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ABSTRACT

One of twelve individualized courses included in an automotive repair curriculum, this course covers theory and construction, inspection diagnoses, and service and overhaul of automotive engines. The course is comprised of five units: (1) Fundamentals of Four-Cycle Engines, (2) Engine Construction, (3) Valve Train, (4) Lubricating Systems, and (5) Cooling Systems. Each unit begins with a Unit Learning Experience Guide that gives directions for unit completion. The remainder of the unit consists of Learning Activity Packages (LAP) that provide specific information for completion of a learning activity. Each LAP is comprised of the following parts: objective, evaluation procedure, resources, procedure, supplemental sheets, study guide, and a LAP test with answers. The course is preceded by a pretest which is designed to direct the student to units and performance activities. (LRA)

MOUNTAIN PLAINS LEARNING EXPERIENCE GUIDE:
Automotive Repair.

Course: Engine Repair.

File Code: 37.08.00.00.B1-1

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

COURSE: ENGINE REPAIR

DESCRIPTION:

Engine Repair covers theory and construction, inspection and diagnoses, and service and overhaul of automotive engines.

RATIONALE:

The theory and technique covered in this course will enable you to diagnose and repair automotive engines.

PREREQUISITES:

Math Skills level as determined by the specific requirement of the particular job titles.
Communication as determined by the specific requirement of the particular job title.

OBJECTIVE:

Inspect, service and make general repairs to automotive engines.

RESOURCES.

A resource list is attached.

GENERAL INSTRUCTIONS:

This Course has five units. Each unit has a Unit Learning Experience Guide (LEG) that gives directions for unit completion. Each unit consists of Learning Activity Packages (LAPs) that provide specific information for completion of a learning activity. Pretesting results direct the student to units and performance activities.

The general procedure for this course is as follows:

1. Read the assigned unit LEG for this course.
2. Begin and complete the first assigned LAP.
   a. Take and score the LAP test.

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GENERAL INSTRUCTIONS (Cont.)

   b. Turn in the LAP test answer sheet.
   c. Determine the reason for any missed items on the LAP test.
   d. Proceed to the next assigned LAP in the unit.
   e. Complete all required LAPs for the unit by following steps (a) through (d).
3. Take the unit tests as described in the Unit LEG "Evaluation Procedures".
4. Proceed to the next assigned unit in this course.
5. Follow steps 1 through 4 for all required units for this course.
6. Proceed to the next assigned course.

You will work independently unless directed to do otherwise. When questions or problems arise, you are expected to discuss them with the instructor. At all times remember to follow correct safety procedures during the performance activity.

UNIT TITLES:

.01 Fundamentals of 4-Cycle Engines
.02 Engine Construction
.03 Valve Train
.04 Lubricating Systems
.05 Cooling Systems

EVALUATION PROCEDURE:

Course evaluation is by pre and post testing using a multiple-choice type of test.

In this course, the course test is used as a pretest to determine which units, if any, the student may be able to validate. The student is considered validated for a particular unit if 4 out of 5 items are correctly answered for each LAP part on the course pretest and that particular unit does not have a performance test requirement.

For those units with performance test requirements, the student must also satisfactorily complete the performance test to validate that unit. Unit performance test validation procedures are given in the "Evaluation Procedure" section of the unit Learning Experience Guide (LEG).

The course test will also be taken by the student as a post test to determine any changes resulting from taking all or part of the course. Score at least 80% correct on the post test.

FOLLOW-THROUGH

Go to the first assigned Unit Learning Experience Guide (LEG) listed on your Student Progress Record (SPR).

RESOURCE LIST

Printed Materials

1. Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc., 1969.
2. Automotive Encyclopedia. Motor Services.
3. Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc., 1969.
4. Operator's Manuals.
5. Motor's Auto Repair Manual. Motor. The Hearst Corporation, 1972 (or equivalent).
6. Time and Parts Manual.

Audio/Visuals

Equipment

1. Automobile needing:
   - cooling system inspection and repair
   - flushing
   - hose inspection and replacement
   - thermostat
   - water pump inspection and replacement
2. Automobile with:
   - engine block
   - camshaft
   - connecting rods
   - overhead cam head
   - overhead valve head
   - pistons
3. AVT System Super 8 mm Instant Film Loop Player
4. Replacement parts:
   - bearings, crankshaft
   - hoses and hose clamps
   - oil pump
   - gaskets:
     - pan gasket set
     - thermostal gadget
     - valve grind gasket set
     - water pump gasket
   - thermostat
   - water pump
   - valves
5. Safety equipment:
   - goggles
   - gloves
6. Supplies:
   - anti-freeze
   - coolant
   - oil
   - source of heat
   - wire

8. Test equipment: dial indicator
pressure tester
remote oil test guage
R.P.M. meter

9. Tools, basic hand: chisel and punch set
5/32" pin punch
3/16" solid
gauge, feeler (.002" - .025")
hammer, ball peen
hammer, plastic tip
handle, speed
hex key set
pliers, diagonal cutting
pliers, needle nose
scraper, gasket
screwdriver, standard (set)
screwdriver, Phillips (set)
screw starter
socket set (3/8" drive)
estension (3")
handle (6" flex)
ratchet
socket, spark plug
extension (6")
wrench, combination (set)
wrench, combinition ignition (set)

10. Tools, general: carbon scraper
drain pan
electric drill with wire brush
feeler gauge
funnel
fender covers
flush gun and water source
magnifying glass
micrometers
plasti-gauge
ruler, straight edge
squeegee
thermometer
torque wrench

11. Tools, engine rebuilder: boring bar
crack finder
cylinder hone
piston knurlizer
piston pin hone
piston pin press
rod and cap grinder
surface grinder
valve grind equipment
valve grind installer
valve seat replacer
valve spring compressor

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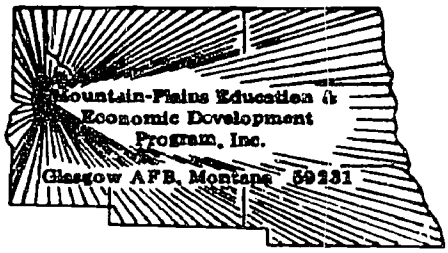


COURSE TEST: ENGINE REPAIR

37.08.01.01

1. With the piston at the extreme bottom of its cycle, it is 6 inches from the head to the top of the piston; with the piston at the extreme top of its stroke, it is one inch from the head to the top of the piston. The compression ratio of this cylinder is:

   a. 6 to 1
   b. 3 to 1
   c. 5 to 1
   d. 7 to 1

2. The crankshaft turns:

   a. at the same speed of the camshaft.
   b. 2 times the speed of the camshaft.
   c. 1/4 the speed of the camshaft.
   d. 1/2 the speed of the camshaft.

3. The camshaft receives its power from the crankshaft; the gear that runs the camshaft has:

   a. 1/2 as many teeth as the crankshaft gear.
   b. 4 times as many teeth as the crankshaft gear.
   c. 1/4 as many teeth as the crankshaft gear.
   d. 2 times as many teeth as the crankshaft gear.

4. The connecting rod of an engine connects the:

   a. piston to the block.
   b. piston to the crankshaft.
   c. the crankshaft to the flywheel.
   d. the block to the generator.

5. The valve spring holds the valve:

   a. against the cam lobe.
   b. closed.
   c. in place.
   d. open.

37.08.02.01

6. Cylinder block and cylinder head mating surfaces are:

   a. seldom warped.
   b. often warped.
   c. never warped.
   d. always warped.

37.08.02.01 (continued)

* 7. When honing worn cylinders, always:

a. start honing at the bottom then work up the cylinder.
b. start honing at the top then work down the cylinder.
c. hone at the bottom.
d. hone at the top.

* 8. Worn piston pin bosses in the piston require:

a. replacement.
b. fitting to an oversize pin
c. scrapping the unit.
d. pin expansion by knurling.

* 9. The clearance between the ends of the ring when installed in the cylinder is referred to as:

a. ring gap.
b. ring prapper.
c. ring ridge.
d. ring lip.

*10. Most oversize pistons will have the amount of oversize stamped where on the piston

a. inside of piston.
b. bottom of piston
c. head.
d. outside of piston.

37.08.02.02

11. The bottom rings in a piston are always:

a. compression rings and oil control ring combined.
b. a blockage spring used as a ring.
c. oil control rings.
d. compression rings.

12. Piston pins usually ride on what kind of surface?

a. stainless steel.
b. cast iron.
c. a nickle-coated bushing.
d. aluminum.

*(From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, pages 16-13 and 16-14, #s 12, 21, 24, 27, 44.)

37.08.02.02 (continued)

13. Where are expander devices located in an engine?

a. between rod bearing and crankshaft.
b. between piston pin and the piston bars.
c. between oil pump and oil pump screen.
d. between ring and piston.

14. An eight cylinder in-line engine requires how many connecting rod throws?

a. 12
b. 4
c. 8
d. 16

15. The unit that forms a basic foundation upon which the whole engine is built is called the:

a. head
b. motor mount.
c. block.
d. flywheel.

37.08.02.03

16. A pressurizer hooked to an engine oil system can also be used as a:

a. air bomb.
b. cooling system check.
c. sprayer.
d. bearing leak detector.

17. When installing the engine, the transmission should be:

a. varies with different makes and models.
b. on the bench.
c. in the car.
d. on the engine.

18. You can prevent what is known as dry starting by:

a. pouring oil in the crankcase and letting it drain down.
b. pouring oil down the carburetor.
c. pre-lubing (or priming) the engine oil system.
d. starting the engine and speeding it up very quickly.

19. When not directly working an engine you should:

a. leave it hanging on work stand and don't disturb anything.
b. cover it with a cloth.
c. let all parts remain where you put them so you know where they go.
d. put it under a bench out of the way.

37.08.02.03 (continued)

20. When engine is overhauled and running, you take the car out for a break-in run, which if from 30 to 50 mph and then back to 30 mph. This cycle should be done a minimum of how many times?

a. 10
b. 30
c. 20
d. 5

37.08.02.04

21. To provide proper break in and longer wear, many regrinders cover the cam lobes with a special coating of?

a. phosphate.
b. aluminum.
c. cast iron.
d. chromium.

22. Camshafts are generally hardened to a depth of:

a. .040
b. .060
c. .020
d. .030

23. A chipped or badly worn cam can be built up by:

a. copping lobes.
b. welding.
c. heat soldering.
d. craming.

24. When inspecting a camshaft out of an engine, you would check wear on the cam journals with a(n):

a. feeler gauge
b. dial indicator.
c. micrometer
d. oscilloscope

25. If, when inspecting a camshaft, you find that the out-of-roundness is more than how much will you have to regrind the camshaft?

a. .010
b. .0003
c. .020
d. .001

37.08.02.05

26. Before removing the main bearing caps, you must:

a. remove the camshaft.
b. do a plastic gauge test.
c. remove front and rear bearing oil seal.

37.08.02.05 (continued)

27. Crankshaft journals must not be tapered over:

a. .001
b. .010
c. .005
d. .0001

28. When the engine is in the car, the upper inserts can best be removed by:

a. driving out with a punch.
b. pulling out with a wire.
c. blowing out with air pressure.
d. rolling out with a removal plug.

29. Maximum crankshaft journal out-of-roundness should not exceed:

a. .0001
b. .005
c. .001
d. .010

30. For an acceptable finish, the micro inch finish on a crankshaft should be:

a. 100 micro inch.
b. 1 micro inch.
c. 16 micro inch.
d. 160 micro inch.

37.08.02.06

31. Worn pin bosses in the piston require:

a. pin expansion by knurling.
b. scraping the unit.
c. fitting to an oversized pin.
d. putting new bronze bushing in piston.

32. A typical pin fit in an aluminum piston would have the following clearance:

a. .002 to .004
b. .0002 to .0005
c. .020 to .0205
d. .006 to .010

33. A cast type piston has one of the following characteristics:

a. usually very heavy.
b. very smooth finish inside and out.
c. very strong.
d. fairly weak.

37.08.02.06 (continued)

34. The lower piston ring groove contains what ring(s)?

a. compression ring
b. oil ring
c. five compression rings
d. oil and compression ring.

35. Worn or collapsed pistons can be resized by:

a. honing
b. knurling
c. scraping
d. fitting an oversized sleeve

37.08.02.07

36. Rod bearings are connected to the:

a. crankshaft main bearing journal
b. crankshaft counterweight
c. crankshaft rod journal
d. camshaft

37. When loosening a rod, the crankshaft must be turned to a position:

a. in the middle dead center.
b. at top dead center.
c. at bottom dead center.
d. it does not matter where crankshaft is.

38. Before you take rods out of an engine, you should:

a. wash them.
b. ream them.
c. mark them.
d. burnish them.

39. When the centerlines of the upper and lower rod bearing bases are out of alignment in a horizontal plane, they are:

a. bent.
b. twisted.
c. offset.
d. scored.

40. Due to the lightness in weight of connecting rods, they tend to distort the big end bearing base and:

a. scuff rod.
b. burn rod.
c. score rod.
d. bend rod.

37.08.02.08

41. Worn timing gears or chains will not:

    a. tighten timing chain.
    b. cause damage to camshaft.
    c. overheat engine.
    d. alter valve timing.

42. It is possible on most cars to remove the camshaft gear without removing the camshaft by using:

    a. a crow bar.
    b. a pulley puller.
    c. your hands.
    d. a small hammer.

43. To remove the crankshaft timing gear you must:

    a. use a puller.
    b. tap off with a light hammer.
    c. heat the gear.
    d. take off two bolts.

44. Backlash on timing gears can be measured by:

    a. dial indicator.
    b. mandrel.
    c. oscilloscope
    d. micrometer.

45. The distance the crankshaft gear will turn without turning the camshaft is called:

    a. backlash.
    b. gear vibration.
    c. gear tolerance.
    d. gear wobble.

37.08.03.01

*46. Excessive valve spring installed height can cause:

    a. seal damage.
    b. slow valve timing.
    c. valve float.
    d. heavy spring tension.

*47. A valve seat that is too wide will:

    a. pack with carbon, start to leak and burn.
    b. break the valve stem.
    c. run too cold.
    d. be hard to open.

*(From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, pp. 13-39 and 13-40, #s 2, 4, 5, 7, 16, 22, 24, 26, and 35).

37.08.03.01 (continued)

48. To check valve stem to guide clearance you would use a:

a. oscilloscope.
b. dial indicator.
c. feeler gauge.
d. hydrometer.

49. What is one tool you use when checking cylinder head for warpage?

a. hydrometer.
b. straightedge.
c. dial indicator.
d. cup seal.

50. What do you use to inspect the plunger check valve seat for nicks in a hydraulic lifter?

a. a magnifying glass.
b. soapy water.
c. an exhaust analyzer.
d. a light oil.

37.08.03.02

51. When checking a cylinder head, total warpage should not exceed:

a. .006"
b. .002"
c. .005"
d. .003"

52. A tool used to check for warpage on a cylinder head is a:

a. oscilloscope
b. dial indicator
c. feeler gauge
d. magnifying glass

53. An aluminum cylinder head can not be:

a. cracked.
b. replaced.
c. surfaced.
d. magnafluxed.

54. To inspect a cylinder head, the valve springs should be removed with a(n):

a. feeler gauge.
b. guide reamer.
c. spring compressor.
d. valve guide remover.

37.08.03.02 (continued)

55. To determine the amount of valve stem wear, you would use a:

a. dial indicator.
b. micrometer.
c. feeler gauge.
d. snap gauge.

37.08.03.03

56. When grinding valve stem end in an overhead valve head, you should not remove more than:

a. .200
b. .010
c. .030
d. .020

57. A "valve in head" engine is when you have both valves in the head. What type of head is a "valve in head" head?

a. l head
b. T head
c. L head
d. F head

58. On an overhead valve head the rocker arm has what kind of movement on the rocker arm shaft?

a. pivot
b. sliding
c. oscillating
d. slipping

59. When inspecting valve springs, which of the following would you not look for?

a. cracks
b. tension
c. progressive windings
d. diameter of wire

60. How much clearance is there in hydraulic overhead valves when setting the valves?

a. none
b. .015
c. .10
d. .005

37.08.03.04

61. An overhead camshaft is operated by:

a. oversized timing gears.
b. a regular timing chain.
c. a long timing chain.
d. regular timing gears.

