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ABSTRACT

This workplace skills course on mathematics is a review of basic number concepts focused on helping participants to understand and be able to record filling level data accurately. The introductory materials in the curriculum guide include a course outline, course objectives, a topical outline, information on course length and continuing education units, and resources. Lesson plans for six sessions are provided on the following topics: decimals (place value/addition/subtraction/multiplication); decimals (rounding/order); metrics; specific gravity; averages; calculators; weights; percents; tolerance; and estimation. The session materials include objectives, topics, methods, evaluation criteria, a pretest, information sheets, and handouts. (KC)

MERCER COUNTY
COMMUNITY
COLLEGE

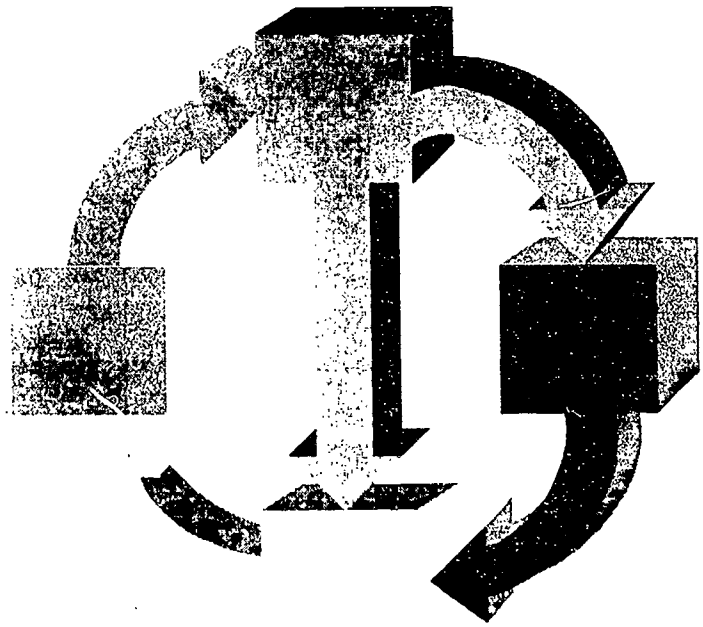
TRENTON • NEW JERSEY

Math for Quality Control

P.R.I.D.E.

PEOPLE RETRAINING for INDUSTRY EXCELLENCE

Math for Quality Control



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National Workplace Literacy Program

1995

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Mercer County Community College thanks Jean Meier, Senior Education Specialist/Curriculum Developer for creating this manual. Through her valuable contributions employees in manufacturing and service industries learned concepts relevant to their existing jobs and strategies for learning other tasks if that opportunity should arise.

WORKPLACE SKILLS TRAINING PHILOSOPHY

A factory or service center creates a classroom that is very different from the one we are used to seeing in colleges and adult schools, so it only follows that our approach to teaching in the factory should also differ.

Our goal is to teach employees skills that they need in order to be functional and successful in their work environment, and encourage them to apply those skills on the job and at home. For example, we motivate students to do the following:

- work more efficiently and more safely
- make fewer mistakes
- solve problems working interactively
- take greater responsibility for their jobs
- recognize the interconnectedness of the various jobs in their workplace
- be better communicators in the workplace

Company needs are revealed through a needs assessment. At that time, we also determine the basic skills needs of the employees. We are learner centered, as the individual employee's needs are considered alongside those of the company.

Once we have determined those needs, we develop curricula that incorporate basic skills, using the workplace literature (e.g. forms, applications, codes, abbreviations, charts and tables, handbooks, regulations, procedures, policies, memos, letters) of the company. Because each company is different, the needs and literature are also different; hence, we develop new materials for every company in which we teach. By utilizing these workplace items, we help students transfer and apply their skills directly to their jobs.

We rely on the classroom techniques of problem solving, cooperative learning, and group discussion. Our overall approach is concept based, with the emphasis on application, such as in role plays, dialogues, and group work. Despite the specific course titles, we incorporate the elements of math, English, and communication skills into all of our sessions.

In terms of students evaluation, after initial testing we give a pre-test and post-test in order to determine comprehension. Students receive feedback throughout the course from the instructor, as well as from fellow students as we sincerely believe in the powerful positive reinforcement of peer critiques and cooperative exchanges.

In essence, we believe that although we make the materials for the students with which to work, it is the students who truly make the class.

MATH FOR QUALITY CONTROL

COURSE OUTLINE:

This course is a review of basic number concepts focused on helping participants understand and be able to accurately record filling level data. Strategies are provided for increasing accuracy when doing computations with decimals and percents. Rounding and averaging will be covered together with metrics and specific gravity. Participants will be trained in determining when fill levels are outside of required specification limits so that appropriate action can be taken to remedy the situation.

