DOCUMENT RESUME

ED 096 491 CE 002 103

| | |
|---|---|
| TITLE | Abrasives and Grinding Machines; Machine Shop Work--Advanced: 9557.02. |
| INSTITUTION | Dade County Public Schools, Miami, Fla. |
| PUB DATE | Jan 73 |
| NOTE | 27p.; An Authorized Course of Instruction for the Quinmester Program |
| EDRS PRICE | MF-$0.75 HC-$1.85 PLUS POSTAGE |
| DESCRIPTORS | Behavioral Objectives; *Curriculum Guides; *Industrial Education; *Machine Tools; Secondary Grades; *Shop Curriculum; Skill Development; Technical Education |
| IDENTIFIERS | *Quinmester Program |

ABSTRACT

The course outline has been prepared as a guide to assist the instructor in systematically planning and presenting a variety of meaningful lessons to facilitate the necessary training for the machine shop student. The material contained in the outline is designed to enable the student to learn the manipulative skills and related knowledge necessary to understand and use correctly abrasives, grinding wheels, and precision grinding machines safely and productively. Prior to entry into this course, the student must display a mastery of the skills outlined in "Basic Machine Shop Mathematics." This is the second Quinmester course of the second year, consisting of three blocks of instruction, which are subdivided into several units each. The course is 135 hours in length. A posttest and a bibliography are appended; specific objectives are provided for each instructional block. (Author/AJ)

VT

BEST COPY AVAILABLE

# AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM



Course Outline
MACHINE SHOP WORK - ADVANCED - 9557
(Abrasives and Grinding Machines)
Department 48 - Quin 9557.02

DADE COUNTY PUBLIC SCHOOLS
DIVISION OF INSTRUCTION • 1973

D A D E  C O U N T Y  P U B L I C  S C H O O L S

1450 NORTHEAST SECOND AVENUE

M I A M I,  F L O R I D A  33132

Course Outline

# MACHINE SHOP WORK - ADVANCED - 9557
(Abrasives and Grinding Machines)

Department 48 - Quin 9557.02

county office of

VOCATIONAL AND ADULT EDUCATION

Dr. E. L. Whigham, Superintendent of Schools
Dade County Public Schools
Miami, Florida 33132

January, 1973

Published by the School Board of Dade County

## Course Description

| 9557 | 48 | 9557.02 | Abrasives and Grinding Machines |
|---|---|---|---|
| State Category Number | County Dept. Number | County Course Number | Course Title |

This quinmester explains to the student the proper selection of grain sizes for abrasives and grinding wheels. The student selects the proper wheel, sets up the grinder and completes at least one project using the proper feeds and speeds. Safety, theory, and industrial processes are emphasized as the student uses the grinding machines.

This is the second quinmester course to be taken in the second year of the Vocational Machine Shop Course.

Indicators of Success: Prior to entry into this course, the student must display a mastery of the skill indicated in Quin 9557.01.

Clock Hours: 135

# PREFACE

The following quinmester course outline has been prepared as a guide to assist the instructor in systematically planning and presenting a variety of meaningful lessons programmed to facilitate the necessary training for the machine shop student.

The material contained in this outline is designed to enable the student to learn the manipulative skills and related knowledge necessary to understand and use correctly abrasives, grinding wheels, and precision grinding machines and their operations in a safe and productive manner.

Prior to entry into this course, the student must display a mastery of the skill indicated in Quin 9557.01. This is the second quinmester course of the second year, consisting of three blocks of instruction, which are subdivided into several units each. This course is 135 hours in length.

The classroom instruction includes lectures, demonstrations, group discussion, study periods, and use of various audiovisual aids.

By satisfactorily completing this course, the student can advance to the next course in this series needed to obtain the skills and technology of the machinery trades.

This outline was developed through the cooperative efforts of the instructional and supervisory personnel, the Quinmester Advisory Committee, and the Vocational Curriculum Materials Service, and has been approved by the Dade County Vocational Curriculum Committee.

