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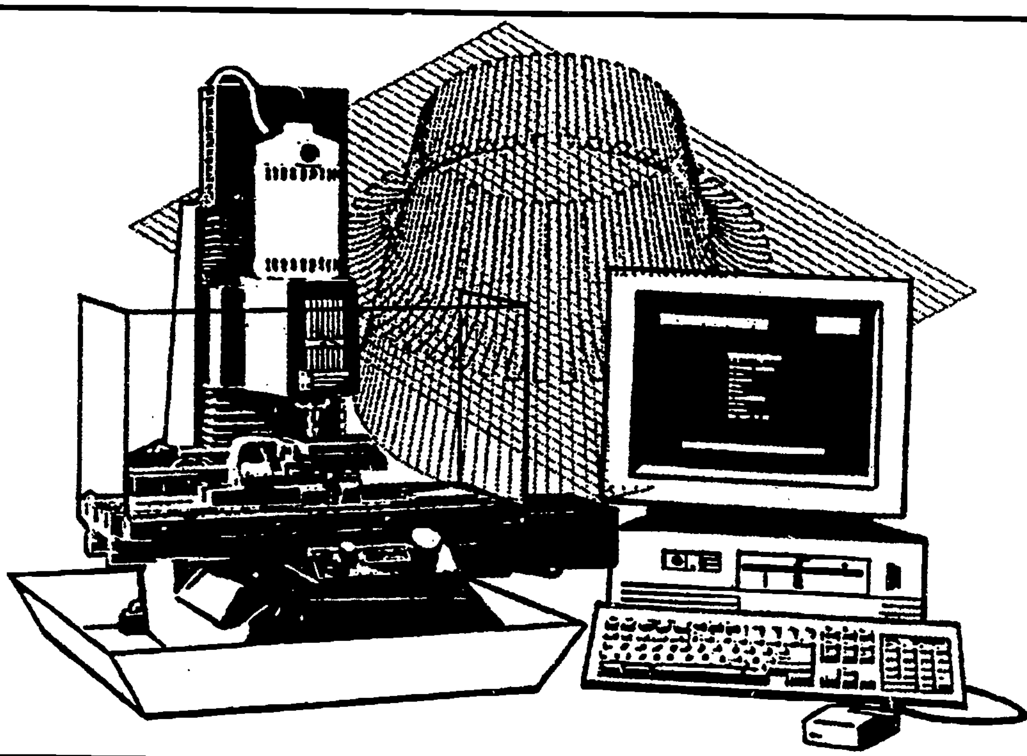
ABSTRACT

This module presents a real-world context in which mathematics skills (geometry and trigonometry) are used as part of a daily routine. The context is the machine tool technology field, and the module aims to help students develop the ability to analyze diagrams in order to make mathematical computations. The modules, which features applications from the Michelin Corporation, is designed for inclusion in a tech prep curriculum. Materials in the module, most of which are designed for the teacher to duplicate and distribute to students, include the following: (1) information on careers in the field of machine tool technology and about the Michelin Corporation; (2) an introduction to the lesson; (3) a task to be performed and information sheets necessary to complete the task; (4) related problems; (5) an answer key; and (6) appendixes containing sample job ads for machining tool technologists and career information about machinists, machine operators, and mechanical and electronics technicians employed by Michelin. (KC)

MATHEMATICS FOR THE WORKPLACE



APPLICATIONS FROM MACHINE TOOL TECHNOLOGY

(MICHELIN TIRE CORPORATION)

A TEACHER'S GUIDE

Developed by:

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(September, 1991)

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Curt McKinney, Department Head, Machine Tool Technology, Tri-County Technical College

Joe Stearns, Mathematics Instructor, Tri-County Technical College

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INTRODUCTION

The workplace of tomorrow will require a skills level beyond the twelfth grade. Technological advances have necessitated higher levels of mathematical skills for employees to function efficiently in the workplace. Many employers need workers who can think creatively and use a variety of approaches to problem solving.

Because of the higher levels of mathematical skills needed to succeed in the workplace, now more than ever, there needs to be greater relevance between what is taught in the classroom and what transpires in the real world on a daily basis. Teaching skills in an isolated setting does little to motivate many students to take their academic studies seriously.

When information is presented in an isolated setting, students who are unable to see a connection between what is taught in the classroom and real-world applications may become disinterested in the subject. Consequently, students perceive no need to apply themselves to their studies and may not take courses which challenge them as learners.

Examples from real-life settings often help students better understand the need to study and learn mathematical skills taught in the classroom. Real-life applications can provide the needed relevance to motivate students, not only to apply themselves to their studies, but also to take the highest level of mathematics they are capable of handling successfully. ***Mathematics for the Workplace: Applications from Machine Tool Technology*** is designed to present a real-world context wherein mathematics skills (geometry and trigonometry) are used as part of a daily routine. An additional purpose is to help students develop the ability to accurately analyze diagrams in order to make mathematical computations.

This module, featuring applications from the Michelin Corporation, is designed for inclusion in the Tech Prep curriculum offered at the secondary level. Tech Prep programs of study provide students with the opportunity to learn more than just academic concepts. These programs combine academic and vocational studies with career understanding to give students the opportunity to take full advantage of all options available during high school and after graduation.

HOW TO USE THIS MODULE

The table of contents lists the sections contained in the module. This is a teacher's guide, not a packet of materials designed entirely to be duplicated and presented to students. ***There are, however, several sections which need to be duplicated and given to students so they can complete the assigned tasks.***

Pages 3-8 give students an introduction to the career field of machine tool technology. Included in this section is such information as a description of the careers available in the field, job-related duties, working conditions, high school preparation and other special opportunities. This section also includes some general information about the Michelin Corporation. **These pages should be duplicated and given to students as introductory information.**

Pages 9-13 present a job-related task. In this section, students are given an explanation of the task and information to help them understand the need for the task. This section also provides teachers with an understanding of the requirements to complete the task. **This section can be duplicated and given to students as information.**

Pages 14-18 give ***RELATED PROBLEMS*** to be solved by students once the appropriate concepts have been covered in class. **These pages should be duplicated and given to students.**

Pages 19-29 are the answer keys to the ***RELATED PROBLEMS.***

Appendix A contains sample job ads from local newspapers for industries wishing to hire individuals with machining experience. Also included are questions which can be used to create interest in the module. (These questions are designed for general class discussion, not an an individual assignment.)

Appendix B contains career information about machinists, machine operators, and mechanical and electronics technicians who are employed by Michelin. **These pages can be duplicated and given to students as information.**

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Examining The Career Field: ***Machine Tool Technology***

Machine tool technicians set up, operate and maintain machinery used in the production of such items as aircraft, construction equipment, industrial machinery, soft-drink containers, durable and nondurable goods and artifical heart valves. Machine tool technicians can specialize in related areas. Examples of specialized machine tool technicians include the following:

- **machinists** who produce metal goods that are made in numbers too small to produce with automated machinery;

- **maintenance mechanics** who trouble-shoot mechanical, pneumatic or hydraulic problems on production machines and assembly-line equipment in order to make repairs;

- **numerical control machine tool operators** who set up and operate multi-purpose numerical control machines to perform a wide array of machining operations;

- **tool and die makers** who fabricate simple and complex machine tools, as well as jigs, fixtures, and precision gauges; and

- **set-up technicians** who set up, maintain and perform minor repair of production machinery and assembly lines in order to produce a quality product.

Other areas of specialization may include robotics, laser cutting machines, electro-chemical machines, and injection molding (plastics) machines.

Duties of Technicians

The range of duties performed by machine tool technicians may vary depending upon the specialty area in which they work. However, general duties performed by all technicians include

- analyzing blueprints, schematic drawings and other specification sheets to determine required procedures and materials;

- verifying dimension, precision, and conformity of final products;

- monitoring machines to ensure that the rate of feed and speed and amount of lubricant and coolant are properly maintained; and

- measuring. marking and positioning the stock (metal or other material) on the machine tool.