OBJECTIVES:

Upon completion of this course, students will be able to:

- perform basic operations involving decimals and percents
- round numbers
- perform mental arithmetic
- calculate averages
- accurately weight tubes and record the data
- compare data with minimum and maximum limits to determine if tube weights are within required specifications

TOPICAL OUTLINE:

- rounding
- estimating
- averaging
- computations with decimals
- per cent concepts
- metric system
- weights and measures
- specific gravity

MATH FOR QUALITY CONTROL

OTHER:

- Hours: 12
- CEU: 1.2

SOURCES:

Mitchell, Robert. **Math Skills that Work, Book One.** Chicago: Contemporary Books, 1991

MATH FOR QUALITY CONTROL

COURSE OUTLINE

Session 1

- Pretest
- Overview/rationale of the training
- Practice filling out information about the batch
- Decimals (place value/addition/subtraction/multiplication)

Session 2

- Decimals (rounding/order)
- Metrics
- Specific Gravity

Session 3

- Averages
- Use of the memory function on a calculator
- Practice weighing empty tubes and recording data
- Calculation of tare weight and minimum fill weight

Session 4

- Review of percents
- Calculation of maximum fill weight

Session 5

Tolerance
Practice weighing filled tubes
Calculate average weight
Determine if weight is within specifications

Session 6

- Practice with the complete process
- Use estimation to catch mistakes
- Posttest

MATH FOR QUALITY CONTROL ♦ SESSION 1

OBJECTIVES:

Upon completion of this session, students will be able to:

- add, subtract and multiply decimals

TOPICS:

- pretest
- overview of the training
- arithmetic operations with decimals

METHOD:

- lecture
- completion of pretest
- practice recording data from workorders

EVALUATION:

- evaluation of accuracy of information recorded

MATERIALS:

- pretest
- workorders
- Filling Level Data forms
- handouts

MATH FOR QUALITY CONTROL ♦ PRETEST

1. Which is larger: .1 or .03?

_____

2. Put these numbers in order from smallest to largest:

9.9	98.7	0.9	9.0	99	0 .03	.1	9
____	____	____	____	____	____	____	____

3. What is .01 X 220?

_____

4. Find 1 % of 220g.

_____

5. What is 3% of 220g?

_____

6. In the number 39.18 what place is the 1 in?

a. tenths b. hundredths c. thousandths d. ones

_____

7. Find the average of: 56.8 and 53.6 and 59g. Round your answer to the nearest tenth.

_____

8. Subtract: .15 from 20.

_____

9. A recipe calls for 200 grams of an ingredient. Your supervisor tells you to add 3% more. How much extra should you add?

_____

10. How many ml. in one liter?

_____

11. Write the following numbers:

- three tenths _____
- four hundredths _____

12. Which of the following would be measured with milliliters (ml)?

- the volume of paint in a tube?
- or the weight of a filled tube of paint? _____

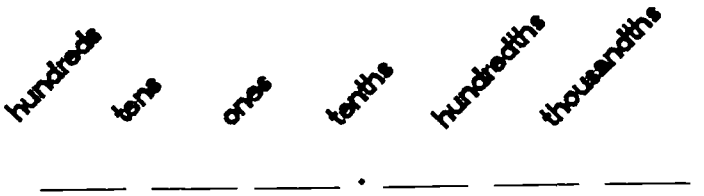
13. Round the following number to the nearest hundredth: 98.1266666666

_____

DECIMALS

To read a decimal fraction, read the number as a whole number, then say the name of the place value where the last digit falls. A decimal point is read "*and*".

0.9	is read as 9 tenths
0.12	is read as 12 hundredths
5.008	is read as 5 and 8 thousandths



The value of a number is determined by its place or location compared to the *decimal point*. Thus 0.5 has the same value as .50 but it is not the same as .05.

Circle the largest number in each pair:

.1	.05
0.6	.06
8	8.0

The decimal point is usually not written in whole numbers but it can be put in.

Where would you put a decimal point in the whole number 76 ?

What is half of .1?

OPERATIONS WITH DECIMAL NUMBERS

A. Addition/Subtractions Skills
- add/subtract decimals, mixed decimals and whole numbers

Adding/subtracting decimal fractions

To add/subtract decimal fractions:

1) arrange the numbers so that the decimal points are directly under each other,

2) add, as with whole numbers and

3) place the decimal point in the answer directly under the other decimal points.

e.g. Add 5 + .02 Subtract 3.07 − .005

5.	3.070
+ .02	− .005
5.02	3.065

Note: To reduce the possibility of error, place zeros in all place values which have no digits.