TABLE OF CONTENTS
with Suggested Hourly Breakdown

## GOALS

The student must be able to demonstrate:

1. Familiarity with shop equipment, materials, and regulations regarding school, shop, and safety; and an awareness of the employment opportunities in the machine trades.

2. Knowledge of selecting and using abrasives and grinding wheels.

3. A basic knowledge of the surface grinder and cylindrical grinder nomenclature, safety regulations, feeds, abrasive wheels, holding devices, and to be proficient in the operations of internal, external, and surface grinding.

4. A basic knowledge of the tool and cutter grinder nomenclature, safety regulations, abrasive wheels, various setups, and to demonstrate a minimum measurable proficiency in tool sharpening operations.

## SPECIFIC BLOCK OBJECTIVES

### BLOCK I - ABRASIVES AND GRINDING WHEELS

The student must be able to:

1. Identify the different types of bonds, abrasives, and grinding wheels.
2. Exhibit the ability to select the proper abrasive wheel for a particular application.

### BLOCK II - GRINDING MACHINES AND THEIR OPERATION

The student must be able to:

1. Exhibit the ability to care for, operate, and maintain grinding machines within the safety standards required by industry.
2. List the various types of grinding machines, grinding machine parts, holding devices, accessories, and demonstrate the ability to operate them in a safe, proper, and productive manner.
3. Calculate the proper wheel speed, desired work, and table feeds, by using formulas, charts, or handbooks.
4. Explain, orally, how to remove, balance, mount, true, dress, and shape grinding wheels.
5. Demonstrate the ability to set up and perform various surface and cylindrical grinding operations within the tolerances specified.

### BLOCK III - QUINMESTER POST-TEST

The student must be able to:

1. Satisfactorily complete the quinmester post-test.

Course Outline

MACHINE SHOP WORK - ADVANCED - 9557
(Abrasives and Grinding Machines)

Department 48 - Quin 9557.02

I. ABRASIVES AND GRINDING WHEELS

A. Types and Uses of Abrasives
1. Properties
a. Penetration hardness
(1) Mohs hardness scale
(2) Knoop hardness value
b. Fracture resistance
c. Wear resistance
2. Natural
a. Crocus
b. Emery
c. Diamond
3. Artificial
a. Silicon carbide
b. Aluminum oxide
c. Boron carbide

B. Grinding Wheels and Their Selection
1. Cutting action
2. Classification
a. Size and shape
(1) Straight
(2) Cut off
(3) Cylinder
(4) Recessed one side
(5) Straight cup
(6) Beveled cup
(7) Flaring cup
(8) Dish
(9) Saucer
(10) Relieved one side
(11) Relieved two sides
b. Types of abrasives
(1) Aluminum oxide
(2) Silicon carbide
(3) Industrial diamond
c. Grain sizes
(1) Availability
(a) Coarse
(b) Medium
(c) Fine
(d) Very fine
(2) Uses

d. Bonding materials
(1) Vitrified
(2) Silicate
(3) Rubber
(4) Shellac
(5) Resinoid
e. Grades
(1) Soft
(2) Hard
f. Structures
(1) Close
(2) Open
g. Markings
h. Speeds
i. Diamond grinding wheel
j. Selecting and using wheels
(1) Ordering
(2) Precautions in using

C. Coated Abrasives
1. Abrasive materials
a. Silicon carbide
b. Aluminum oxide
c. Crocus cloth
2. Backing materials
a. Paper
b. Cloth
c. Fiber
3. Bonding materials
a. Hide glue
b. Synthetic
4. Types of coating
a. Closed
b. Open
5. Grain size
6. Polishing

II. GRINDING MACHINES AND THEIR OPERATIONS

A. Grinding and Grinding Machines
1. Safety precautions
a. Personal
(1) Eye protection
(2) Proper clothing
(3) Jewelry removal
b. Work hazards
(1) Mechanical
(2) Materials
(3) Holding devices
(4) Floor area
(5) Abrasive wheels
(6) Work guards
(7) Flying particles