Working Conditions

Most technicians work in shops or industries that are well-lighted and ventilated. Because of hazards within the work area, technicians must wear safety glasses and earplugs. Machining work requires stamina because operators are on their feet for most of the work day.

Most machining technicians work a 40-hour week. Technicians may work one of three shifts--day, evening or night. Overtime work may be required during periods of high manufacturing activities.

High School Preparation

In order to be best prepared for a program of studies in machine tool technology, students in high school should take courses including algebra, geometry, physics for the technologies, industrial technology, computer science and trigonometry. Occupational related courses such as blueprint reading, mechanical drawing and machine tool operations will provide a base of technical skills for persons entering technician careers.

Students who take machine tool operations (machine shop) courses in high school may qualify for advanced placement at a technical college. Technical Advanced Placement (TAP) is a special part of the Tech Prep program which enables qualified high school students to earn Tri-County Technical College credit. [TAP is the term applied to advanced placement at Tri-County Technical College; other local two-year colleges have a similar version of TAP.]

The purpose of TAP is to

--reduce overlapping between high school and college programs; and

--enable students who do well in high school/career center courses to save time, money and/or to carry lighter course loads in their first term of studies at Tri-County Technical College.

Students who are interested in learning more about TAP opportunities at Tri-County Technical College or similar programs offered through other area technical colleges should contact their high school or career center counselor.

Special Opportunities

Students wishing to gain experience in the machining industry while enrolled in high school can often do so through cooperative (co-op) educational programs. Co-op is a program that provides students with an opportunity to integrate classroom study with planned and supervised work experience. This experience allows the student to learn skills in the classroom and laboratory and then put those skills into practice on the job with a sponsoring company. In a co-op program, the sponsoring company usually provides approximately 20 hours per week of relevant work experience for the student. The student also attends regularly scheduled, curriculum-related classes.

Another opportunity whereby individuals can gain work-related experience while enrolled in postsecondary educational studies is through apprenticeship programs. In apprenticeship programs, students usually work from 17-25 hours per week while completing coursework toward an associate degree. The industry sponsoring the apprenticeship program usually pays the total costs associated with earning the degree.

Two special opportunities in Anderson, Oconee and Pickens counties which allow participants to gain experience while enrolled in postsecondary educational programs are the Bosch Apprenticeship Program and the Oconee Industries Partnership Program. A brief explanation of each program follows.

Bosch Apprenticeship Program

The Bosch Apprenticeship Program, a three-year apprentice program, provides training for machine tool technology areas such as toolmaker, maintenance mechanic and set-up technician. During the first two years of the program, training hours are divided among the classroom, lab, and apprentice shop. Upon successful completion of the second year, students receive an Associate in Industrial Technology degree from Tri-County Technical College. During the third year, apprentices receive specialized classroom, lab, shop and on-the-job training. Upon successful completion of the third year, students graduate from the program as journeymen craftsmen.

Oconee Industries Partnership Program

The Oconee Industries Partnership Program is designed to attract qualified applicants into one of the largest growing areas in Oconee County--metalworking. The two-year program involves training hours divided among classroom, lab and on-the-job work experience. Upon successful completion of the program, students receive an Associate in Industrial Technology degree, with a major in Machine Tool Technology, from Tri-County Technical College. Students attend classes and lab at Tri-County Technical College during the morning hours and work on site with the sponsoring company during the afternoon. This program is open to any qualified student in Anderson, Oconee and Pickens counties as well as Georgia and other neighboring areas.

Postsecondary Educational Opportunities

Most employers prefer to hire technicians with technical training or college courses. Some positions may require specialized or on-the-job training.

Machine Tool Technology programs are offered at the following area two-year colleges. If you would like additional information about the Machine Tool Technology program at one of these colleges, you should contact the person listed under each college.

Greenville Technical College
Charles G. Wilson
Department Head
Machine Tool Technology
P. 0. Box 5616
Station B
Greenville, SC 29606-5616
803-250-8109

Piedmont Technical College
Michael Reid
Department Head
Engineering Technologies
P. 0. Drawer 1467
Greenwood, SC 29648-1467
1-800-868-5528

Spartanburg Technical College
Charles W. Shaw
Department Head
Machine Tool Technology
P. 0. Drawer 4386
Spartanburg, SC 29305
803-591-3600

Tri-County Technical College
Curt McKinney
Department Head
Machine Tool Technology
P. 0. Box 587
Pendleton, SC 29670
803-646-8361, ext. 2272

Earnings and Advancements

In South Carolina during 1989-90, machine tool technicians earned between $13,957 and $36,504, depending upon the type of specialty area they were employed in. Computer numeric control tool operators earned between $14,851 and $26,354; machinists earned between $13,957 and $36,504; tool and die makers earned between $20,613 and $30,160. Graduates of Tri-County Technical College's Machine Tool Technology program in 1990 reported salaries ranging from $14,000 to $30,000. Additional income can be earned through overtime hours.

Technicians advance as they gain on-the-job experience and additional specialized training. Some move into supervisory and administrative positions within their firms while others may open their own machining shops.

Employment Outlook

Over all, the employment outlook for machine tool technicians calls for an increase in the job opporotunities to the year 2000. All areas of specialization should see a growth in the number of workers. The growth in some areas of specialization will increase faster than other areas.

Advancements in equipment and automation within the workplace may require many technicians to gain a much broader background in machine operations, blueprint reading, mathematics and the properties of metals and plastics.

ABOUT MICHELIN TIRE CORPORATION

Michelin, an international group of corporations, is more than just another tire company. Worldwide, Michelin employs more than 100,000 people. The company is dedicated to the disciplines of science and research, manufacturing and marketing.

Michelin people are not driven by the clock, or by the watchful eye of a supervisor, but by their own sense of achievement. Employees are encouraged to follow their interests into other fields. At Michelin, personal development is considered to be in the long-term interest of the individual as well as the corporation.

But what does Michelin look for in employees? Michelin looks for people who want to create their careers with the company. The company is committed to building careers and developing people according to their skills and interests.

Michelin has over 54 manufacturing locations in Canada, Europe, the Far East, South America and the United States. Because Michelin is international in scope, the possibilities of lifestyles are limitless: from the adventure of a metropolitan city to the family life of a close-knit community. In the United States, three of the four Michelin plants are located in South Carolina, with all three plants located in upstate counties: Anderson, Greenville and Spartanburg.

Personnel from the Michelin plant located in Sandy Springs, South Carolina were very instrumental in the development of this module. The commitment which Michelin has to educating its present and future workforce is shown by its willingness to share examples of how mathematical skills are used at the plant.

INTRODUCING THE LESSON

One suggestion for introducing this module would be to invite a machine tool technician to come and speak to the class. (The Guide to Area Business Speakers, published by the PACE consortium, is an excellent source for identifying speakers.) By listening to a machine tool technician, students gain first-hand knowledge about the characteristics of the workplace, job duties and requirements and other job-related specifics. (NOTE: Since this module uses applications from Michelin, the teacher might want to make an initial contact with Michelin about inviting a speaker. At Michelin, contact Mr. Grover Stewart at 260-2651.)

After the technician has spoken to the class, the job ads and questions in **Appendix A** can be used to generate discussion about machine tool technicians and requirements for the career. Students can be given the sample problem to work as a class assignment. After seeing an example of a problem to be solved by a technician, the **Related Problems** can be assigned as homework or as additional problems during the class.

The **Related Problems** are diagrams which require technicians to compute a missing dimension. These diagrams should be given to students to complete. A suggested activity for completing the exercises is to have students work together as a team. This activity will give students the opportunity to build team-working/communication skills as well as learning the mathematical concepts.