62. With an overhead camshaft it will help prevent valves at high speeds from:

a. carboning.
b. burning.
c. floating.
d. glazing.

63. How many camshafts would an overhead cam "v" type engine most often have?

a. 5
b. 2
c. 4
d. 3

64. An overhead camshaft's timing chain is kept tight by:

a. the crankshaft sprocket.
b. oversized gears.
c. rubbing blocks.
d. it cannot be kept tight.

65. Which of the following parts are eliminated by an overhead cam head?

a. rocker arms and pushrods.
b. valve stems.
c. valve guides.
d. valve springs.

37.08.04.01

66. End clearance in an oil pump rotor should not exceed:

a. .010
b. .004
c. .020
d. .001

67. End clearance is measured by a strightedge and a(n):

a. dial indicator.
b. feeler gauge.
c. oscilloscope.
d. kruhl.

37.08.04.01 (continued)

*68. A spin on filter should be tightened:

a. to 60 feet turns.
b. only until the gasket contacts the base.
c. two full turns after contacting the base.
d. one-half turn after contacting the base.

69. Oil resistance to flow is the definition of:

a. splash flow.
b. friction.
c. viscosity.
d. shunt flow.

70. The object of the pickup screen is to:

a. prevent large particles from entering system.
b. collect sludge.
c. send oil to the systems.
d. filter the dirt from the oil.

37.08.04.02

71. Badly worn bearings will cause:

a. good mileage.
b. low oil pressure.
c. high engine torque.
d. good oil mileage.

72. Using adapters, you would connect the oil test gauge to the:

a. oil pump.
b. exhaust manifold.
c. oil pickup pipe.
d. oil sending unit.

73. To check rotor end clearance on an oil pump, you would use a(n):

a. straightedge
b. dial indicator
c. triometer
d. oscilloscope

74. When you overhaul an engine, you should test an oil pump for:

a. torque.
b. compression.
c. oil pressure.
d. leaks.

*(From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, pp. 17-15 and 17-16, #16).

37.08.04.02 (continued)

75. One instrument used to measure oil pump moving parts is a(n):

a. rotor measuring gear.
b. dial indicator.
c. oscilloscope.
d. feeler gauge.

37.08.04.03

76. The name of the valve in the oil pump used to regulate the oil pressure is the:

a. relief valve.
b. diaphragm valve.
c. vapor return valve.
d. pulsator return valve.

77. If you use a jack to raise an engine, you must place it:

a. under the vibration damper.
b. under the oil pan using a board to distribute the weight.
c. under the middle of the oil pan.
d. under the crankshaft pulley.

78. To take off the oil pan to replace the oil pump, you must sometimes:

a. remove the vibration damper.
b. disconnect the transmission.
c. disconnect the motor mounts.
d. disconnect the drive shaft.

79. If the oil pump and gear is removed on an oil pump driven distributor, which of the following will happen?

a. the distributor gear will have to be replaced.
b. the crankshaft will rotate freely.
c. the timing will be thrown off.
d. the crankshaft will rotate with little compression.

80. On some engines what must be drained when the oil pump is removed?

a. the oil filter.
b. the engine oil.
c. the transmission.
c. the antifreeze.

37.08.05.01

*81. In a pressurized cooling system, you should always use what type of radiator cap?

a. aluminum.
b. 30 lbs. regular cap.
c. pressurized cap.
d. non-pressurized cap.

*82. When an alcohol base antifreeze is used, the thermostat temperature rating should not exceed:

a. 160 F.
b. 180 F.
c. 140 F.
d. 190 F.

83. When reverse flushing a radiator, the maximum air pressure you can use is:

a. 50 lbs.
b. 20 lbs.
c. 25 lbs.
d. 30 lbs.

*84. What type of antifreeze is referred to as permanent antifreeze?

a. denatured alcohol.
b. methyl alcohol.
c. ethylene glycol.
d. wood alcohol.

*85. The extent of radiator clogging can best be checked by:

a. looking in the filter cap.
b. draining and checking coolant color.
c. reverse flushing.
d. flow testing.

37.08.05.02

86. Cooling failure of most air cooled engines is due to:

a. too great a clearance in moving parts.
b. low gear operation.
c. improper operation.
d. high speed operation.

87. What can be done to prevent overheating in an air cooled engine?

a. drive slowly.
b. keep rpm up fairly high.
c. lug down engine.
d. don't drive too hard on a hot day.

*(From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, pp. 19-19 and 19-20, #s 1, 6, 7, 13, 14, 21, 26, 28, 31).

37.08.05.02 (continued)

88. Temperature in an air cooled engine which has forced air circulation is controlled by:

a. air jackets.
b. a thermostat.
c. water jackets.
d. dorsal fins.

89. Air movement over the engine fins in an air cooled engine while at an idle is created by:

a. the fan.
b. wind blowing through fins.
c. outside air hitting it
d. movement of vehicle.

90. Air cooling is more efficient when applied to engines which are constructed of:

a. special steel alloys.
b. cast iron.
c. bronze.
d. aluminum.

37.08.05.03

91. Deterioration in hoses is checked:

a. by a dial indicator.
b. by an oscilloscope.
c. by a strand tension gauge.
d. visually.

92. When replacing a hose, you must use the correct hose by measuring the:

a. length.
b. inside of connection or engine or radiator.
c. inside diameter and length.
d. outside diameter.

93. When you bend heater hoses, you check for:

a. corrosion.
b. silt build-up.
c. cracking.
d. rust build-up.

94. Air bubbles in a cooling system will tell you that:

a. your top radiator hose is loose or broken.
b. your bottom radiator hose is loose or broken.
c. your thermostat is stuck closed.
d. your thermostat is stuck open.

37.08.05.03 (continued)

95. The bottom radiator hose is under:

a. vacuum.
b. water pressure.
c. air pressure.
d. less heat than top hose.

37.08.05.04

96. One place you usually inspect a water pump for leaks is the:

a. seal drain hole.
b. head.
c. impeller.
d. drive hub.

97. To remove the water pump hub, you need to:

a. press it off.
b. first remove bearing assembly shaft.
c. tap it off.
d. screw it off.

98. A good place to check on a water pump for leaks is the:

a. drive assemble shaft.
b. impeller.
c. drive hub.
d. gasket area.

99. Before inspection of the inside of a water pump, you should measure:

a. the clearance between impeller and housing.
b. the size of the shaft and bearings.
c. the coolant temperature.
d. the size of the diameter of the hub.

100. The one part you never soak in cleaning solvent on a water pump is the:

a. impeller.
b. shaft and bearings.
c. hub.
d. pump housing.

37.08.05.05

101. Pulley misalignment when installing a water pump may cause:

a. shaft bending.
b. impeller wear.
c. rapid belt wear.
d. fan malfunction.

37.08.05.05 (continued)

102. For water pump gaskets and mating surfaces, heavy application of what compound is recommended?

a. rubber cement.
b. cleaning solvent.
c. plastic cement.
d. Permatex

103. To remove a water pump you need to:

a. flush coolant system.
b. remove the radiator.
c. remove the thermostat.
d. drain coolant system.

104. The most common kind of replacement water pump is the:

a. rotor type.
b. impeller type.
c. belt type.
d. thermostat type.

105. Water pumps are easily cracked by:

a. careless tightening.
b. impeller clearance too close together.
c. too large a fan.
d. impeller clearance too far apart.

37.08.05.06

106. When removing a thermostat, you should also check:

a. the system for rust, sludge, etc.
b. the radiator inlet
c. the radiator outlet.
d. your water level compared to your antifreeze level.

107. To install a thermostat, the pellet must:

a. face engine block coolant.
b. face radiator coolant.
c. not be placed where its pellet hits the hottest coolant.
d. have an opening reading of above 180F.

108. When replacing a thermostat, it is important that you also replace the:

a. gasket.
b. coolant.
c. radiator cap.
d. inlet hose.

37.08.05.06 (continued)

109. To replace the thermostat, you need to drain the cooling system:

a. just the engine block.
b. below the level of thermostat housing.
c. completely.
d. just the radiator.

110. After replacing a thermostat and while putting in coolant you should have:

a. the car engine off.
b. added as much antifreeze as the system would hold.
c. the car engine running.
d. already run water through the system.

37.08.05.07

111. In a non-pressurized system, what kind of a thermostat do you use?

a. base type.
b. bellows type.
c. curve type.
d. pellet type.

112. The thermostat on some engines can cause overheating by:

a. sticking in an open position.
b. driving too hard on a hot day.
c. sticking part way open.
d. failing to open.

113. To test opening temperature of a thermostat, you would:

a. lay thermostat in boiling water.
b. suspend thermostat in water while heating slowly, and using a thermometer to check opening temperature.
c. hold thermostat over a flame.
d. hold thermostat over a burner coil.

114. To do an accurate test on a thermostat, you need a:

a. hydrometer.
b. dial indicator.
c. thermometer.
d. flow tester.

115. A good thermostat valve when cold should:

a. have a 1/10" opening between seat and valve.
b. have a 1/32" opening between seat and valve.
c. contact seat snuggly.
d. be completely open, away from the seat.

37.08.05.08

116. The maximum air pressure used in flushing a system is:

a. 20 lbs.
b. 60 lbs.
c. 10 lbs.
d. 40 lbs.

117. When flushing the engine on some cars, you need to remove the water pump because:

a. it collects rust particles.
b. it restricts flow.
c. pressure can ruin seal.
d. you need to hook flushing system there.

118. When flushing an engine, you must remove the:

a. water pump.
b. thermostat.
c. drain plugs.
d. heater hoses.

119. "Reversed flushing" is defined as:

a. flushing system in reverse of normal flow.
b. flushing system in same course of flow.
c. using air pressure of 40 lbs to flush.
d. using back pressure in engine to flush.

120. At what temperature should the engine be when flushing?

a. cold.
b. normal.
c. boiling.
d. hot.

UNIT TEST ANSWER SHEET

Occupational Area: Automotive
File Code: 37.08
Name:
Family Pay Number: Sex: M F (Circle 1)

ANSWERS

0101	1.	A	0204	21.	A	0208	41.	A
	2.	B		22.	A		42.	C
	3.	D		23.	B		43.	A
	4.	B		24.	C		44.	A
	5.	B		25.	D		45.	A
0201	6.	B	0205	26.	D	0301	46.	C
	7.	A		27.	A		47.	A
	8.	B		28.	D		48.	B
	9.	A		29.	C		49.	B
	10.	C		30.	C		50.	A
0202	11.	C	0206	31.	C	0302	51.	A
	12.	D		32.	B		52.	C
	13.	D		33.	D		53.	D
	14.	C		34.	B		54.	C
	15.	C		35.	B		55.	B
0203	16.	D	0207	36.	A	0303	56.	B
	17.	A		37.	C		57.	A
	18.	C		38.	C		58.	A
	19.	B		39.	B		59.	D
	20.	C		40.	D		60.	A

UNIT TEST ANSWER SHEET

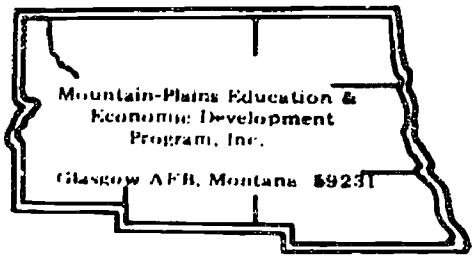
Occupational Area: Automotive
File Code: 37.08
Name: _____

ANSWERS

0304	61.	C	0501	81.	C	0505	101.	C
	62.	C		82.	A		102.	D
	63.	B		83.	B		103.	D
	64.	C		84.	C		104.	B
	65.	A		85.	D		105.	A
0401	66.	B	0502	86.	C	0506	106.	A
	67.	B		87.	B		107.	A
	68.	D		88.	B		108.	A
	69.	C		89.	A		109.	B
	70.	A		90.	D		110.	C
0402	71.	B	0503	91.	B	0507	111.	B
	72.	D		92.	C		112.	D
	73.	A		93.	C		113.	B
	74.	C		94.	B		114.	C
	75.	D		95.	A		115.	C
0403	76.	A	0504	96.	A	0508	116.	A
	77.	B		97.	A		117.	C
	78.	C		98.	D		118.	B
	79.	C		99.	A		119.	A
	80.	B		100.	B		120.	B

File Code: 37.08.01.00.B1-1

Date Published: 3/9/76



Learning Experience Guide

UNIT: FUNDAMENTALS OF 4-CYCLE ENGINES

RATIONALE:

The fundamentals in this unit enable you to identify the four cycles and the operation of each cycle.

PREREQUISITES:

None

OBJECTIVE:

Identify the components and proper operation of the four-cycle engine.

RESOURCES:

Printed Materials

Auto Mechanics Fundamentals, Martin W. Stockel, Goodheart-Willcox Company, Inc.

GENERAL INSTRUCTIONS:

This Unit consists of one Learning Activity Package (LAP). The LAP will provide specific information for completion of a learning activity.

The general procedure for this Unit is as follows:

(1) Read the assigned Learning Activity Package (LAP).

(2) Begin and complete the assigned LAP.

(3) In this Unit, the LAP and Unit test is combined.

(4) Take the Unit/LAP test as described in the Unit LEG "Evaluation Procedures".

(5) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of 4-Cycle Engines

Principal Author(s): C. Schramm/W. Osland

EVALUATION PROCEDURE:

When pretesting:

1. Take the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.

When post testing:

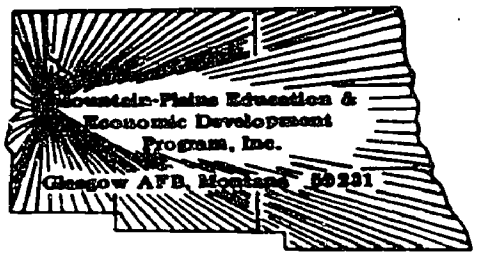
1. Take the multiple-choice unit post test.
2. There is no performance test for this unit.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.08.01.00.B1-2

Date: _____ Date Published: 3/12/76



UNIT/LAP PRETEST: FUNDAMENTALS OF 4-CYCLE ENGINES

1. Vacuum in an engine is:

   a. a high pressure area.
   b. a stratospheric area.
   c. an atmospheric area.
   d. a low pressure area.

2. Gasoline is a mixture of:

   a. fuel and air.
   b. fire and heat.
   c. hydrocarbons.
   d. water and crude oil.

3. The connecting rod of an engine connects the:

   a. piston to the crankshaft.
   b. the crankshaft to the flywheel.
   c. piston to the block.
   d. the block to the generator.

4. The crankshaft turns:

   a. 1/2 the speed of the camshaft.
   b. at the same speed of the camshaft.
   c. 1/4 the speed of the camshaft.
   d. 2 times the speed of the camshaft.

5. The crankshaft of an engine is used to:

   a. change expanding energy into straight line motion.
   b. change rotary motion into reciprocating motion.
   c. change reciprocating motion into rotary motion.
   d. change circular energy into straight line motion.

6. The valve spring holds the valve:

   a. closed.
   b. open.
   c. up.
   d. down.

7.

8. The area between the piston and cylinder head is called the:

   a. head spacing.
   b. valve spacing.
   c. spark plug chamber.
   d. combustion chamber.

9. The valve has a special angle cut on its edge. The reason for this angle is:

   a. that it is easier to pry out a stuck valve.
   b. that it pushes out any dirt or rust that gets into the engine.
   c. that the angle matches the direction of expanding gases.
   d. to allow the valve to seat flush with the head so power isn't lost.