II. GRINDING MACHINES AND THEIR OPERATIONS (Contd.)

2. Kinds of operations
   a. Surface
   b. Cylindrical
   c. Internal
   d. Form
   e. Plunge
   f. Centerless
   g. Cutter and tool
   h. Offhand
3. Kinds of machines
   a. Surface
      (1) Horizontal - spindle type
      (2) Vertical - spindle type
   b. Plain
   c. Universal
   d. Internal
   e. Cutter and tool
   f. Universal and tool
4. Gauging ground parts
5. General preliminary procedure
6. Possible grinding troubles

B. Surface Grinder Operation
   1. Machine features
      a. Size
      b. Feed
      c. Attachments
         (1) Wet
         (2) Dry
      d. Accessories
   2. Procedures
      a. General - Setups
         (1) Clamps
         (2) Vise
         (3) Adjustable swivel vise
         (4) Permanent magnetic chuck
         (5) Index centers
         (6) Sine plate
         (7) Perma sine
         (8) V-blocks
         (9) Precision vise
         (10) Adjustable vise
      b. Feeds
         (1) Manual
         (2) Power
         (3) Power cross
      c. Cutting
      d. High-speed attachments

C. Change and Balance Grinding Wheels
   1. Removing
      a. Wheel and sleeve unit
      b. Wheel from sleeve

2. Mounting
    a. Wheel on the sleeve
    b. Wheel and sleeve unit
3. Balancing
    a. Adding lead
    b. Using segments

D. True or Dress Grinding Wheels
1. Surface grinder
2. Universal or plain grinders
    a. Footstock fixture
    b. Truing the radius

E. Shape Grinding Wheels
1. Surface grinder
2. Universal or plain grinders
    a. Convex face
    b. Concave face
    c. Angular face

F. Grind Centers

G. Grinding Cutting Speeds and Feeds
1. Wheel speed
2. Work surface speed
3. Table travel
4. Depth of feed

H. Universal Grinding Machine
1. Principal parts
    a. Wheel stand
    b. Head stock unit
2. Longitudinal table travel
3. Cross-feed mechanism
    a. Selecting amount
    b. Setting positive stop
4. Accessories

I. Universal Grinder Operation - Cylindrical Work
1. Procedures
    a. General
    b. Mounting stock
    c. Setting table travel
    d. Manual cross feed
    e. Automatic cross feed
2. Setups
    a. External tapers
    b. Internal grinding
    c. Sharpen cutters

J. Plain Grinder Operation - Cylindrical Work
1. Orientation
    a. Cross feed controls

II. GRINDING MACHINES AND THEIR OPERATIONS (Contd.)

b. Wheel-slide rapid travel
c. General precautions

2. Procedure
   a. General
   b. Manual cross feed
   c. Automatic cross feed
   d. Tapered cuts
   e. Angular cuts
   f. Spring back rest

III. QUINMESTER POST-TEST

BIBLIOGRAPHY
(Abrasives and Grinding Machines)

Basic References:


1. Althouse, Andrew D., and Others. Modern Welding. Chicago: Goodheart-Willcox Co., Inc., 1967. Pp. 712.

2. Giachino, J. W., and Others. Welding Technology. Chicago: American Technical Society, 1968. Pp. 480.

3. Johnson, Harold V. General-Industrial Machine Shop. Peoria: Illinois: Charles A. Bennett Co., Inc., 1963. Pp. 182

4. Ludwig, Oswald A. Metalwork Technology and Practice. Bloomington, Illinois: McKnight and McKnight, 1967. Pp. 399.

5. McCarthy, Willard J., and Smith, Robert E. Machine Tool Technology. Bloomington, Illinois: McKnight and McKnight, 1968. Pp. 672.

6. Oberg, Erik, and Jones, F. D. Machinery's Handbook. 18th ed. New York: The Industrial Press, 1968. Pp. 2293.

7. Porter, Harold W., and Others. Machine Shop Operations and Setups. Chicago: American Technical Society, 1967. Pp. 517.