Additional activities that can be conducted may include a field trip to the local technical college or career center to visit machine tool technology programs; viewing career videos about machining (the PACE Office has several videos which can be loaned to teachers; call the office at 646-8361, 225-2250, 882-4412 or 859-7033, ext. 2107 to check out the videos) or conducting cooperative projects or joint lab activities with an occupational class.

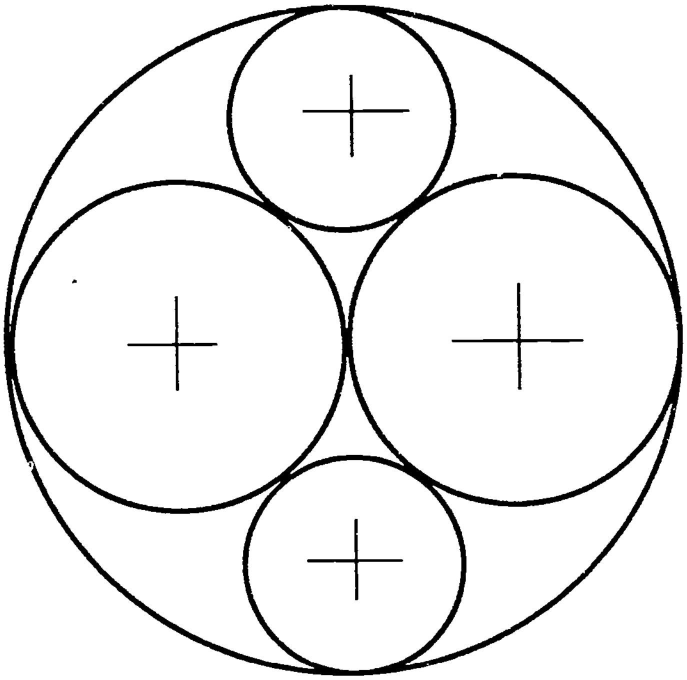
INTRODUCTION TO THE TASK

One task of a machine tool technician is to fabricate machines or parts of machines to be used in the manufacturing process within industry. The piece to be produced may be a replacement for a part that has been broken during the manufacturing process. Oftentimes when parts break, a critical dimension may be missing. The technician may have to use the blueprint to determine the missing dimension.

Sometimes the blueprint will not have all the dimensions of the various components indicated on the drawing. If any dimensions are missing, the technician will have to calculate the missing dimensions before producing the part.

On the next page is a cross-sectional drawing of a large cylinder containing four smaller cylinders inside. If one of the smallest cylinders becomes worn and must be replaced, the technician may have to use the blueprint drawing to determine the diameter of the cylinder. Using the information given, calculate the diameter of the smallest cylinder.

NAME: ______________________ DATE: ______________________



The diameter of the large containment cylinder is 30. The diameter of the middle-sized cylinder is 15. What is the diameter of the smallest cylinder? (Not drawn to scale.)

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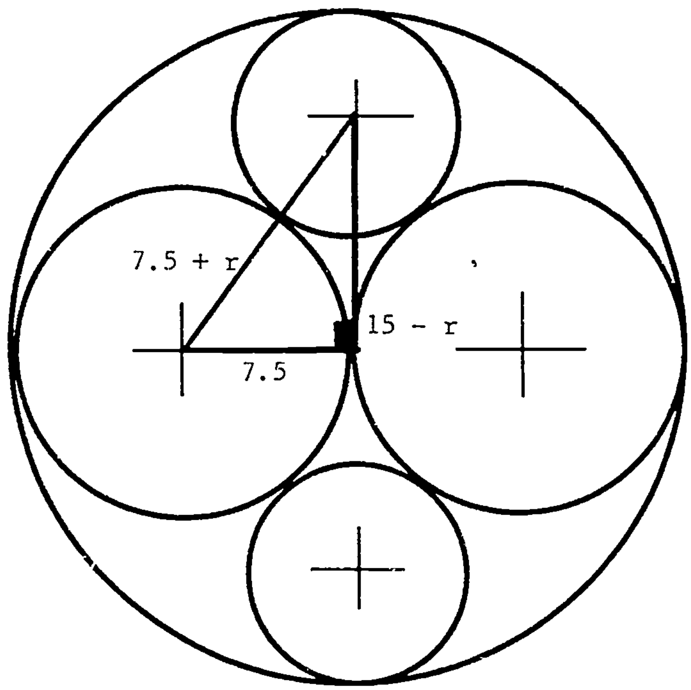
MANUFACTURING DIVISION

DOSSIER NO. ______________________

In order to compute the diameter of the smallest cylinder, basic geometry concepts and the Pythagorean theorem must be used.

From the information given, we see that the radius of the containment cylinder is 15, the radius of the middle-sized cylinder is 7.5, and the radius of the smallest cylinder is *'r'*. (Remember Diameter = 2 X Radius)

We can construct a right triangle in the center of the containment cylinder using the above information. We can then calculate the length of each side of the triangle using the Pythagorean Theorem. **(See Diagram Below.)**



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The length of the hypotenuse is the sum of the radius of the middle-sized cylinder, 15, and the radius of the smallest cylinder *'r'*, or

length of the hypotenuse = 7.5 + r.

The length of the short leg of the triangle is the same as the length of the radius of the middle-sized cylinder or 7.5.

The length of the longer leg of the triangle is the radius of the containment cylinder, 15, minus the radius of the smallest cylinder, *'r'*, or

length of the longer leg = 15 - r.

Since we have a right triangle, the Pythagorean theorem can be used to compute *'r'*.

Using the Pythagorean theorem gives $(7.5 + r)^2 = (15 - r)^2 + (7.5)^2$.

Squaring both sides of the equation gives $56.25 + 15r + r^2 = 225 - 30r + r^2 + 56.25$.

Simplifying the right side gives $56.25 + 15r + r^2 = 281.25 - 30r + r^2$.

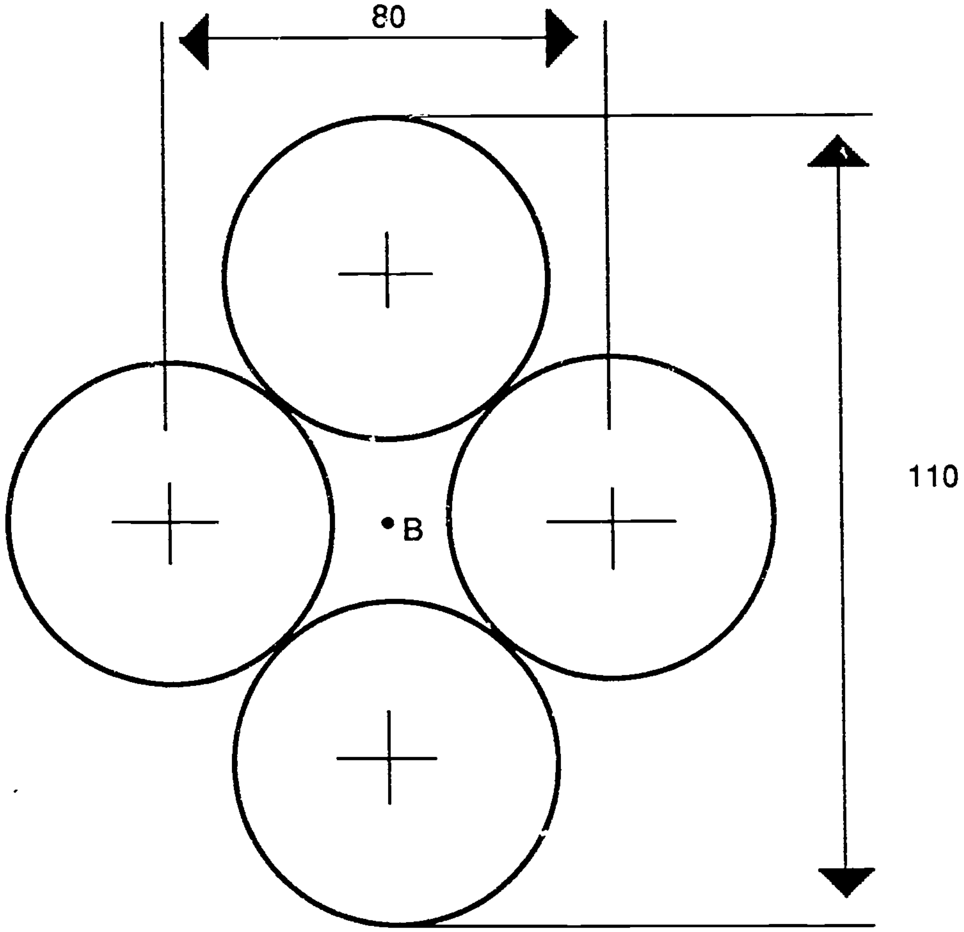
Combining likes terms gives $45r = 225$.

