are calculated only when the company sells more than one product.

Level 3 variances also include manufacturing input variances. Manufacturing input variances will be covered first, followed by sales variances, sales quantity, and sales mix variances.

Level 3 Variances: Manufacturing Input and Sales Quantity and Sales Mix Variances

Before examining the different individual variances in greater detail, we begin by listing the different variances to be studied. You need to know how to calculate each of these variances and understand what they mean. Additionally, you also must be able to identify possible causes of the different variances. The following are the variances that will be studied:

Manufacturing Input Variances:

Direct Materials Variances

- 1) **Price variance**
- 2) **Quantity or efficiency variance**
 - 2a) **Mix variance***
 - 2b) **Yield variance***

Direct Labor Variance

- 3) **Rate (price) variance**
- 4) **Efficiency (quantity) variance**
 - 4a) **Mix variance***
 - 4b) **Yield variance***

Factory Overhead Variances

- 5) **Total Variable overhead variance**
 - 5a) **Variable overhead spending variance**
 - 5b) **Variable overhead efficiency variance**
- 6) **Total Fixed overhead variance**
 - 6a) **Fixed overhead spending or budget variance**
 - 6b) **Fixed overhead production-volume variance**

Sales Variances

- 7) **Flexible budget variance**
 - 8) **Sales volume variance**
 - 8a) **Quantity variance****
 - 8b) **Mix variance****
- } **Level 2 variances**
- } **Level 3 variances**

* These specific manufacturing variances are calculated only when there is more than one input (either classes of labor or types of material) into the final product.

** These specific sales variances are calculated only when the company sells more than one product.

Note: The above list contains a lot of variances. However, the number of variances should not be a cause for discouragement. A number of these variances are simply variations on a theme. You do not need to memorize a separate formula for each variance.

Manufacturing Input Variances

Manufacturing input variances are a special class of variances. They include direct materials, direct labor, and manufacturing overhead **used in production**. These variances are concerned with **inputs** to the manufacturing process, as follows:

- Whether the amount of inputs used per unit manufactured was over or under the standard (a quantity, or efficiency, variance),
- Whether the inputs used cost more or less per unit than the standard (a price variance), and
- What the monetary impact was of each type of variance.

Manufacturing input variances are used in controlling production. Manufacturing input variances are also called flexible budget variances, and the flexible budget amounts used are based on the price and quantity of the **input allowed for the actual production**. Manufacturing input variances are reported on a production variance report, not on a report in the form of an income statement, because they report on units produced, not on units sold.

In the accounting system, manufacturing input variances are closed out at the end of each period to cost of sales or, if material, they are prorated among cost of sales, finished goods inventory, work in process inventory and, for direct material variances only, direct materials inventory.

The Difference Between Sales Variances and Production Variances

The variance reports seen so far have been sales variance reports, and they present only the results of units sold. Sales variances are Level 2 variances. In its variable manufacturing costs section, a Level 2 sales variance report presents the **total** flexible budget variance for variable manufacturing costs for units **sold**. This total flexible budget variance includes both the manufacturing input price and the manufacturing input quantity variances. They are presented on the report as one combined variance.

A production variance report, which is a Level 3 report, is required to present the detail behind the total flexible budget variance. However, a production variance report includes all units **produced**, whether they were sold or remained in inventory as unsold units at the end of the period.

Because a Level 2 sales variance report presents information on units sold and a Level 3 production variance report presents information on units produced, the two cannot be reconciled for a given reporting period unless the units that were sold are the same units as the units that were produced during the period. The total flexible budget variances for variable manufacturing costs on the Level 2 report cannot be broken down between manufacturing input price and quantity variances because the information needed to do that is not available.

Thus, Level 2 variances based on revenue and costs of units sold should not be expected to reconcile with the detail variances on a production variance report covering the same reporting period unless an exam question gives information that can be interpreted to mean that **the same units that were produced were the same units that were sold**.

For example, an exam question might say that the company is a new company that just started in business (thus beginning inventory was zero), and it sold all of its first period's production during its first period of operation. In that case, the company sold the same units as it produced. Other information given in the problem might also make it possible to reconcile the manufacturing input quantity variance and price variance on the production variance report to the total flexible budget variance on a sales variance report. But if the information given does not enable reconciliation, do not try to reconcile them, because it will not work.

What Causes Manufacturing Input Variances?

Before we get into the specific manufacturing input variances, consider the possible reasons for an actual input cost to be different from the standard (that is, expected or budgeted) cost. The standard cost is determined using an **estimated cost** and an **estimated level of usage**. Obviously, if a company either pays a different price for an input than had been budgeted or uses a different amount of the input than was budgeted for the actual level of output, or both, then the actual cost for the actual level of output will be different from the budgeted cost for the actual level of output.

The simple fact that the actual cost was different from the budgeted amount is not, by itself, very useful information to management. Management needs to know **why** the actual cost was different from the budgeted amount.

- Was it because a different amount of raw materials or labor was used than should have been used for the actual output?
- Was it because a different price per unit was paid for the raw materials or labor?
- Was it because of differences in both? (This is the most likely scenario.)

The process of variance analysis enables management to identify the specific reason or reasons for the variance and then the company can focus its efforts on the areas that have a negative impact on the business.

In variance analysis, we subdivide input cost variances into their two causes:

- 1) A **price variance** that reflects the difference between actual and budgeted input prices.
- 2) A **quantity variance**, also called an **efficiency variance**, that reflects the difference between actual and budgeted input **quantities used**.

Variance analysis exam questions are not difficult if you can master a conceptual understanding of these two basic causes of variances.

Summary of Manufacturing Input Variances

The following table summarizes the formulas and the terms used in variance analysis, and it is presented here as an overview of the material that will be covered in detail later. This table will appear again at the end of the topic of variances.

Prime Costs	Price Variance $(AP - SP) \times AQ$	Quantity Variance $(AQ - SQ) \times SP$
Materials	Price Variance	Quantity Variance
Labor	Rate Variance	Efficiency Variance
Multiple Inputs (both Material and Labor)	Mix Variance $(waspAM - waspSM) \times AQ$	Yield Variance $(AQ - SQ) \times waspSM$
Variable Overhead	Spending Variance $(AP - SP) \times AQ$	Efficiency Variance $(AQ - SQ) \times SP$
Fixed Overhead	Spending (Flexible Budget) Variance Actual OH – Budgeted OH	Production Volume Variance Budgeted OH – Applied OH

Direct Materials Variances

We start by looking at the variances related to direct materials and their usage.

The **total direct material variance** is also the **flexible budget variance** for direct material. The total direct material variance is easy to calculate. It is the difference between the actual direct materials costs for the period and the standard costs for the standard amount of materials at the standard price per unit **for the level of output actually produced** (the flexible budget).

Example: Medina Co. produces footballs. Each football requires a standard of 1 square meter of leather that has a standard cost of \$5. During the period, Medina produced 250 footballs and used 290 square meters of leather. The actual cost of the leather was \$4.50 per square meter.

The total actual cost of the leather used was \$1,305 (290 × \$4.50). However, given the actual output of 250 footballs, Medina should have used only 250 square meters of leather. Since each square meter should have cost \$5, Medina should have spent \$1,250 on leather in order to produce 250 footballs (250 × \$5).

The total direct materials variance is:

Actual cost – 290 meters × \$4.50	\$ 1,305
Standard cost – 250 meters × \$5.00	\$ <u>1,250</u>
Total variance	\$ <u>55</u> U

Medina spent more money than it should have for the leather to make the footballs. A manager might conclude that this situation is acceptable (it is an unfavorable variance, but it is not that large) and does not require any significant attention. However, a more in-depth examination reveals that the company used more materials than it should have but paid less for each square meter of leather than expected. Management will most certainly look at the production process to find out why so much leather was required to make 250 footballs.

Even though Medina's total actual cost came close to the total standard cost, there is a significant problem with production. The company may have a very inefficient process that wastes too much leather, or perhaps it has new workers who are not as experienced as they will be in the future. Perhaps the less expensive leather was more difficult to work with and therefore an excessive amount was spoiled in the production process. In any case, despite the total cost variance being small, Medina needs to investigate further the cause of the variance in its leather usage. This investigation of an unfavorable variance is an example of **management by exception**⁴⁶.

Because of the need for more useful analysis, the total materials variance is divided into two components: price and quantity. The **quantity variance (also called the efficiency or usage variance)** measures how much of the variance is due to using more or less direct material than budgeted, and the **price variance** measures how much of the total variance was caused by having paid a different amount for the material than had been budgeted.

The **quantity variance** plus the **price variance** equals the **total variance**, which is also the **flexible budget variance**.

⁴⁶ "Management by exception" refers to a system whereby only significant variances between actual results and the budget or plan are brought to the attention of management. Management by exception focuses management on the things that have the highest priority, defined as the greatest variances.

Note: In a system where variances are identified and reported to the appropriate level of the company, management can **manage by exception** once the standards have been set. As a result, management can focus time in areas where there are problems identified by an unfavorable variance. While management by exception allows management to focus on areas that have problems, the disadvantage of this method is that negative trends may be overlooked at earlier stages. Also, if too many deviations from the budget occur, this approach can become a very confusing and complex process of trying to fix all the problems at once. Management would need to decide which variances are the most important.

Management should look into the departments and divisions that have favorable variances, too. It is possible that one of the departments has adopted a new policy or procedure that might be beneficial in other departments. By overlooking favorable variances, management might be missing the opportunity to implement positive changes throughout the company.

The Quantity Variance

The **quantity variance** (also called the **efficiency** or **usage variance**) is calculated as:

$$\begin{aligned} & (\text{Actual Quantity} - \text{Standard Quantity for Actual Output}) \times \text{Standard Price} \\ & \text{or} \\ & \mathbf{(AQ - SQ) \times SP} \end{aligned}$$

This formula calculates the difference between the actual material usage and the standard usage for the level of actual output, multiplied by the standard price. The quantity variance formula is used to calculate the portion of the total variance that was caused by either too much or too little material having been used, without any reference to the amount of the variance that was caused by a difference between the actual and the standard price per unit of the material used. We multiply by the standard price in order to remove any effect of the price variance from the result.

Because this is a cost, a positive result in the formula is an unfavorable variance, while a negative result of the formula is a favorable variance.

In the example above, the **quantity variance** is calculated as:
 $(290 - 250) \times \$5 = \200

This is an **unfavorable variance** because it is a positive variance for a cost. The \$200 variance means that if the actual price had been the same as the standard price, Medina would have had to pay \$200 more than it should have for the materials used, given the number of footballs produced, because it used too much material.

The Price Variance

Though it is commonly called the "price variance" for materials, the more complete name for this variance is the "price usage variance." The variance is called the "price usage variance" to distinguish it from the "purchase price variance," which will be covered next. For the sake of brevity, from this point onward "price variance" will be used to mean the "price usage variance."

The price variance is calculated as:

$$\begin{aligned} & (\text{Actual Price} - \text{Standard Price}) \times \text{Actual Quantity} \\ & \text{or} \\ & \mathbf{(AP - SP) \times AQ} \end{aligned}$$

The price variance formula is used to calculate the portion of the total variance that was due to a difference between what was paid (the actual price) and the amount budgeted to be paid (the standard price) per unit of direct materials used.

In the example above, the **price variance** is calculated as:
 $(\$4.50 - \$5.00) \times 290 = \$(145)$

Medina saved \$145 because the price of the leather was lower than expected, a **favorable variance**. A negative variance for a cost is a favorable variance because it means the actual cost was lower than the budgeted cost. Even though Medina used more leather than it should have for each football it manufactured, it saved \$0.50 per square meter of leather actually used because the price was lower than expected.

The variance of \$(145) means that, because the price per square meter was lower than expected, the company's cost for direct materials was \$145 lower for the amount of materials it actually used than the standard cost for that quantity of materials.

Adding these two variances together results in the total materials variance.

Quantity variance	\$ 200	U
Price variance	<u>(145)</u>	F
Total Variance	<u>\$ 55</u>	U

In total, Medina had a positive variance of \$55, which is **unfavorable**, because the cost for the extra leather that was used was more than the savings on each square meter of leather used.

Materials Purchase Price Variance

A materials price variance computed at the time of purchase is called a **materials purchase price variance**. Note that this variance is called the "materials purchase price variance," which is different from the materials price usage variance we calculated above. The materials purchase price variance is calculated in exactly the same way as the materials price usage variance, except the AP (Actual Price) is the price paid for the materials during the period and the AQ (Actual Quantity) used in the formula is the quantity of direct materials **purchased**, not the quantity of direct materials **used**.

For better control, materials price variances should be determined as soon as materials are received, not when the materials are put into production. If the variance is not computed until the materials are requisitioned for production, corrective action will be more difficult because more time will have elapsed from the purchase.

If an exam question asks for the **purchase price variance**, calculate the purchase price variance using **all of the units purchased**, not just the units that were put into production. You need to be certain to notice the word "purchase" if it is used since it changes the way the variance is calculated. If an exam question is about the purchase price variance, it will give information that will enable you to know it is asking for the purchase price variance.

However, a question may not call the variance by its name of "purchase price variance." Instead, a question may describe the materials purchase price variance, to test whether you know what the materials purchase price variance is.

Exam Tip:

- If a question asks for the **materials price variance** (or **materials price usage variance**), use the units **used**, not the units purchased, in the variance calculation.
- If a question asks for the **materials purchase price variance**, or if the question says that the company recognizes variances **as early as possible** (or some other description of the materials purchase price variance), use the **quantity purchased** instead of the quantity used.

Most questions ask for the materials price usage variance, using the units placed into production. However, a question could be about the materials purchase price variance instead. Therefore, be aware of this possible variation.

Note: The materials price variance (or materials price **usage** variance) is calculated at the time of **usage**, while the materials **purchase** price variance is calculated at the time of **purchase**.

Note: On the exam, you will need to identify possible reasons why a particular variance is favorable or unfavorable. You should usually be able to do this by common sense. For example, an unfavorable quantity variance may be caused by the purchasing department having bought an inferior product that was damaged or broken, or it may be caused by new, untrained employees or poor techniques.

In the Medina Co. example, the variances could be due to the purchasing department's having gotten a good price on inferior leather that was damaged in the production process or was not always of an acceptable quality.

Accounting for Direct Materials Variances in a Standard Cost System

Standard costing systems use actual variance accounts to record the variances from the standard costs as they occur. The way the accounting is done depends upon whether materials price variances are recognized when the direct materials are purchased (materials **purchase price** variance) or when the direct materials are put into production (materials **price usage** variance).

Accounting for Materials *Purchase Price* Variances

Purchases of direct materials are recorded as debits to the Materials Inventory account at their **standard cost**, while the actual amount due the vendor is credited to Accounts Payable. Any difference between the actual price and the standard price for the quantity of materials purchased is recorded in the Materials Purchase Price Variance account.