10. When gas burns very quickly, it is said to:

   a. smoke.
   b. ignite.
   c. fire.
   d. explode.

UNIT/LAP PRETEST ANSWER KEY: FUNDAMENTALS OF 4-CYCLE ENGINES

LAP 01

1. D
2. C
3. A
4. D
5. C
6. A
7. A
8. D
9. D
10. D

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Date Published: 3/9/76

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of 4-Cycle Engines

OBJECTIVE:

Identify the components and describe the operation of the 4-cycle engine.

EVALUATION PROCEDURE:

Score at least 80% on the unit/LAP multiple-choice test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.

PROCEDURE:

1. Read Chapter 1, "Building an Engine", pp. 7-21.
2. Study the figures 1-1 through 1-45.
3. Neatly answer test questions (pp. 20-21) 1 through 21 on paper.
4. When completed, give the test answer sheet to the instructor for evaluation.
5. Return text to the proper shelf.
6. Take and score the unit/LAP test.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.01.00. C1-2

Date: _____ Date Published: 3/12/76

Mountain-Plains Education & Economic Development Program, Inc.
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UNIT/LAP POST TEST: FUNDAMENTALS OF 4-CYCLE ENGINES (A)

1. Gasoline is a mixture of:

   a. hydrocarbons.
   b. water and crude oil.
   c. fire and heat.
   d. fuel and air.

2.

3. The device that opens the valves is the:

   a. drive shaft.
   b. crankshaft.
   c. gear shaft.
   d. camshaft.

4. The crankshaft of an engine is used to:

   a. change circular energy into straight line motion.
   b. change rotary motion into reciprocation motion.
   c. change reciptocating motion into rotary motion.
   d. change expanding energy into straight line motion.

5. Vacuum in an engine is:

   a. a low pressure area.
   b. a stratospheric area.
   c. a high pressure area.
   d. an atmospheric area.

6. When gas burns very quickly, it is said to:

   a. smoke.
   b. fire.
   c. ignite.
   d. explode.

7. The valve spring holds the valve:

   a. open.
   b. up.
   c. closed.
   d. down.

8. The connecting rod of an engine connects the:

   a. the block to the generator.
   b. piston to the block.
   c. the camshaft to the flywheel.
   d. piston to the crankshaft.

9. The area between the piston and cylinder head is called the:

   a. head spacing.
   b. combustion chamber.
   c. valve spacing.
   d. spark plug chamber.

10.

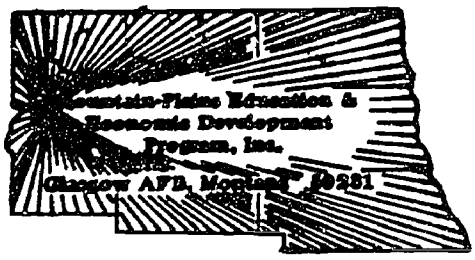
37.08.01.00.C1-2
37.08.01.01.C1-2

UNIT/LAP POST TEST ANSWER KEY: FUNDAMENTALS OF 4-CYCLE ENGINES A

1. A
2. ~~C~~
3. D
4. C
5. A
6. D
7. C
8. D
9. B
10. ~~D~~

Grade: _____ File Code: 37.08.01.00.C1-2(B)

Date: _____ Date Published: 5-23-77



UNIT/LAP POST TEST: FUNDAMENTALS OF 4-CYCLE ENGINES (B)

1. The area between the piston and cylinder head is called the:

   a. head spacing.
   b. combustion chamber.
   c. valve spacing.
   d. spark plug chamber.

2. The connecting rod of an engine connects the:

   a. the block to the generator.
   b. piston to the block.
   c. the camshaft to the flywheel.
   d. piston to the crankshaft.

3. The valve spring holds the valve:

   a. open.
   b. up.
   c. closed.
   d. down.

4. When gas burns very quickly, it is said to:

   a. smoke.
   b. fire.
   c. ignite.
   d. explode.

5. Vacuum in an engine is:

   a. a low pressure area.
   b. a stratospheric area.
   c. a high pressure area.
   d. an atmospheric area.

6. The crankshaft of an engine is used to:

   a. hange rcular energy into straight line motion.
   b. change rotary motion into reciprocation motion.
   c. change reciptocating motion into rotary motion.
   d. change expanding energy into straight line motion.

7. The device that opens the valves is the:

   a. drive shaft.
   b. crankshaft.
   c. gear shaft.
   d. camshaft.

8. Gasoline is a mixture of:

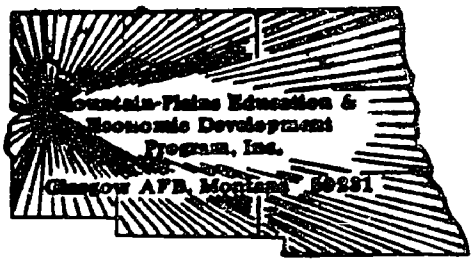
   a. hydrocarbons.
   b. water and crude oil.
   c. fire and heat.
   d. fuel and air.

UNIT/LAP POST TEST: FUNDAMENTALS OF 4-CYCLE ENGINES (B)

1. B
2. D
3. C
4. D
5. A
6. C
7. D
8. A

Student: _____ File Code: _____

Date: _____ Date Published: 5-23-77



UNIT/LAP POST TEST: FUNDAMENTALS OF 4-CYCLE ENGINES (C)

1. The crankshaft of an engine is used to:

   a. change circular energy into straight line motion.
   b. change rotary motion into reciprocation motion.
   c. change reciprocating motion into rotary motion.
   d. change expanding energy into straight line motion.

2. The connecting rod of an engine connects the:

   a. block to the generator.
   b. piston to the block.
   c. camshaft to the flywheel.
   d. piston to the crankshaft.

3. Vacuum in an engine is:

   a. a low pressure area.
   b. a stratospheric area.
   c. a high pressure area.
   d. an atmospheric area.

4. The area between the piston and cylinder head is called the:

   a. head spacing.
   b. combustion chamber.
   c. valve spacing.
   d. spark plug chamber.

5. When gas burns very quickly, it is said to:

   a. smoke.
   b. fire.
   c. ignite.
   d. explode.

6. The device that opens the valves is the:

   a. drive shaft.
   b. crankshaft.
   c. gear shaft.
   d. camshaft.

7. Gasoline is a mixture of:

   a. hydrocarbons.
   b. water and crude oil.
   c. fire and heat.
   d. fuel and air.

8. The valve spring holds the valve:

   a. open.
   b. up.
   c. closed.
   d. down.

UNIT/LAP POST TEST ANSWER KEY: FUNDAMENTALS OF 4-CYCLE ENGINES (C)

1. C
2. D
3. A
4. B
5. D
6. D
7. A
8. C

File Code: 37.08.02.00.B1-1

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: ENGINE CONSTRUCTION

RATIONALE:

The fundamentals in this unit will enable you to identify and diagnose the parts of the engine, the correct operation of the components and overhaul engine blocks.

PREREQUISITES:

None

OBJECTIVE:

Identify engine components and the proper operation of the engine. Using proper procedures, overhaul engine block.

RESOURCES:

Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor. The Hearst Corporation, 1972 or equivalent.

... Universe ... on and Visual Arts

Si... Pist... Caliper Ass... y (#7776).
S... ston Cleaning and Inspection (#7775).
S... gle Piston Caliper Disassembly (#7774).

Automobile with: engine block
connecting rods needing inspection
Boring bar
Cylinder hone
Dial indicator
Dril and wire brush
Fender covers
Feeler gauge
Gasket set
Magnifying glass
Micrometers
Plasti-gauge

Principal Author(s): C. Schramm/W. Osland

Piston pin hone
Piston pin press
Replacement parts as needed
Rod cap grinder
Straight edge
Tools, Basic Hand: Chisel and Punch Set
5/32" Pin Punch
3/16" Solid

Gauge, feeler (.002" - .025")

Hammer, ball peen
Hammer, plastic tip
Handle, speed
Hex Key Set

Pliers, diagonal cutting
Pliers, needle nose

Scraper, gasket
Screwdriver, standard (Set)
Screwdriver, phillips (Set)
Screw starter

Socket Set (3/8" drive)
extension (3")
ratchet

Socket Set (1/4" drive)
extension (3")
handle (6" flex)
ratchet

Socket, spark plug
extension (6")

Wrench, combination (Set)
Wrench, combination ignition (Set)

Torque wrench

GENERAL INSTRUCTIONS:

This unit consists of eight Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.

(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) In this Unit, there are some LAPs that have tests combined with other LAP tests. These combined tests are taken after completing the last LAP covered by the test.
(9) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(10) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of Engine Block
.02 Engine Block Construction
.03 Overhaul Engine Block
.04 Camshaft
.05 Crankshaft and Bearings
.06 Pistons
.07 Rods
.08 Timing Gears and Chains

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.08.02.00.B1-2

Date: _____ Date Published: 3/12/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT PRETEST: ENGINE CONSTRUCTION

37.08.02.01.

*1. For each inch of cylinder diameter, it is advisable to allow a minimum gap of what range when installing rings?

a. .005 to .010
b. .020 to .030
c. .003 to .004
d. .030 to .040

*2. Connecting rod big end bore elongation is corrected by:

a. building up with arc welding then boring to standard.
b. knurling.
c. reducing diameter by removing stock from the parting surfaces and honing.
d. honing to a suitable oversize.

*3. The clearance between the ends of the ring when installed in the cylinder is referred to as:

a. ring lip.
b. ring ridge.
c. ring wrapper.
d. ring gap.

4. Worn piston pin bores in the rod or piston require:

a. scraping the unit.
b. pin expansion by knurling.
c. replacement.
d. fitting to an oversize pin.

5. If the ring ridge is not removed:

a. the rings will not seat properly.
b. the top ring and piston can be broken.
c. the piston will be hard to install.
d. the cylinder walls will be distorted.

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, pp. 16-34, #38, and pp. 13-39 and 13-40, #s 2, 4, 6, 7, 16, 22, 24, 26, 35.)

37.08.02.02.

6. One of the two most common angles for valve seats is:

   a. 75 degrees.
   b. 30 degrees.
   c. 65 degrees.
   d. 15 degrees.

*7.

8. Connecting rods are used to connect what to where?

   a. piston to camshaft.
   b. camshaft to lifter.
   c. piston to crankshaft.
   d. crankshaft to valves.

9.

10. The unit that forms a basic foundation upon which the whole engine is built is called the:

   a. head.
   b. motor mount.
   c. block.
   d. flywheel.

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, pp. 13-39 and 13-40, #s 2, 4, 6, 7, 16, 22, 24, 26, 35.)

37.08.02.03.

11. When installing the engine, the transmission should be:

    a. on the engine.
    b. varies with different makes and models.
    c. in the car.
    d. on the bench.

12. You can prevent what is known as dry starting by:

    a. pressurizing engine lubrication.
    b. pressurizing filter cap.
    c. pressurizing air tank.
    d. pressurizing instant lubrication.

13.

14. A pressurizer hooked to an engine can also be used as a:

    a. air bomb.
    b. sprayer.
    c. bearing leak detector.
    d. cooling system check.

15. When an engine is overhauled and running, you take the car out for a break-in run, which is from 30 mph to 50 mph and then back to 30 mph. This cycle should be done a minimum of how many times?

    a. 10.
    b. 20.
    c. 5.
    d. 30.

37.08.02.04.

16. You will need to regrind the camshaft if the overall wear exceeds:

    a. .030
    b. .020
    c. .0015
    d. .0010

17. A chipped or badly worn cam can be built up by:

    a. capping lobes.
    b. welding.
    c. heat soldering.
    d. craming.

37.08.02.04. cont.

18. Camshafts are generally surface-hardened to a depth of:

a. .030
b. .060
c. .020
d. .040

19. To provide proper break in and longer wear, many regrinders cover the cam lobes with a special coating of:

a. aluminum.
b. chromium.
c. phosphate.
d. cast iron.

20. To remove camshaft bearings, you use a drive bar and a:

a. bronze shaft.
b. punch.
c. mandrel.
d. pulley puller.

37.08.02.05.

21. To remove main bearing caps you:

a. use a wire with a small hook on the end.
b. use a pry bar between cap and crank journal.
c. hit caps with a small ball peen hammer.
d. carefully pry caps free.

22. Crankshaft journals must not be tapered over:

a. .005
b. .010
c. .0001
d. .001

23. Maximum journal out-of-roundness should not exceed:

a. .001
b. .010
c. .0001
d. .005

24.

37.08.02.05. cont.

25. For an acceptable finish, the micro inch finish on a crankshaft should be:

a. 160 micro inch.
b. 100 micro inch.
c. 1 micro inch
d. 16 micro inch

37.08.02.06.

26. Worn piston pin bores in the piston require:

a. fitting to an oversize pin.
b. scraping the unit.
c. pin expansion by knurling.
d. putting new bronze bushing in piston.

27. A typical pin fit in an aluminum piston would have the following clearance:

a. .006 to .010
b. .002 to .004
c. .020 to .0205
d. .0002 to .0005

28. The lower piston ring groove contains what ring(s)?

a. compression ring
b. oil ring
c. oil and compression ring
d. five compression rings

29. Cast iron pistons work best in what type of engines?

a. high compression.
b. racing.
c. low compression.
d. heavy duty.

30. Temperature of piston heads often runs up to about how many degrees?

a. 200 degrees to 300 degrees
b. 1500 degrees to 2000 degrees
c. 600 degrees to 700 degrees
d. 800 degrees to 1000 degrees

37.08.02.07.

31. Before you take rods out of an engine you should:

a. wash them.
b. burnish them.
c. ream them.
d. mark them.

37.08.02.07. cont.

32. Rod bearings are connected to the:

a. crank shaft rod journal.
b. crank shaft main journal.
c. crank shaft counterweight.
d. cam shaft.

33. Due to the lightness in weight of connecting rods, they tend to distort the big end bearing race and:

a. score rod.
b. bend rod.
c. burn rod.
d. scuff rod.

34. Out-of-roundness on the big end bore should not exceed:

a. .001
b. .010
c. .020
d. .0020

35. After resizing the bore, you should clean the rod by:

a. working in hot soapy water.
b. using gasoline.
c. soaking in solvent.
d. blowing off excess material with compressed air.

37.08.02.08.

36.

37. The distance the crankshaft gear will turn without turning the camshaft is called:

a. gear tolerance.
b. backlash.
c. gear vibration.
d. gear wobble.

38.

37.08.02.08. cont.

39

40. Extensively long timing chains are used in what kind of engines?

a. overhead cam engines.
b. high compression engines.
c. low compression engines.
d. two cycle engines.

UNIT PRETEST ANSWER KEY: ENGINE CONSTRUCTION

LAP .01

1. c
2. c
3. d
4. d
5. b

LAP .02

6. b
7. b
8. c
9. a
10. c

LAP .03

11. b
12. a
13. c
14. c
15. b

LAP .04

16. c
17. b
18. d
19. c
20. c

LAP .05

21. d
22. d
23. a
24. d
25. d

LAP .06

26. a
27. d
28. b
29. c
30. c

LAP .07

31. d
32. a
33. b
34. a
35. c

LAP .08

36. b
37. b
38. a
39. a
40. a

File Code: 37.08.02.01.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of Engine Block

OBJECTIVE:

Recognize the procedure for servicing engine blocks during overhauls.

EVALUATION PROCEDURE:

Score 80% or better on the multiple-choice test.

RESOURCES:

Auto Service and Repair, Stockel.

PROCEDURE:

1. Obtain a text copy and secure a quiet place to study.
2. Read Chapter 16, "Servicing Engine Blocks, Cylinders, Rings, Connecting Rods", pp. 16-1 through 16-33.
3. Study the figures 16-1 through 16-87 closely for detailed information.
4. Neatly answer the test questions on pages 16-33 and 16-34 on paper. #1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 15, 19, 22, 27, 30, 35, 39, 40, 42, and 44.
5. When completed, give test answer sheet to the instructor for evaluation.
6. Return textbook to the proper shelf.
7. Take and score the LAP test.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.02.01.B1-2

Date: _____ Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: FUNDAMENTALS OF ENGINE BLOCK

*1. When honing worn cylinders, always:

a. hone at the top.
b. start honing at the top then work down the cylinder.
c. start honing at the bottom then work up the cylinder.
d. hone at the bottom.