Solving for **r** gives $r = 5$.

The radius of the smallest cylinder is 5. The diameter is two times the radius or 10.

RELATED PROBLEM 1

NAME: ____________________	DATE: ____________________



Given that the pins are all the same size, find the diameter of the pins. (Point B is the horizontal and vertical midpoint.)

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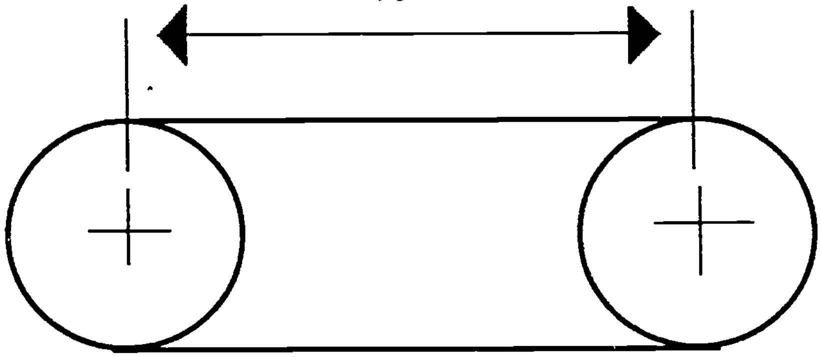

If the diameter of the rollers is 5", what is the total length of the belt?

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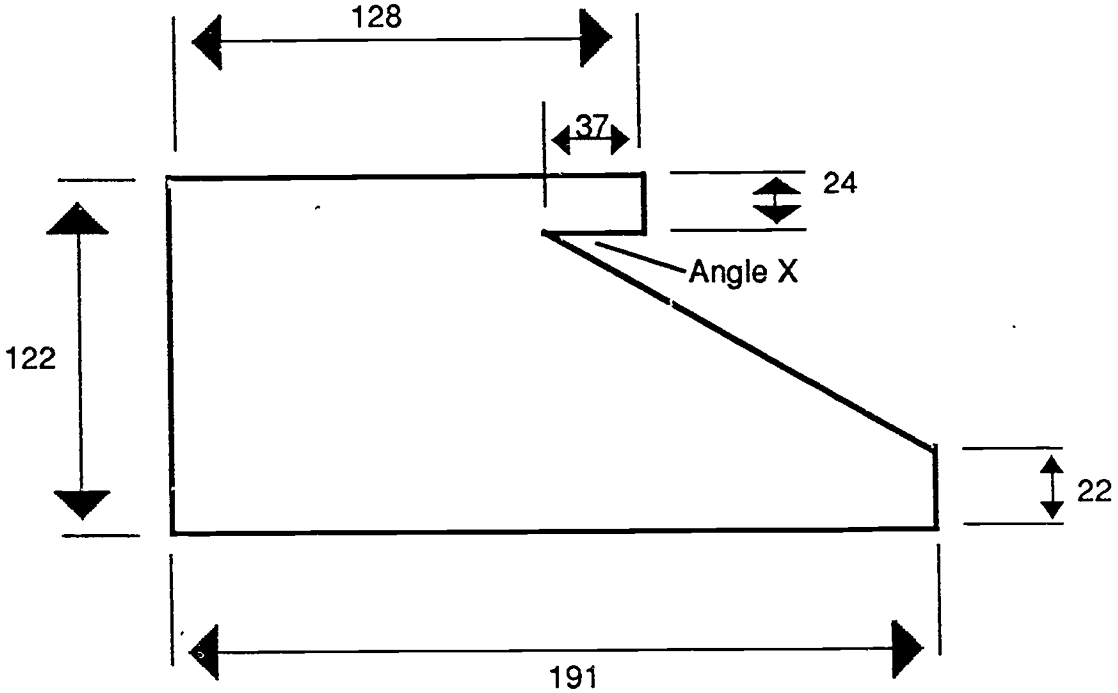
MANUFACTURING DIVISION

DOSSIER NO. ______________________

NAME: ____________	DATE: ____________



Using the information given in the diagram, compute the measure of Angle X.

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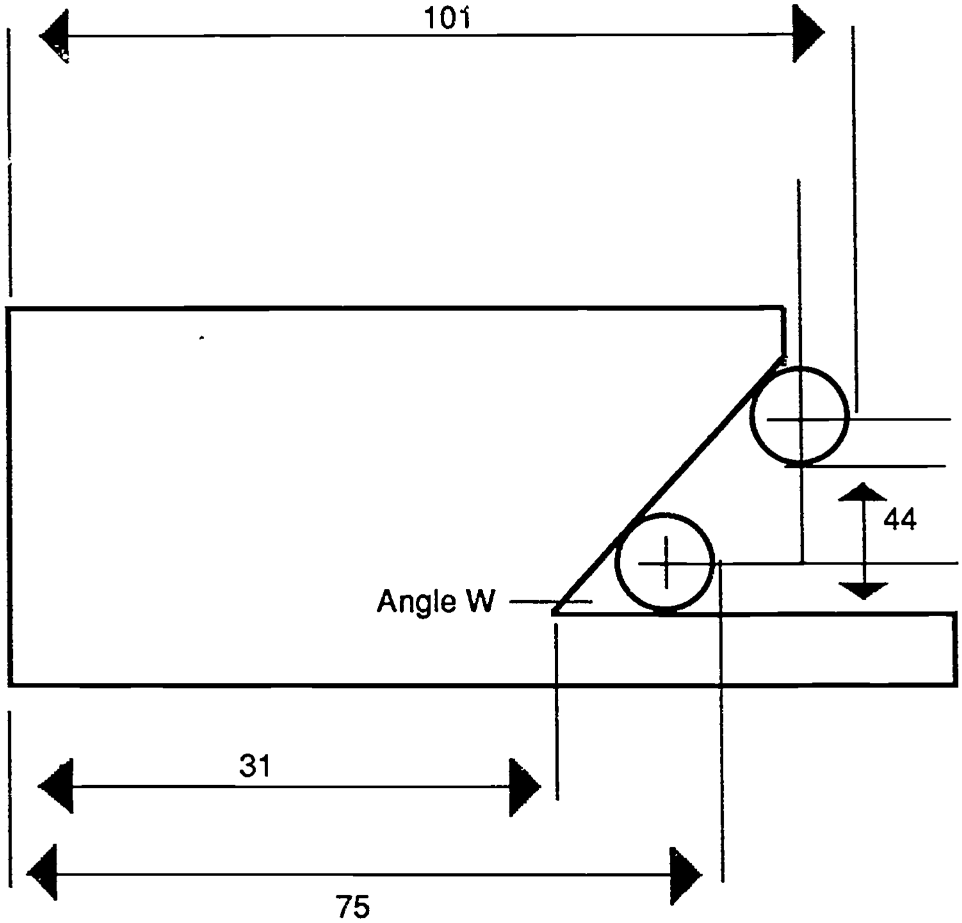
MICHELIN TIRE CORP. MANUFACTURING DIVISION	DOSSIER NO. ____________

NAME: ______________________ DATE: ______________________



Using the information given in the diagram, compute the measure of Angle W.