When the direct materials are put into production, work-in-process inventory is debited for the standard cost of the amount of direct materials **allowed** for the actual units produced. The Materials Inventory account is credited for the standard cost of the **actual** amount of direct materials used for the actual units produced. The difference is debited or credited to the Materials Quantity Variance account.

In this system, the price variance is recognized when the materials are purchased, while the quantity variance is recognized when they are used. Also, in this system **inventory is valued at standard cost**.

See Example #1 that follows.

Example #1: Materials Purchase Price Variance

Prinz Company's standard cost for direct materials is \$8.00 per unit of direct materials. **Prinz recognizes materials price variances as soon as possible.** Two units of direct materials are allowed per unit produced. Prinz purchases 10,000 units of direct materials at \$7.50 per unit, for a total of \$75,000. When the materials are received on August 1, the cost accountants calculate the price variance as follows:

$$\begin{aligned} \text{Price Variance} &= (\text{AP} - \text{SP}) \times \text{AQ} \\ \text{Price Variance} &= (\$7.50 - \$8.00) \times 10,000 \\ \text{Price Variance} &= \$5,000 \text{ Favorable} \end{aligned}$$

Prinz records the receipt with the following entry:

Direct Materials Inventory/Control	80,000	[\$8.00 standard × 10,000 purchased]
Accounts Payable	75,000	[\$7.50 actual × 10,000 purchased]
Materials Purchase Price Variance	5,000	[\$0.50 favorable price variance × 10,000 purchased]

One batch consists of 4,000 units. On August 15, 8,200 units of direct materials are requisitioned and used to produce one batch. The cost accountants now calculate the quantity variance as follows:

$$\begin{aligned} \text{Quantity Variance} &= (\text{AQ} - \text{SQ}) \times \text{SP} \\ \text{Quantity Variance} &= (8,200 - 8,000) \times \$8.00 \\ \text{Quantity Variance} &= \$1,600 \text{ Unfavorable} \end{aligned}$$

The entry to record the usage of materials is:

Work-in-Process Inventory	64,000	[\$8.00 std. × 4,000 FG units × 2 units allowed/FG unit]
Materials Quantity Variance	1,600	[\$8.00 std. × 200 pcs. unfavorable quantity variance]
Direct Materials Inventory/Control	65,600	[\$8.00 std. × 8,200 pcs. actually used]

The balance of direct materials from this purchase of 10,000 units remaining in Direct Materials Inventory (also called Direct Materials Control) is \$14,400 (\$80,000 – \$65,600), representing 1,800 units on hand (10,000 units purchased – 8,200 units requisitioned) at the standard cost of \$8.00 per unit.

Accounting for Materials Price Usage Variances

Purchases of direct materials are recorded as debits to the Materials Inventory account at their **actual cost** and Accounts Payable is credited for the actual cost. **No variance is calculated at this time.**

When the direct materials are put into production, work-in-process inventory is debited for the **standard cost** of the amount of direct materials **allowed** for the actual units produced, and the Materials Inventory account is credited for the **actual cost** of the amount of direct materials **actually used** for the actual units produced. The difference between the two amounts is a combination of the price variance and the quantity variance. The amount for each variance is debited or credited to the Materials Quantity Variance account and debited or credited to the Materials Price Usage Variance account, as appropriate.

In this system, **materials inventory is recorded at its actual cost.**

See Example #2 that follows.

Example #2: Materials Price Usage Variance

Prinz Company's standard cost for direct materials is \$8.00 per unit of direct materials. **Prinz recognizes material price variances when the materials are used.** Two units of direct materials are allowed per unit produced. Prinz purchases 10,000 units of direct materials at \$7.50 per unit, for a total of \$75,000. When the materials are received on August 1, Prinz records the receipt with the following entry:

Direct Materials Inventory/Control	75,000	[\$7.50 actual × 10,000 purchased]
Accounts Payable	75,000	[\$7.50 actual × 10,000 purchased]

One batch consists of 4,000 units. On August 15, 8,200 units of direct materials are requisitioned and used to produce one batch. Prinz calculates the price and quantity variances for the units of direct materials used as follows:

$$\begin{aligned} \text{Price Variance} &= (\text{AP} - \text{SP}) \times \text{AQ} \\ \text{Price Variance} &= (\$7.50 - \$8.00) \times 8,200 \\ \text{Price Variance} &= \$4,100 \text{ Favorable} \end{aligned}$$

$$\begin{aligned} \text{Quantity Variance} &= (\text{AQ} - \text{SQ}) \times \text{SP} \\ \text{Quantity Variance} &= (8,200 - 8,000) \times \$8.00 \\ \text{Quantity Variance} &= \$1,600 \text{ Unfavorable} \end{aligned}$$

Compare these variances to those calculated in Example #1. The Quantity Variance is the same, but the Price Variance is different.

The entry to record the usage of materials is:

Work-in-Process Inventory	64,000	[\$8.00 std. × 4,000 FG units × 2 units allowed/FG unit]
Materials Quantity Variance	1,600	[\$8.00 std. × 200 pcs. unfavorable quantity variance]
Direct Materials Inventory/Control	61,500	[\$7.50 actual × 8,200 pcs. actually used]
Materials Price Usage Variance	4,100	[\$0.50 favorable price variance × 8,200 pcs. used]

Compare this entry with the entry made in Example #1. The amounts debited to work-in-process inventory when the materials are put into production are the same: 8,000 standard quantity × \$8.00 standard price, or \$64,000. However, the balances remaining in Direct Materials Inventory (or Direct Materials Control) are different. The balance remaining in Example #1 was \$14,400 (1,800 units at \$8.00 per unit). The balance remaining in this example is \$13,500 (1,800 units at \$7.50 per unit). The balance of direct materials in Materials Inventory/Control can also be calculated as \$75,000 minus \$61,500.

There is a difference in the materials inventory balance between the two examples because in Example #1 when the materials are received, they are debited to materials inventory/control at their standard cost, whereas in Example #2 the materials are debited to materials inventory/control at their actual cost, which in this example is lower than the standard cost.

Recording the variances in separate variance accounts accomplishes two things:

- 1) It isolates the variances so they can be analyzed.
- 2) It maintains standard costs in the Work-In-Process Inventory accounts during the production process.

At the end of the period, the variances are closed out, either to cost of goods sold or, if they are material, they should be prorated among direct materials inventory, work-in-process inventory, finished goods inventory, and cost of goods sold.⁴⁷

⁴⁷ According to US federal income tax regulations, for tax reporting significant standard cost variances must be apportioned between inventories and cost of goods sold. If the variance amount is not significant relative to total incurred costs, allocation between inventories and cost of goods sold is required **only** if the company allocates the variances in its financial reporting. See *Code of Federal Regulations*, Sections 1.471-11(d)(3) and Section 1.263A-1(f)(3)(ii)(B) for the tax statutes.

Note: Over a long enough time period, both methods will produce the same total expenses and profits because in the long-term all expenses will go to the income statement. The difference between these methods is one of allocation between periods, not a question of totality.

Exam Tip: For the exam you need to be able to use these formulas to solve for the variance itself and also to solve for any of the individual variables in these formulas.

For example, each variance uses three amounts to calculate the variance. In a straightforward question, the variance is the unknown. The amounts for the formula (AP, SP, AQ, or SQ) are on the left side of the equals sign and the calculated variance is on the right.

Instead, you may be given the variance and two of the amounts for the formula (or you may be given enough information to determine what they are) and to answer the question, you will need to solve for the third amount on the left side of the equals sign, which will be the unknown. To do the calculation, you will simply use the same formulas but use algebra to solve for a different unknown.

The following information is for the next three questions: ChemKing uses a standard costing system in the manufacture of its single product. The 35,000 units of raw material in inventory were purchased for \$105,000, and 2 units of raw materials are required to produce 1 unit of final product. In November, the company produced 12,000 units of product. The standard cost for material allowed for the output was \$60,000, and there was an unfavorable quantity variance of \$2,500.

Question 98: ChemKing's standard price for one unit of material is:

- a) \$2.00
- b) \$2.50
- c) \$3.00
- d) \$5.00

Question 99: The units of material used to produce November output totaled:

- a) 12,000 units.
- b) 12,500 units.
- c) 23,000 units.
- d) 25,000 units.

Question 100: The materials price variance for the units used in November was:

- a) \$2,500 unfavorable.
- b) \$11,000 unfavorable.
- c) \$12,500 unfavorable.
- d) \$3,500 unfavorable.

(CMA Adapted)

Question 101: Garland Company uses a standard cost system. The standard for each finished unit of product allows for 3 pounds of plastic at \$0.72 per pound. During December, Garland bought 4,500 pounds of plastic at \$0.75 per pound, and used 4,100 pounds in the production of 1,300 finished units of product. What is the materials price variance for the month of December?

- a) \$117 unfavorable.
- b) \$123 unfavorable.
- c) \$135 unfavorable.
- d) \$150 unfavorable.

(CMA Adapted)

Question 102: Price variances and efficiency variances can be key to the performance measurement within a company. In evaluating performance, all of the following can cause a materials efficiency variance except the:

- a) Performance of the workers using the material.
- b) Actions of the purchasing department.
- c) Design of the product.
- d) Sales volume of the product.

(CMA Adapted)

Direct Labor Variances

As with the materials variance, the **total labor variance** (also called the **flexible budget variance**) is the difference between the standard labor costs allowed for the actual level of output (the flexible budget) and the actual labor costs incurred by the company. Also similar to the materials variance, this total variance is attributable to variances in both labor rates and labor usage, meaning that the company either paid a different wage rate than standard, used a different number of labor hours than standard for this level of output, or did both.

Because the direct labor variances are so similar to variance analysis for materials, they will not be covered in detail again. Briefly, the total labor variance can be broken down into the labor rate variance (a price variance) and the labor efficiency variance (a quantity variance). Direct labor price and quantity variances are calculated in the exact same manner as the direct material price and quantity variances; but, when direct labor is analyzed, different names are used for the price and quantity variances.

The Direct Labor Rate Variance

The direct labor rate variance is calculated in the same manner as the direct materials price variance:

$$(\text{Actual Rate} - \text{Standard Rate}) \times \text{Actual Hours}$$

or

$$(\mathbf{AP} - \mathbf{SP}) \times \mathbf{AQ}$$

The Direct Labor Efficiency Variance

The direct labor efficiency variance is calculated the same manner as the direct materials quantity variance:

$$(\text{Actual Hours} - \text{Standard Hours for Actual Output}) \times \text{Standard Rate}$$

or

$$(\text{AQ} - \text{SQ}) \times \text{SP}$$

Exam Tip: As with direct material variances, for the exam you need to be able to use these formulas to solve for the variance itself and also to solve for any of the individual variables in these formulas.

For example, each variance uses three amounts to calculate the variance. In a straightforward question, the variance is the unknown. The amounts for the formula (AP, SP, AQ, or SQ) are on the left side of the equals sign and the calculated variance is on the right.

Instead, you may be given the variance and two of the amounts for the formula (or you may be given enough information to determine what they are) and to answer the question, you will need to solve for the third amount on the left side of the equals sign, which will be the unknown. To do the calculation, you will simply use the same formulas but use algebra to solve for a different unknown.

Accounting for Direct Labor Variances in a Standard Cost System

The production payroll is recorded by debiting Work-In-Process Inventory for the total number of **standard hours for the units manufactured** at the **standard hourly rate**. The credit is to accrued payroll at the **total number of hours actually spent** and at the **actual hourly rate**. The difference between the two is recorded in the Direct Labor Rate Variance (the price variance) and the Direct Labor Efficiency Variance (the quantity variance) accounts. For both the Rate Variance and the Efficiency Variance, unfavorable variances are recorded as debits and favorable variances are recorded as credits.

As with direct materials variances, direct labor variances are closed out at the end of the period, either to cost of goods sold or, if they are material, prorated among work-in-process inventory, finished goods inventory, and cost of goods sold.⁴⁸

Unlike the direct materials price variance, there can be no purchase price variance for direct labor because labor cannot be bought and stored the way materials can be.

Note: The company must decide how the costs of employee-related costs, such as employee benefits and payroll taxes, will be treated. These costs may be included in the cost of direct labor or treated as an overhead and allocated to the units produced in that way. The method in which these costs are treated may have a small effect on cost of goods sold, income, or inventory. Only in cases where direct labor is a large portion of the total expenses will this difference be significant.

Question 103: An unfavorable direct labor efficiency variance could be caused by a(n):

- a) Unfavorable variable overhead spending variance.
- b) Unfavorable materials usage variance.
- c) Unfavorable fixed overhead volume variance.
- d) Favorable variable overhead spending variance.

(CMA Adapted)

⁴⁸ According to US federal income tax regulations, for tax reporting significant standard cost variances must be apportioned between inventories and cost of goods sold. If the variance amount is not significant relative to total incurred costs, allocation between inventories and cost of goods sold is required **only** if the company allocates the variances in its financial reporting. See *Code of Federal Regulations*, Sections 1.471-11(d)(3) and Section 1.263A-1(f)(3)(ii)(B) for the tax statutes.

The following information is for the next three questions: Jackson Industries employs a standard cost system that carries direct materials inventory at standard cost. Jackson has established the following standards for the prime costs of one unit of product:

	<u>Standard Quantity</u>	<u>Standard Price</u>	<u>Standard Cost</u>
Direct Materials	5 pounds	\$3.60 per pound	\$18.00
Direct Labor	1.25 hours	\$12.00 per hour	<u>15.00</u>
			\$33.00

During May, Jackson purchased 125,000 pounds of direct material at a total cost of \$475,000. The total factory wages for May were \$364,000, 90% of which were direct labor. Jackson manufactured 22,000 units of product during May, using 108,000 pounds of direct materials and 28,000 direct labor hours.

Question 104: The direct materials usage (quantity) variance for May is:

- a) \$7,200 unfavorable.
- b) \$7,600 favorable.
- c) \$5,850 unfavorable.
- d) \$7,200 favorable.

Question 105: The direct labor price (rate) variance for May is:

- a) \$8,400 favorable.
- b) \$7,200 unfavorable.
- c) \$8,400 unfavorable.
- d) \$6,000 unfavorable.

Question 106: The direct labor usage (efficiency) variance for May is:

- a) \$5,850 favorable.
- b) \$6,000 unfavorable.
- c) \$5,850 unfavorable.
- d) \$6,000 favorable.

(CMA Adapted)

More than One Material Input or One Labor Class

Thus far we have outlined the variance analysis process when we have only one material input into the product or only one class of labor. (Each class of labor has a different wage rate).