*2. Cylinder wear is greatest:

a. at the bottom of ring travel.
b. at the top of ring travel.
c. at the center of ring travel.
d. near the spark plug.

*3. The clearance between the ends of the ring when installed in the cylinder is referred to as:

a. ring wrapper.
b. ring gap.
c. ring ridge.
d. ring lip.

*4. For each inch of cylinddr diameter. it is advisable to allow a minimum gap of what range when installing rings?

a. .005 to .010
b. .003 to .004
c. .020 to .030
d. .030 to .040

*5.

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, pp. 13-39, 13-40, 16-13, and 16-14, #s 2, 3, 4, 6, 7, 12, 16, 22, 24, 26, 35, 38.)

*6.

*7. If therring ridge is not removed:

a. the top ring and piston can be brcken.
b. the cylinder walls will be distorted.
c. the rings will not seat properly.
d. the piston will be hard to install.

*8. A typical pin fit in an aluminum piston would have the following clearance:

a. .0002 to .0005
b. .002 to .004
c. .020 to .0205
d. .006 to .010

9. After honing, you should clean cylinders with:

a. gasoline.
b. hot, soapy water.
c. cleaning solvent.
d. oil.

10. If a cylinder is tapered less than how many inches, it does not require reboring.

a. 0.12 inches
b. 1.2 inches
c. .012 inches
d. .0012 inches

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, pp. 13-39, 13-40, 16-13, and 16-14, #s 2, 3, 4, 6, 7, 12, 16, 22, 24, 26, 35, 38.)

LAP TEST ANSWER KEY: FUNDAMENTALS OF ENGINE BLOCK

1. C
2. B
3. B
4. B
5. D
6. D
7. A
8. A
9. B
10. C

File Code: 37.08.02.02.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Engine Block Construction

OBJECTIVE:

Identify the components and their operations in the internal combustion engine.

EVALUATION PROCEDURE:

Score 80% or better on the multiple-choice test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.

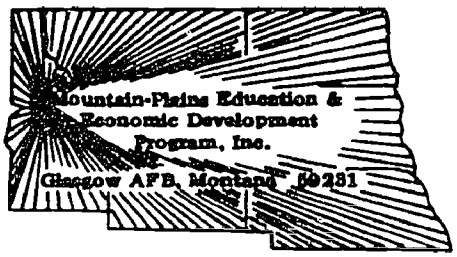
PROCEDURE:

1. Obtain a text copy and secure a quiet place to study.
2. Read Chapter 2, "Design, Construction, Application of Engine Components", pp. 23 through 49.
3. Study the figures 2-1 through 2-84.
4. Neatly answer the following text questions: #1, 6, 10, 13, 15, 17, 19, 30, 32, 33, 38, 39, 40.
5. When completed, return the test answer sheet to the instructor for evaluation.
6. Return the text book to the proper shelf.
7. Take and score the LAP test.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37 08.02.02.B1-2

Date: _____ Date Published: 3/9/76



LAP TEST: ENGINE BLOCKKCONSTRUCTION

*1. Cast iron pistons work best in what type engine?

a. high compression.
b. low compression.
c. supercharged.
d. turbocharged.

2. Piston pins usually ride on what kind of surface?

a. stainless steel.
b. a nickle-coated bushing.
c. aluminum.
d. cast iron.

3. One type of material used for rings is:

a. bronze, with a molybdenum outside coating.
b. aluminum.
c. 4130 chrome.
d. cast iron

4. The function of an engine camshaft is to:

a. open the valves.
b. eliminate vibration.
c. hold the timing chain.
d. push the connecting rod up and down.

5. An eight cylinder in-line engine requires how many connecting rod throws?

a. 8
b. 4
c. 16
d. 12

6. A timing gear is installed where on the engine?

a. the rear of the camshaft.
b. the front end of a drive shaft
c. the rear end of a crankshaft
d. the front end of a crankshaft

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, p. 50,

7. A heat dam in an engine is:

   a. another name for a piston sleeve.
   b. an inner shield on the cylinder heads to prevent heat.
   c. a groove cut into the head of a piston.
   d. a small well in the exhaust manifold.

*8. The bottom rings in a piston are always:

   a. blockage springs used as rings.
   b. compression rings.
   c. compression rings and oil control ring combined.
   d. oil control rings.

9. Expanding devices used for rings are designed for:

   a. worn rings.
   b. compress rings.
   c. new cylinders.
   d. worn cylinders.

10. One of the two most common angles for valve seats is:

   a. 75 degrees.
   b. 25 degrees.
   c. 30 degress.
   d. 65 degrees.

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, p. 50, #s 8 and 24.)

LAP TEST ANSWER KEY: ENGINE BLOCK CONSTRUCTION

1. B
2. C
3. D
4. A
5. A
6. D
7. C
8. D
9. D
10. C

File Code: 37.08.02.03.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Overhaul Engine Block

OBJECTIVE:

Following correct procedures, correctly overhaul an engine block.

EVALUATION PROCEDURE:

80% correct on LAP test to be taken after completing LAP 37.08.02.04.

RESOURCES:

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

Engine block needing overhaul
Engine repair stand
Fender covers
Replacement parts (as needed)
Tools, Basic Hand: (See Unit LEG)

PROCEDURE:

NOTE: Read pages 16-1 through 16-9 in Auto Service and Repair.

1. If the engine needs to be removed from the automobile, find the manual's removal and installation section and follow the removal procedure.
   NOTE: Due to the variety of automobiles and engines, it is necessary to follow the manufacturer's recommended procedure for each engine.
2. Use fender covers during engine removal and installation.
3. After engine is removed, clean up work area, push the car outside for storage and lock until time to install the overhauled engine.
4. Place the engine on an engine repair stand and move it to your engine overhaul work station.
5. By following the manufacturer's recommended procedure of overhaul, carefully proceed.
   NOTE: Utilize the manual's specification pages for all information needed. If doubt or problems occur, ask the instructor for assistance.
6. As you disassemble and inspect the engine, make an accurate list of needed replacement parts and sizes. Refer to LAPs 37.09.04.02, 37.09.04.03, 37.09.04.04, 37.09.04.05 and 37.09.04.06 as needed.

Principal Author(s): J. Anderson/W. Osland

PROCEDURE: (continued)

6. (continued)
   When the engine overhaul is completed, clean your overhaul work station thoroughly.
7. Push the vehicle inside and install the engine following the manual's procedure.
8. Install an exterior oil test gauge and fill the crankcase with the proper amount of oil.
9. After starting the engine, adjust the valves according to specifications.
10. Ask the instructor to evaluate your work.
11. Upon satisfactory completion, clean your work area.
12. Return all equipment and tools.
13. Proceed to the next LAP.

File Code: 37.08.02.04.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Camshaft

OBJECTIVE:

Following correct procedures, perform an inspection of the camshaft.

EVALUATION PROCEDURE:

80% correct on LAP test.

RESOURCES:

Motor's Auto Repair Manual.
Camshaft
Micrometer Set

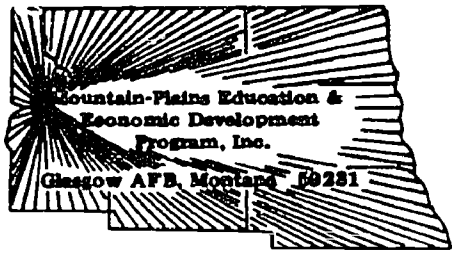
PROCEDURE:

1. Obtain a camshaft.
2. Secure a clean work station.
3. Obtain an outside micrometer set and the repair manual that contains information about the cam you have.
4. From the manual, find the cam specifications: amount of journal wear limit, size of cam bearing journals, size of cam lobes, wear limit of cam lobes.
5. Record all the cam inspection specifications on the work order.
6. Using a micrometer measure the cam journals and record the readings on the work order. Now, compare measurement with specifications to determine wear.
7. Measure the cam lobes and record the readings on the work order. Compare measurements with specifications to determine amount of wear.
8. Continue cam inspection as specified in the manual.
9. Record on the work order whether the cam is all right for use or if it should be replaced and why.
10. Show your results to the instructor for evaluation.
11. Return all equipment and clean your work station.
12. Take and score the LAP test.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.02.03.B1-2
37.08.02.04.B1-2

Date: _____ Date Published: 7/15/76



LAP TEST: OVERHAUL ENGINE BLOCK/CAMSHAFT

37.08.02.03.

1. When installing the engine, the transmission should be:

   a. on the bench.
   b. varies with different makes and models.
   c. in the car.
   d. on the engine.

2. When assembling an engine and you have mushroom type valve lifters, they have to be installed before the:

   a. crankshaft.
   b. camshaft.
   c. connecting rods.
   d. pistons.

3. You can prevent what is known as dry starting by:

   a. pressurizing engine lubrication.
   b. pressurizing instant lubrication.
   c. pressurizing air tank.
   d. pressurizing filler cap.

4. A pressurizer hooked to an engine can also be used as a:

   a. sprayer.
   b. bearing leak detector.
   c. air bomb.
   d. cooling system check.

5.

37.08.02.04.

6. A chipped or badly worn cam can be built up by:

   a. welding.
   b. craming.
   c. heat soldering.
   d. copping lobes.

7. Camshafts are generally surface-hardened to a depth of:

   a. .020
   b. .040
   c. .030
   d. .060

8.

9. To remove the camshaft bearings you would use a drive bar and which of the following:

   a. a mandrel.
   b. a punch.
   c. a pulley puller.
   d. a bronze shaft.

10. In order to provide for longer wear, which of the following materials is used to cover the cam lobes after regrinding:

   a. chromium.
   b. phosphate.
   c. aluminum.
   d. cast iron.

LAP TEST ANSWER KEY: OVERHAUL ENGINE BLOCK/CAMSHAFT

LAP		
01	1.	B
	2.	B
	3.	A
	4.	B
	~~5.~~	~~A~~
02	6.	A
	7.	B
	~~8.~~	~~C~~
	9.	A
	10.	B

File Code: 37.08.02.05.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Crankshaft and Bearings

OBJECTIVE:

Following correct procedures, perform an inspection of the crankshaft and bearings.

EVALUATION PROCEDURE:

80% correct on LAP test to be taken after LAP # 37.08.02.06.

RESOURCES:

Motor's Auto Repair Manual.
Crankshaft and Bearings
Feeler gauge
Micrometers
Plasti-gauge
Tools, Basic Hand: (See Unit LEG)
Torque wrench

PROCEDURE:

1. Obtain an engine with a crankshaft and bearings.
2. Prepare a work station.
3. Check to see that the main bearing cap bolts are tightened to the proper torque. (See manual for amount of torque.)
4. Check side play of crankshaft with feeler gauges. Work the crankshaft ahead and back with a pry bar and check the amount of end play at the thrust bearings with feeler gauges.
5. Compare the feeler gauge results to the manual specifications and record on the work order. (Show your results to the instructor for evaluation.)
6. Now, test for bearing clearance by using plasti-gauge.
7. Remove all the main bearing caps and bearing inserts.
8. Wipe the journal surfaces clean and place 1/2 inch of plasti-gauge on the journal.
9. Replace the inserts and bearing caps and tighten to the torque recommended. (Do not turn the crankshaft with plasti-gauge in place.)

Principal Author(s): J. Anderson/W. Osland

PROCEDURE: (continued)

10. Remove the caps and compare the flattened plasti-gauge with the wrapper and record the thickness on the work order.
11. Now compare the test results to the manual's recommended bearing clearance. Record the difference.
12. Remove the crank from the block and place it on the bench. Wipe it clean for further inspection.
13. Inspect the crank and rod journals for score marks, nicks, and scratches that may render it unuseable. Record your results on your work order.
14. Now using the micrometers, measure for out-of-round wear and taper wear. Record results of each main journal and rod journal on the work order.
15. Compare these results to the manual's specifications and record on the work order.
16. Show your work order to the instructor for evaluation.
17. With approval from the instructor, reassemble the crank and block.
18. Wipe all the tools clean and return.
19. Clean your work station area.
20. Proceed to the next LAP.

File Code: 37.08.02.06.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Pistons

OBJECTIVE:

Following correct procedure, perform an inspection of pistons.

EVALUATION PROCEDURE:

80% correct on the LAP test.

RESOURCES:

Motor's Auto Repair Manual.

Magnifying Glass
Micrometers
Pistons

PROCEDURE:

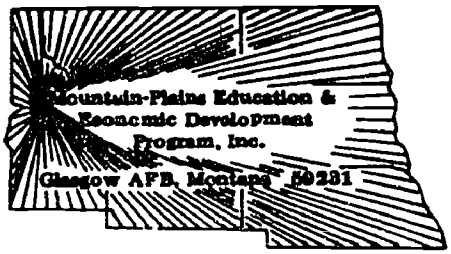
NOTE: View the filmstrips listed in the resources.

1. Obtain several pistons.
2. Clean the pistons thoroughly for easier inspecting.
3. Prepare a work station area.
4. Obtain the proper manual to find the specifications on these particular pistons.
5. Locate the piston diameter specifications and neatly record on your work order.
6. Use the micrometer to measure the piston diameter and record the results.
7. Determine the amount of difference or wear and record on the record sheet.
8. Determine whether the piston is usable or not. Record on the work order.
9. With the magnifying glass, inspect the pistons closely for cracks, nicks, worn surfaces. Record on the work order whether the piston is reusable or not.
10. Show the instructor your record sheet for evaluation.
11. Upon satisfactory completion, return the pistons to their proper place.
12. Clean the tools and equipment.
13. Clean your work station area.
14. Obtain a copy of the LAP test. Answer all of the questions and return the test to the instructor for evaluation.
15. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.02.05.B1-2
37.08.02.06.B1-2

Date: _____ Date Published: 3/9/76



LAP TEST: CRANKSHAFT AND BEARINGS/PISTONS

37.08.02.05.

1. When installing the wick type seal:

   a. lay the excess across the parting surface.
   b. trim the ends flush with the parting surface.
   c. drive the excess down into the groove.
   d. let the excess protrude.

2. When the engine is in the car, the upper inserts can best be removed by:

   a. rolling out with a removal plug.
   b. pulling out with a wire.
   c. driving out with a punch.
   d. blowing out with air pressure.

3.

4. Before removing the main bearings you must:

   a. do a plastic gauge test.
   b. mark them.
   c. remove the camshaft.
   d. remove front and rear bearing oil seal.

5. Bearing races should not show out-of-roundness in excess of:

   a. .0001
   b. .0150
   c. .0015
   d. .007

6. A typical pin fit in an aluminum piston would have the following clearance:

   a. .002 to .004
   b. .0002 to .0005
   c. .020 to .0205
   d. .006 to .010

7. How many ring grooves are there usually in a piston?

   a. 6
   b. 5
   c. 3
   d. 4

8. The lower piston ring groove contains what ring(s)?

   a. oil and compression ring
   b. compression ring
   c. oil ring
   d. five compression rings

9.

10.

LAP TEST ANSWER KEY: CRANKSHAFT AND BEARINGS/PISTONS

LAP

03	1.	B
	2.	A
	~~3.~~	~~D~~
	4.	B
	5.	C
04	6.	B
	7.	C
	8.	C
	~~9.~~	~~A~~
	~~10.~~	~~C~~

File Code: 37.08.02.07.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow A.F.B. Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Connecting Rods

OBJECTIVE:

Following correct procedure, inspect connecting rods.

EVALUATION PROCEDURE:

80% correct on the LAP test to be taken after completing LAP 37.08.02.08.