Supplementary References:


8. Axelrod, Aaron. Machine Shop Mathematics. 2nd ed. New York: McGraw-Hill Book Company, Inc., 1951. Pp. 359.

9. Burghardt, Henry D., and Others. Machine Tool Operation. Part I. 5th ed. New York: McGraw-Hill Book Company, Inc., 1959. Pp. 588.

10. _____. Machine Tool Operation. Part II. 4th ed. New York; McGraw-Hill Book Company, Inc., 1960. Pp. 681.

11. Colving, Fred H., and Stanley, Frank A. American Machinist's Handbook. New York: McGraw-Hill Book Company, Inc., n.d. n.p.

12. Felker, C. A. Machine Shop Technology. Milwaukee: The Bruce Publishing Co., 1962. Pp. 491.

13. Heat Treatment of Metals. Albany, New York: Delmar Publishers, Inc., 1970. Pp. 58.

14. Henry Ford Trade School. Shop Theory. New York: McGraw-Hill Book Company, Inc., 1942. Pp. 267.

15. Jenson, C. H., and Mason, F. H. S. Drafting Fundamentals. 2nd ed. Toronto: McGraw-Hill Company of Canada Limited, 1967. Pp. 242.

16. Johnson, Carl G., and Weeks, William R. Metallurgy. 4th ed. Chicago: American Technical Society, 1956. Pp. 454.

17. Olivo, C. Thomas, and Payne, Albert V. Basic Blueprint Reading and Sketching. Albany, New York: Delmar Publishers, Inc., 1952. Pp. 145.

Manufacturer's Booklet:

18. Illinois Tool Works. Trigonometry Tables and Involute Functions. Chicago, 1963.

Periodicals:

19. Industrial Arts and Vocational Education. Milwaukee: The Bruce Publishing Co.

20. School Shop. Ann Arbor, Michigan: School Shop.

Teacher Aids:

21. Job Sheets, 100 and 200 Series. Miami, Florida: Division of Vocational and Adult Education, Dade County Public Schools.

22. Ohio Trade and Industrial Education Service. Job Sheets. Columbus, Ohio: Division of Vocational Education, State Department of Education, 1962.

23. Unit of Instruction Plans. Miami, Florida: Division of Vocational and Adult Education, Dade County Public Schools.

Films:

1. Anyone at All. (Safety). 16 mm. 22 min. B/W. Sound. n.d. Encyclopedia Britannica Films, Inc.

2. Cutting Threads with Taps and Dies. 16 mm. 19 min. B/W. Sound. United World Films, Inc.

3. Fundamentals of Filing. 16 mm. 12 min. B/W. Sound. United World Films, Inc.

4. Grinding Cutter Bits. 16 mm. 20 min. Color. Sound. South Bend Lathe Works.

5. Grinding a Parallel Bar. Part I. 16 mm. 14 min. B/W. United World Films, Inc.

6. Hacksaws. 16 mm. 18 min. B/W. Sound. United World Films, Inc.

7. Hammers. 16 mm. 11 min. B/W. Sound. United World Films, Inc.

8. Hand Soldering. 16 mm. 17 min. B/W. Sound. United World Films, Inc.

9. Hardness Testing: Rockwell. 16 mm. 18 min. B/W. Sound. United World Films, Inc.

10. Inspection of Threads. 16 mm. 22 min. B/W. Sound. United World Films, Inc.

11. Metal Working Lathe. 16 mm. 20 min. Color. Sound. South Bend Lathe works.

12. Micrometer. 16 mm. 15 min. B/W. Sound. United World Films, Inc.

13. Milling Machine. 16 mm. 8 min. B/W. Sound. United World Films, Inc.

14. Plain Indexing and Cutting a Spur Gear. 16 mm. 26 min. B/W. Sound. United World Films, Inc.

15. Plain Turning. 16 mm. 20 min. Color. Sound. South Bend Lathe Works.

16. Pliers and Screwdrivers. 16 mm. 18 min. B/W. Sound. United World Films, Inc.

17. Precisely So (History of Measurements). 16 mm. 20 min. B/W. Sound. General Motors, Inc.

18. Principles of Gearing: An Introduction. 16 mm. 18 min. B/W. Sound. United World Films, Inc.

19. Principles of Lubrication. 16 mm. 16 min. B/W. Sound. United World Films, Inc.

20. Punches, Drifts, and Bars. 16 mm. 14 min. B/W. Sound. United World Films, Inc.

21. Shop Procedures. 16 mm. 17 min. B/W. Sound. McGraw-Hill Book Company, Inc.

22. Steel Rule. 16 mm. 14 min. B/W. Sound. United World Films, Inc.

23. Steel Town. 16 mm. 17 min. B/W. Sound. United World Films, Inc.

24. Verniers. 16 mm. 19 min. B/W. Sound. United World Films, Inc.

25. Wrenches. 16 mm. 20 min. B/W. Sound. United World Films, Inc.

# A P P E N D I X

## Quinmester Post-Test Sample

Quinmester Post-Test

Name _____ Date _____ Score ____

## Multiple Choice Test Items

Each statement needs a word, a figure, or a phrase to make it correct. Only one of the choices listed is correct. Place the letter of the choice you make in the space provided at the left. Each question counts two points.

____ 1. Abrasives are rated for hardness mostly by the

a. Knoops Hardness Scale
b. Mohs Hardness Scale
c. Brinnel Hardness Scale
d. Rockwell Scale of Hardness

____ 2. The name of the artificial abrasive material that was first developed by Dr. Edward G. Acheson about 1891 was

a. Emery
b. Aluminum oxide
c. Silicon carbide
d. Boron carbide

____ 3. The artificial abrasive is more advantageous than the natural type because it is

a. Harder and tougher
b. More plentiful
c. More economical
d. Cheaper to obtain

____ 4. The best selection of an economical abrasive for a job involving the lapping of a very hard die material is

a. Emery
b. Carborundum
c. Aluminum oxide
d. Boron carbide

____ 5. In which of the following applications would the abrasive forms be considered foreign?

a. Sharpening sticks
b. Wheel lubrication
c. Coated papers
d. Grinding wheels

____ 6. Which of the following is related to the artificial category of abrasives?

a. Diamond
b. Silicon carbide
c. Emery
d. Crocus

____ 7. What percentage of all grinding wheels made and used today are made from aluminum oxide?

a. 75%
b. 90%
c. 60%
d. 45%

____ 8. When an abrasive grain maintains sharpness, it's a measure of

a. Toughness
b. Softness
c. Penetration hardness
d. Wear resistance

____ 9. Crocus is actually a compound of

a. Aluminum and oxygen
b. Carborundum
c. Iron and oxygen
d. Silicon and carbon

____ 10. Abrasive machining is distinguished from finish grinding by the fact that

a. Metal is removed more rapidly
b. A faster wheel speed is required
c. A softer wheel is used
d. A harder wheel is used