A total variance, a price variance, and a quantity variance are still calculated in situations where more than one direct material input or more than one class of labor is used in producing the product. The difference when multiple inputs are used (called a mix of inputs) is that the quantity variance is broken down into two sub-variances: the **mix variance** and the **yield variance**.

The **mix variance** shows the portion of the quantity variance that resulted because the actual **mix** was different from the standard mix (that is, more of one ingredient was used and less of another ingredient was used). The **yield variance** shows the portion of the quantity variance that resulted because the **total** actual amount of all ingredients used was different from the **total** standard amount.

In a situation with multiple inputs, the price variance is not broken down the way the quantity variance is.

Note: The mix of inputs (labor or materials) is called a **weighted mix**. To calculate the mix and yield variances for a given batch, we will need to calculate the weighted average standard price of the **actual mix** used in the batch and the weighted average standard price of the **standard mix** for the batch.

Total Variance of a Weighted Mix

The **total variance** of a weighted mix is the **Total Actual Cost** for labor or materials minus the **Total Standard Cost** for labor or materials.

We will illustrate all of these variances in a numerical example at the end of this section. In that example, we will be producing cereal using several different grains, so we will use cereal also in the smaller examples leading up to the large example.

Here are the facts that will be used in the examples that follow:

A company produces cereal made up of different grains. The material prices in effect for the fiscal year ending June 30 and the standard kilograms (kg) allowed for the output of April are:

	<u>Standard Price/Kg</u>	<u>Standard Kg for Output</u>	<u>Standard Cost</u>
Corn	\$10.00	250	\$2,500.00
Wheat	\$ 8.00	250	2,000.00
Rice	\$ 3.00	<u>250</u>	<u>750.00</u>
		<u>750</u>	<u>\$5,250.00</u>

Due to several natural disasters around the world, the price for each input increased on January 1. The standard prices were not revised, and the actual output in April was the same as planned.

The actual material prices and the actual usage for April were as follows:

	<u>Actual Price</u>	<u>Actual Usage</u>	<u>Actual Cost</u>
Corn	\$12.00	375	\$4,500.00
Wheat	\$ 8.50	200	1,700.00
Rice	\$ 5.50	<u>325</u>	<u>1,787.50</u>
		<u>900</u>	<u>\$7,987.50</u>

Materials Price Variance (or Labor Rate Variance) of a Weighted Mix

The price variance of a weighted mix is the sum of the price variances for each component of the mix, each one calculated individually using the formula $(AP - SP) \times AQ$.

We will calculate a price variance for each separate input, and these individual price variances are then summed to calculate the total materials price variance.

Total Materials *Quantity* or Labor *Efficiency* Variance of a Weighted Mix

The **total** materials quantity or labor efficiency variance of a weighted mix is the sum of the quantity variances for each component of the mix, each one calculated individually.

The formula $(AQ - SQ) \times SP$ is used to calculate the quantity variance for each component of the mix separately. The individual quantity variances are then summed to calculate the total quantity variance.

Because more than one material is used in the production process, we cannot use the total materials quantity variance to determine exactly why the variance occurred. The variance may have occurred simply because a different total volume of materials was used in production (though the individual materials were used in the correct ratio). Alternatively, it may have occurred because a different mix of materials was used, even though the total volume of the materials used was equal to the standard. Of course, the variance could have also been caused by differences from the standards for both the total volume and the mix.

“A different mix” means that the actual ratio of the inputs into the product was different from the standard ratio of inputs for the product. In the example used here, instead of the input mix for cereal consisting of equal parts of corn, wheat and rice, it turned out to be 42% corn, 22% wheat, and 36% rice. The total volume of corn, wheat, and rice may have been equal to the total standard volume of 750 kilograms allowed for April’s production, though in this example it was 900 kilograms instead. Regardless of the total volume used, because the ratio of the inputs used was different from the standard ratio of inputs, a total materials quantity variance arose.

When we break down this total materials quantity or labor efficiency variance into two sub-variances (the **mix** and the **yield** variances) we are able to see how much each of these factors contributed to the total quantity variance. (The same process for calculating the mix and yield variances is used for labor and materials.)

1) The *Mix* Variance (Materials or Labor)

Note: This is the first of the two sub-variances of the total quantity variance.

The mix variance is the portion of the quantity variance that results from the actual mix of materials used or the actual mix of the labor used being different from the standard mix that should have been used. Returning to the cereal example, the cause of a mix variance would be including a higher percentage of corn and rice and a lower percentage of wheat in the cereal than called for by the standard.

A mix variance could occur if the company’s inventory of wheat is low and it deliberately substitutes corn and rice for a portion of the wheat required. A mix variance could also occur accidentally if, for example, the wrong proportions are used when the materials are added to the production process.

Note: Variances are calculated in order to determine the cause or causes of variances from the standard, or planned, amounts. Once the variances have been calculated, the person who made the decisions that resulted in each variance should be responsible for explaining why the variance occurred. Responsibility for explaining a mix variance should be given to an individual **only** if that person actually had control over the mix and over substitutions made in the mix during the reporting period when the variance arose.

The formula used to calculate the mix variance is a variation of the **price variance** formula: $(AP - SP) \times AQ$. Instead of using the actual and standard prices for the input, we use **weighted average standard prices**. We calculate the weighted average standard price of the **actual** mix and the weighted average standard price of the **standard** mix, as follows:

- 1) The **weighted average standard price of the actual mix**: the actual quantity used for each input is multiplied by the standard cost for that input, the products are summed, and the sum is divided by the total volume of all inputs used. The result is the weighted average standard price of one unit of the actual mix.

The weighted average standard price that results from this calculation is how much one standard input **should** have cost, based on the actual mix used. In the example of cereal, at the end of April we

determine the actual mix used in the production of cereal and calculate how much one kilogram of this actual mix of grains (42% corn, 22% wheat, and 36% rice) **should** have cost. In order to calculate how much one kilogram of the actual mix **should** have cost, we use the standard price for each input.

The weighted average standard price of the actual mix cannot be calculated until after the end of the reporting period, because the actual inputs used cannot be known until that time.

- 2) The **weighted average standard price of the standard mix**: The standard quantity of each input **allowed for the actual output** is multiplied by the standard cost for each input, the results are summed, and the sum is divided by the total volume of all inputs allowed for the actual output.

The weighted average standard price for the standard output that results from this calculation is how much one standard unit of the mix **should** have cost, based on the standard mix allowed for the actual output. In the example of cereal, we determine how much one kilogram of the standard mix allowed for the actual output (1/3 each of corn, wheat and rice) **should** have cost.

The weighted average standard price of the standard mix can be calculated at the beginning of the period even though the actual output is not known at that point. The weighted average standard price of the standard mix will be the same regardless of the volumes used for each input in the calculation, as long as the standard cost per kilogram of each input and the standard ratio of the inputs to one another are used in the calculation.

Calculations of the weighted average standard price of the actual mix and the weighted average standard price of the standard mix will be demonstrated in the comprehensive example that follows this explanation. (It is not as bad as it sounds.)

The mix variance is calculated as follows:

$$\left(\begin{array}{l} \text{Weighted Average Standard Price of the **Actual** Mix} \\ - \\ \text{Weighted Average Standard Price of the **Standard** Mix} \\ \text{(both calculated using the **Standard Price**)} \end{array} \right) \times \text{Actual Quantity of all material or labor inputs}$$

or

$$(\text{waspAM} - \text{waspSM})^{49} \times \text{AQ}$$

Note: the way the mix variance is calculated is similar to the way a price variance is calculated, because a price variance is calculated as $(AP - SP) \times AQ$. However, the mix variance is not a price variance. The mix variance formula uses the **standard** price of both the actual mix and the standard mix.

To calculate the amount of any variance caused by a difference between the actual and the standard values of one variable, we isolate the actual and the standard for that variable within the parentheses. In the mix variance, we are calculating the amount of variance caused by a difference between the actual mix and the standard mix, so the mix is the item that must vary within the parentheses.

To isolate the difference between the actual mix and the standard mix, we need to use the same price for both mixes. Therefore, we use the "weighted average standard price" for both mixes and the variable that differs is the mix: actual mix (AM) versus standard mix (SM).

⁴⁹ Note: "waspAM" and "waspSM" are abbreviations that are unique to HOCK study materials, as is the method presented here for calculating the mix and yield variances. The method presented here is simpler than the method taught in most cost accounting textbooks, and it results in the correct variances. If you use these abbreviations in an answer to an exam essay question, you should explain what they stand for so that the grader can understand what you are doing.

2) The *Yield Variance* (Material or Labor)

Note: This is the second of the two sub-variances of the total quantity variance.

The yield variance results from a difference between the **total actual quantity** of the inputs that were used to produce the actual output and the **total standard quantity** of inputs that should have been used to produce the actual output.

The formula to calculate the yield variance is a variation of the **quantity variance** of the mix: $(AQ - SQ) \times SP$. Instead of using the standard price of a single input, we use the **weighted average standard price of the standard mix, or waspSM**. (This is the same waspSM as was used in the calculation of the mix variance [above].)

The yield variance is calculated as follows:

$$\left(\begin{array}{l} \text{Actual Total Quantity of All Inputs} - \\ \text{Standard Total Quantity of All Inputs} \end{array} \right) \times \begin{array}{l} \text{Weighted Average Standard Price} \\ \text{of Standard Mix of All Inputs} \end{array}$$

or

$$(AQ - SQ) \times \text{waspSM}$$

Note: In the formula above, the actual quantity of input to the product (AQ) is equal to the **total** kilograms or hours (or whatever else) **actually used** to produce the actual level of output.
 The standard quantity of input to the product (SQ) is equal to the **total** kilograms or hours (or whatever else) that **should have been used** to produce the actual level of output.

Note: Remember, if a product has only one input, there is no need to calculate these two additional variances.

The total variance, the price variance, the quantity variance, and the materials mix and yield variances are calculated on the following pages in the comprehensive example for the weighted cereal mix.

Example: We will use the following information to calculate the following variances and items:

- 1) Total variance
- 2) Materials price variance
- 3) Materials quantity variance
- 4) Weighted average standard price of the standard mix (waspSM)
- 5) Weighted average standard price of the actual mix (waspAM)
- 6) Mix variance
- 7) Yield variance

A company produces cereal made up of different grains. The material prices in effect for the fiscal year ending June 30 and the standard kilograms (kg) allowed for the output of April are:

	<u>Standard Price/Kg</u>	<u>Standard Kg for Output</u>	<u>Standard Cost</u>
Corn	\$10.00	250	\$2,500.00
Wheat	\$ 8.00	250	2,000.00
Rice	\$ 3.00	<u>250</u>	<u>750.00</u>
		<u>750</u>	<u>\$5,250.00</u>

Due to several natural disasters around the world, the price for each input increased on January 1. The standard prices were not revised, and the actual output in April was the same as planned.

The actual material prices and the actual usage for April were as follows:

	<u>Actual Price</u>	<u>Actual Usage</u>	<u>Actual Cost</u>
Corn	\$12.00	375	\$4,500.00
Wheat	\$ 8.50	200	1,700.00
Rice	\$ 5.50	<u>325</u>	<u>1,787.50</u>
		<u>900</u>	<u>\$7,987.50</u>

1) Total Variance

The total variance is the difference between the **standard cost for the actual level of output** and the **actual cost**. The standard cost for April was \$5,250. The actual cost for April was \$7,987.50. This gives a **total unfavorable variance of \$2,737.50**, which is broken down into the price and the quantity variances as below.

2) Materials Price Variance

The materials price variance is calculated by determining the price variance for each of the three products individually and summing them. The formula is $(AP - SP) \times AQ$ and the 3 calculations are:

Corn	$(\$12 - \$10) \times 375$	=	\$ 750.00
Wheat	$(\$8.50 - \$8) \times 200$	=	100.00
Rice	$(\$5.50 - \$3) \times 325$	=	<u>812.50</u>

Total Materials Price Variance **\$1,662.50 Unfavorable**

3) Materials Quantity Variance

The total materials quantity variance is calculated by using the usage formula $(AQ - SQ) \times SP$ for each of the classes individually and then summing them:

Corn	$(375 - 250) \times \$10$	=	\$ 1,250.00
Wheat	$(200 - 250) \times \$8$	=	(400.00)
Rice	$(325 - 250) \times \$3$	=	<u>225.00</u>

Total Materials Quantity Variance **\$1,075.00 Unfavorable**

At this point, we can do a simple test of the two main variances. The price variance plus the quantity variance should equal the total variance. This is true: $\$1,662.50 + \$1,075.00 = \underline{\underline{\$2,737.50}}$.

(Continued)

Calculation of Mix and Yield Variances

From this point, we need to calculate the mix variance and the yield variance, and when those two items are summed they must equal \$1,075, the total material quantity variance.

The first step is to calculate waspAM and waspSM. We will repeat the information about the actual and standard prices and quantities, but this time we will add some labels to clarify the information. The unused information has been made lighter and the boxes have been clearly labeled.

	Standard Price SP <u>Standard Price/Kg</u> Corn \$10.00 Wheat \$ 8.00 Rice \$ 3.00	Standard Quantity SM <u>Standard Kg for Output</u> 250 250 250 <u>750</u>	Standard Cost \$2,500.00 2,000.00 750.00 <hr/> \$5,250.00
	NOT USED <u>Actual Price</u> Corn \$12.00 Wheat \$ 8.50 Rice \$ 5.50	Actual Quantity AM <u>Actual Usage</u> 375 200 325 <u>900</u>	Actual Cost \$4,500.00 1,700.00 1,787.50 <hr/> \$7,987.50

The first step in calculating the mix and yield variances is to calculate waspAM and waspSM. Since the mix and yield variances are subdivisions of the total quantity variance, the actual price **is not used**. The actual price is used in calculating the price variance, but it is not used for quantity variances such as we are calculating here.

Note that arrows have been added to show the sources of the values used in the calculations of waspAM and waspSM.

4) The Weighted Average Standard Price of the Standard Mix (waspSM) is calculated as follows:

$$\text{Total Standard Cost} \div \text{Total Standard Kgs}$$

The total standard kilograms is 750 and the total standard cost is calculated as follows:

Corn	\$10 × 250 kg =	\$2,500
Wheat	\$ 8 × 250 kg =	2,000
Rice	\$ 3 × 250 kg =	750
Total Standard Cost	750 kg	<u>\$5,250</u>

The **waspSM is \$7.00 per kg** (\$5,250 ÷ 750).