RESOURCES:

Motor's Auto Repair Manual.
Connecting rods needing inspection
Micrometer
Torque wrench
Tools, Basic Hand: (See Unit LEG)

PROCEDURE:

1. Obtain connecting rods.
2. Obtain the hand tools, micrometers, manual, torque wrench.
3. With the bearing inserts removed, tighten the connecting rod caps to the proper amount of torque according to manufacturer's recommendations.
4. Using the inside micrometer, carefully measure the inside of the connecting rod bore for out-of-round.
5. Record the bore size, the maximum and minimum of each rod in a proper order.
6. Compare your measurement results to the manuals specifications to determine the status of the connecting rods.
7. Record your opinion of each rod - whether it is all right to be used again or not, and why.
8. Obtain the rod alignment tool and manual.
9. Follow the directions of the rod alignment manual to check the rod's straightness. Record results of each.

Principal Author(s): J. Anderson/W. Osland

10. When completed, ask the instructor to evaluate your recorded results. You will need to demonstrate how you measured the rod bores and operated the rod alignment tool.
11. When completed satisfactorily, clean and return all tools and equipment.
12. Return the connecting rods to their proper place.
13. Clean up your work station bench.
14. Proceed to the next LAP.

File Code: 37.08.02.08.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Timing Gears and Chains

OBJECTIVE:

Following correct procedure, inspect engine timing gears and chains.

EVALUATION PROCEDURE:

80% correct on the LAP test.

RESOURCES:

Motor's Auto Repair Manual.

Engine block, assembled
Measuring tools
Tools, Basic Hand: (See Unit LEG)

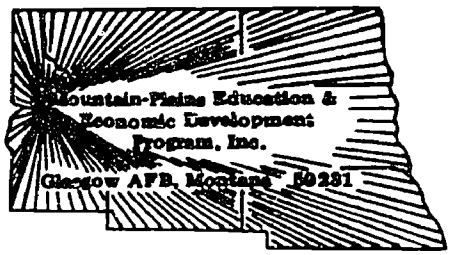
PROCEDURE:

1. Secure the proper repair manual for that particular engine model and year.
2. Find the timing gear and chain inspection section of the manual.
3. Follow the inspection procedure of the manual closely, using the advised equipment and record your results.
   NOTE: Due to the variety of engines, it is recommended to follow the manufacturer's procedure of inspection rather than to follow one standard procedure.
4. After you have mastered the inspection and are positive of your measurement results, demonstrate the inspection to the instructor.
5. Return tools and equipment to their proper place.
6. Take and score the LAP test.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.02.07.B1-2
37.08.02.08.B1-2

Date: _____ Date Published: 3/9/76



LAP TEST: RODS/TIMING GEARS AND CHAINS

37.08.02.07.

1. Before you take rods out of an engine, you should:

   a. wash them.
   b. ream them.
   c. burnish them.
   d. mark them.

2.

3. Due to the lightness in weight of connecting rods, they tend to distort the big end bearing race and:

   a. scuff rod.
   b. burn rod.
   c. bend rod.
   d. score rod.

4. When loosening the rod, the crankshaft must be:

   a. at top dead center.
   b. at bottom dead center.
   c. it does not matter where crankshaft is.
   d. in the middle dead center.

5.

6. Extensively long timing chains are used in what kind of engines?

   a. overhead cam engines
   b. low compression engines
   c. two cycle engines
   d. high compression engines

7. Worn timing gears or chains will not:

   a. tighten timing chain.
   b. overheat engine.
   c. cause damage to camshaft.
   d. alter valve timing.

8. Backlash on timing gear can be measured by a(n):

   a. oscilloscope.
   b. mandrel.
   c. micrometer.
   d. dial indicator.

9.

10. To remove the crankshaft timing gear you must:

    a. remove two bolts.
    b. tap it off with a light hammer.
    c. use a puller.
    d. heat the gear.

LAP TEST ANSWER KEY: RODS/TIMING GEARS AND CHAINS

LAP

05
1. D
2. ~~B~~
3. C
4. B
5. ~~C~~

06
6. A
7. A
8. D
9. ~~A~~
10. C

Student: _____ File Code: 37.08.02.00. C1-2

Date: _____ Date Published: 3/12/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: ENGINE CONSTRUCTION (A)

37.08.02.01.

*1. Cylinder wear is greatest:

a. near the spark plug.
b. at the top of ring travel.
c. at the bottom of ring travel.
d. at the center of ring travel.

*2. Heavy score marks on pistons require:

a. they are ok.
b. knurling.
c. replacing them.
d. filing to remove cracks.

*3. If a cylinder is tapered less than how many inches, it does not require reboring.

a. .012 inches.
b. .0012 inches.
c. 1.2 inches.
d. 0.12 inches.

*4. A typical pin fit in an aluminum piston would have the following clearance:

a. .0002 to .0005
b. .006 to .010
c. .020 to .0205
d. .002 to .004

5. After honing, you should clean cylinders with:

a. hot, soapy water.
b. oil.
c. cleaning solvent.
d. gasoline.

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, p. 16-13, #s 3 and 22, and pp. 13-39 and 13-40, #s 2, 4, 6, 7, 16, 22, 24, 26, 35.)

37.08.02.02.

6.

7.

8. A heat dam in an engine is:

   a. an inner shield on the cylinder heads to prevent heat.
   b. another name for a piston sleeve.
   c. a groove cut into the head of a piston.
   d. a small well in the exhaust manifold.

9. What are the approximate number of rings usually found on pistons used in auto engines?

   a. 4
   b. 6
   c. 3
   d. 5

10. The function of a split skirt in an engine is to:

   a. compensate for heat.
   b. compensate for a backfire in an engine.
   c. balance an engine.
   d. minimize engine vibration.

37.08.02.03.

11. When installing the engine, the transmission should be:

a. on the engine.
b. varies with different makes and models.
c. in the car.
d. on the bench.

12. When assembling an engine and you have mushroom type valve lifters, they have to be installed before the:

a. camshaft.
b. crankshaft.
c. pistons.
d. connecting rods.

13. When not directly working on an engine, you should:

a. let all parts remain where you put them so you know where they go.
b. put it under a bench out of the way.
c. cover it.
d. leave it hanging on work stand and don't disturb anything.

14. When connecting all lines while installing an engine and you have an automatic transmission oil cooler, where do you hook them up?

a. to the engine block
b. to the pressurized coolant pump
c. to the radiator
d. to the air conditioning unit.

15. You can prevent what is known as dry starting by:

a. pressurizing engine lubrication.
b. pressurizing filter cap.
c. pressurizing air tank
d. pressurizing instant lubrication.

37.08.02.04.

16. When inspecting a camshaft out of an engine, you would check wear on the cam journals with a(n):

a. feeler gauge.
b. dial indicator.
c. micrometer.
d. oscilloscope

37.08.02.04. cont.

17. You will need to regrind the camshaft if the overall wear exceeds:

a. .030
b. .020
c. .0015
d. .0010

18.

19. A chipped or badly worn cam can be built up by:

a. capping lobes.
b. welding.
c. heat soldering.
d. craming.

20. To provide proper break in and longer wear, many regrinders cover the cam lobes with a special coating of:

a. aluminum.
b. chromium.
c. phosphate.
d. cast iron.

37.08.02.05.

21. Before removing the main bearings, you must:

a. remove the camshaft.
b. do a plastic gauge test.
c. remove front and rear bearing oil seal.
d. mark them.

22. Bearing bores should not show out-of-roundness in excess of:

a. .0015
b. .0001
c. .007
d. .0150

23.

37.08.02.05. cont.

24. When installing the wick type seal:

a. drive the excess down into the groove.
b. let the excess protrude
c. lay the excess across the parting surface.
d. trim the ends flush with the parting surface.

25. When the engine is in the car, the upper inserts can best be removed by:

a. pulling out with a wire.
b. blowing out with air pressure.
c. driving out with a punch.
d. rolling out with a removal plug.

37.08.02.06.

26. Heavy score marks on pistons require:

a. knurling.
b. filing to remove marks.
c. replacing the pistons.
d. cleaning by a wire brush.

27. Worn or collapsed pistons can be resized by:

a. honing.
b. scraping.
c. fitting an oversize sleeve.
d. knurling.

28. A typical pin fit in an aluminum piston would have the following clearance:

a. .006 to .010
b. .002 to .004
c. .020 to .0205
d. .0002 to .0005

29. The lower piston ring groove contains what ring(s) ?

a. compression ring
b. oil ring
c. oil and compression ring
d. five compression rings

30. How many ring grooves are there usually in a piston?

a. 5
b. 4
c. 3
d. 6

37.08.02.07.

31. When loosening a rod, the crankshaft must be:

a. it doesn't matter where crankshaft is
b. at top dead center.
c. in the middle dead center.
d. at bottom dead center.

32. Rod bearings are connected to the:

a. crankshaft rod journal.
b. crankshaft main journal.
c. crankshaft counterweight.
d. camshaft.

33. Due to the lightness in weight of connecting rods, they tend to distort the big end bearing race and:

a. score rod.
b. bend rod.
c. burn rod.
d. scuff rod.

34.

35.

37.08.02.08.

36. Worn timing gears or chains will not:

a. tighten timing chain.
b. alter valve timing.
c. overheat engine.
d. cause damage to camshaft.

37.

37.08.02.08. cont.

38.

39.

40.

UNIT POST TEST ANSWER KEY: ENGINE CONSTRUCTION A

LAP .01

1. b
2. c
3. a
4. a
5. a

LAP .02

~~6. a~~
~~7. b~~
8. c
9. c
10. a

LAP .03

11. b
12. a
13. c
14. c
15. a

LAP .04

16. c
17. c
~~18. b~~
19. b
20. c

LAP .05

21. d
22. a
~~23. a~~
24. d
25. d

LAP .06

26. c
27. d
28. d
29. b
30. c

LAP .07

31. d
32. a
33. b
~~34. d~~
~~35. b~~

LAP .08

36. a
~~37. b~~
~~38. d~~
~~39. a~~
~~40. d~~

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: ENGINE CONSTRUCTION (B)

37.08.02.01

* 1. Cylinder wear is greatest:

a. near the spark plug.
b. at the top of ring travel.
c. at the bottom of ring travel.
d. at the center of ring travel

* 2. If a cylinder is tapered less than how many inches, it does not require reboring:

a. .012"
b. .0012"
c. 1.2"
d. 0.12"

* 3. A typical pin fit in an aluminum piston would have the following clearance:

a. .0002 to .0005
b. .005 to .010
c. .020 to .0205
d. .002 to .004

* 4. Heavy score marks on pistons require:

a. they are ok.
b. knurling.
c. replacing them.
d. filing to remove cracks.

5. After honing, you should clean cylinders with:

a. hot, soapy water.
b. oil.
c. cleaning solvent.
d. gasoline.

37.08.02.02

6. The function of a split skirt in an engine is to:

a. compensate for heat.
b. compensate for a backfire in an engine.
c. balance an engine.
d. minimize engine vibration.

*(From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, p. 16-13, #s 3 and 22, and pp. 13-39 and 13-40, #s 2, 4, 6, 7, 16, 22, 24, 26, 35.)

37.08.02.02

7. What are the approximate number of rings usually found on pistons used in [illegible] engines?

   a. 4
   b. 6
   c. 3
   d. 5

8. A heat dam in an engine is:

   a. an inner shield on the cylinder heads to prevent heat.
   b. another name for a piston sleeve.
   c. a groove cut into the head of a piston.
   d. a small well in the exhaust manifold.

37.08.02.03

9. You can prevent what is known as dry starting by:

   a. pressurizing engine lubrication.
   b. pressurizing filter cap.
   c. pressurizing air tank.
   d. pressurizing instant lubrication.

10. When connecting all lines while installing an engine and you have an automatic transmission oil cooler, where do you hook them up?

   a. to the engine block.
   b. to the pressurized coolant pump.
   c. to the radiator.
   d. to the air conditioning unit.

11. When not directly working on an engine, you should:

   a. let all parts remain where you put them so you know where they go.
   b. put it under a bench out of the way.
   c. cover it.
   d. leave it hanging on work stand and don't disturb anything.

12. When assembling an engine and you have mushroom type valve lifters, they have to be installed before the:

   a. camshaft.
   b. crankshaft.
   c. pistons.
   d. connecting rods.

13. When installing the engine, the transmission should be:

   a. on the engine.
   b. varies with different makes and models.
   c. in the car.
   d. on the bench.

37.08.02.04

14. To provide proper break in and longer wear, many regrinders cover the cam lobes with a special coating of:

    a. aluminum.
    b. chromium.
    c. phosphate.
    d. cast iron.

15. A chipped or badly worn cam can be built up by:

    a. capping lobes.
    b. welding.
    c. heat soldering.
    d. craming.

16. You will need to regrind the camshaft if the overall wear exceeds:

    a. .030
    b. .020
    c. .0015
    d. .0010

17. When inspecting a camshaft out of an engine, you would check wear on the cam journals with a(n):

    a. feeler gauge.
    b. dial indicator.
    c. micrometer.
    d. oscilloscope.

37.08.02.05

18. When the engine is in the car, the upper inserts can best be removed by:

    a. pulling out with a wire.
    b. blowing out with air pressure.
    c. driving out with a punch.
    d. rolling out with a removal plug.

19. When installing the wick type seal:

    a. drive the excess down into the groove.
    b. let the excess protrude.
    c. lay the excess across the parting surface.
    d. trim the ends flush with the parting surface.

20. Bearing bores should not show out-of-roundness in excess of:

    a. .0015
    b. .0001
    c. .007
    d. .0150

37.08.02.05 (continued)

21. Before removing the main bearings, you must:

    a. remove the camshaft.
    b. do a plastic gauge test.
    c. remove front and rear bearing oil seal.
    d. mark them.

37.08.02.06

22. How many ring grooves are there usually in a piston?

    a. 5
    b. 4
    c. 3
    d. 6

23. The lower piston ring groove contains what ring(s)?

    a. compression ring
    b. oil ring
    c. oil and compression ring
    d. five compression rings

24. A typical pin fit in an aluminum piston would have the following clearance:

    a. .006 to .010
    b. .002 to .004
    c. .020 to .0205
    d. .0002 to .0005

25. Worn or collapsed pistons can be resized by:

    a. honing.
    b. scraping.
    c. fitting an oversize sleeve.
    d. knurling.

26. Heavy score marks on pistons require:

    a. knurling.
    b. filing to remove marks.
    c. replacing the pistons.
    d. cleaning by a wire brush.

37.08.02.07

27. Due to the lightness in weight of connecting rods, they tend to distort the big end bearing race and:

    a. score rod.
    b. bend rod.
    c. burn rod.
    d. scuff rod.

37.08.02.07 (continued)

28. Rod bearings are connected to the:

    a. crankshaft rod journal.
    b. crankshaft main journal.
    c. crankshaft counterweight.
    d. camshaft.

29. When loosening a rod, the crankshaft must be:

    a. it doesn't matter where crankshaft is.
    b. at top dead center.
    c. in the middle dead center.
    d. at bottom dead center.

37.08.02.08

30. Worn timing gears or chains will not:

    a. tighten timing chain.
    b. alter valve timing.
    c. overheat engine.
    d. cause damage to camshaft.

UNIT POST TEST ANSWER KEY: ENGINE CONSTRUCTION (B)

1.	B	16.	C
2.	A	17.	C
3.	A	18.	D
4.	C	19.	D
5.	A	20.	A
6.	A	21.	D
7.	C	22.	C
8.	C	23.	B
9.	A	24.	D
10.	C	25.	D
11.	C	26.	C
12.	A	27.	B
13.	B	28.	A
14.	C	29.	D
15.	B	30.	A

Project: _____ File Code: 37.08.02.00.C1-2(C)

Date: _____ Date Published: 5-23-77

UNIT POST TEST: ENGINE CONSTRUCTION (C)

37.08.02.01

*1. If a cylinder is tapered less than how many inches, it does not require boring:

a. .012"
b. .0012"
c. 1.2"
d. 0.12"

*2. A typical pin fit in an aluminum piston would have the following clearance:

a. .0002 to .0005
b. .006 to .010
c. .020 to .0205
d. .002 to .004

*3. Heavy score marks on pistons require:

a. they are ok.
b. knurling.
c. replacing them.
d. filling to remove cracks.