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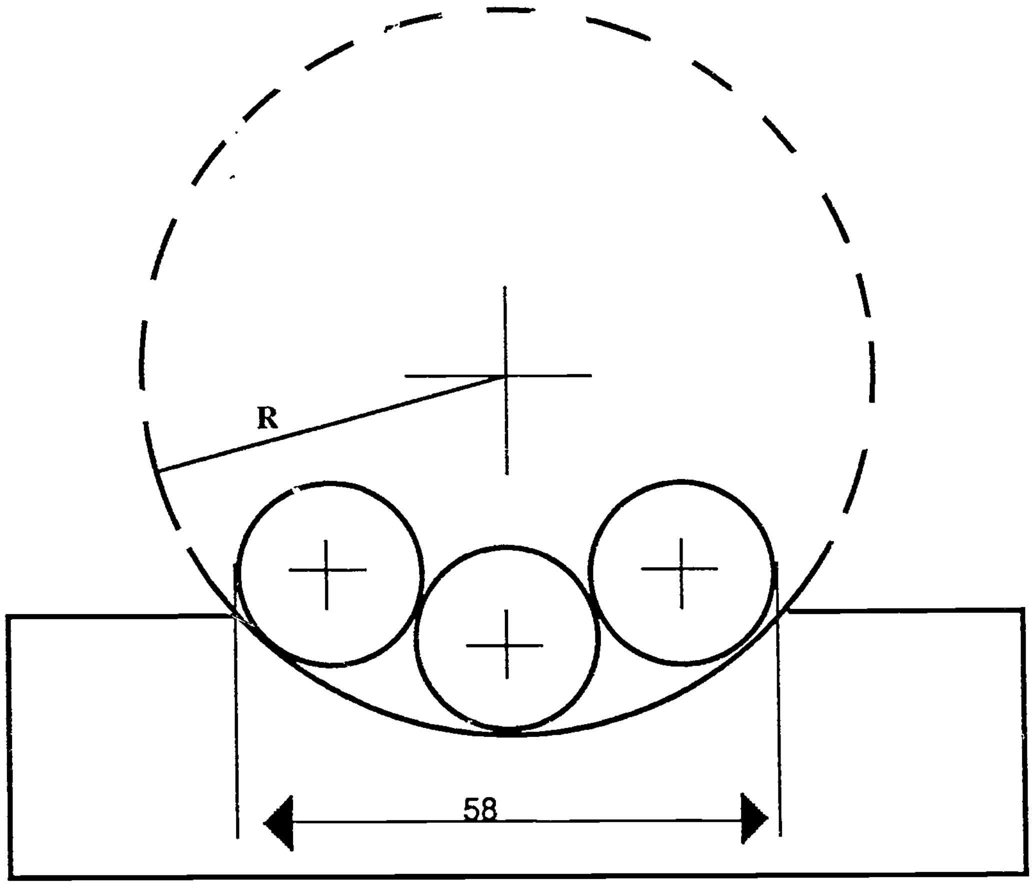

If the length of the diameter of the smaller cylinders is 20, what is the radius '**R**'?

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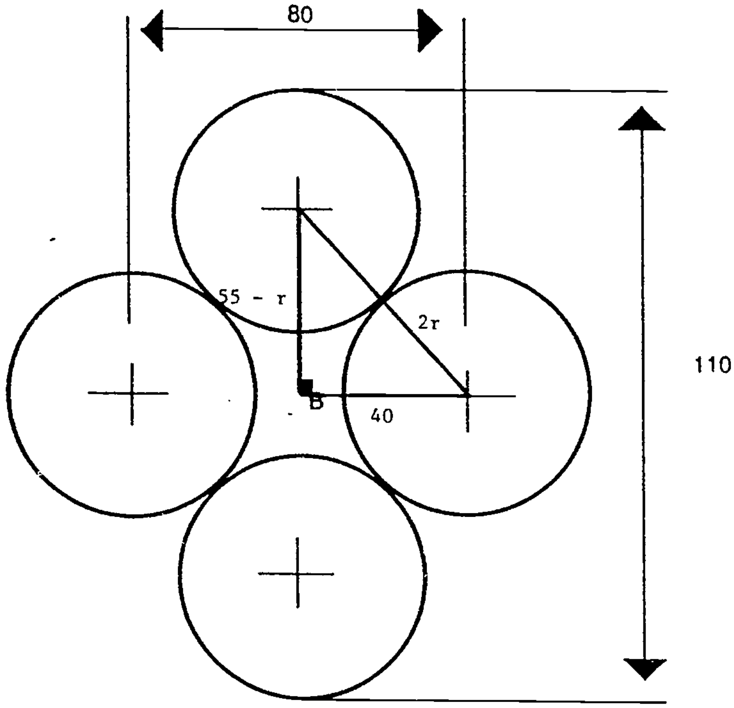
ANSWER KEY
RELATED PROBLEM 1

In order to determine the diameter of each pin, a right triangle must be constructed. **(See Diagram Below).**



From the information given, we can conclude that the distance from point B to point C is one-half of 80 or 40. Therefore, the length of side BC is 40.

The distance from point B, through point A, to the top of the circle is one-half of 110 or 55. The radius of the pins is *'r'*. The distance from point B to point A is 55 - r. Therefore, the length of side AB is 55-r.

The distance from point A to point C is the sum of the radius for each circle or 2r.

By using the Pythagorean Theorem, we can set up an equation and solve for *'r'*.

Substituting into the Pythagorean Theorem we get $(2r)^2 = (40)^2 + (55-r)^2$.

Squaring both sides we get $4r^2 = 1600 + 3025 - 110r + r^2$.

Combining like terms gives $4r^2 = 4625 - 110r + r^2$.

Setting the equation equal zero gives $3r^2 + 110r - 4625 = 0$.

Solving the equation can be accomplished using the quadratic formula or factoring.

QUADRATIC FORMULA

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}; \qquad a = 3; \quad b = 110; \qquad c = -4625$$

$$\frac{-110 \pm \sqrt{110^2 - 4 \times 3 \times -4625}}{2 \times 3}$$

$$\frac{-110 \pm \sqrt{12100 + 55500}}{6}$$

$$\frac{-110 \pm \sqrt{67600}}{6}$$

$$\frac{-110 \pm 260}{6}$$

$$\frac{-110 + 260}{6} \qquad \frac{-110 - 260}{6}$$

$$\frac{150}{6} = 25 \qquad \frac{-370}{6} = -61.667$$

The only valid answer for the radius is 25. Therefore the diameter is 50.

FACTORING

$$3r^2 + 110r - 4625 = 0$$

$$(3r + 185)(r - 25) = 0$$

$$3r + 185 = 0 \qquad r - 25 = 0$$

$$3r = -185 \qquad r = 25$$

$$r = -61.667$$

The only valid answer for the radius is 25. Therefore, the diameter is 50.

ANSWER KEY
RELATED PROBLEM 2

In order to compute the length of the belt, the problem must be broken into two parts: computing the linear length between the roller and then computing the length of portion around the rollers.

The length of the linear portion is 2 x 70" or 140".