5) The Weighted Average Standard Price of the Actual Mix (waspAM) is calculated as follows:

$$\text{Total Cost using Actual Kg and Standard Price} \div \text{Total Actual Kg}$$

The total actual kg was 900 and the total standard cost of the actual mix is calculated as follows:

Corn	\$10 × 375 kg =	\$3,750
Wheat	\$ 8 × 200 kg =	1,600
Rice	\$ 3 × 325 kg =	975
Total Cost at Standard Rate	900 kg	<u>\$6,325</u>

The **waspAM is \$7.0277 per kg** (\$6,325 ÷ 900).

(Continued)

Because the mix was wrong, the weighted average standard price of each kilogram of actual input used was \$0.0277 more than it should have been.

6) Mix Variance

The mix variance is the portion of the total material quantity variance that resulted from the actual mix being different from the standard mix. The mix variance is the difference between the weighted average standard prices of the actual and the standard mix multiplied by the actual total quantity used of all inputs. The formula is:

$$(\text{waspAM} - \text{waspSM}) \times \text{AQ}$$

Putting the numbers we calculated into the formula $(\text{waspAM} - \text{waspSM}) \times \text{AQ}$, we get the following:

$$(\$7.0277 - \$7.00) \times 900 = \mathbf{\$25 \text{ Unfavorable Materials Mix Variance}}$$

Therefore, \$25 of the \$1,075 unfavorable quantity variance arose because the mix of grains was not correct.

7) Yield Variance

The yield variance is the portion of the quantity variance that occurred as a result of using more or less total input than the standard total input. In calculating this variance, we are not worried about the mix of the inputs, just the total quantity of inputs used. The formula is:

$$(\text{AQ} - \text{SQ}) \times \text{waspSM}$$

The waspSM was \$7.00 per kilogram from the previous calculations, the Actual Quantity was 900 kilograms, and the Standard Quantity was 750 kilograms.

Putting all of this into the formula, we get the following:

$$(900 - 750) \times \$7 = \mathbf{\$1,050 \text{ Unfavorable Materials Yield Variance}}$$

Therefore, \$1,050 of the \$1,075 unfavorable quantity variance occurred because the company used more material input than it should have for the amount of output.

Summary, Reconciliation, and Interpretation

From these calculations, we see that the change in the mix was not a material cause of the unfavorable quantity variance, since it was responsible for only \$25 of the unfavorable variance. Rather, the unfavorable quantity variance was primarily caused by a general inefficiency in the use of the material inputs.

To prove all of the calculations, we can do a simple check comparing the two sub-variances to the total quantity variance:

	Materials Mix Variance	\$ 25 U
+	<u>Materials Yield Variance</u>	<u>1,050 U</u>
=	Total Materials Quantity Variance	<u>\$1,075 U</u>

The following information is for the next two questions: Azat Corporation produces ketchup. Azat mixes two varieties of tomatoes: a locally grown variety to provide excellent taste and an imported variety to provide a richer color. The standard costs and inputs for a 200-kg batch of ketchup are as follows:

<u>Tomato Type</u>	<u>Standard Quantity in Kg.</u>	<u>Standard Cost per Kg</u>	<u>Total Cost</u>
Local	200	\$0.75	\$150
Imported	<u>100</u>	\$0.90	<u>90</u>
Total	<u>300</u>		<u>\$240</u>

A total of 110 batches were produced during the current period. The quantities actually purchased and used during the current period as well as the prices paid are shown below:

<u>Tomato Type</u>	<u>Quantity in Kg.</u>	<u>Actual Cost per Kg</u>	<u>Total Cost</u>
Local	21,000	\$0.65	\$13,650
Imported	<u>14,000</u>	\$0.95	<u>13,300</u>
Total	<u>35,000</u>		<u>\$26,950</u>

Question 107: What is the materials mix variance for the current period?

- a) \$1,050 favorable
- b) \$350 favorable.
- c) \$1,050 unfavorable.
- d) \$350 unfavorable.

Question 108: What is the materials yield variance for the current period?

- a) \$1,600 favorable.
- b) \$1,600 unfavorable.
- c) \$1,620 unfavorable.
- d) \$1,620 favorable.

(HOCK)

Factory Overhead Variances

Overheads are production and operation costs that a company cannot trace to any specific product or unit of a product. Because these costs are incurred and paid for by the company and are necessary for the production process, the company needs to know what these costs are and allocate them to the various products that are produced. This allocation must occur so that the full costs of production and operation are known in order to set the selling prices for the different products. If a company does not take overheads into account when it determines the selling price for a product, there is significant risk that it will price the product so that it is actually selling at a loss. The price that a company charges may cover the direct costs of production, but it may not cover all of the indirect costs of production.

Furthermore, generally accepted accounting principles require the use of absorption costing for external financial reporting. In absorption costing, all overhead costs associated with manufacturing a product become a part of the product's cost base along with the direct costs. Along with the direct costs, the overhead costs flow to the income statement as cost of goods sold when the units they are attached to are sold. Therefore, all manufacturing overhead costs must be allocated to the units produced.

Factory overhead costs are segregated into variable overheads that increase or decrease in total with increased or decreased production and fixed overheads that ordinarily do not change in total as a result of changes in the production level⁵⁰. Thus, factory overhead variances are also segregated into variable overhead variances and fixed overhead variances.

Factory overhead costs are incurred as production takes place, and an estimated amount is applied to each unit as manufacturing takes place. The amount of overhead costs to be applied to each unit produced is usually based on the standard usage allowed per unit of a **cost allocation base**⁵¹. The standard usage allowed for a reporting period is the usage of the allocation base allowed for the actual production level achieved⁵² during the period.

The overhead allocation rate is predetermined⁵³ at the beginning of the period by dividing the total budgeted overhead cost by the budgeted usage of the allocation base or by the budgeted production level in units. As with other manufacturing costs, overhead costs are applied to production as production takes place using the predetermined or standard rate instead of an actual incurred rate, because the actual rate is not known until after the end of the period.

Common cost allocation bases used to allocate overhead to products are direct labor hours and machine hours allowed for the actual production of one unit of product. Thus the incurring of factory overhead costs is separate from the application of those costs to the products manufactured. Differences between the overhead costs incurred and the overhead costs applied account for the majority of factory overhead variances.

We begin with the total overhead variance, move on to variable overhead variances, and conclude with the fixed overhead variances. Both the total variable overhead variance and the total fixed overhead variance can be broken down into two sub-variances, similar to the way that the direct material and labor variances were broken down. Therefore, you need to know four individual variances that are calculated for factory overhead.

⁵⁰ Fixed factory overhead costs are fixed as long as production activity remains within a given range, called the **relevant range**. If production drops below the relevant range or increases above the relevant range, fixed overhead will change, and then it will again be fixed as long as production remains within the new relevant range.

⁵¹ A cost allocation base is a measure of activity that is used to assign costs to cost objects. Direct labor hours and machine hours are commonly used as cost allocation bases for factory overhead. A cost object is anything for which cost information is desired.

⁵² This discussion assumes that standard costing and flexible budgeting are being used.

⁵³ Determination of the predetermined overhead allocation rate is explained in Section B of this text, within the major topic *Setting Standard Costs* under the minor topic headings *Establishing Manufacturing Overhead Standards* and *Determining the Level of Activity to Use*.

The four individual variances are:

- 1) Variable overhead spending variance.
- 2) Variable overhead efficiency variance.
- 3) Fixed overhead spending variance.
- 4) Fixed overhead production-volume variance.

The four overhead variances can be combined in various ways, such as four-way, three-way, and two-way analyses. The different methods are simply different combinations of the same four variances. We will first look at the four variances individually and then look at the different combinations.

Overview of Total Manufacturing Overhead Variances

Before looking at more specific overhead variances, we will start with a very general overhead variance. The total overhead variance includes both the variable and the fixed overhead variances:

$$\begin{aligned}
 & \text{Actual total variable and fixed overhead incurred (money actually spent on these items)} \\
 & - \text{Total variable and fixed overhead applied to production using predetermined rates} \\
 & = \text{Total Overhead Variance}
 \end{aligned}$$

As with all cost variances, a positive variance is unfavorable and a negative variance is favorable.

The total overhead variance is the same as the amount of over- or under-applied factory overhead. Over- and under-applied overhead is calculated as Actual Overhead Incurred minus Applied Overhead. The formula above is the same formula as the formula for over- and under-applied overhead.

The total overhead variance is **not** the difference between actual overhead incurred and budgeted overhead. Rather, it is the difference between the actual overhead incurred and the **overhead applied to production**. (This subject will be covered in more detail later.)

The total overhead variance is divided into the total variable overhead variance and the total fixed overhead variance. The total variable and total fixed overhead variances are calculated the same way as the total overhead variance: actual overhead incurred minus overhead applied to production. (The calculation is explained below.)

The total variable and total fixed overhead variances are both subdivided into two other sub-variances:

$ \begin{aligned} & \text{Variable overhead } \textit{spending} \text{ variance} \\ + & \text{Variable overhead } \textit{efficiency} \text{ variance} \\ = & \textit{Total} \text{ variable overhead variance} \end{aligned} $	$ \begin{aligned} & \text{Fixed overhead } \textit{spending} \text{ variance} \\ + & \text{Fixed overhead } \textit{production volume} \text{ variance} \\ = & \textit{Total} \text{ fixed overhead variance} \end{aligned} $
---	---

Variable Overhead (VOH) Variances

Variable overheads are overhead costs that change as the level of production changes. Examples of variable overheads are plant electricity, equipment maintenance, other utilities, and so forth. Overhead costs cannot be traced to specific units manufactured, and for that reason they are called overhead costs. However, since they do increase when production increases and decrease when production decreases, they are variable costs.

Total Variable Overhead Variance (or Variable Overhead Flexible Budget Variance)

The total variable overhead variance is equal to the difference between the actual variable overhead incurred and the standard variable overhead applied. The standard variable overhead applied is based on the standard usage (given the actual output) of the overhead allocation base (machine hours, direct labor hours, and so forth).

$$\begin{aligned}
 & \text{Actual total variable overhead incurred (money spent on these items)} && (AP \times AQ) \\
 - & \text{Variable overhead applied to production using predetermined rate}^{54} && (SP \times SQ) \\
 = & \text{Total variable overhead variance}
 \end{aligned}$$

The interpretation of the Variable Overhead Variance is the same as for other cost variances:

- A **positive** variance is an **unfavorable** variance because actual costs were **greater than** costs applied, and
- A **negative** variance is a **favorable** variance because actual costs were **less than** the amount of cost applied.

Note: This calculation is also referred to as the amount of variable overhead that was over- or under-applied.

The total variable overhead variance may be broken down into the **spending** and **efficiency** variances.

1) Variable Overhead Spending Variance

This variance is the difference between the **actual amount of variable overhead incurred** and the **standard amount of variable overhead allowed for the actual quantity of the VOH allocation base used for the actual quantity produced**.

The variable overhead spending variance is essentially a price variance and this variance is caused by a difference between the actual variable overhead cost per unit of the allocation base (calculated as the actual overhead costs ÷ the actual usage of the allocation base) and the standard application rate per unit of the application base.

$$\begin{aligned}
 & \text{Actual total variable overhead incurred (money actually spent)} && (AP \times AQ) \\
 - & \text{Budgeted variable overhead based on inputs actually used} && (SP \times AQ) \\
 = & \text{Variable overhead spending variance}
 \end{aligned}$$

The interpretation of the Variable Overhead Spending Variance is the same as for other cost variances:

- A **positive** variance is an **unfavorable** variance because actual costs were **greater than** budgeted costs, and
- A **negative** variance is a **favorable** variance because actual costs were **less than** budgeted costs.

Note: The first line of this formula is the same as the first line of the total variable overhead formula.

The budgeted variable overhead, based on inputs actually used, is the standard (budgeted) variable overhead rate per hour (machine hour or direct labor hour, as appropriate) multiplied by the number of hours **actually used** to produce the actual output.

⁵⁴ Overhead is applied to individual products produced, usually on the basis of either direct labor hours, machine hours, materials costs, units of production, weight of production, or some other similar measure. Overhead is covered in depth in Section D, *Cost Management*. The “variable overhead applied to production” is calculated as (Standard Rate × Standard Quantity Allowed for the Actual Production Level).

The variable overhead spending variance can also be calculated as follows:

$$\left(\begin{array}{l} \text{Actual VOH Cost Per Unit of Allocation Base} \\ \text{Actually Used} - \text{Standard VOH Cost Per Unit of} \\ \text{Allocation Base [i.e., Standard Application Rate]} \end{array} \right) \times \begin{array}{l} \text{Actual Quantity of VOH Allocation Base} \\ \text{Used for Actual Output} \end{array}$$

or

$$(\text{AP} - \text{SP}^{55}) \times \text{AQ}$$

2) Variable Overhead Efficiency Variance

The variable overhead efficiency variance is essentially a quantity variance, and it determines the amount of the total variance caused by a different usage of the allocation base than was expected (that is, the standard hours allowed for the actual output). It measures the effect on variable factory overhead cost of efficient or inefficient use of the allocation base used to apply the variable overhead.

Budgeted variable overhead based on inputs actually used	(AQ x SP)
- Standard variable overhead allowed for production/applied to production	(SQ x SP)
= <u>Variable overhead efficiency variance</u>	

The variable overhead efficiency variance is closely related to efficiency or inefficiency in the use of whatever allocation base is used to apply the variable overhead. For example, if variable overhead is applied on the basis of direct labor hours, the variable overhead efficiency variance will be unfavorable when the direct labor efficiency variance is unfavorable and vice versa.

The variable overhead efficiency variance calculation begins with budgeted variable overhead instead of actual variable overhead, but the budgeted cost per unit of input (SP) is multiplied by the amount of inputs (direct labor hours, machine hours, and so forth) **actually used**. Therefore, the interpretation of the variable overhead efficiency variance is the same as for other cost variances:

- A **positive** variance is an **unfavorable** variance because actual usage of the allocation base was **greater than** the amount allowed for the production that took place, and
- A **negative** variance is a **favorable** variance because actual usage of the allocation base was **less than** the amount allowed for the production that took place.

Note: The second line of this formula is the same as the second line of the total variable overhead formula. Also, the first line of this formula is the same as the second line of the previous formula. This illustrates the split of the total variance into the two sub-variances.

⁵⁵ The "P" in this formula represents a rate, not a price. It refers to the standard predetermined overhead application rate. We use the letter P in this formula to keep it the same as in the materials and labor variances, since the formulas are essentially the same.

The variable overhead efficiency variance is also calculated as follows:

$$\left(\frac{\text{Actual Quantity of VOH Allocation Base Used for Actual Output} - \text{Standard Quantity of VOH Allocation Base Allowed for Actual Output}}{\text{Standard Quantity of VOH Allocation Base Allowed for Actual Output}} \right) \times \text{Standard Application Rate}$$

or

$$(\text{AQ} - \text{SQ}) \times \text{SP}$$

Because the variable overhead efficiency variance is related so closely to the usage of whatever activity measure is used to allocate variable overhead to production, management should carefully select the allocation base to be used. If variable overhead is applied using an activity measure that is not well correlated with the incurrence of variable manufacturing costs, the variable overhead efficiency variance will not provide useful information to management.