*4. Cylinder wear is greatest:

a. near the spark plug.
b. at the top of ring travel.
c. at the bottom of ring travel.
d. at the center of ring travel.

5. After honing, you should clean cylinders with:

a. hot, soapy water.
b. oil.
c. cleaning solvent.
d. gasoline.

37.08.02.02

6. The function of a split skirt in an engine is to:

a. compensate for heat.
b. compensate for a backfire in an engine.
c. balance an engine.
d. minimize engine vibration.

*(From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, p. 16-13, #s 3 and 22, and pp. 13-39 and 13-40, #s 2, 4, 6, 7, 16, 22, 24, 26, 35.)

37.08.02.02

7. What are the approximate number of rings usually found on pistons used in auto engines?

   a. 4
   b. 6
   c. 3
   d. 5

8. A heat dam in an engine is:

   a. an inner shield on the cylinder heads to prevent heat.
   b. another name for a piston sleeve.
   c. a groove cut into the head of a piston.
   d. a small well in the exhaust manifold.

37.08.02.03

9. When installing the engine, the transmission should be:

   a. on the engine.
   b. varies with different makes and models.
   c. in the car.
   d. on the bench.

10. You can prevent what is known as dry starting by:

   a. pressurizing engine lubrication.
   b. pressurizing filter cap.
   c. pressurizing air tank.
   d. pressurizing instant lubrication.

11. When assembling an engine and you have mushroom type valve lifters, they have to be installed before the:

   a. camshaft.
   b. crankshaft.
   c. pistons.
   d. connecting rods.

12. When connecting all lines while installing an engine and you have an automatic transmission oil cooler, where do you hook them up?

   a. to the engine block.
   b. to the pressurized coolant pump.
   c. to the radiator.
   d. to the air conditioning unit.

13. When not directly working on an engine, you should:

   a. let all parts remain where you put them so you know where they go.
   b. put it under a bench out of the way.
   c. cover it.
   d. leave it hanging on work stand and don't disturb anything.

37.08.02.04

14. When inspecting a camshaft out of an engine, you would check wear on the cam journals with a(n):

    a. feeler gauge.
    b. dial indicator.
    c. micrometer.
    d. oscilloscope.

15. To provide proper break in and longer wear, many regrinders cover the cam lobes with a special coating of:

    a. aluminum.
    b. chromium.
    c. phosphate.
    d. cast iron.

16. You will need to regrind the camshaft if the overall wear exceeds:

    a. .030
    b. .020
    c. .0015
    d. .0010

17. A chipped or badly worn cam can be built up by:

    a. capping lobes.
    b. welding.
    c. heat soldering.
    d. craming.

37.08.02.05

18. Before removing the main bearings, you must:

    a. remove the camshaft.
    b. do a plastic gauge test.
    c. remove front and rear bearing oil seal.
    d. mark them.

19. When the engine is in the car, the upper inserts can best be removed by:

    a. pulling out with a wire.
    b. blowing out with air pressure.
    c. driving out with a punch.
    d. rolling out with a removal plug.

20. When installing the wick type seal:

    a. drive the excess down into the groove.
    b. let the excess protrude.
    c. lay the excess across the parting surface.
    d. trim the ends flush with the parting surface.

37.08.02.05 (continued)

21. Bearing bores should not show out-of-roundness in excess of:

a. .0015
b. .0001
c. .007
d. .0150

37.08.02.06

22. Heavy score marks on pistons require:

a. knurling.
b. filing to remove marks.
c. replacing the pistons.
d. cleaning by a wire brush.

23. How many ring grooves are there usually in a piston?

a. 5
b. 4
c. 3
d. 6

24. The lower piston ring groove contains what ring(s)?

a. compression ring
b. oil ring
c. oil and compression ring
d. five compression rings

25. Worn or collapsed pistons can be resized by:

a. honing.
b. scraping.
c. fitting an oversize sleeve.
d. knurling.

26. A typical pin fit in an aluminum piston would have the following clearance:

a. .006 to .010
b. .002 to .004
c. .020 to .0205
d. .0002 to .0005

37.08.02.07

27. When loosening a rod, the crankshaft must be:

a. it doesn't matter where crankshaft is.
b. at top dead center.
c. in the middle dead center.
d. at bottom dead center.

37.08.02.07 (continued)

28. Due to the lightness in weight of connecting rods, they tend to distort the big end bearing race and:

    a. score rod.
    b. bend rod.
    c. burn rod.
    d. scuff rod.

29. Rod bearings are connected to the:

    a. crankshaft rod journal.
    b. crankshaft main journal.
    c. crankshaft counterweight.
    d. camshaft.

37.08.02.08

30. Worn timing gears or chains will not:

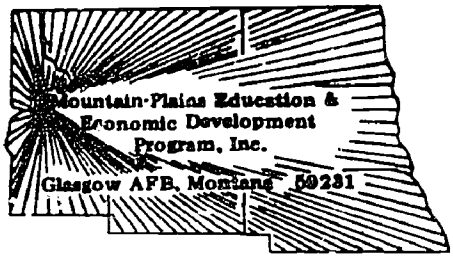
    a. tighten timing chain.
    b. alter valve timing.
    c. overheat engine.
    d. cause damage to camshaft.

UNIT POST TEST ANSWER KEY:: ENGINE CONSTRUCTION (C)

1. A
2. A
3. C
4. B
5. A
6. A
7. C
8. C
9. B
10. A
11. A
12. C
13. C
14. C
15. C
16. C
17. B
18. D
19. D
20. D
21. A
22. C
23. C
24 B
25. D
26. D
27. D
28. B
29. A
30. A

Student: _____ File Code: 37.08.02.00.B1-5

Date: _____ Date Published: 3/10/76



Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: ENGINE CONSTRUCTION

OBJECTIVE 1:

Inspection and overhaul of engine block.

OBJECTIVE 2:

Inspection and overhaul of engine block components.

TASK:

The student will be assigned a vehicle on which he must perform an engine overhaul consisting of inspecting and overhauling the block, camshaft, crankshaft, pistons, rods, and timing gears.

ASSIGNMENT:

CONDITIONS:

The student may use only those materials provided for the test and take the test in the auto shop.

RESOURCES:

Auto engine
Repair manual
Time and parts manuals
New parts, if necessary
Boring bar
Piston Pin Press
Piston Pin Hone
Straight edge

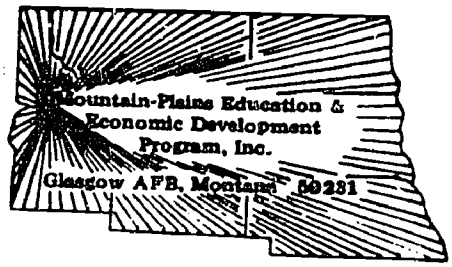
RESOURCES: (Continued)

Torque wrench
Rod cap grinder
Micrometers
Dial indicators
Plasti gauge
Electric drill
Cylinder hone
drill wire brush
Overhaul gasket set
Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: _____ File Code: 37.08.02.00.B1-5

Date: _____ Date Published: 3/10/76

Family Pay Number: _____ Sex: M F (Circle 1)



PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION Met	Not Met
Objective 1:		
1. Safely remove engine from vehicle.		
Criterion: No damage to engine, parts, or vehicle.		
2. Disassemble, clean, and inspect cylinder block.		
Criterion: Compare to manufacturer's specifications, engine and parts clean.		
3. Bore and/or hone cylinder block.		
Criterion: Must meet manufacturer's specifications.		
Objective 2:		
4. Inspect camshaft and bearings.		
Criterion: Must meet manufacturer's specifications.		
5. Install new bearings on crankshaft.		
Criterion: Must meet manufacturer's specifications.		
6. Inspect pistons.		
Criterion: Compare to manufacturer's specifications.		

	CRITERION Met	Not Met
7. Knurl pistons.		
Criterion: Must meet manufacturer's specifications.		
8. Inspect rods.		
Criterion: Compare to manufacturer's specifications.		
9. Inspect connecting rods.		
Criterion: Must meet manufacturer's specifications.		
10. Inspect and/or install new timing chain and gears.		
Criterion: Must meet manufacturer's specifications.		
11. Assemble engine.		
Criterion: All bearings lubricated and measured for specified clearances; engine must run when in car.		
12. Complete test in allotted time.		
Criterion: Must meet flat rate.		
Student must satisfactorily complete 10 of 12 line items to pass test.		

File Code: 37.08.03.00.B1-1

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: VALVE TRAIN

RATIONALE:

The fundamentals and techniques in this unit will enable you to diagnose and overhaul cylinder heads.

PREREQUISITES:

None

OBJECTIVE:

Identify the components of the cylinder head.

Perform proper cylinder head inspection and overhaul.

RESOURCES:

Printed Materials

Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Auto Service and Repair, Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor. The Hearst Corporation, (1972 or equivalent).

Equipment

Carbon
Cylinder head
Dial indicator
Feeler gauges
Fender covers
Magnifying glass
Straight edge ruler
Tools, Basic Hand: Chisel and Punch Set
5/32" Pin Punch
3/16" Solid

Gauge, feeler (.002" - .025")

Hammer, ball peen
Hammer, plastic tip
Handle, speed
Hex Key Set

Principal Author(s): C. Schramm/W. Osland

Pliers, diagonal cutting
Pliers, needle nose

Scraper, gasket
Screwdriver, standard (Set)
Screwdriver, phillips (Set)
Screw starter

Socket Set (3/8" drive)
extension (3")
ratchet

Socket Set (1/4" drive)
extension (3")
handle (6" flex)
ratchet

Socket, spark plug
extension (6")

Wrench, combination (Set)
Wrench, combination ignition (Set)

Valve spring compressor
Wire brush with electric drill
Overhead valve head needing overhaul
Valve grind equipment
Valve grind gasket set
Replacement valves
Overhead cam head

GENERAL INSTRUCTIONS:

This unit consists of four Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) In this Unit, there are some LAPs that have tests combined with other LAP tests. These combined tests are taken after completing the last LAP covered by the test.
(9) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(10) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of Cylinder Head
.02 Inspecting Cylinder Head
.03 Overhaul Overhead Valve Head
.04 Overhaul Overhead Cam Head

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

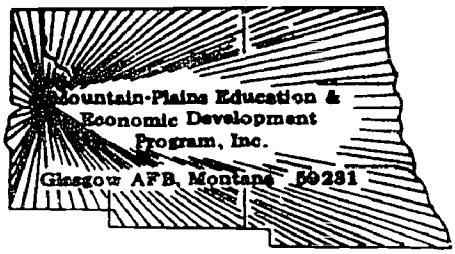
1. The student takes a multiple-choice post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.08.03.00.B1-2

Date: _____ Date Published: 3/12/76



UNIT PRETEST: VALVE TRAIN

37.08.03.01. A

1. It is important to keep the wheels dressed on a valve grinding machine because:

   a. they will wear longer.
   b. they will do better and faster work.
   c. they will look better.
   d. they will keep the stone in the middle of the valve.

2. A valve seat that is too wide will:

   a. pack with carbon, start to leak and burn.
   b. run too cold.
   c. be hard to open.
   d. break the valve stem.

3. Valve seat runout should be kept within:

   a. .006
   b. .002
   c. .020
   d. .0003

4. When the valve is ground at a slightly different angle (about one degree) than the seat, what kind of a fit is produced?

   a. margin fit
   b. an interference fit
   c. face fit
   d. an indented fit

5. You should never remove a cylinder head when:

   a. the rocker shaft is off the head.
   b. valves are in head.
   c. hot.
   d. cold.

37.08.03.02.

6. To inspect a cylinder head, you remove the valve springs with a:

   a. guide reamer.
   b. dial indicator.
   c. spring compressor.
   d. valve guide remover.

7. You should check valve seats for:

   a. stone strikes.
   b. burning and cracking.
   c. guide shimmy.
   d. peening marks.

8. When checking cylinder head warpage, it should not exceed:(Total)

   a. .006
   b. .003
   c. .002
   d. .005

9. A tool used to check for warpage on a cylinder head is a(n):

   a. magnifying glass.
   b. dial indicator.
   c. oscilloscope.
   d. feeler gauge.

10. To check valve stem to guide clearance, you would use a (n):

   a. feeler gauge.
   b. oscilloscope.
   c. dial indicator.
   d. hydrometer.

37.08.03.03.

11. A "valve in head" engine is where you have both valves in the head. What type of head is a "valve in head" head?

    a. L head
    b. I head
    c. T head
    d. F head

12.

13. How much clearance is there in hydraulic overhead valves when setting the valves?

    a. .10
    b. .005
    c. .015
    d. none

14. When grinding a valve stem end in an overhead valve head, you should not remove more than:

    a. .020
    b. .010
    c. 0.20
    d. .030

15.

37.08.03.04.

16. When you have an overhead cam head, it eliminates:

    a. valve stems.
    b. valve springs.
    c. rocker arms and pushrods.
    d. valve guides.

17. An overhead camshaft will help prevent valves at high speeds from:

    a. burning.
    b. carbonizing.
    c. glazing.
    d. floating.

18.

19. When reassembling an overhead cam engine, you have to align the cam with the:

    a. valves.
    b. crankshaft
    c. pistons.
    d. pushrods.

20. An overhead camshaft timing chain is kept tight by:

    a. rubbing blocks.
    b. oversized gears.
    c. it cannot be kept tight.
    d. the crankshaft sprocket

UNIT PRETEST ANSWER KEY: VALVE TRAIN

LAP		
01	1.	B
	2.	A
	3.	B
	4.	B
	5.	C
02	6.	C
	7.	B
	8.	A
	9.	D
	10.	C
03	11.	B
	12.	A
	13.	D
	14.	B
	15.	B
04	16.	C
	17.	D
	18.	B
	19.	B
	20.	A

File Code: 37.08.03.01.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of Cylinder Head

OBJECTIVE:

Identify the components and the proper operation and correct repair procedure for the cylinder head.

EVALUATION PROCEDURE:

Score at least 80% on the multiple-choice test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.
Auto Service and Repair, Stockel.

PROCEDURE:

1. Read pages 157-171 in Auto Mechanics Fundamentals.
2. Read Chapter 13, "Cylinder Head, Valve and Valve Train Service", pages 13-1 through 13-38 in Auto Service and Repair.
3. Study figures 13-1 through 13-108.
4. Neatly answer on paper the test questions on page 13-30 and 13-40.

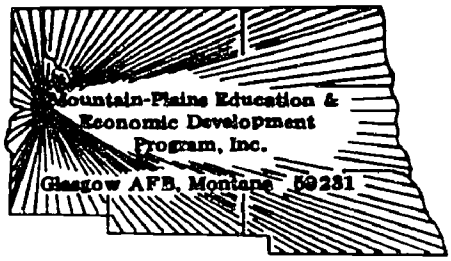
   Questions: 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 22, 23, 28, 29, 35

5. Upon completion, give the test answer sheet to the instructor for evaluation.
6. Return the text to the proper shelf.
7. Take and score the LAP test.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.03.01.B1-2

Date: _____ Date Published: 3/9/76



LAP TEST: FUNDAMENTALS OF CYLINDER HEAD

1. You would remove rocker arm assembly by:

   a. loosening each bracket, in turn, a little until all are loose.
   b. loosening each bracket all the way before going to the next one.
   c. loosening the front end first.
   d. leaving one bracket tight until all others have been loosened.

2. It is neceaary to keep all parts in order because:

   a. they may be lost.
   b. it is important they be returned to their original positions.
   c. they can be kept in a smaller area.
   d. it is just a good habit.