____ 11. A foreign classification of grinding wheels is

a. Abrasive and bond
b. Grain size
c. Size and shape
d. Weight

____ 12. A common type of bonding material used today in grinding wheels is

a. Resinoid
b. Shellac
c. Vitrified
d. Silicate

____ 13. The most economical abrasive best suited for grinding and maintaining tungsten carbide cutting tools is

a. Diamond
b. Emery
c. Aluminum oxide
d. Silicon carbide

____ 14. The factor that is being discussed when mentioning dense or open grinding wheels is

a. Structure
b. Grade
c. Grain size
d. Bond

____ 15. A bonding material used in grinding wheel to produce the highest degree of work finish is

a. Shellac
b. Silicate
c. Resinoid
d. Vitrified

____ 16. When a grinding wheel is designated as (32A46J6VG), the "J" stands for the

a. Grain size
b. Structure
c. Type of bond
d. Grade of hardness

____ 17. A common backing for coated abrasives is

a. Stone
b. Paper
c. Sheet steel
d. Glass

____ 18. The cross feed of the surface grinding table beneath the wheel should not exceed

a. 3/4 of its width
b. 1/4 of its width
c. 1/2 of its width
d. 1/8 of its width

____ 19. The rough cut in surface grinding should vary in depth from

a. .0002 to .0003
b. .001 to .003
c. .010 to .013
d. .0001 to .0003

____ 20. Finish cuts in surface grinding are usually less than

a. .00001
b. .000
c. .001
d. .0001

____ 21. In surface grinding, the power cross feed for average work generally ranges from

a. .160 to .200
b. .010 to .040
c. .050 to .100
d. .100 to .150

____ 22. The term used to describe the correcting of eccentricity of an out-of-round condition on a grinding wheel is

a. Truing
b. Sharpening
c. Deglazing
d. Dressing

____ 23. What process does the term "dressing" refer to?

a. Restoring concentricity
b. Exposing of new and sharp abrasive grains
c. Periphery forming
d. Recoating the wheel with new abrasive grains

____ 24. A work surface speed of 200 FPM is usually recommended for cylindrical grinding of

a. Cast iron
b. Stainless steel
c. High carbon steel
d. Aluminum and brass

____ 25. When a very fine smooth finish is desired, the relative rate of table travel is

a. Slow
b. Medium fast
c. Fast
d. Medium slow

____ 26. The surface speed of the work generally used for cylindrical grinding is

a. 20 to 50 RPM
b. 120 to 150 FPM
c. 50 to 100 FPM
d. 50 to 80 RPM

____ 27. What is the surface speed of the wheel generally recommended for cylindrical grinding?

a. 4,500 to 5,500 FPM
b. 5,500 to 6,500 FPM
c. Speed not listed
d. 5,500 to 6,500 RPM

____ 28. The major advantage of precision grinding that is considered to be second only to that advantage of its capability for producing close dimensional tolerances is

a. Low initial cost
b. A good method to machine hardened parts
c. Ease of set up
d. Speed of operation

____ 29. The minimum warm-up time before maximum accuracy of the grinding machine is

a. 15 minutes
b. 20 minutes
c. 5 minutes
d. 10 minutes

____ 30. Center rest should be used on a cylindrical grinder when grinding

a. Centers
b. Hard and tough work pieces
c. Long slender work pieces
d. Internally

____ 31. What is the table hesitation prior to each reversal called?

a. Hold
b. Stabilizer
c. Stop
d. Dwell

____ 32. A common industrial practice is grinding mass produced parts to a tolerance of plus or minus

a. .00001
b. .0001
c. .001
d. .010

Select the correct answer for the following problems which must be solved by use of one of the formulas listed below:

$$\left(\frac{\text{Diameter of wheel in " x } 3.1416}{12"} - \text{Feet circumference}\right)$$

$$\left(\text{RPM} = \frac{\text{Surface Speed}}{\text{Circumference}}\right)$$

(Surface speed = RPM of spindle X Circumference of wheel in feet)

(RPM = $\frac{\text{Work speed in feet X 12}}{\text{Circumference of work in inches}}$)

(Table travel = RPM X Width of wheel travel)

____ 33. The circumference, in feet, of a 12" grinding wheel is

a. 31.416
b. .7854
c. 7.854
d. 3.1416

____ 34. A wheel 3" wide has a work speed of 210 RPM and a table travel of 1/3 the width of the wheel per revolution. What is the table travel in inches per minute?

a. 210
b. 420
c. 21
d. 84

____ 35. The diameter of the workpiece is 1", and a work speed of no more than 90 FPM is used. What is the work RPM, approximately?