Furthermore, the person who is responsible for controlling the activity used to allocate the variable overhead (direct labor hours, machine hours, and so forth) should also be responsible for reporting on the variable overhead efficiency variance.

Note: This discussion is focused on standard costing. Under standard costing, overhead is applied to production on the basis of the amount of the allocation base **allowed** for the actual production. Under standard costing, a company will probably have both a Variable Overhead Spending Variance and a Variable Overhead Efficiency Variance. But if normal costing or extended normal costing is being used instead of standard costing, overhead would be applied based on the amount of the allocation base **actually used** for the actual units of output rather than on the standard amount allowed. Thus, if normal costing or extended normal costing is being used, we would use the AQ (Actual Quantity) for both the AQ and the SQ in the formula above. Thus, the variance formula under normal costing would become $(\text{AQ} - \text{AQ}) \times \text{SP}$, which would be zero. Therefore, if overhead is applied based on the amount of the allocation base **actually used** for the actual units of output rather than on the standard amount allowed, there will be no Variable Overhead Efficiency Variance.

Normal costing and extended normal costing are explained in Section D of these study materials.

Fixed Overhead Variances

Fixed overheads are overhead costs that do not change in total as the level of production changes, as long as the production level remains within the relevant range. The best example of fixed overhead is factory rent, which cannot be traced to specific units manufactured and therefore is classified as an overhead cost. Because the rent payment is the same regardless of the factory's production level (as long as the production level remains within the maximum volume that can be produced on the premises), rent is a fixed cost.

Total Fixed Overhead Variance

Fixed overhead costs are allocated to units produced using the predetermined fixed overhead rate. Therefore, the total fixed overhead variance is the difference between the actual fixed overhead incurred and the amount that was applied using the standard rate and the standard usage of the application base for the actual level of output.

$$\begin{aligned} & \text{Actual fixed overhead incurred (money actually spent)} \\ - & \text{Standard fixed overhead applied (standard rate} \times \text{standard usage for actual output)}^{56} \\ = & \text{Total fixed overhead variance} \end{aligned}$$

The Total Fixed Overhead Variance is interpreted the same way as for other cost variances:

- A **positive** variance is an **unfavorable** variance because actual fixed costs were **greater than** the amount of fixed costs allowed for the actual output, and
- A **negative** variance is a **favorable** variance because actual fixed costs were **less than** the amount of fixed costs allowed for the actual output.

Note: Again, the fixed overhead variance is the same as the amount of over- or under-applied fixed overhead.

- If the amount of fixed overhead applied is **less than** the actual fixed overhead incurred, fixed overhead is **under-applied**.
- If the amount of fixed overhead applied is **greater than** the actual fixed overhead incurred, fixed overhead is **over-applied**.

Over- and under-applied fixed factory overhead are covered in detail in Section D of these study materials.

As with the total variable overhead variance, the total fixed overhead variance can be broken down into two other variances: the spending (or budget) variance and the production-volume variance.

When the fixed overhead spending variance and the fixed overhead production-volume variance are combined, they will equal the total fixed overhead variance and the amount of over- or under-applied fixed overhead.

1) Fixed Overhead Spending (Flexible Budget) Variance

The fixed overhead spending variance, also called the flexible budget or the budget variance, is the difference between the actual fixed overhead costs incurred and the budgeted fixed overhead (flexible budget **and/or** static budget)⁵⁷ amount.

$$\begin{aligned} & \text{Actual Fixed Overhead Incurred} \\ - & \text{Budgeted Fixed Overheads (the flexible budget OR the static budget amount)} \\ = & \text{Fixed Overhead Spending/Flexible Budget Variance} \end{aligned}$$

⁵⁶ The "standard for actual output" in the formula is the **standard amount of the application base allowed for the actual output**.

⁵⁷ As long as production remains within the relevant range, budgeted fixed costs in the flexible budget will be the same as budgeted fixed costs in the static budget.

The cause of the Fixed Overhead Spending, or Fixed Overhead Flexible Budget/Spending Variance, is fixed factory overhead that is different from (either greater than or less than) the amount budgeted for it. The interpretation of the Fixed Overhead Budget/Spending Variance is the same as for other cost variances:

- A **positive** variance is an **unfavorable** variance because actual costs were **greater than** budgeted costs, and
- A **negative** variance is a **favorable** variance because actual costs were **less than** budgeted costs.

Note: The first line of this formula is the same as the first line of the total fixed overhead formula.

Also, the flexible budget and the static budget amounts are the same because fixed overhead is fixed and thus does not change with changes in production as long as production remains within the relevant range.

2) Fixed Overhead Production-Volume Variance

The fixed overhead production-volume variance is the difference between the budgeted amount of fixed overhead and the amount of fixed overhead applied (standard rate × **standard input for the actual level of output**). The Fixed Overhead Production-Volume Variance is caused by a difference between the actual production level and the production level used to calculate the budgeted fixed overhead rate.

The fixed overhead production-volume variance has no connection to any actually incurred costs, so it is not a comparison between actual and budgeted costs in the way other variances are. Instead, it is a measure of capacity utilization.

The fixed overhead production-volume variance is calculated as follows:

$$\begin{aligned}
 & \text{Budgeted Fixed Overheads (the flexible budget OR the static budget amount)} \\
 & - \text{Standard fixed overhead applied (standard rate } \times \text{ standard input for actual output)} \\
 & = \text{Fixed Overhead Production-Volume Variance}
 \end{aligned}$$

Note: The second line of the Fixed Overhead Production-Volume Variance formula is the same as the second line of the Total Fixed Overhead formula. Also, the first line of the Fixed Overhead Production-Volume Variance formula is the same as the second line of the Fixed Overhead Flexible Budget/Spending Variance formula. This is how the total fixed overhead variance is split into two variances.

$$\begin{array}{rcl}
 \text{Actual Fixed OH Incurred} & \left. \vphantom{\text{Actual Fixed OH Incurred}} \right\} = & \text{FOH Flexible Budget/} \\
 - \text{Budgeted Fixed OH} & & \text{Spending Variance} \\
 & & + \\
 \text{Budgeted Fixed OH} & \left. \vphantom{\text{Budgeted Fixed OH}} \right\} = & \text{FOH Production-} \\
 - \text{FOH Applied} & & \text{Volume Variance} \\
 & & \left. \vphantom{\text{FOH Production-}} \right\} = \text{Total FOH Variance}
 \end{array}$$

Interpretation of whether the Fixed Overhead Production-Volume Variance is favorable or unfavorable is the same as for other cost variances, but this variance is calculated differently.

- A **negative amount** (applied fixed overhead is greater than budgeted fixed overhead) is **Favorable** because it indicates that actual production has **exceeded** the budgeted production level.
- A **positive amount** (budgeted fixed overhead is greater than applied fixed overhead) is **Unfavorable** because it indicates that actual production has been **lower** than the budgeted production level.

Note: This is the only time for a cost variance that a budgeted cost amount comes before an actual cost amount and yet a negative amount is Favorable. This variance is different because it does not measure a difference between an actual incurred cost and a budgeted cost.

The Total Overhead Flexible Budget Variance

Variances are used for different purposes. The Total Overhead Variance that we calculated above is the difference between total actual overhead incurred (fixed and variable) and the total amount of overhead applied (fixed and variable). The Total Overhead Variance is the sum of the overhead variances that arises in the accounting system when production is accounted for. These are the variances that are resolved at the end of the reporting period as part of the closing process. As we have seen, this total variance can be subdivided into four sub-variances.

However, the Total Overhead Variance does not indicate the difference between the actual overhead incurred and the flexible budget overhead. For the difference between actual overhead incurred and the flexible budget overhead, we need the **Total Overhead Flexible Budget Variance**. The Total Overhead Flexible Budget Variance includes these three of the four overhead sub-variances:

- 1) Variable Overhead Spending Variance.
- 2) Variable Overhead Efficiency Variance.
- 3) Fixed Overhead Spending Variance.

The Total Overhead Flexible Budget Variance **does not** include the Fixed Overhead Production-Volume Variance because the Fixed Overhead Production-Volume Variance is not a comparison between actual and budgeted costs as the other variances are.

The **total overhead flexible budget variance** is

$$\begin{aligned} & \text{Actual total variable and fixed overhead incurred (money spent on these items)} \\ & - \text{Total flexible budget variable and fixed overhead amounts for the actual output} \\ & = \text{Total Overhead Flexible Budget Variance} \end{aligned}$$

It is important to recognize that **the flexible budget amount for fixed overhead is exactly the same as the static budget amount for fixed overhead**, but the flexible budget amount for **variable** overhead will be an **adjusted amount** because it is the amount **allowed** for the actual output.

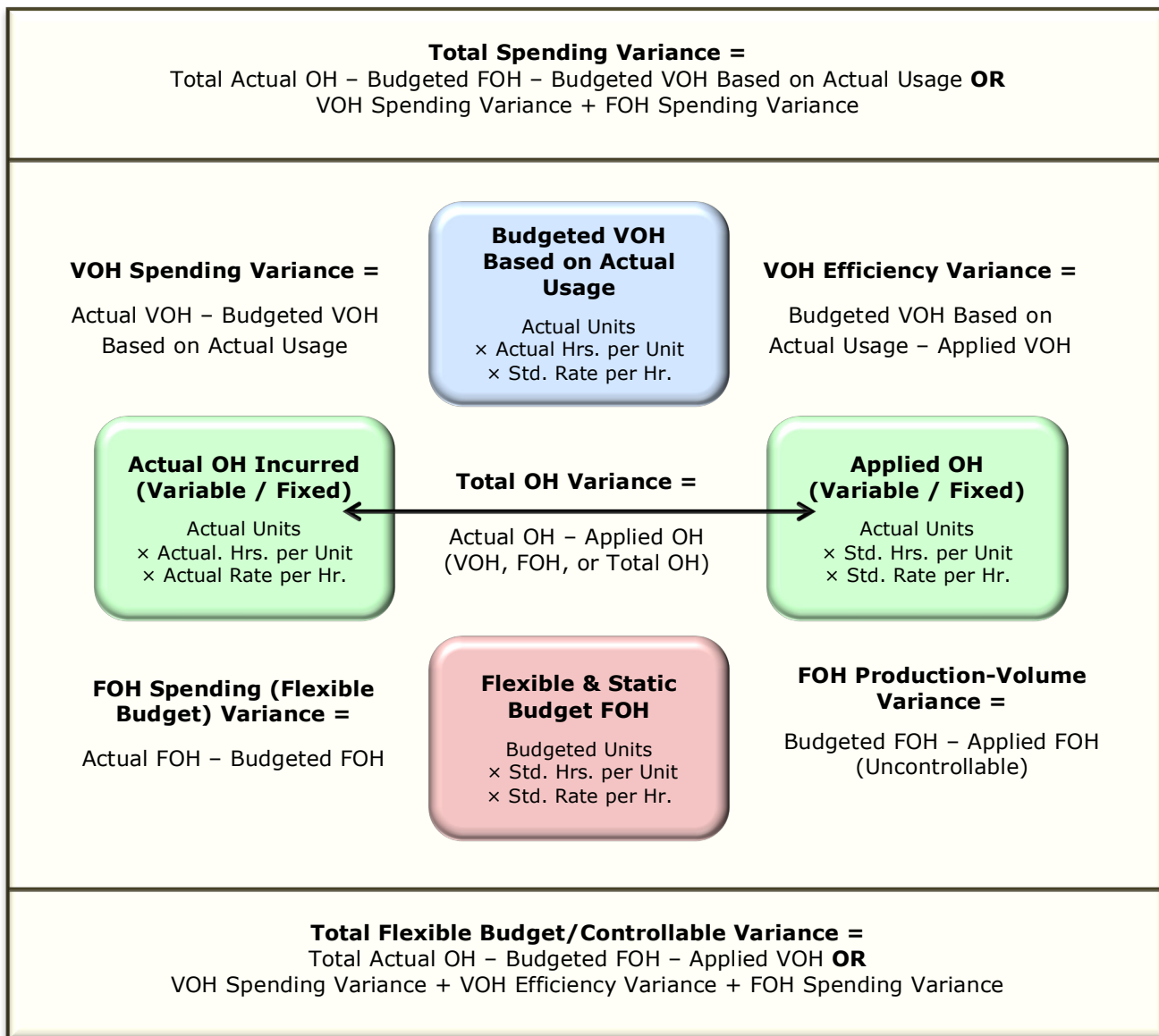
The variable overhead spending (budget) variance plus the variable overhead efficiency variance equals the total variable overhead variance. However, only the fixed overhead spending (budget) variance is included in the total overhead flexible budget variance.

To reiterate: The fixed overhead production-volume variance is omitted from the calculation of the total overhead flexible budget variance because it has no connection to any actually incurred costs, so it is not a comparison between actual and budgeted costs as the other sub-variances are.

Note: There is no fixed overhead efficiency variance because fixed costs do not relate to levels of output and therefore cannot be used either efficiently or inefficiently.

Overhead Variances Graphic

The graphic below was developed by someone who was using the HOCK study materials to prepare for her CMA exams and graciously offered it for the assistance of our other students. Many thanks to Laura Zaverdinos.



Graphic created by Laura Zaverdinos, CPA, CMA, CLU, ChFC. Used by permission.

Comprehensive Example of Overhead Variances

The following is a comprehensive example of variable, fixed, and total overhead variance calculations. In addition to this example, you will find a comprehensive example of accounting for fixed overhead and fixed overhead variances in Section D of this textbook under the topic of *The Process of Accounting for Factory Overhead*. The example in Section D highlights fixed overhead and shows how the fixed overhead variances arise in the accounting system and how they are cleared out. The fixed overhead example in Section D uses the same amounts as this example does for fixed overhead.