3. It is important to keep the wheels dressed on a valve grinding machine because:

   a. they will wear longer.
   b. they will do better and faster work.
   c. they will look better.
   d. they will keep the stone in the middle of the valve.

4. A valve seat that is too wide will:

   a. pack with carbon, start to leak and burn.
   b. run too cold.
   c. be hard to open.
   d. break the valve stem.

5. Valve seat runout should be kept within:

   a. .002
   b. .006
   c. .020
   d. .0003

6.

7. **Excessive valve clearance will:**

   a. cause late valve opening and a lower lift.
   b. prolong the life of the valve.
   c. cause early valve opening.
   d. increase horsepower.

8. A cracked valve seat of the integral type can often be repaired by:

   a. installing a valve guide.
   b. installing annew guide.
   c. installing a seal.
   d. installing an insert.

9.

10.

LAP TEST ANSWER KEY: FUNDAMENTALS OF CYLINDER HEAD

1. A
2. B
3. B
4. A
5. A
6. C
7. A
8. D
9. A
10. C

File Code: 37.08.03.02.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Inspecting Cylinder Head

OBJECTIVE:

Using proper procedure perform the inspection of the cylinder head.

EVALUATION PROCEDURE:

80% correct on written post test to be taken after LAP 37.08.03.04.

RESOURCES:

Auto Service and Repair, Stockel.
Carbon scraper
Cylinder head
Dial indicator
Feeler gauges
Magnifying glass
Straight edge ruler
Tools, Basic Hand: (See Unit LEG)
Valve Spring compressor
Wire brush with electric drill

PROCEDURE:

NOTE: Review Chapter 13 if necessary in Auto Service and Repair.

1. Clean cylinder head thoroughly. Use a carbon scraper and electric drill equipped with a wire brush.
2. Remove valve springs with the valve spring compressor. Keep the springs in order of removal.
3. Check valve guide to stem clearance with a dial indicator. Compare measure- specifications from a repair manual. Record results on work order.
4. Remove and clean each valve and inspect the valve stem and valve face for wear and damage.
5. Place each valve in a valve board. Mark the valve board to insure exact valve re-installation.

Principal Author(s): J. Anderson/W. Osland

PROCEDURE: (continued)

6. Inspect the head combustion chambers, valve seats and valve guides for cracks.
7. Test the tension of the valve springs with the valve spring compressor. Refer to the manual for the manufacturer's specifications on the correct tension. Record results on work order.
8. Inspect the rocker arm assembly for signs of wear, cracks and damage. Record results on work order.
9. Inspect cylinder head flat surface for cracks.
10. Inspect the cylinder head for warpage using a straight edge and feeler gauge. Record results on work order.
11. Ask the instructor to evaluate your work.
12. Clean and return all tools and equipment.
13. Clean work areas.
14. Proceed to the next LAP.

File Code: 37.08.03.03.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Overhaul Overhead Valve Head

OBJECTIVE:

Using proper procedure, overhaul an overhead valve cylinder head.

EVALUATION PROCEDURE:

80% correct on LAP test to be taken after LAP 37.08.03.04.

RESOURCES:

Auto Service and Repair, Stockel.
Fender covers
Tools, Basic Hand: (See Unit LEG)
Valve grind equipment
Valve grind gasket set and replacement valves (if needed)
Wire brush with electric drill

PROCEDURE:

NOTE: Review Chapter 13 in Auto Service and Repair.

1. Obtain the overhead valve cylinder head.
   NOTE: If you need to remove the head from an engine, use the repair manual for that model and follow the recommended removal procedure.
2. After head is removed, clean the head chambers with an electric drill and wire brush.
3. Remove the grease and dirt from the head.
   NOTE: Be sure to place fender covers over the fenders.
4. Obtain the valve spring compressor tool and remove the valve keepers and springs. Place these in a small box and be careful not to lose any.
5. Place the valves in a valve board in order.
6. With the electric drill and wire brush, clean the valve ports.
7. Refer to the manual for the correct valve and seat angles used for grinding.
8. Obtain the valve grind manual and follow the procedure for operating the valve grinder. Grind the valves.
   NOTE: Always be careful! One error may cost a new valve or valve seat insert or sometimes, a new head! (When the valves are completed, ask the instructor to inspect them.)

Principal Author(s): J. Anderson/W. Osland

PROCEDURE: (continued)

9. Follow the operator's manual and carefully grind the valve seats. (Ask the instructor to evaluate the grinding.)
10. When grinding is completed, clean the head and valves to remove the metal chips.
11. Reassemble the valve springs and keepers.
12. Ask the instructor to evalute your completed head.
13. Thoroughly clean up your work station area and grinder equipment.
14. Proceed to the next LAP.

File Code: 37.08.03.04.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Overhaul Overhead Cam Head

OBJECTIVE:

Using proper procedure, overhaul an overhead cam cylinder head.

EVALUATION PROCEDURE:

80% correct on LAP test.
80% accuracy on unit performance test.

RESOURCES:

Auto Service and Repair, Stockel.
Fender covers
Overhead cam head (needing overhauling)
Tools, Basic Hand: (See Unit LEG)
Valve grind equipment
Valve spring compressor
Wire brush with electric drill

PROCEDURE:

Note: Review Chapter 13 in Auto Service and Repair.

1. Obtain the overhead cam head.
   NOTE: To remove head from engine, obtain the proper manual and follow the recommended procedure of removal.
2. Clean the head. Remove grease and dirt.
3. Obtain the valve spring compressor tool and remove the valve springs and keepers. (Place these in a box for safekeeping.)
   NOTE: Place fender covers over the fenders.
4. Remove the valves and place them in the valve board.
5. Clean the valves on the electric wire brush wheel.
6. Clean the head chamber and ports with the electric drill and wire brush.
7. Refer to the manual for the correct valve and valve seat grind angles. (Record angles on the work order.)
8. Obtain the valve grinder operator's manual and follow the valve grinding procedure to grind the valves.
   NOTE: Always be cautious when grinding; one error may cost a new valve, new valve seat insert, or even a new head.

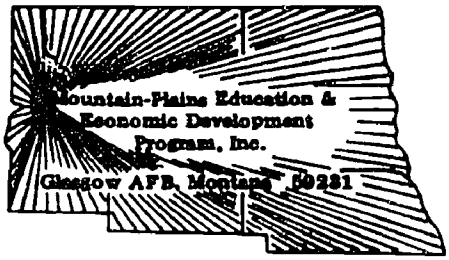
Principal Author(s): J. Anderson/W. Osland

PROCEDURE: (continued)

9. When the valves are completed, ask the instructor to evaluate your work.
10. Follow the valve grinder operator's manual for grinding the valve seats.
11. Ask the instructor to evaluate your work.
12. Clean the head and valves to remove any metal chips.
13. Reassemble the valves, springs, and keepers in the head.
14. Ask the instructor to evaluate your work.
15. Clean up the bench, the valve grind equipment and work area.
16. Obtain a copy of the LAP test. Answer all of the questions and return the test to the instructor for evaluation.
17. Upon successful completion of the LAP test, obtain the unit 37.08.03 post test. Answer all of the questions and return the test to the instructor for evaluation.
18. Upon successful completion, proceed to the next unit.

Student: _____ File Code: 37.08.03.02.B1-2
37.08.03.03.B1-2
37.08.03.04.B1-2

Date: _____ Date Published: 3/9/76



LAP TEST: INSPECTING CYLINDER HEAD - OVERHAUL OVERHEAD VALVE/CAM HEADS

37.08.03.02.

1. You should check valve seats for:

   a. stone strides.
   b. burning and cracking.
   c. guide shimmy.
   d. peening marks.

2. A tool used to check for warpage on a cylinder head is a(n):

   a. magnifying glass.
   b. dial indicator.
   c. oscilloscope.
   d. feeler gauge.

3. To check valve stem to guide clearance, you would use a (n):

   a. feeler gauge.
   b. oscilloscope.
   c. dial indicator.
   d. hydrometer.

37.08.03.03.

4. In an overhead valve head the rocker arm has what kind of movement on the rocker arm shaft?

   a. slipping
   b. oscillating
   c. sliding
   d. pivoting.

5. When grinding a valve stem end in an overhead valve head, you should not remove more than:

   a. .020
   b. .010
   c. 0.20
   d. .030

6.

37.08.03.04.

7. When you have an overhead cam head, it eliminates:

   a. valve stems.
   b. valve springs.
   c. rocker arms and pushrods.
   d. valve guides.

8. An overhead camshaft will help prevent valves at high speeds from:

   a. burning.
   b. carbonizing.
   c. glazing.
   d. floating.

9. An overhead camshaft is operated by:

   a. a long timing chain.
   b. oversize timing gears.
   c. a regular timing chain.
   d. a regular timing gears.

10. When reassembling an overhead cam engine, you have to align the cam with the:

   a. valves.
   b. crankshaft by timing chain.
   c. pistons.
   d. pushrods.

LAP TEST ANSWER KEY. INSPECTING CYLINDER HEAD - OVERHAUL OVERHEAD VALVE/CAM HEADS

LAP		
02	1.	B
	2.	D
	3.	C
03	4.	D
	5.	B
	[illegible]	
04	7.	C
	8.	D
	9.	A
	10.	B

Student: _____ File Code: 37.08.03.00.C1-2

Date: _____ Date Published: 3/12/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: VALVE TRAIN (A)

37.08.03.01.

1. Valve grinding stones are dressed with:

   a. a hardened steel rod.
   b. a file.
   c. another stone.
   d. a diamond.

2. When grinding the valve face:

   a. move the valve back and forth - staying on the stone.
   b. keep the valve in the center of the stone.
   c. move the valve back and forth - off both sides of the stone.
   d. keep the valve on the right hand side of the stone.

3. When the valve is ground at a slightly different angle (about one degree) than the seat, what kind of a fit is produced?

   a. margin fit
   b. an interference fit
   c. face fit
   d. an indented fit.

4. To facilitate accurate head, gasket and block alignment, what is used when installing the head?

   a. guide pins
   b. split keepers.
   c. swing levers.
   d. retainers

5. You should never remove a cylinder head when:

   a. the rocker shaft is off the head.
   b. valves are in head.
   c. hot.
   d. cold.

37.08.03.02.

6. To inspect a cylinder head, you remove the valve springs with a:

   a. guide reamer.
   b. dial indicator.
   c. spring compressor.
   d. valve guide remover.

7. When inspecting a cylinder head, you would check valve guide to stem clearance with a:

   a. pilot shaft.
   b. flat feeler gauge.
   c. round gauge.
   d. dial indicator.

8. When checking cylinder head warpage, it should not exceed?(total)

   a. .006
   b. .003
   c. .002
   d. .005

9. What is one tool you use when checking cylinder head for warpage?

   a. dial indicator
   b. cup seal
   c. straightedge
   d. hydrometer

10. A tool used to check for warpage on an cylinder head is a (n):

   a. magnifying glass.
   b. dial indicator.
   c. oscilloscope.
   d. feeler gauge.

37.08.03.03-

11. A "valve in head" engine is where you have both valves in the head. What type of head is a "valve in head" head?

    a. L head
    b. I head
    c. T head
    d. F head

12.

13. How much clearance is there in hydraulic overhead valves when setting the valves?

    a. .10
    b. .005
    c. .015
    d. none

14. When grinding a valve the margin on the valve face should <u>not</u> be less than:

    a. 1/4"
    b. 5/16"
    c. 1/32"
    d. 1/8"

15.

37.08.03.04.

16. When you have an overhead cam head, it eliminates:

    a. valve stems.
    b. valve springs.
    c. rocker arms and pushrods.
    d. valve guides.

17.

18. An overhead camshaft is operated by:

    a. a long timing chain.
    b. oversize timing gears.
    c. a regular timing chain.
    d. a regular timing gear.

19. When reassembling an overhead cam engine, you have to align the cam with the:

    a. valves.
    b. crankshaft
    c. pistons.
    d. pushrods.

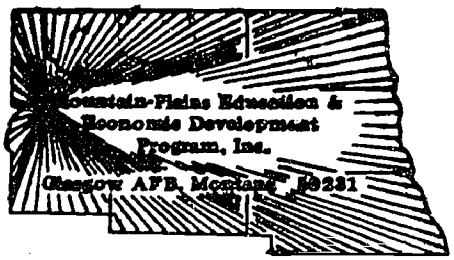
20. An overhead camshafts timing chain is kept tight by:

    a. rubbing blocks.
    b. oversized gears.
    c. it cannot be kept tight.
    d. the crankshaft spocket.

UNIT POST TEST ANSWER KEY: VALVE TRAIN A

LAP

01	1.	D
	2.	A
	3.	B
	4.	A
	5.	C
02	6.	C
	7.	D
	8.	A
	9.	C
	10.	D
03	11.	B
	~~12.~~	~~A~~
	13.	D
	14.	C
	~~15.~~	~~B~~
04	16.	C
	~~17.~~	~~B~~
	18.	A
	19.	B
	20.	A



UNIT POST TEST: VALVE TRAIN (B)

37.08.03.01

1. You should never remove a cylinder head when:

   a. the rocker shaft is off the head.
   b. valves are in head.
   c. hot.
   d. cold.

2. To facilitate accurate head, gasket and block alignment, what is used when installing the head?

   a. guide pins.
   b. split keepers.
   c. swing levers.
   d. retainers.

3. When the valve is ground at a slightly different angle (about one degree) than the seat, what kind of a fit is produced?

   a. margin fit.
   b. an interference fit.
   c. face fit.
   d. an indented fit.

4. When grinding the valve face:

   a. move the valve back and forth - staying on the stone.
   b. keep the valve in the center of the stone.
   c. move the valve back and forth - off both sides of the stone.
   d. keep the valve on the right hand side of the stone.

5. Valve grinding stones are dressed with:

   a. a hardened steel rod.
   b. a file.
   c. another stone.
   d. a diamond.

37.08.03.02

6. A tool used to check for warpage on a cylinder head is a(n):

   a. magnifying glass.
   b. dial indicator.
   c. oscilloscope.
   d. feeler gauge.

37.08.03.02 (continued)

7. What is one tool you use when checking cylinder head for warpage?

   a. dial indicator.
   b. cup seal.
   c. straightedge.
   d. hydrometer.

8. When checking cylinder head warpage, it should not exceed? (total)

   a. .006
   b. .003
   c. .002
   d. .005

9. When inspecting a cylinder head, you would check valve guide to stem clearance with a:

   a. pilot shaft.
   b. flat feeler gauge.
   c. round gauge.
   d. dial indicator.

10. To inspect a cylinder head, you remove the valve springs with a:

   a. guide reamer.
   b. dial indicator.
   c. spring compressor.
   d. valve guide remover.

37.08.03.03

11. When grinding a valve the margin on the valve face should not be less than:

   a. 1/4"
   b. 5/16"
   c. 1/32"
   d. 1/8"

12. How much clearance is there in hydraulic overhead valves when setting the valves?

   a. .10
   b. .005
   c. .015
   d. none

13. A "valve in head" engine is where you have both valves in the head. What type of head is a "valve in head" head?

   a. L head
   b. I head
   c. T head
   d. F head

37.08.03.04

14. An overhead camshaft timing chain is kept tight by:

    a. rubbing blocks.
    b. oversized gears.
    c. it cannot be kept tight.
    d. the crankshaft spocket.

15. When reassembling an overhead cam engine, you have to align the cam with the:

    a. valves.
    b. crankshaft.
    c. pistons.
    d. pushrods.

16. An overhead camshaft is operated by:

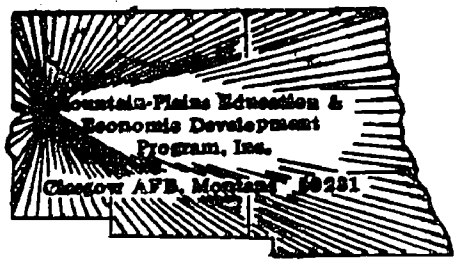
    a. a long timing chain.
    b. oversize timing gears.
    c. a regular timing chain.
    d. a regular timing gear.