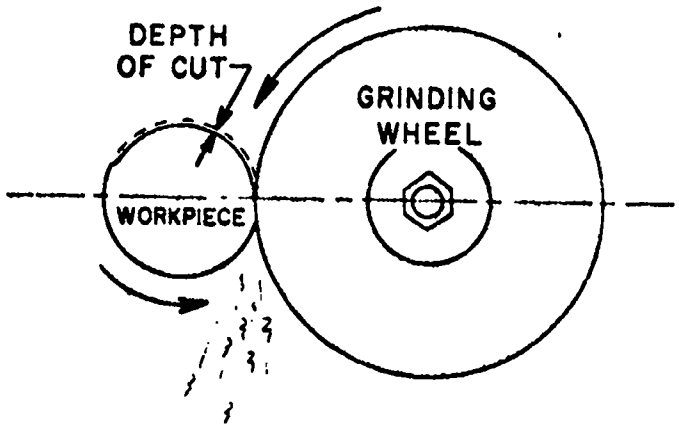
a. 444
b. 434
c. 344
d. 334

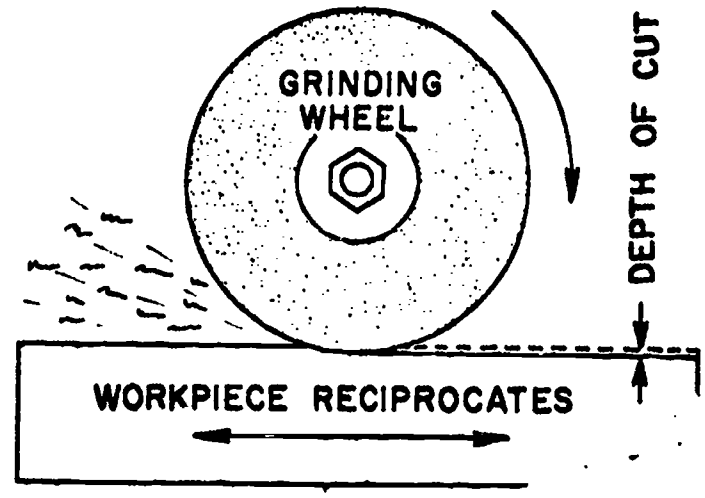
____ 36. A cylinder grinder will produce a spindle speed of 2050 RPM. With a 10" wheel diameter, what is the surface speed of the wheel in approximate FPM?

a. 205
b. 20,500
c. 536.7
d. 5,367

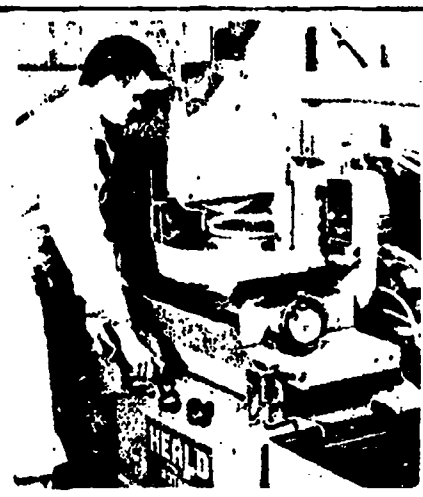
## Identification Test-Items

Examine the figures and pictures below. Determine the types of grinding being done and the types of grinding machines. Insert the correct name in the space provided under each picture or figure.