Example: In this example, we will calculate the following variances:

- 1) Total overhead variance
- 2) Total variable overhead variance
- 3) Variable overhead spending variance
- 4) Variable overhead efficiency variance
- 5) Total fixed overhead variance
- 6) Fixed overhead spending variance
- 7) Fixed overhead production-volume variance
- 8) Total overhead flexible budget variance

OPQ Company applies overhead to production based on machine hours. Before 20X0 begins, the company budgets the following for the year 20X0:

Standard for number of machine hours used/unit produced.....	5 MH/unit	
Budgeted activity level	1,000,000 units	
Budgeted fixed overhead	\$10,000,000	
Budgeted fixed overhead application rate:		
\$10,000,000 ÷ (5 MH/unit × 1,000,000 units)	\$2/MH	(also \$10/unit)
Budgeted variable overhead for budgeted activity level.....	\$5,000,000	
Budgeted variable overhead application rate:		
\$5,000,000 ÷ (5 MH/unit × 1,000,000 units)	\$1/MH	(also \$5/unit)

Actual overhead incurred during 20X0 was:

Variable overhead incurred	\$ 5,670,000
Fixed overhead incurred	<u>11,000,000</u>
Total overhead incurred	\$16,670,000

Actual production during 20X0 is 1,200,000 units. The **standard** number of machine hours (the machine hours **allowed** for the actual production) is 1,200,000 units × 5 MH per unit, or 6,000,000 machine hours. The **actual** number of machine hours used during 20X0 for the actual production is 6,300,000 hours.

During 20X0, fixed and variable overhead is applied to production at the predetermined rates of \$2 per machine hour **allowed** for fixed overhead and \$1 per machine hour **allowed** for variable overhead, for a total of \$3 per machine hour allowed. Since 6,000,000 machine hours were allowed for the actual production of 1,200,000 units, the total amount of fixed overhead applied is \$2 × 6,000,000, or \$12,000,000; and the total amount of variable overhead applied is \$1 × 6,000,000, or \$6,000,000. Total fixed and variable overhead applied is \$12,000,000 + \$6,000,000, or \$18,000,000.

1) Total Overhead Variance

Actual overhead incurred during 20X0 was:

Fixed overhead	\$11,000,000
Variable overhead	<u>5,670,000</u>
Total actual overhead incurred	\$16,670,000

Applied overhead for 20X0:

Fixed overhead (\$2/MH × 5MH/unit × 1,200,000 units produced)	\$12,000,000
Variable overhead (\$1/MH × 5MH/unit × 1,200,000 units produced)	<u>6,000,000</u>
Total flexible budget overhead, fixed and variable	\$18,000,000

Total overhead variance (total actual OH – total applied OH)	<u>\$(1,330,000)</u> Favorable
--	---------------------------------------

(Continued)

Variable Overhead Variances**2) Total Variable OH Variance:**

Actual Total Variable OH incurred	\$5,670,000
Minus: VOH Applied: standard rate × standard qty. of application base (machine hours) allowed for actual output (\$1 × 5 × 1,200,000)	<u>6,000,000</u>
Equals: Total Variable Overhead Variance	<u>\$(330,000)</u> Favorable

The total variable overhead variance is broken down into the **variable overhead spending variance** and the **variable overhead efficiency variance**.

3) Variable Overhead Spending Variance:

Actual VOH incurred – Budgeted VOH based on actual usage =
 $\$5,670,000 - (6,300,000 \times \$1) = \mathbf{\$(630,000) Favorable}$

OR

Actual VOH cost/unit of allocation base actually used Minus standard VOH application rate/unit of allocation base	} ×	Actual Qty. of VOH application base used for actual output
--	-----	--

OR $(AP - SP) \times AQ$

$[(\$5,670,000 \div 6,300,000) - \$1] \times 6,300,000 = (0.90 - 1.00) \times 6,300,000 = \mathbf{\$(630,000) Favorable}$

4) Variable Overhead Efficiency Variance:

Budgeted VOH based on actual usage – Variable OH applied to production =
 $(6,300,000 \times \$1) - (\$1 \times 5 \times 1,200,000) = \mathbf{\$300,000 Unfavorable}$

OR

Actual activity level of VOH application base actually used Minus standard activity level of application base allowed	} ×	Standard Application Rate
--	-----	---------------------------

OR $(AQ - SQ) \times SP$

$[6,300,000 - (1,200,000 \times 5)] \times \$1 = (6,300,000 - 6,000,000) \times \$1 = \mathbf{\$300,000 Unfavorable}$

The Variable Overhead Spending Variance of \$(630,000) Favorable plus the Variable Overhead Efficiency Variance of \$300,000 Unfavorable equals the Total Variable Overhead Variance of \$(330,000) Favorable.

The variance analysis tells us that the actual variable overhead cost per unit of the allocation base (machine hours) incurred was lower than budgeted for the amount actually produced (\$630,000 Favorable), but the number of units of the allocation base (machine hours) actually used was higher than budgeted (\$300,000 Unfavorable). The net, or total, variable overhead variance is $(630,000) + 300,000 = (330,000)$ Favorable.

Fixed Overhead Variances**5) Total Fixed Overhead Variance:**

Actual fixed overhead incurred	\$11,000,000
Minus: Applied fixed overhead (standard rate × standard quantity of application base for actual output, or \$2 × 6,000,000 MH)	<u>12,000,000</u>
Equals: Total fixed overhead variance	<u>\$(1,000,000)</u> Favorable

(Continued)

The total fixed overhead variance is broken down into the **fixed overhead spending variance** and the **fixed overhead production-volume variance**.

6) Fixed Overhead Spending (Flexible Budget) Variance:

Actual fixed overhead incurred	\$11,000,000	
Minus: Flexible & static budget fixed overhead	<u>10,000,000</u>	
Equals: Fixed overhead spending variance	<u>\$1,000,000</u>	Unfavorable

7) Fixed Overhead Production-Volume Variance:

Budgeted Fixed Overhead	\$10,000,000	
Minus: Applied fixed overhead (standard rate × standard quantity of application base for actual output, or \$2 × 6,000,000 MH)	<u>12,000,000</u>	
Equals: Fixed overhead production-volume variance	<u>\$(2,000,000)</u>	Favorable

The Total Fixed Overhead Variance is the total of the \$1,000,000 Unfavorable spending variance plus the \$2,000,000 Favorable production-volume variance, or \$1,000,000 Favorable.

- The unfavorable spending variance means more fixed overhead was actually incurred than was budgeted.
- The favorable production-volume variance means that actual production exceeded the budgeted production level.

The total variable overhead variance of \$(330,000) Favorable plus the total fixed overhead variance of \$(1,000,000) Favorable is equal to the total overhead variance we calculated at the beginning of this example of \$(1,330,000) Favorable.

8) Total Overhead Flexible Budget Variance

The Total Overhead Variance is the difference between total actual overhead incurred and total overhead applied. The Total Overhead Variance, calculated at the beginning of this example, is \$(1,330,000) Favorable.

The Total Overhead Flexible Budget Variance is the difference between total actual overhead incurred and the total flexible budget total overhead. The Total Overhead Flexible Budget Variance reveals something different. This total overhead variance is Unfavorable, not Favorable.

Actual overhead incurred during 20X0:

Fixed overhead	\$11,000,000
Variable overhead	<u>5,670,000</u>
Total actual overhead incurred	\$16,670,000

Budgeted overhead for 20X0 (**flexible** budget):

Budgeted fixed overhead (flexible and static budget amount)	\$10,000,000
Flexible budget variable overhead (\$1/MH × 5MH/unit × 1,200,000 units produced)	<u>6,000,000</u>
Total flexible budget overhead, fixed and variable	\$16,000,000

Total overhead flexible budget variance (total actual overhead incurred minus total flexible budget overhead)	<u>\$ 670,000</u>	Unfavorable
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(Continued)

The total overhead flexible budget variance is made up of the variable overhead spending variance, the variable overhead efficiency variance, and the fixed overhead spending variance, all of which are calculated in this example. They are:

Variable overhead spending variance	\$(630,000)	Favorable
Variable overhead efficiency variance	300,000	Unfavorable
Fixed overhead spending variance	<u>1,000,000</u>	Unfavorable
 Total overhead flexible budget variance	 <u>\$ 670,000</u>	 Unfavorable

- The Total Overhead Variance is \$(1,330,000) Favorable.
- The Total Overhead Flexible Budget Variance is \$670,000 Unfavorable.

Why are these two total overhead variances so different? The difference is in the fixed overhead production-volume variance, which is included in the Total Overhead Variance and not included in the Total Overhead Flexible Budget Variance. The fixed overhead production-volume variance was \$(2,000,000) Favorable. When we omit that variance, the Total Overhead Variance changes from \$(1,330,000) Favorable to the Total Overhead Flexible Budget variance of \$670,000 Unfavorable. The Fixed Overhead Production-Volume variance was favorable because production exceeded expectations (1,200,000 units produced versus 1,000,000 units budgeted), which generally is a good thing because it means the fixed production facilities were being utilized to a greater degree than the company had expected. When fixed production facilities are used to a greater degree, the fixed cost of each unit produced decreases.

However, total actual fixed costs exceeded the amount budgeted by \$1,000,000. Therefore, the amount of fixed cost of each unit may not have decreased after all. Did actual fixed costs increase because production was so great that the fixed cost moved out of the relevant range? That question is something that needs to be investigated, and it may be that the predetermined or standard application rate for fixed costs needs to be adjusted.

Question 109: Variable overhead is applied on the basis of standard direct labor hours. If the direct labor efficiency variance is unfavorable, the variable overhead efficiency variance will be:

- Favorable.
- Unfavorable.
- The same amount as the labor efficiency variance.
- Indeterminable because it is not related to the labor efficiency variance.

(CMA Adapted)

Question 110: The JoyT Company manufactures Maxi Dolls for sale in toy stores. In planning for this year, JoyT estimated variable factory overhead of \$600,000 and fixed factory overhead of \$400,000. JoyT uses a standard costing system, and factory overhead is allocated to units produced on the basis of standard direct labor hours. The denominator level of activity budgeted for this year was 10,000 direct labor hours, and JoyT used 10,300 actual direct labor hours.

Based on the output accomplished during the year, 9,900 standard direct labor hours should have been used. Actual variable factory overhead was \$596,000, and actual fixed factory overhead was \$410,000 for the year. Based on this information, the volume variance for JoyT for this year is

- \$4,000 unfavorable
- \$6,000 unfavorable
- \$10,000 unfavorable
- \$16,000 unfavorable

(ICMA 2010)

Question 111: The total fixed overhead variance is the:

- a) Measure of the lost profits from the lack of sales volume.
- b) Amount of the under-applied or over-applied fixed overhead costs.
- c) Potential cost reduction that can be achieved from better cost control.
- d) Measure of production inefficiency.

(CMA Adapted)

Two-Way, Three-Way, and Four-Way Analysis of Overhead

We have covered the analysis of overheads (fixed and variable) in the four-way method. There are four overhead variances and each is calculated and reported separately. There are also three-way and two-way methods of analyzing overheads, which are done by combining some of the four-way analysis variances that we calculated.

In **Three-Way Analysis**, the three variances are the volume, efficiency, and spending variances.

- 1) The **volume variance** is equal to the production-volume variance as calculated for fixed overhead.
- 2) The **efficiency variance** is equal to the variable overhead efficiency variance.
- 3) The **spending variance** is equal to the variable overhead spending variance **plus** the fixed overhead spending variance.

Two-Way Analysis uses the same information as calculated for four-way analysis, but we are going to combine it in a slightly different manner than we do under Three-Way Analysis. The two variances involved are called the volume variance and the controllable (or budget) variance.

- 1) The **volume variance** is equal to the production-volume variance for fixed overhead.
- 2) The **controllable variance** is equal to the sum of the remaining three variances, which are the variable spending variance, variable efficiency variance, and fixed spending variance.

Note: The controllable variance is the total overhead flexible budget variance.

The following table illustrates the way the four variances are combined for three-way and two-way analysis.

	Variable Overhead Variance Analysis		Fixed Overhead Variance Analysis	
Four-Way	Efficiency Variance $(AQ - SQ) \times SP$	Spending Variance $(AP - SP) \times AQ$	Spending Variance Actual – Budgeted	Production-Volume Variance Budgeted – Applied
Three-Way	Efficiency Variance	Spending Variance		Volume Variance
Two-Way	Controllable Variance			Volume Variance

In the example above for OPQ Company, we did the four-way analysis first. We actually did the Controllable Variance part of the two-way analysis second, when we calculated the Total Overhead Flexible Budget Variance.

Two-Way Overhead Variance Analysis

Variance #1: The Controllable Variance

The Controllable Variance in two-way analysis is the same as the Total Overhead Flexible Budget Variance that we calculated in the OPQ Company example. In that example, the Total Overhead Flexible Budget Variance included the Variable Overhead Spending Variance, the Variable Overhead Efficiency Variance, and the Fixed Overhead Spending Variance. The Controllable Variance is the same number. The Controllable Variance can be calculated either by summing those other three variances or by calculating it directly as:

$$\begin{aligned}
 & \textbf{Total Actual Overhead Incurred} \\
 - & \textbf{Budgeted Fixed Overhead (static and flexible)} \\
 - & \textbf{Flexible Budget Variable Overhead (or variable overhead applied to production)} \\
 = & \textbf{Controllable Variance}
 \end{aligned}$$

For OPQ Company the Controllable Variance is:

$$\begin{aligned}
 & \$16,670,000 \quad \text{Total Actual Overhead Incurred} \\
 - & \quad 10,000,000 \quad \text{Budgeted Fixed Overhead (static and flexible)} \\
 - & \quad \underline{6,000,000} \quad \text{Variable OH Applied: } \$1/\text{MH} \times 5\text{MH/unit} \times 1,200,000 \text{ units produced} \\
 = & \quad \underline{\$ \quad 670,000} \quad \textbf{Unfavorable} \text{ Controllable Variance}
 \end{aligned}$$

Note that \$670,000 Unfavorable is also the Total Overhead Flexible Budget Variance that we calculated for OPQ Company.

Variance #2: The Fixed Overhead Volume Variance

The Fixed Overhead Volume Variance in two-way analysis is the same as the Fixed Overhead Production-Volume Variance in four-way analysis. For OPQ Company, it is \$(2,000,000) Favorable, calculated as:

$$\begin{array}{r}
 \text{Budgeted Fixed Overhead} & \$10,000,000 \\
 \text{Minus: Applied fixed overhead (standard rate} \times \text{ standard quantity of} \\
 \quad \text{application base for actual output, or } \$2 \times 6,000,000 \text{ MH)} & \underline{12,000,000} \\
 \text{Equals: Fixed Overhead Volume Variance} & \underline{\underline{\$(2,000,000)}} \quad \textbf{Favorable}
 \end{array}$$

Reconciling to the Total Overhead Variance:

$$\begin{array}{r}
 \text{Controllable Variance} & \$ \quad 670,000 \\
 \text{Fixed Overhead Volume Variance} & \underline{(2,000,000)} \\
 \text{Total Overhead Variance} & \underline{\underline{\$(1,330,000)}} \quad \textbf{Favorable}
 \end{array}$$

Three-Way Overhead Variance Analysis

Variance #1: The Total Spending Variance

In three-way overhead variance analysis, the Variable Overhead Spending Variance and the Fixed Overhead Spending Variance are combined into one Spending Variance.