The length of the portion around the rollers is found by computing the circumference of one of the rollers. (The portion around the rollers would be one-half of the circumference of both rollers or just the circumference of one roller.)

The formula for circumference of a circle is $\pi \times D$.

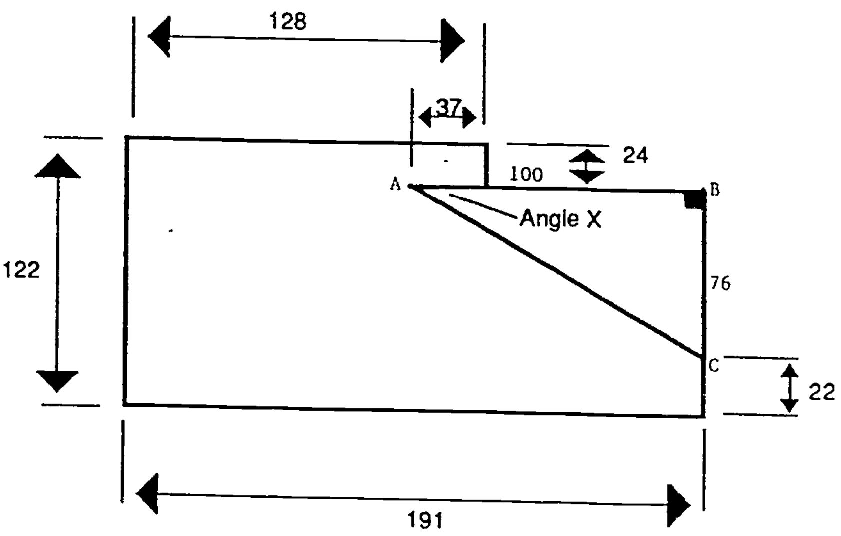
Substituting into the formula we get

3.14 x 5" or 15.7" as the length of the circular portion.

The length of the belt is the sum of the length of the linear portion (140") plus the length of the circular portion (15.7") or 155.7".

ANSWER KEY
RELATED PROBLEM 3

By drawing a perpendicular line joining the sides of Angle X and labeling the angles as A, B, and C, we can form a right triangle. **(See Diagram Below.)**



We know that Angle X and Angle A are the same measure. Therefore, by determining the measure of Angle A, we will know the measure of Angle X.

The tangent of Angle A is defined as the side opposite Angle A divided by the side adjacent to angle A or

$$\text{TAN A} = \frac{BC}{AB}.$$

The length of BC is 122 - 22 - 24 or 76.

The length of AB is 191 - (128 - 37) or 100.

Substituting into the formula we get

$$\text{TAN A} = \frac{BC}{AB} = \frac{76}{100} \text{ or } .76.$$

Using the inverse tangent function of a scientific calculator, we find the measure of Angle A as 37° 14' or

$$\text{TAN}^{-1}(.76) = 37.235° = 37° 14'.$$

If students do not have access to a scientifc calculator, the interpolation process must be used to compute TAN A to the nearest minute.

Using a table of trig functions, we find the angle with a tangent of .76 lies between 37° 10' (tangent of .7581) and 37° 20' (tangent of .7627).

Using interpolation we get

	37° 10'		.0019	.7581	
x	A	10'		.7600	.0046
	37° 20'			.7627	

Setting up a proportion we get

$$\frac{x}{10} = \frac{.0019}{.0046.}$$

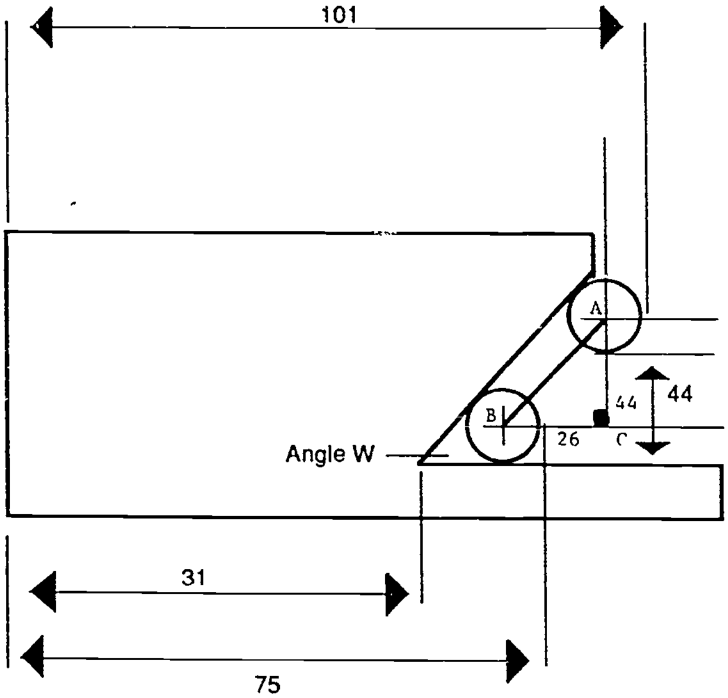
Cross multiplication gives $.0046x = .019.$

Solving for **x** gives $x = \frac{.019}{.0046}$ or $x = 4.$

Therefore, the measure of Angle A, to the nearest minute, is 37° 14'.

ANSWER KEY
RELATED PROBLEM 4

By extending the radius of circle B and then drawing a line from the center of circle A perpendicular to the extended radius of circle B, a right triangle is formed. The angles of the triangle can be labeled A, B and C. **(See Diagram Below.)**



By recalling rules regarding parallel lines cut by a transversal, we can determine that Angle W is equal to Angle B. Therefore, by computing the measure of Angle B we will know the measure of angle W.

The tangent of Angle B is defined as side opposite divided by side adjacent or

$$\text{TAN B} = \frac{AC}{BC.}$$

The length of BC is 101 - 75 or 26. The length of AC is 44. Substituting into the formula we get

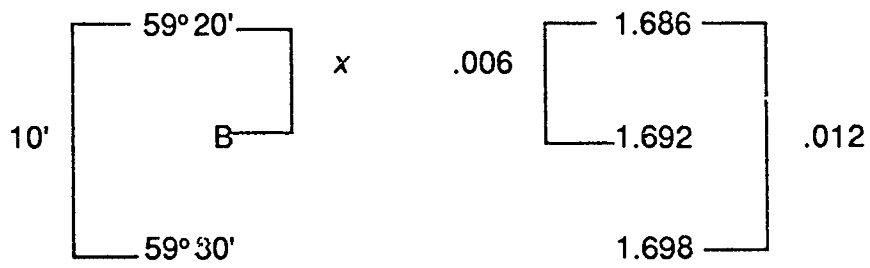
$$\text{TAN B} = \frac{44}{26} \quad \text{or} \quad \text{TAN B} = 1.692.$$

Using the inverse tangent function of a scientific calculator, we find the measure of Angle B as 59° 25' or

$$B = \text{TAN}^{-1}(1.692) = 59.421^\circ = 59^\circ\, 25'.$$

Using a table of trig functions, we find the angle with a tangent of 1.692 lies between 59° 20' and (tangent of 1.686) and 59° 30' (tangent of 1.698).