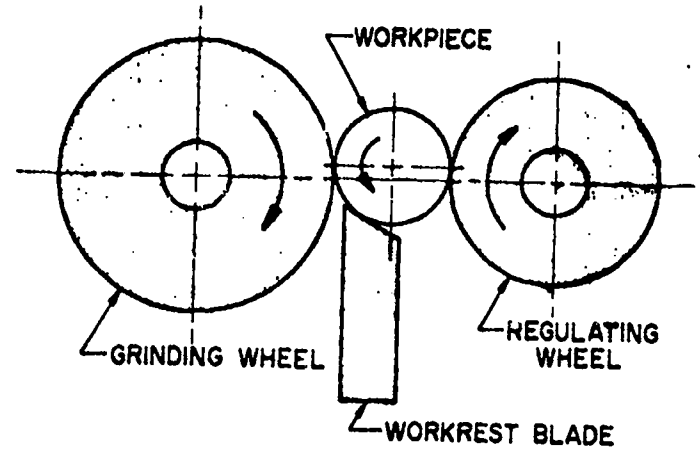


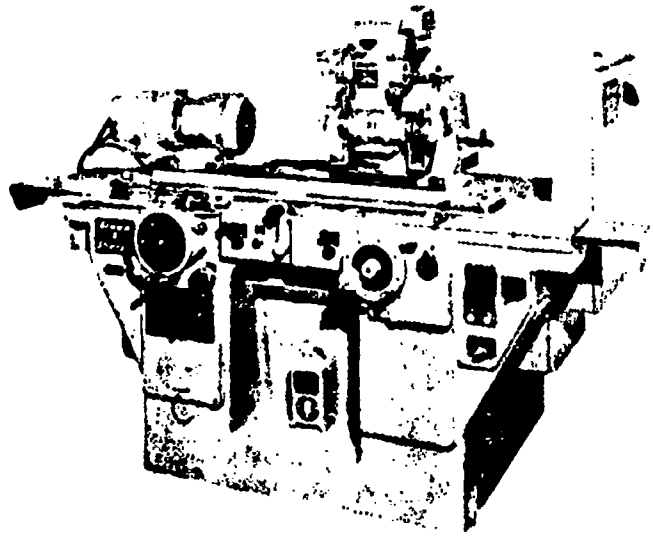

1. _____



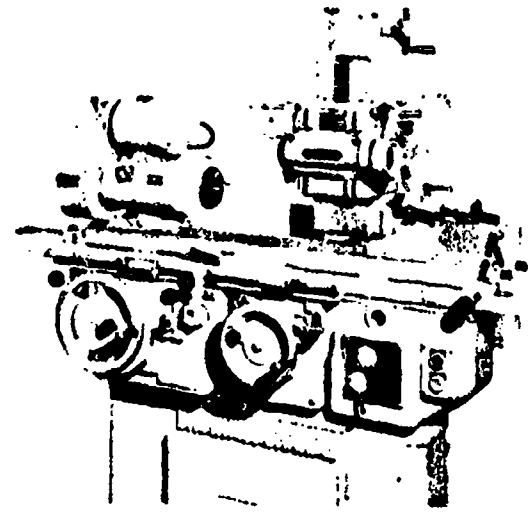
2. _____




3. _____



4. _____



5. _____

6. _____

## Matching Test-Items

The words or phrases in the left-hand column are significant in connection with an expression in the right-hand column. Match them properly by placing the figure preceding the item in the left-hand column in the brackets at the right of the matching items.

| | | Produces the following: |
|---|---|---|
| 37. | Form grinding | ____ a. An accurately flat smooth surface |
| 38. | Cylindrical grinding | ____ b. Smooth and accurate surfaces in a cylindrical hole |
| 39. | Surface grinding | ____ c. A nonprecision ground surface |
| 40. | Plunge grinding | ____ d. A straight or tapered surface on a cylindrical or conical work piece |
| 41. | Centerless grinding | ____ e. A renewed surface on edged tools |
| 42. | Internal grinding | ____ f. An accurate surface of a special shape |
| 43. | Tool and cutter grirding | ____ g. An accurately ground part without a fixed mounting of the work piece |
| 44. | Offhand grinding | ____ h. A straight, tapered, or formed surface on a work piece as the wheel moves into the work |

# Quinmester Post-Test Key

## Multiple Choice

1. b
2. c
3. a
4. d
5. b
6. b
7. a
8. d
9. c
10. a
11. d
12. c
13. d
14. a
15. a
16. d
17. b
18. c
19. b
20. c
21. c
22. a
23. b
24. d
25. a
26. c
27. b
28. b
29. a
30. c
31. d
32. b
33. a
34. a
35. c
36. d

## Identification

1. Cylindrical grinding
2. Surface grinding
3. Rotary table surface grinder
4. Centerless grinding
5. Universal grinding machine
6. Universal and tool grinding machine

## Matching

a. 39
b. 42
c. 44
d. 38
e. 43
f. 37
g. 41
h. 40