The total Spending Variance (fixed and variable) can be calculated by combining those two variances, or it can be calculated directly as:

$$\begin{aligned}
 & \text{Actual Total Overhead Incurred} \\
 & - \text{Budgeted Fixed Overhead (static and flexible budget)} \\
 & - \text{Budgeted Variable Overhead based on actual usage of the allocation base} \\
 & = \text{Total Spending Variance}
 \end{aligned}$$

For OPQ Company, the Total Spending Variance is:

$$\begin{aligned}
 & \$16,670,000 \quad (\text{Actual Total Overhead Incurred}) \\
 & - \quad 10,000,000 \quad (\text{Budgeted fixed overhead}) \\
 & - \quad \underline{6,300,000} \quad (6,300,000 \text{ actual machine hours used} \times \$1/\text{MH}) \\
 & = \underline{\$ \quad 370,000} \quad \text{Unfavorable}
 \end{aligned}$$

The same variance calculated by combining the Variable Overhead Spending Variance and the Fixed Overhead Spending Variance for OPQ Company is:

Variable Overhead Spending Variance	\$(630,000)	Favorable
Fixed Overhead Spending Variance	<u>1,000,000</u>	Unfavorable
Spending Variance	<u>\$ 370,000</u>	Unfavorable

Variances #2 and 3: The Variable Overhead Efficiency Variance and The Fixed Overhead Volume Variance

In three-way overhead analysis, the Variable Overhead Efficiency Variance and the Fixed Overhead Volume Variance are the same as in four-way analysis. Both of these variances are calculated as they are for four-way variance analysis.

Variance #2: The Variable Overhead Efficiency Variance

For OPQ, the Variable Overhead Efficiency Variance is:

$$\begin{aligned}
 & \text{Budgeted VOH based on actual usage} - \text{Variable OH applied to production} = \\
 & (6,300,000 \times \$1) - (\$1 \times 5 \times 1,200,000) = \underline{\$300,000 \text{ Unfavorable}}
 \end{aligned}$$

OR

$$\left[\begin{array}{l} \text{Actual activity level of VOH application base **actually used**} \\ \text{Minus standard activity level of application base **allowed**} \end{array} \right] \times \text{Standard Application Rate}$$

OR $(AQ - SQ) \times SP$

$$[6,300,000 - (1,200,000 \times 5)] \times \$1 = (6,300,000 - 6,000,000) \times \$1 = \underline{\$300,000 \text{ Unfavorable}}$$

(Continued)

Variance #3: The Fixed Overhead Volume Variance is calculated the same way as the Fixed Overhead Production-Volume Variance is calculated in four-way analysis.

For OPQ, the Fixed Overhead Volume Variance is:

	Budgeted Fixed Overhead	\$10,000,000	
Minus:	Applied fixed overhead (standard rate × standard quantity of application base for actual output, or \$2 × 6,000,000 MH)	<u>12,000,000</u>	
Equals:	Fixed Overhead Volume Variance	<u>\$(2,000,000)</u>	Favorable

Reconciliation to the Total Overhead Variance:

	Spending Variance	\$ 370,000	Unfavorable
Plus:	Variable Overhead Efficiency Variance	300,000	Unfavorable
Minus:	Fixed Overhead Volume Variance	<u>(2,000,000)</u>	Favorable
Equals:	Total Overhead Variance	<u>\$(1,330,000)</u>	Favorable

Question 112: Which of these variances is least significant for cost control?

- a) Labor price variance.
- b) Materials quantity variance.
- c) Fixed O/H volume variance.
- d) Variable O/H spending variance.

(CMA Adapted)

The following information is for the next six questions: Franklin Glass Works' production budget for the year ended November 30 was based on 200,000 units. Each unit required two standard hours of labor for completion. Total overhead was budgeted at \$900,000 for the year, and the fixed overhead rate was estimated at \$3.00 per unit. Both fixed and variable overhead are assigned to the product on the basis of direct labor hours. The actual data for the year ended November 30 is presented as follows:

Actual production in units	198,000
Actual direct labor hours	440,000
Actual variable overhead	\$352,000
Actual fixed overhead	\$575,000

Question 113: The standard hours allowed for actual production for the year ended November 30 total:

- a) 247,500
- b) 396,000
- c) 400,000
- d) 495,000

Question 114: Franklin's variable overhead efficiency variance for the year is:

- a) \$33,000 unfavorable.
- b) \$35,520 favorable.
- c) \$66,000 unfavorable.
- d) \$33,000 favorable.

Question 115: Franklin's variable overhead spending variance for the year is:

- a) \$20,000 unfavorable.
- b) \$19,800 favorable.
- c) \$22,000 unfavorable.
- d) \$20,000 favorable.

Question 116: Franklin's fixed overhead spending variance for the year is:

- a) \$19,000 favorable.
- b) \$25,000 favorable.
- c) \$5,750 favorable.
- d) \$25,000 unfavorable.

Question 117: The fixed overhead applied to Franklin's production for the year is:

- a) \$484,200.
- b) \$575,000.
- c) \$594,000.
- d) \$600,000.

Question 118: Franklin's fixed overhead volume variance for the year is:

- a) \$6,000 unfavorable.
- b) \$19,000 favorable.
- c) \$25,000 favorable.
- d) \$55,000 unfavorable.

(CMA Adapted)

Summary Table of Manufacturing Variance Calculations

The following table summarizes the calculations that are made and the different terms used in variance analysis.

Prime Costs	Price Variance $(AP - SP) \times AQ$	Quantity Variance $(AQ - SQ) \times SP$
Materials	Price Variance	Quantity Variance
Labor	Rate Variance	Efficiency Variance

Multiple Inputs (both Material and Labor)	Mix Variance $(waspAM - waspSM) \times AQ$	Yield Variance $(AQ - SQ) \times waspSM$
---	--	--

Variable Overhead	Spending Variance $(AP - SP) \times AQ$	Efficiency Variance $(AQ - SQ) \times SP$
Fixed Overhead	Spending (Flexible Budget) Variance Actual OH – Budgeted OH	Production Volume Variance Budgeted OH – Applied OH

Comprehensive Example of All Manufacturing Variances for OPQ Company

This example uses the OPQ Company facts from the overhead variances example a few pages back but we will add direct materials and direct labor variances and will reconcile the total variances figure to the individual variances.

- Standard costing is being used.
- The standard number of machine hours allowed per unit = 5.
- The standard number of units of direct materials allowed per unit manufactured = 6.
- The standard cost per unit of direct materials used = \$3.
- The standard number of direct labor hours allowed per unit = 2 hours.
- The standard cost per hour of direct labor = \$20 per hour.
- Overhead is applied based on machine hours.
- Budgeted production for the period is 1,000,000 units.
- Budgeted fixed overhead for the budgeted production of 1,000,000 units is \$10,000,000, and the predetermined fixed overhead rate is \$10 per unit or \$2 per machine hour since 5 machine hours are allowed per unit manufactured.
- Budgeted variable overhead for the budgeted production of 1,000,000 units is \$5,000,000, or \$5 per unit or \$1 per machine hour allowed per unit manufactured.
- Actual production is 1,200,000 units.
- Actual direct materials used for the actual production is 8,000,000 units at an actual cost of \$2.50 per unit of direct materials.
- Actual direct labor used for the actual production is 2,300,000 hours at an actual cost of \$21 per hour.
- Actual fixed overhead incurred = \$11,000,000.
- Actual variable overhead incurred for the actual production = \$5,670,000.
- Actual number of machine hours used for the actual production = 6,300,000 hours.

(Continued)

Direct Materials Variances:			
<i>Price Variance:</i>	$(AP - SP) \times AQ$		
	$(\$2.50 - \$3.00) \times 8,000,000 =$	\$(4,000,000)	F
<i>Quantity Variance:</i>	$(AQ - SQ) \times SP$		
	$(8,000,000 - 7,200,000) \times \$3 =$	\$ 2,400,000	U
Direct Labor Variances:			
<i>Rate Variance:</i>	$(AP - SP) \times AQ$		
	$(\$21 - \$20) \times 2,300,000 =$	\$ 2,300,000	U
<i>Efficiency Variance:</i>	$(AQ - SQ) \times SP$		
	$(2,300,000 - 2,400,000) \times \$20 =$	\$(2,000,000)	F
Variable Overhead Variances:			
<i>Spending Variance:</i>	$(AP - SP) \times AQ$		
	AP = $\$5,670,000 \div 6,300,000 = \0.90 per machine hour		
	SP = $\$5,000,000 \div (5 \text{ MH per unit} \times 1,000,000 \text{ units}) = \1.00 per MH		
	AQ = 6,300,000 MH		
	$(\$0.90 - \$1.00) \times 6,300,000 =$	\$ (630,000)	F
<i>Efficiency Variance:</i>	$(AQ - SQ) \times SP$		
	SQ = 1,200,000 units produced $\times 5 \text{ MH/unit} = 6,000,000 \text{ MH allowed}$		
	$(6,300,000 - 6,000,000) \times \$1 =$	\$ 300,000	U
Fixed Overhead Variances:			
<i>Spending (Flexible Budget) Variance:</i>	Actual FOH Cost Incurred - Flexible/Static Budget FOH		
	$\$11,000,000 - \$10,000,000 =$	\$ 1,000,000	U
<i>Production-Volume Variance:</i>	Flexible/Static Budget FOH - FOH Applied		
	$\$10,000,000 - \$12,000,000 =$	\$(2,000,000)	F
Total Variance		<u>\$(2,630,000)</u>	F
Reconciliation of Total Variance to Actual Costs Minus Applied Costs			
Actual Costs:			
Direct Material ($\$2.50 \times 8,000,000$ units)		\$ 20,000,000	
Direct Labor ($\$21 \times 2,300,000$)		48,300,000	
Variable Overhead		5,670,000	
Fixed Overhead		<u>11,000,000</u>	
Total Actual Costs		\$ 84,970,000	
Applied Costs:			
Direct Material ($\$3 \times 1,200,000$ units $\times 6$ units DM/unit)		\$ 21,600,000	
Direct Labor ($\$20/\text{hr.} \times 1,200,000$ units $\times 2$ hrs. DL per unit)		48,000,000	
Variable Overhead ($\$1$ per MH $\times 1,200,000$ units $\times 5$ MH/unit)		6,000,000	
Fixed Overhead ($\$2$ per MH $\times 1,200,000$ units $\times 5$ MH/unit)		<u>12,000,000</u>	
Total Applied Costs		\$ 87,600,000	
Total Variance (Actual Costs Minus Applied Costs)		<u>\$(2,630,000)</u>	F
This Total Variance is equal to the Total Variance calculated on the previous page. This is a favorable variance because it cost less than expected to produce the actual output based on the standard costs of the company.			

If all the costs have been accounted for properly, the standard costs as applied to production during the period combined with the variances will reconcile to the actual, incurred costs. To do this reconciliation, adjust the applied costs by the amounts of the variances. Maintain the same "signs" as the signs for the calculated variances. In other words, subtract favorable variances from the applied costs and add unfavorable variances to the applied costs. The result should be equal to the actual, incurred costs. This reconciliation follows for OPQ Company.

Reconciliation of costs applied to production to actual, incurred costs for OPQ Company:

Standard variable costs applied to production as calculated on the preceding page:

Direct materials: $1,200,000 \times 6 \times \3	\$21,600,000
Direct labor: $1,200,000 \times 2 \times \20	48,000,000
Variable overhead: $1,200,000 \times 5 \times \1	<u>6,000,000</u>

Total standard variable costs applied to production \$ 75,600,000

Fixed Overhead applied to production: $1,200,000 \times 5 \times \2 12,000,000

Total costs applied to production \$ 87,600,000

Variances as calculated on the preceding page:

Direct Material Price Variance	\$ (4,000,000)	F
Direct Material Quantity Variance	2,400,000	U
Direct Labor Rate Variance	2,300,000	U
Direct Labor Efficiency Variance	(2,000,000)	F
Variable Overhead Spending Variance	(630,000)	F
Variable Overhead Efficiency Variance	300,000	U
Fixed Overhead Spending Variance	1,000,000	U
Fixed Overhead Volume Variance	<u>(2,000,000)</u>	F

Actual costs incurred \$ 84,970,000

Reconciliation to total costs incurred:

Direct Materials: $8,000,000 \text{ units} \times \2.50	\$ 20,000,000
Direct Labor: $2,300,000 \text{ hours} \times \21	48,300,000
Variable Overhead incurred	5,670,000
Fixed Overhead incurred	<u>11,000,000</u>

Total costs incurred \$ 84,970,000

Difference \$ 0

week to the other firm, the number of customers each firm has will stop changing because each firm will gain the same number of customers each week as it loses each week.

94 d – The expected payoff for selling coffee is the sum of the products of individual payoffs times the probability of the corresponding states of nature: $(0.4 \times \$1,900) + (0.6 \times \$2,000) = \$1,960$.

95 a – All the shirts will be sold, but total revenue, and thus total profit, depends on the amount sold at retail (that is, before and at the game) for \$25 and the amount sold at wholesale (that is, sold to the discounter after the game) for \$10.

Expected total sales before and at the game is a weighted average of the sales at the probabilities for the various demand levels weighted according to their probabilities. However, Carson will purchase only 6,000 shirts. So at the demand level of 7,000, Carson will be able to sell only the number of shirts it has. It cannot sell 7,000 shirts. Therefore, the expected total sales before and at the game will be $(4,000 \times 0.15) + (5,000 \times 0.20) + (6,000 \times 0.65) = 5,500$.

Expected revenue before and at the game will thus be $5,500 \times \$25$, or \$137,500. The 500 shirts not sold before and at the game will be sold to the discounter for $500 \times \$10$, or \$5,000. Total expected revenue is thus \$142,500. The cost for 6,000 shirts at \$13 each is \$78,000. Therefore, Carson's expected profit is $\$142,500 - \$78,000 = \$64,500$.

96 c – Top management should not be involved in setting budget standards for production because this is a low-level activity best done by those more directly involved with budget-related matters.

97 d – Standard costing systems are often and best used together with a flexible budget. By using standard costs, the firm can prepare the flexible budgets that enable better analysis at the end of the period.

98 b – The total standard cost allowed for the actual output is \$60,000. Two units of raw material are allowed for each unit produced and the company produced 12,000 units. Therefore, the standard quantity allowed for the actual output is $12,000 \times 2$, or 24,000 units. The standard price for one unit of material is $\$60,000 \div 24,000$ units of direct materials, or \$2.50 per unit of direct materials.