Using interpolation we get



Setting up a proportion we get

$$\frac{x}{10} = \frac{.006}{.012}.$$

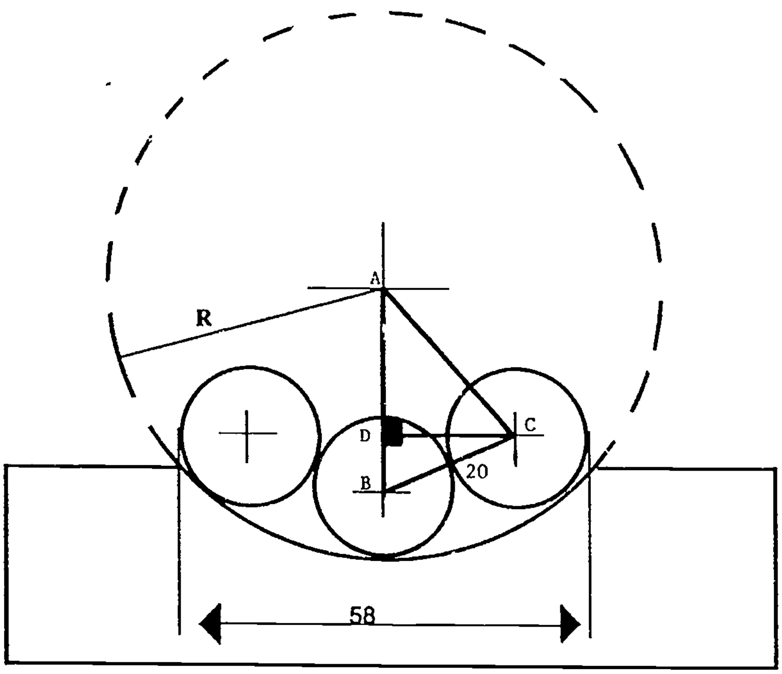
Cross multiplication gives $.012x = .06.$

Solving for **x** gives $x = \frac{.06}{.012}$ or $x = 5.$

Therefore, the measure of Angle B to the nearest minute is 59° 25'.

ANSWER KEY
RELATED PROBLEM 5

Computing the radius of the large circle will require drawing a triangle using the centers of the large circle and two of the smaller circles as vertices. Once the large triangle has been drawn, a smaller, right triangle can be drawn by picking a point perpendicular to point B and parallel to point C and drawing a segment. **(See Diagram Below.)**



After constructing the two triangles, it can be seen that in order to determine the length **'R'**, we must know the length of segment AC and the length of the radius of the smaller circle. The length of the radius of the smaller circle is 10. (The diameter of the smaller circle, 20, was given in the original problem.) In order to compute the length of AC, we must first determine the length of side DC and the measure of Angle A. Once these measures are known, trigonometric ratios can be used to compute the length of AC.

By examining the smaller triangle, we see that the length of BC is 20, or twice the radius of the smaller circle.

The distance from point D through point C to the outside of the pin is 29 (one-half of 58.) (A diameter that is perpendicular to a chord bisects the chord.) Since the radius of the smaller circle is 10, the length of DC is 29 - 10 or 19.

Now that we know the lengths of BC and DC, we can use trigonometric ratios to compute the measure of Angle B.

$$\text{SIN B} = \frac{\text{opposite}}{\text{hypotenuse}} \quad \text{or} \quad \frac{19}{20} \quad \text{or } .95.$$

Using the inverse sine function of a scientific calculator, we find that the measure of Angle B is 71° 48' or

$$B = \text{SIN}^{-1}(.95) = 71.805^\circ = 71^\circ\, 48'.$$

However, if students do not have access to a scientific calculator, the interpolation process can be used to compute SIN B to the nearest minute.

Using a table of trig functions, we find that the angle with a sine of .95 lies between 71° 41' (sine of .9492) and 71° 50' (sine of .9502).

Using interpolation we get

$$10'\left[\begin{array}{l}\left.\begin{array}{l}71^\circ\; 40' \\ \qquad B\end{array}\right]x \\ \\ 71^\circ\; 50'\end{array}\right. \qquad\qquad .001\left[\begin{array}{l}\left.\begin{array}{l}.9492 \\ .9500\end{array}\right].0008 \\ \\ .9502\end{array}\right.$$

Setting up a proportion we get

$$\frac{x}{10} = \frac{.0008}{.001.}$$

Cross multiplication gives $\quad .001x = .008.$

Solving for **x** gives $\quad x = \frac{.008}{.001} \text{ or } x = 8.$

Therefore, the measure of Angle B, to the nearest minute, is 71° 48'.

Triangle ADC is a right triangle. If we know the measure of one angle and the length of one side, we can compute any missing side or angle.

If we look closely at Triangle ABC, we can see that it is an isosceles triangle. Therefore, the measure of Angle C is the same as the measure of Angle B or 71° 48'. The measure of Angle A is 180° minus the sum of Angles B and C or

$$\begin{aligned}\text{Angle A} &= 180^\circ - (71^\circ 48' + 71^\circ 48') \\ &= 180^\circ - 143^\circ 36' \\ &= 36^\circ 24'.\end{aligned}$$

From the previous calculation, we know the length of DC is 19. Since we know the measure of Angle A (36° 24') and the length of DC (19), we can use the sine function to compute the length of side AC.

$$\text{SIN A} = \frac{DC}{AC}$$

$$\text{SIN } 36^\circ 24' = \frac{19}{AC}$$

$$.5934 = \frac{19}{AC}$$

Solving for AC gives $.5934 \times AC = 19.$

$$AC = \frac{19}{.5934}$$

$$AC = 32.019.$$

Since radius 'R' is the sum of AC (32.019) and the length of a radius of a smaller circle (10), **the length of radius 'R' is 42.019.**

Computing the Sine of 36° 24'.

If students do not have access to a scientific calculator, the interpolation process must be used to compute the sine of Angle A.

An angle with a measure of 36° 24' lies between 36° 20' (sine of .5925) and 36° 30' (sine of .5948).

Using interpolation we get

$$10\left[\begin{array}{l} 4\left[\begin{array}{l} 36^\circ\,20' \\ 36^\circ\,24' \end{array}\right. \\ 36^\circ\,30' \end{array}\right. \qquad .0023\left[\begin{array}{l} x\left[\begin{array}{l} .5925 \\ A \end{array}\right. \\ .5948 \end{array}\right.$$

Setting up a proportion we get

$$\frac{4}{10} = \frac{x}{.0023.}$$

Cross multiplication gives $10x = .0092$

Solving for **x** gives $x = \dfrac{.0092}{10}$ or $x\ \ .0009.$

Therefore, the sine of an angle measuring 36° 24' is .5934.

APPENDIX A

SAMPLE JOB ADS

Careers For Machinists And Machine Operators

Michelin Tire Corporation's opportunities offer superior advantages to people who want to use their talents and get ahead. Our sophisticated manufacturing operation provides tremendous challenge and many benefits.

MACHINISTS

Applicants should have at least 2 years experience as a machinist or training in the military or at a technical school. Sound knowledge of machining technology practices is required as well as the ability to read blueprints and use math from basic arithmetic through algebra and trigonometry.

Assignment to the Central Machining Group involves the set-up and operation of lathes and mills in a job shop environment. Applying blueprint analysis skills and math skills, Michelin machinists produce high quality parts made to precise tolerances with minimal supervision.

MACHINE OPERATORS

Applicants should have at least 2 years experience as a machine operator or training in the military or at a technical school. General knowledge of machining technology/practices is required as well as the ability to read blueprints and apply basic and intermediate math.

Assignment to the Production Machining Group involves the set-up and operation of machines to produce large quantities of similar parts. Machinists in the production group at Michelin utilize math skills, blueprint analysis skills and sound machine shop practices to manufacture precision parts at an extremely efficient rate.

Apply in confidence by sending your resume and salary history to: **Joe Ashworth, Dept. SPOT-27, Michelin Tire Corporation, P.O. Box 2846, Greenv[illegible], SC 29602.** An equal opportunity employer

MICHELIN

PUTTING CAREERS IN MOTION™

T09054-16

WABCO

JOURNEYMAN
TOOL & DIE TECHNICIAN

5 - 7 years experience in manual & CNC machine tools could land you this job as a Journeyman Tool & Die Technician with this progressive state of the art manufacturing company.