OPERATIONS WITH DECIMAL NUMBERS

B. Multiplication Skills
- multiply decimal numbers

Multiplying Decimal Numbers

To multiply decimals, multiply using the same procedure as with whole numbers. Place the decimal point in the answer the same number of decimal places as there are in both numbers being multiplied.

e.g.	50.123	(3 places)
	x 0.87	(2 places)
	43.60701	(5 places)

MULTIPLICATION TIPS

.01 means **one hundredth** therefore

multiplying by .01 is the same as ***dividing by 100***

To multiply by .01

move the decimal point two places to the left

Example: .01 X 10.4 = .104

.03 is **three times** .01 therefore

To multiply by .03

1) move the decimal point two places to the left

2) multiply by 3

Example: .03 X 10.4 =

1. move the decimal two places to left .104
2. multiply by 3 .312

MATH FOR QUALITY CONTROL ♦ SESSION 2

OBJECTIVES:

Upon completion of this session, students will be able to:

- round decimals
- use the metric system
- understand specific gravity

TOPICS:

- rounding decimals
- metrics
- specific gravity

METHOD:

- lecture
- discussion of worksheets
- groupwork

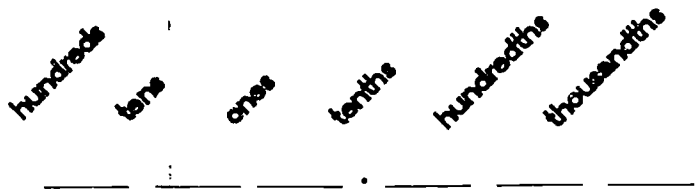
EVALUATION:

- self evaluation based on discussion of the work sheets

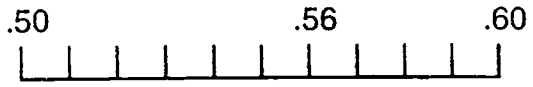
MATERIALS:

- handouts: Working With Decimals
  Metrics
  Specific Gravity

ROUNDING



Round .56 to the nearest tenth:



.56 is closer to .6
round *up*

To round a decimal fraction, determine the number of decimal places required,

- if the digit to the right of this decimal place is less that 5, eliminate all the digits following it.

  e.g. round 5.318 to the nearest tenth

  5.318 = 5.3

- if the digit to the right of this decimal place is 5 or more, add one to the last required digit and eliminate all the digits following it.

  e.g. round 5.368 to the nearest hundredth

  5.368 = 5.4

DECIMALS

1. Write a number for each of the following:

   a) five and two hundredths _____

   b) sixty-five thousandths _____

   c) three and four tenths _____

2. Round each number to the tenths place.

   a) 130.125 _____

   b) 12.0731 _____

   c) 5.666666 _____

   d) 43.02333 _____

METRICS

In the metric system the root word used indicates what is being measured:

- **Liters** are used to measure **liquid volume**
- **Grams** are used to measure **weight**
- **Meters** are used to measure **distance**

The same prefixes are used with each root word:

Kilo	Hecto	Deka	**Unit**	Deci	Cent	**Milli**
			Liter			
			Gram			
			Meter			

Measurements get 10 times larger each place you go to the left
☞ *or*
10 times smaller each place that you move to the right.
☞ *therefore*
You can convert from one unit to the other by simply moving the decimal point one place left or right for the number of places you move left or right on the chart

1. Is a kilogram (kg.) larger or smaller than a gram (g)? By how much?

2. Is a milliliter (ml.) larger or smaller than a liter (L)? By how much?

3. For instance 83g. would be _____ kg. (move the decimal point 3 places to the left)

4. Try the following:

81g.	=	kg.	671ml.	=	L.
.34kg	=	g.	.475L	=	ml.

5. What units are used on the label of a tube of paint? Why?

SPECIFIC GRAVITY

The **density** of a material is its mass (or weight) per unit of volume. For example, a one inch cube of cork is very light. A cube of iron the same size is much heavier. Therefore iron has a much higher density than cork.

Specific gravity is often used instead of density for the purpose of comparing materials.

Specific gravity is defined as a comparison of the density of a substance to the density of water. Specific gravity has no units.

$$\text{Specific Gravity} = \frac{\textit{Density ot material}}{\textit{Density of water}}$$

The density of water is:

⇒ one gram per milliliter — 1ml. of water weighs 1g.

or

⇒ one kilogram per liter — 1L. of water weighs 1kg.

Therefore, if the specific gravity of a substance is 1.2 then

⇒ 1ml. would weigh 1.2g
⇒ 1L. would weigh 1.2kg.

Volume (L.) X S.G. = Weight (Kg.)