99 d – For this question, solve the materials quantity variance formula for AQ. The variance formula is $(AQ - SQ) \times SP$. SQ can be calculated because the company produced 12,000 units, and two units of raw materials are required for each unit of output. Therefore, the standard quantity for the actual output is 24,000 units. The standard price per unit of raw material can also be calculated because the standard cost allowed for the actual output is \$60,000. Since the standard quantity for the actual output is 24,000 units, the standard price per unit of raw materials is $\$60,000 \div 24,000$, or \$2.50. The quantity variance is \$2,500 unfavorable. Therefore, the formula is:

$$(AQ - 24,000) \times \$2.50 = \$2,500.$$

Solving for AQ, we get $AQ = 25,000$, as follows:

$$2.5AQ - 60,000 = 2,500$$

$$2.5AQ = 62,500$$

$$AQ = \underline{25,000}$$

100 c – The formula for calculating the materials price variance is $(AP - SP) \times AQ$. The actual price for raw materials is $\$105,000 \div 35,000$ units in inventory, or \$3.00 per unit. The standard price is \$2.50 per unit of raw materials ($\$60,000 \div 12,000$ units actually produced $\div 2$ units of materials per unit produced). The Actual Quantity in the formula is the actual quantity of the raw materials that were **used** in producing the 12,000 finished units. It is not the actual quantity of product produced, nor is it the standard quantity of materials for the actual quantity produced.

To calculate the price variance, we need to know the number of units actually used in production, but the question does not provide this number. However, the question states that there is an unfavorable quantity variance of 2,500. Therefore, to determine the number of units of materials actually used, use the quantity variance formula to solve for AQ.

The quantity variance formula is $(AQ - SQ) \times SP$. Since the question indicates that the materials standard is 2 units of raw materials for each unit produced, the standard quantity of materials for 12,000 units is 24,000 units. The actual quantity is not yet known. The standard price is \$2.50 per unit of raw material ($\$60,000$ standard allowed $\div 12,000$ units actually produced $\div 2$ units of materials per unit produced). The quantity variance is 2,500 Unfavorable. The formula is:

$$(AQ - 24,000) \times \$2.50 = \$2,500$$

Solving for AQ, we get $AQ = 25,000$, as follows:

$$2.5AQ - 60,000 = 2,500$$

$$2.5AQ = 62,500$$

$$AQ = 25,000$$

Now, we can input the actual quantity of materials used into the materials price variance formula and calculate the materials price variance formula, $(AP - SP) \times AQ$:

$$(\$3.00 - \$2.50) \times 25,000 = \underline{\$12,500} \text{ Unfavorable}$$

101 b – The price variance formula is $(AP - SP) \times AQ$. Entering the figures from the question into the formula, we get $(\$0.75 - \$0.72) \times 4,100$. The answer is an unfavorable variance of \$123. (Remember for the price variance to use the number of units **used** in production, unless the problem asks for the **purchase** price variance.)

102 d – The actual sales volume of the product will not impact the materials efficiency variance. The difference between sales and production does not affect the comparison of the amount of material that should have been used in the production and the amount actually used.

103 b – If the company has an unfavorable materials usage variance, then more materials were used than necessary. The variance in materials usage may in turn cause more labor hours in order to handle and process the additional materials. Therefore, the unfavorable materials usage variance may also cause an unfavorable labor variance.

104 d – To solve for the direct materials usage variance, use the following formula: $(AQ - SQ) \times SP$. The standard price is \$3.60 per pound and the standard quantity required to produce the actual quantity of output is 110,000 (22,000 units \times 5 pounds per unit). The actual quantity used is 108,000; therefore, the formula is $(108,000 - 110,000) \times \$3.60 = \underline{\$(7,200)}$ Favorable.

105 a – To solve for the direct labor rate variance, use the following formula: $(AP - SP) \times AQ$. The actual quantity of labor hours is 28,000 and the standard rate is \$12.00 per hour. The actual rate is calculated by dividing the actual cost (\$327,600, which is 90% of the total labor cost) by the actual hours worked (28,000). The result is an actual labor rate of \$11.70 per hour. Inputting these numbers into the formula, we get $(\$11.70 - \$12.00) \times 28,000 = \underline{\$(8,400)}$ Favorable.

106 b – To solve for the direct labor usage (efficiency) variance, use the following formula: $(AQ - SQ) \times SP$. The standard price is \$12.00 and the actual quantity is 28,000. The standard quantity for the actual level of output is 27,500 (22,000 units \times 1.25 hours per unit). Putting these numbers into the formula, we get $(28,000 - 27,500) \times \$12 = \underline{\$6,000}$ Unfavorable.

107 d – The materials mix variance equals the actual total quantity used times the difference between the weighted average standard price for the actual mix per unit and the weighted average standard price for the standard mix per unit. The weighted average standard price for the actual mix is $(21,000 \times \$0.75) + (14,000 \times \$0.90) = \$28,350$. Therefore, the weighted average standard price for the actual mix per unit is \$0.81 $(\$28,350 \div 35,000 \text{ kg})$. The weighted average standard price for the standard mix is \$0.80 per unit. $(\$240 \text{ standard total cost per batch} \div 300 \text{ standard total kg per batch})$. The mix variance is $(\$0.81 - \$0.80) \times 35,000 = \underline{\$350}$ Unfavorable.

108 b – The materials yield variance equals the weighted average standard price for the standard mix per unit multiplied by the difference between the actual total quantity used and the standard total quantity for the actual output achieved. The weighted average standard price for the standard mix is \$0.80 per kg. $(\$240 \text{ standard total cost per batch} \div 300 \text{ standard total kg per batch})$. The actual total quantity used is 35,000. The standard total quantity for the actual output achieved is 300 kg per batch \times 110 batches = 33,000 kg. Therefore, the yield variance is $(35,000 - 33,000) \times \$0.80 = \underline{\$1,600}$ Unfavorable.

109 b – The variable overhead efficiency variance is essentially a quantity variance, and it determines the amount of the total variance caused by a different usage of the allocation base than was expected (that is, the standard hours allowed for the actual output).

The variable overhead efficiency variance is closely related to efficiency or inefficiency in the use of whatever allocation base is used to apply the variable overhead. For example, if variable overhead is applied on the basis of direct labor hours, the variable overhead efficiency variance will be unfavorable when the direct labor efficiency variance is unfavorable and vice versa.

The variable overhead efficiency variance is:

Budgeted VOH based on actual usage – Variable OH applied to production

Or: $(AQ - SQ) \times SP$

Where: AQ is the actual quantity of the variable overhead allocation base (direct labor hours or direct machine hours) used for the actual output,

SQ is the standard quantity of the variable overhead allocation base allowed for the actual output, and

SP is the standard variable overhead application rate.

The direct labor efficiency variance is:

$$(AQ - SQ) \times SP$$

Where: AQ is the actual hours used,

SQ is the standard hours used for the actual output, and

SP is the standard direct labor rate

Note that when variable overhead is applied on the basis of direct labor hours, "AQ" and "SQ" are the same amounts in both the variable overhead efficiency variance and the direct labor efficiency variance. Thus, when variable overhead is applied on the basis of direct labor hours and the direct labor efficiency variance is favorable, the variable overhead efficiency variance will also be favorable and vice versa.

110 a – The production-volume variance (or the volume variance) is the flexible/static budgeted fixed overhead minus the amount of fixed overhead applied. The flexible/static budget fixed overhead amount is given as \$400,000.

The predetermined application rate for fixed overhead is $\$400,000 \div 10,000$ DLH, or \$40 per DLH.

With standard costing, overhead is applied to production on the basis of the amount of the application base that is **allowed** for the actual output. The amount of DLH allowed for the actual output is 9,900 hours.

Therefore, the amount of fixed overhead applied to production is \$40 per DLH multiplied by the amount of DLH allowed for the actual output, which is 9,900 hours. So the fixed overhead applied is \$396,000.

The Volume Variance is $\$400,000 - \$396,000$, which equals \$4,000. Since the amount is positive, the variance is unfavorable. It is unfavorable because it means the facilities were not used to the extent planned.

111 b – The total fixed overhead variance is the difference between the actual total fixed overhead cost incurred and the applied fixed overhead. It is the amount of the under-applied or over-applied fixed overhead costs.

112 c – The fixed overhead volume variance results from a difference between actual and budgeted production. Unlike other variances, the fixed overhead production-volume variance (or the volume variance) does not relate to an expenditure problem in which either too much is paid or too much is used. Therefore, the fixed overhead volume variance is the least significant variance for cost control.

113 b – Two standard direct labor hours are allowed for each unit. Since Franklin Glass Works produced 198,000 units, the standard total hours should be 396,000 ($198,000 \times 2$).

114 a – To solve for the variable overhead efficiency variance, use the following equation: $(AQ - SQ) \times SP$, where AQ is the actual quantity of the direct labor hours used, SQ is the standard quantity of direct labor hours allowed for the actual output, and SP is the standard variable overhead application rate.

In order to calculate the standard variable overhead allocation rate (the "SP" in the formula), determine the total variable overhead that was budgeted. The **total** budgeted overhead is \$900,000 and the **fixed** overhead is \$3 per unit. Since 200,000 units are budgeted for production, the total budgeted fixed overhead is \$600,000 ($200,000 \times \3). Therefore, the budgeted variable overhead is \$300,000 ($\$900,000 - \$600,000$). Since 200,000 units were budgeted and 2 direct labor hours are allowed per unit, 400,000 direct labor hours were budgeted. Calculating the allocation rate, we get \$0.75 of variable overhead allocated per direct labor hour ($\$300,000 \div 400,000$ hours).

The actual number of direct labor hours is 440,000 and the standard number of direct labor hours allowed for the actual production is 396,000 (198,000 units actually produced multiplied by 2 direct labor hours allowed per unit produced). Therefore, the formula is: $(440,000 - 396,000) \times \0.75 and the variance is an unfavorable \$33,000.

115 c – To solve for the variable overhead spending variance, use the following equation: $(AP - SP) \times AQ$, where AP is the actual variable overhead cost per direct labor hour, SP is the standard variable overhead allocation rate per direct labor hour, and SQ is the actual quantity of direct labor hours used for the actual output.

The SP, the variable overhead allocation rate per direct labor hour, is \$0.75 (calculated in the previous question).

The AP is calculated as the actual variable overhead \div actual direct labor hours. The actual variable overhead is \$352,000 and 440,000 direct labor hours were actually used. Thus, the AP is $\$352,000 \div 440,000 = \0.80 per direct labor hour.

Therefore, the formula is: $(\$0.80 - \$0.75) \times 440,000$. The variance is an unfavorable \$22,000.

116 b – To solve for the fixed overhead spending variance, subtract budgeted fixed overheads from the actual fixed overheads incurred. The actual fixed overheads are \$575,000 and the budgeted fixed overheads

are \$600,000 (as calculated for the question above). Therefore, the fixed overhead spending variance is $\$575,000 - \$600,000 = \$(25,000)$, a favorable variance.

117 c – The amount of fixed overhead applied is calculated as the application rate (\$3 per unit) multiplied by the number of units produced (198,000). Fixed overhead applied is \$594,000.

118 a – The fixed overhead volume variance is calculated as the budgeted fixed overhead minus the applied fixed overhead, and a positive amount is unfavorable because it means production volume was lower than planned. The budgeted fixed overhead is \$600,000 (calculated for a previous question) and the applied amount is \$594,000 (also calculated for a previous question), so the fixed overhead volume variance is an unfavorable \$6,000.

119 d – For a single-product firm, calculate flexible budget amounts for variable lines by dividing the static budget variable amount by the static budget number of units to be sold to get the budgeted amount per unit, and then multiply that figure by the actual number of units sold. In the static or master budget, the contribution per unit is \$4 per unit ($\$40,000 \div 10,000$ units). Therefore, if we actually sold 12,000 units, we would expect the contribution margin to be \$48,000 ($\$4 \times 12,000$ units), and this is the flexible budget amount for the contribution margin. Next, subtract budgeted fixed costs of \$30,000 (which do not change from the static budget amount) to get a flexible budget operating income of \$18,000 at a sales level of 12,000 units.

120 c – The sales volume variance for operating income is the same as the sales volume variance for the contribution margin line and is calculated as $(AQ - SQ) \times SP$, where SP is the standard (or budgeted) contribution margin per unit. The sales volume variance for operating income can also be calculated by subtracting the Static Budget Operating Income from the Flexible Budget Operating Income.

Using the formula $(AQ - SQ) \times SP$ to calculate the sales volume variance for the contribution margin line, the actual quantity is 12,000 and the standard quantity is 10,000. The standard contribution margin per unit (SP) is \$4 ($\$40,000 \div 10,000$ units). This gives a favorable sales volume variance of \$8,000: $(12,000 - 10,000) \times \4 . This is also the sales volume variance for operating income. The sales volume variance for the contribution margin and the sales volume variance for operating income are the same since the sales volume variance for fixed costs is zero.

The sales volume variance for operating income can also be calculated by subtracting the static budget operating income of \$10,000 from the flexible budget operating income of \$18,000, as calculated in the previous question: $\$18,000 - \$10,000 = \$8,000$ Favorable.

121 c – The stand-alone cost allocation method determines the weights for cost allocation by considering each user of the cost as a separate entity. When the stand-alone method is used, total common costs are distributed among the operating units based on each unit's proportion of the entire organization, using an appropriate basis.

122 d – In evaluating segment performance and the segment manager's performance, it is important to distinguish between the performance of the manager and the performance of the segment the manager manages. On a contribution income statement by segment, direct fixed costs controllable by others are the same as non-controllable traceable fixed costs. Costs that are traceable to a segment but controlled by someone other than the segment manager are used in evaluating the performance of the segment, but they should not be used in evaluating the performance of the segment manager.

123 a – Contribution margin is calculated as sales revenue minus the variable costs for the units sold. The sales price is \$100 per unit and the variable costs total \$72 per unit: DM - \$30; DL - \$20; other variable manufacturing costs - \$10; Variable selling costs - \$12. Thus, contribution is \$28 per unit ($\$100 - \72). 900 units were sold, giving a contribution margin of \$25,200.

124 d – Transfer prices based on actual costs can lead to suboptimal decisions for the company as a whole because when the transfer price is based on actual costs, there is no incentive for the producer to control costs. As a result, costs incurred by the producing division may be higher than necessary, and therefore the senior management of the company may make decisions that are not best for the company as a whole. (Transfer prices do not charge inefficiencies to the department that is **transferring** the goods but rather to the department that **purchases** the goods.)

125 d – Given that Division Z is producing at only 60% of its capacity and thus has unused capacity, to maximize total company profits and be most equitable to the managers of Division both divisions, the transfer price should be between the variable costs of production (\$12) and the market price (\$20). \$18 is the only option between these amounts.

126 d – When operating below capacity, the **minimum** transfer price the producing department will sell for internally is its variable cost of production, which is \$7 per unit.