This position requires experience in tool & cutter grinding, programming, as well as knowledge of machining practices and techniques. Must be knowledgeable in properties of various materials and have the ability to modify and alter tool designs, construct tools, jigs, fixtures, interpret part drawings, tool prints and sketches, and work to close tolerances (.0002). Must be willing to work a 2nd shift schedule (4-10 hour workdays).

WABCO operates a 4 year old manufacturing headquarters facility in Spartanburg, SC. A progressive employee relations environment includes a highly participative management philosophy, an all-salaried structure and flextime. This solid fast moving organization provides challenge, recognition and opportunity for highly motivated people.

Send resume including salary history and requirements to:

WABCO
P.O. BOX 11
SPARTANBURG, SC 29304
Attn: Employees Relations Mgr.

EOE

STONE SAFETY CORPORATION, an equal opportunity employer is presently seeking an individual to fill the position of:

FABRICATOR

The successful candidate must be familiar w/all phases of fabrication, have the ability to head & work from blueprints & sketches, as well as use all fabrication equipment. Lathe & general machining exp required. High School education or GED requ'd. Technical school preferred. 4-6 yrs. exp.

Stone Safety pays competitive salary w/exc. benefits. Please submit resume to:

STONE SAFETY CORP.
111 Southchase Blvd.
Fountain Inn, SC 29644
Attn: Human Resources

MECHANICAL SET-UP TECHNICIAN

- Two year Mechanical Degree plus two (2) years related machine repair experience or four (4) years related experience.
- Experience in ceramic production a plus.
- Demonstrated leadership experience dealing with associates.
- Experience in blueprints, metrics, hydraulics/pneumatics, measuring techniques and SPC a must.
- Willing to train in Germany.
- German Language skills a plus.
- Printing experience a plus.

Send resume to:
Human Resources
ROBERT BOSCH CORP.
PO Box 2867
Anderson, SC 29622
EOE M/F

SUPERVISING TOOLMAKER

Progressive, small co. in western NC requires a Supervising Toolmaker to start immediately. Candidate must have formal training & 5-10 yrs. exp. in mold making. Co. offers top pay & benefits in a modern, air conditioned facility. CNC exp. helpful but will train. Send resume to Box K-H, News Piedmont, Greenville, SC 29602

Machinist

Seabrook, Division of Draper Corp., has immediate openings in the following production areas:

Mills
Drills
Lathes
CNC Machining Centers
Screw Machines
Grinders

Previous experience and the ability to read blueprints and micrometers required.
Seabrook is an equal opportunity employer with a competitive wage and benefit package including:

Medical
Life & Disability Insurance
401 K Retirement Plan
Paid Holidays and Vacation
Uniforms Furnished
Educational Aid
Payroll Savings & Credit Union

Interested persons should apply between 8:00am and 4:30pm Monday-Thursday.

Seabrook
Hwy. 29 North
Anderson, SC 29622

MACHINE OPERATORS

need 5 Machine Tool Operators to do set-ups, read mechanical drawings, micrometers, indepth gauges and familiar with metrics. Must be flexible and able to work all three shifts. Also, need 4 Milling Machine Operators with conventional knee & column experience. 1st shift.
Excellent fringe benefits and pay. Call Manpower for appt. 967-2672

CNC MACHINIST

A challenging and rewarding position is now open for a highly motivated individual with exceptional manufacturing abilities. Minimum requirements include a 2-year degree and at least two years of machine shop experience including precision tooling and CNC programming. Doty Scientific is a high-tech manufacturing and R&D company on the northeast side of Columbia with an outstanding eight-year growth record. Competitive salry and benefits commensurate with abilities and experience. Send resume and transcripts to: Debra Chambers, Doty Scientific, Inc., 600 Clemson Rd., Columbia, SC 29223

MACHINIST

Prototype Shop will pay up to \$14/hr. for top machinists with start-to-finish capabilities holding close tolerances. CNC and Machine Operators need not apply. Paid insurance, vacation & holidays. Call 845-3529 for interview

MACHINISTS MECHANICS

BIC Corporation, a leading manufacturer of consumer disposable products (writing instruments, lighters, shavers) has established a manufacturing facility in the greater SPARTANBURG area and has immediate needs for MACHINIST/MECHANICS to join its operation.

Preferred applicants will have a Machinists Technical School Diploma (trade or military equivalent) plus 2-5 years experience in a manufacturing environment.

The individuals selected for this will be required to maintain and repair high speed automated machinery, fabricate replacement parts to print specifications and be able to read electrical schematics in a 3-Shift operation.

Company offers excellent salary, benefits package, and working conditions. Apply in person or send resume to:

BIC CORPORATION
104 HIDDEN LAKE CIRCLE
DUNCAN, SC 29334
An Equal Opportunity Employer M/F

BIC

T05286-16

QUESTIONS FOR USE WITH THE SAMPLE JOB ADS

1. What types of educational backgrounds are required for machine tool technicians?

2. What types of math skills are required in the jobs?

3. In the **WABCO** advertisement, what is meant by "close tolerances (.0002)?"

4. Do any of the advertisements offer opportunities for travel? If so, where to?

5. What types of work schedules are available? What are some fringe benefits offered?

6. What is the yearly salary for the "Machinist" position? (To convert hourly salary to yearly salary, multiply the hourly salary by 2080. 2080 is 40 hours per week times 52 weeks per year.)

7. What types of job duties do machine tool technicians perform?

8. What aspects of a machine tool technology career might interest you? Why?

APPENDIX B

Careers For Machinists And Machine Operators

Machinists

Qualifications:

Applicants should have at least two years' experience as a machinist or training in the military or at a technical school.

Sound knowledge of machining technology/practices is required as well as the ability to read blueprints and use math from basic arithmetic through algebra and trigonometry.

Applicants should show a desire to sharpen their skills in the machining field and learn new skills through Michelin training programs.

Michelin Careers
In the Central Machining Group:

Assignment to the Central Group involves the set-up and operation of lathes and mills in a job shop environment. Applying blueprint analysis skills and math skills, Michelin machinists produce high quality parts made to precise tolerances with minimal supervision.

Machine Operators

Qualifications:

Applicants should have at least two years' experience as a machine operator or training in the military or at a technical school.

General knowledge of machining technology/practices is required as well as the ability to read blueprints and apply basic and intermediate math.

Applicants should show a desire to sharpen their skills in the machining field and learn new skills through Michelin training.

Michelin Careers
In the Production Machining Group:

Assignment to the Production Group involves the set-up and operation of one machine to produce large quantities of similar parts. Machinists in the production group at Michelin utilize math skills, blueprint analysis skills and sound machine shop practices to manufacture precision parts at an extremely efficient rate.

Careers For Mechanical And Electronic Technicians

Michelin offers challenging opportunities for industrial technicians with backgrounds in either mechanics or electronics. These career opportunities are available to individuals who obtained their trade through two to three years of related industrial experience, complemented with training in the military or a vocational/technical school.

Mechanical Technicians must know the theory behind current mechanical technology and be able to read and use blueprints, as well as demonstrate proficiency in the use of math applied to practical situations. Electronics Technicians must also possess sound applied math skills and know the theory behind current electrical/electronic technology. The ability to read and interpret schematic diagrams is imperative.

Michelin is interested in individuals who want to develop current skills and broaden their knowledge through company-sponsored training programs.

Process Control Maintenance Group

Mechanical technicians install, modify, repair and maintain sophisticated process machinery that uses the latest control systems coupled with complex mechanical movements. On the job experience, along with Michelin formal training in hydraulics, pneumatics, electrical and electronics will enable the individual to perform total systems maintenance.

Electronics technicians, depending on job assignment, may perform total systems maintenance or electronic/electrical maintenance. On the job experience, coupled with Michelin formal training, will enable the individual to perform and progress in either maintenance capacity.

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