OR

$$\frac{\textbf{Weight (Kg.)}}{\textbf{SpecificGravity}} = \textbf{Volume (L.)}$$

The table below gives a comparison of some common substances with water:

Substance	Specific Gravity
Copper	8.9
Ice	0.9
Oil	0.9
Water (at 39° F)	1.0

MATH FOR QUALITY CONTROL ♦ SESSION 3

OBJECTIVES:

Upon completion of this session, students will be able to:

- compute averages
- use the memory function on a calculator
- weigh empty tubes and record the data
- calculate tare weight and minimum fill weight

TOPICS:

- averages
- use of a calculator
- using a scale
- tare weight
- minimum fill weight

METHODS:

- guided discussion
- groupwork: weighing empty tubes and recording data

EVALUATION:

- self evaluation based on accuracy of data calculated and recorded

MATERIALS:

- scales
- handouts

CALCULATOR

To erase the display when you begin a new problem or to erase a keying error –

C	Clear
CE	Clear Entry
AC	All Clear
CM	Clear Memory
MC	Memory Clear
M^{R}_{C}	Recall Memory (press the key once) Clear Memory (press the key twice)

Memory Keys

M+	Add to the Memory
M–	Subtract from the Memory
RM	Recall Memory

Examples:

To get a final total –

- ▲ Add each subtotal to the memory
- ▼ Recall the memory to get the final total

1.3 X 57 M+

7.4 + 7.3 + 7.5 = _____ ÷ 3 M–

22 RM

AVERAGES

To compute an average:

- Add up all the values
- Divide by the total number of items
- Round your answer if necessary

Example:

Find the average of 79.5, 81.6, and 80

1. 79.5 + 81.6 + 80 = 241.1
2. 241.1 ÷ 3 = 80.366666
3. Round your answer to 80.4 or 80.37

Your average should always be in the middle between your highest and lowest values. If your average is higher than your highest value or lower than your lowest value, something is wrong.

Some of the ave ages below are correct. Some are incorrect. Without doing any calculations see if you can spot the ones that are wrong.

				Average	Incorrect or correct?
A.	79.3	82.6	81	82.9	
B.	156.2	157	150	154.4	
C.	8	7.7	7.8	8	
D.	11.4	11.1	11	11.2	

MATH FOR QUALITY CONTROL ♦ SESSION 4

OBJECTIVES:

Upon completion of this session, students will be able to:

- calculate maximum fill weight
- catch mistakes using estimation

TOPICS:

- percents
- mental arithmetic

METHOD:

- lecture
- discussion of worksheets
- groupwork

EVALUATION:

- self evaluation based on discussion of the work sheets

MATERIALS:

- handouts

PERCENTS

Percent means per hundred out of a hundred ***or*** divided by a hundred

☞ therefore

5% can be written $\frac{5}{100}$ or 5 ÷ 100 or .05

To find a percent of a number:

1. Change the percent to a decimal
2. Multiply

Example:

Find 3% of 10.4

1. Change 3% to .03
2. Multiply .03 X 10.4

   = .312

To find what percent one number is of another number:

1. Divide (Part ÷ Whole)
2. Change to a percent

Example:

What percent is 3 out of a total of 400?

1. Divide: 3 ÷ 400 = .0075
2. Change to a percent: .0075 = .75%

MATH FOR QUALITY CONTROL ♦ SESSION 5

OBJECTIVES:

Upon completion of this session, students will be able to:

- weigh tubes
- calculate average weight
- determine if weight is within specifications
- write directions that explain the entire process

TOPICS:

- weighing tubes and determining if they fall within tolerance limits
- explaining the process in written form

METHOD:

- lecture
- groupwork

EVALUATION:

- self evaluation based on accuracy of calculations

MATERIALS:

- handouts

MATH FOR QUALITY CONTROL ♦ SESSION 6

OBJECTIVES:

Upon completion of this session, students will be able to:

- complete the entire Filling Level Data forms
- use estimation to catch mistakes

TOPICS:

- practice completing forms
- mental arithmetic
- posttest

METHOD:

- lecture
- groupwork: finding mistakes on already completed forms

EVALUATION:

- self evaluation

MATERIALS:

- completed forms with mistakes

PRODUCTION

In a particular day the following weights of tubes of paint were recorded:

Time	Weight (g)		
9:00 AM	87.0	88.1	87.6
9:15	90.1	91	90.3
9:30	96.3	94.7	95
9:45	91.8	89	90.9
10:00	92	91.6	92.1
Empty tubes	9.3	9.4	9.1

1. Use this data to fill out the Filling Level Data form.

2. Are all these weights within required specification levels?

Filling Level Data

Product Code	Date	
Product	CF #	
NJ # Batch OK by	Machine #	Quantity
	Correct Tube and Label	OK to start run by

_____ (Specific Gravity) x _____ (Theoretical Volume) = _____ Calculated Weight

\+

_____ + _____ + _____ = _____ ÷ 3 = _____ Tare Weight

(Empty Tube Weights) (Total)

=

_____ **Minimum Fill Weight**

Specifications: _____ (Minimum Fill Weight) x 1.05 = _____ **Maximum Fill Weight**

Time																
1																
2																
3																
Total																
Average																
Range																