17. When you have an overhead cam head, it eliminates:

    a. valve stems.
    b. valve springs.
    c. rocket arms and pushrods.
    d. valve guides.

UNIT POST TEST ANSWER KEY: VALVE TRAIN (B)

1. C
2. A
3. B
4. A
5. D
6. D
7. C
8. A
9. D
10. C
11. C
12. D
13. B
14. A
15. B
16. A
17. C



UNIT POST TEST: VALVE TRAIN (C)

37.08.03.01

1. Valve grinding stones are dressed with:

   a. a hardened steel rod.
   b. a file.
   c. another stone.
   d. a diamond.

2. When the valve is ground at a slightly different angle (about one degree) than the seat, what kind of a fit is produced?

   a. margin fit.
   b. an interference fit.
   c. face fit.
   d. an indented fit.

3. You should never remove a cylinder head when:

   a. the rocker shaft is off the head.
   b. valves are in head.
   c. hot.
   d. cold.

4. When grinding the valve face:

   a. move the valve back and forth - staying on the stone.
   b. keep the valve in the center of the stone.
   c. move the valve back and forth - off both sides of the stone.
   d. keep the valve on the right hand side of the stone.

5. To facilitate accurate head, gasket and block alignment, what is used when installing the head?

   a. guide pins.
   b. split keepers.
   c. swing levers.
   d. retainers.

37.08.03.02

6. To inspect a cylinder head, you remove the valve springs with a:

   a. guide reamer.
   b. dial indicator.
   c. spring compressor.
   d. valve guide remover.

37.08.03.02 (continued)

7. What is one tool you use when checking cylinder head for warpage?

   a. dial indicator
   b. cup seal.
   c. straightedge.
   d. hydrometer.

8. A tool used to check for warpage on a cylinder head is a(n):

   a. magnifying glass.
   b. dial indicator.
   c. oscilloscope.
   d. feeler gauge.

9. When checking cylinder head warpage, it should not exceed? (total)

   a. .006
   b. .003
   c. .002
   d. .005

10. When inspecting a cylinder head, you would check valve guide to stem clearance with a:

   a. pilot shaft.
   b. flat feeler gauge.
   c. round gauge.
   d. dial indicator.

37.08.03.03

11. A "Valve in head" engine is where you have both valves in the head. What type of a head is a "valve in head" head?

   a. L head
   b. I head
   c. T head
   d. F head

12. How much clearance is there in hydraulic overhead valves when setting the valves?

   a. .10
   b. .005
   c. .015
   d. none

37.08.03.03 (continued)

13. When grinding a valve the margin on the valve face should not be less than:

    a. 1/4"
    b. 5/16"
    c. 1/32"
    d. 1/8"

37.08.03.04

14. When you have an overhead cam head, it eliminates:

    a. valve stems.
    b. valve springs.
    c. rocker arms and pushrods.
    d. valve guides.

15. When reassembling an overhead cam engine, you have to align the cam with the:

    a. valves.
    b. crankshaft.
    c. pistons.
    d. pushrods.

16. An overhead camshaft timing chain is kept tight by:

    a. rubbing blocks.
    b. oversized gears.
    c. it cannot be kept tight.
    d. the crankshaft spocket.

17. An overhead camshaft is operated by:

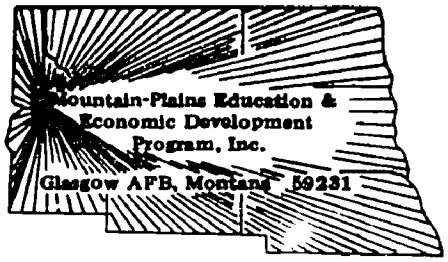
    a. a long timing chain.
    b. oversize timing gears.
    c. a regular timing chain.
    d. a regular timing gear.

UNIT POST TEST ANSWER KEY: VALVE TRAIN (C)

1. D
2. B
3. C
4. A
5. A
6. C
7. C
8. D
9. A
10. D
11. B
12. D
13. C
14. C
15. B
16. A
17. A

Student: _____ File Code: 37.08.03.00.B1-5

Date: _____ Date Published: 3/1/76



Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: VALVE TRAIN

OBJECTIVE 1:

Inspects head.

OBJECTIVE 2:

Overhauls head.

TASK:

The student will be assigned a vehicle on which he must overhaul the valve train and inspect the head.

ASSIGNMENT:

CONDITIONS:

The student may use only those materials provided for the test and complete the test in the auto shop.

RESOURCES:

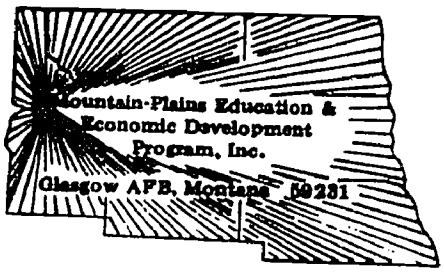
Automobile with cylinder head
Repair manual
Time and Parts Guide
Straight edge
Magniflux machine
Dial indicator
Feeler gauges
Electric drill and wire brush
Valve grinder
Seat grinder

RESOURCES: (Continued)

Valve spring compressor
Valve spring tester
Repair parts, if needed
Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: _____ File Code: 37.08.03.00.B1-5

Date: _____ Date Published: 3/1/76



Family Pay Number: _____ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION Met	Not Met
Objective 1:		
1. Remove head.		
Criterion: Follows service manual; does not damage head		
or vehicle.		
2. Disassembles and cleans valve train and head.		
Criterion: Compares head to manufacturer's specifications.		
3. Tests valve springs.		
Criterion: Compares to manufacturer's specifications.		
4. Tests valve guides for clearance.		
Criterion: Compares to manufacturer's specifications.		
5. Inspects rocker arm assemblies.		
Criterion: Compares to manufacturer's specifications.		
6. Inspects valves.		
Criterion: Compares to manufacturer's specifications.		

(Checklist continued)

	CRITERION Met	Not Met
Objective 2:		
7. Grinds valves.		
Criterion: Must meet manufacturer's specifications.		
8. Knurles guides or replaces.		
Criterion: Meets manufacturer's specifications.		
9. Grinds or replaces valve.		
10. Resurfaces head.		
Criterion: Must meet manufacturer's specifications.		
11. Installs head and valve assembly on car.		
Criterion: Head gasket installed correctly, follows		
tightening sequence, torques to specifications, no leaks		
in cooling system.		
12. Completes test in allotted time.		
Criterion: meets flat rate time on assigned vehicle.		
Student must satisfactorily complete 10 of 12 line items to pass		
test.		

File Code: 37.08.04.00.B1-1

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: LUBRICATING SYSTEMS

RATIONALE:

The fundamentals and techniques in this unit will enable you to diagnose the lubricating system and replace the oil pump.

PREREQUISITES:

None

OBJECTIVES:

Identify the components and the proper operation of the oil pump.

Following correct procedure, test and replace the oil pump.

RESOURCES:

Printed Materials

Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor. The Hearst Corporation, 1972 or equivalent.
Time and Parts Manual

Equipment

Automobile needing oil pump test
Drain pan
Fender covers
Oil
Oil pump
Pan gasket set
Remote oil test gauge
R.P.M. meter
Tools, Basic Hand: Chisel and Punch Set
5/32" Pin Punch
3/16" Solid
Gauge, feeler (.002" - .025")
Hammer, ball peen
Hammer, plastic tip
Handle, speed
Hex Key Set

Principal Author(s): C. Schramm/W. Osland

Resources: Equipment: Continued

Pliers, diagonal cutting
Pliers, needle nose
Scraper, gasket
Screwdriver, standard (set)
Screwdriver, Phillips (set)
Screw starter
Socket Set (3/8" drive)
  extension (3")
  ratchet
Socket Set (1/4" drive)
  extension (3")
  handle (6" flex)
  ratchet
Socket, spark plug
  extension (6")
Wrench, combination (set)
Wrench, combination ignition (set)

GENERAL INSTRUCTIONS:

This unit consists of three Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) In this Unit, there are some LAPs that have tests combined with other LAP tests. These combined tests are taken after completing the last LAP covered by the test.
(9) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(10) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of Oil Pump
.02 Testing Oil Pump
.03 Replacing Oil Pump

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

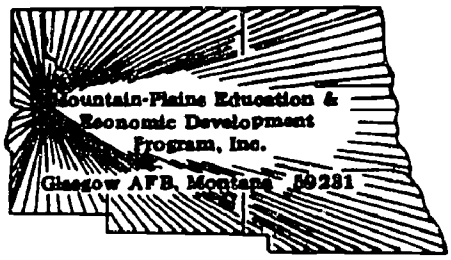
1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.08.04.00.B1-2

Date: _____ Date Published: 3/15/76



UNIT PRETEST: LUBRICATING SYSTEMS

37.08.04.01.

1.

2. End clearance in an oil pump rotor should not exceed:

   a. .010
   b. .004
   c. .001
   d. .020

3. Oil resistance to flow is the definition of:

   a. splash flow.
   b. friction.
   c. shunt flow.
   d. viscosity.

4. You should drain the oil when the engine is at what temperature?

   a. cold operating temperature
   b. normal operating temperature
   c. it doesn't matter what temperature it is
   d. hot operating temperature

5. The part on the oil pump that prevents temporary oil saturation during violent surging of the pump oil supply is the:

   a. check valve.
   b. pick up tube screen.
   c. oil pick up tube.
   d. screen baffle.

37.08.04.02.

6. One instrument used to measure oil pump moving parts is a:

   a. feeler gauge.
   b. rotor gear.
   c. oscilloscope.
   d. dial indicator.

7. Which of the following instruments is used for testing an oil pump?

   a. ammeter
   b. oscilloscope
   c. tachometer
   d. hydrometer

8. Badly worn bearings will result in which of the following?

   a. good gas mileage
   b. good engine torque
   c. low oil pressure
   d. low water pressure

9. When overhauling an engine, the oil pump should be checked for:

   a. leaks.
   b. compression.
   c. torque.
   d. pressure.

10. To check rotor clearance on an oil pump, you would use a:

   a. straightedge.
   b. dial indicator.
   c. triometer.
   d. oscilloscope.

37.08.04.03.

11. To remove an oil pump which is of the distributor gear driver type, before you take off the oil pump you must first take off the:

    a. distributor.
    b. camshaft.
    c. oil pump baffle.
    d. oil pan.

12.

13. In order to take off the oil pan to replace the oil pump you must sometimes:

    a. remove the vibration damper.
    b. disconnect the drive shaft.
    c. disconnect the motor mounts.
    d. disconnect the transmission.

14.

15. The name of the valve in the oil pump that controls oil pressure is:

    a. the diaphragm valve.
    b. the relief valve.
    c. the vapor return valve.
    d. the pulsator return valve.

UNIT PRETEST ANSWER KEY: LUBRICATING SYSTEMS

LAP

01	1.	D
	2.	B
	3.	D
	4.	B
	5.	D
02	6.	A
	7.	C
	8.	C
	9.	D
	10.	A
03	11.	A
	12.	C
	13.	C
	14.	D
	15.	B

File Code: 37.08.04.01.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of Lubrication (Oil Pump)

OBJECTIVE:

Recognize the components and proper operation of the oil pump.

EVALUATION PROCEDURE:

80% correct on the multiple-choice test.

RESOURCES:

Auto Service and Repair, Stockel.

PROCEDURE:

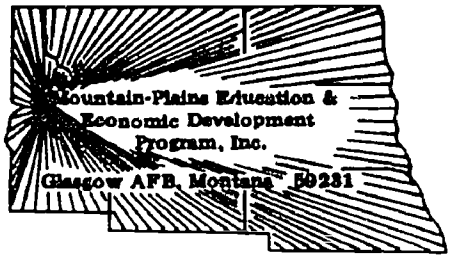
1. Obtain a text copy and secure a quiet place to study.
2. Read Chapter 17, "Engine Lubrication, Ventilation System", page 17-1 to "Diesel Oil", page 17-11.
3. Study figures 17-1 through 17-26 closely.
4. Neatly answer the chapter questions 11 through 20, on page 17-15 and 17-16 on paper.
5. When completed, give answer sheet to the instructor for evaluation.
6. Return textbook to the proper shelf.
7. Take and score the LAP test.

8

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.04.01.B1-2

Date: _____ Date Published: 8/17/76



LAP TEST: FUNDAMENTALS OF OIL PUMP

1. End clearance is measured by a straightedge and a:

   a. kruhl.
   b. dial indicator.
   c. oscilloscope.
   d. feeler gauge.

2. The part of the oil pump that prevents temporary oil loss during violent surging of the oil supply is the:

   a. screen baffle.
   b. check valve.
   c. pickup tube screen.
   d. oil pickup tube.

3. Oil resistance to flow is the definition of:

   a. friction.
   b. viscosity.
   c. splash flow.
   d. shunt flow.

*4. A spin-on filter should be tightened approximately:

   a. to 60 ft. turns.
   b. one-half turn after contacting the base.
   c. two full turns after contacting the base.
   d. only until the gasket contacts the base.

5.

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, pp. 17-15 and 17-16, #16.)

6.

7. The object of the pickup screen is:

   a. to send oil to the systems.
   b. to collect sludge.
   c. to filter the dirt from the oil.
   d. to prevent large particles from entering system.

8. When the filter in a full-flow system clogs up, the oil:

   a. is bypassed directly to the bearings.
   b. forces a hole through the filter element.
   c. is shunted into the pan.
   d. cannot reach the bearings.

9. You should drain the oil when the engine is what temperature?

   a. it doesn't matter what temperature it is.
   b. normal operating temperature.
   c. cold operating temperature.
   d. hot operating temperature.

10. The most commonly used type of oil filtration system is:

   a. splash.
   b. shunt.
   c. bypass.
   d. full-flow.

LAP TEST ANSWER KEY: FUNDAMENTALS OF OIL PUMPS

1. D
2. A
3. B
4. B
5. C
6. B
7. D
8. A
9. B
10. D

File Code: 37.08.04.02.B1-0

Date Published: 8/17/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Testing Oil Pump

OBJECTIVE:

Use the proper procedure for oil pump testing.

EVALUATION PROCEDURE:

80% correct on the LAP test to be taken after completing LAP 37.08.04.03.

RESOURCES:

Motor's Auto Repair Manual.

Automobile engine needing an oil pump test
Fender covers
Remote oil test gauge
R.P.M. meter
Tools, Basic Hand: (See Unit LEG)

PROCEDURE:

1. Place fender covers.
2. Locate and remove oil sender unit on engine. (Refer to manual if unable to locate.)
3. Using adapters, connect oil test gauge to the engine.
4. Locate in the manual the section on oil pump and pressure testing.
5. Record on the work order the manual's specifications about the amount of oil pressure and what R.P.M.'s to check.
6. Start engine and perform tests.
7. Contact the instructor to evaluate your test procedure and results.
8. Clean and return all tools and equipment
9. Clean work station area.
10. Continue to the next LAP.

Principal Author(s): J. Anderson/W. Osland

File Code: 37.08.04.03.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Replace Oil Pump

OBJECTIVE:

Following proper procedure, replace the engine oil pump.

EVALUATION PROCEDURE:

80% correct on multiple-choice test.

RESOURCES:

Motor's Auto Repair Manual.

Oil
Oil pump
Pan gasket set
Tools, Basic Hand: (See Unit LEG)

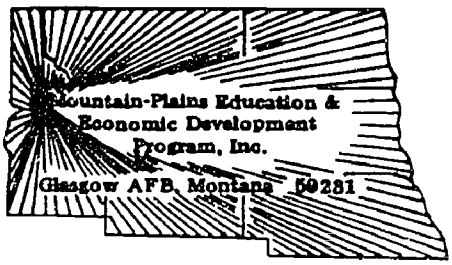
PROCEDURE:

1. Drain the engine oil.
   NOTE: The procedures for oil pan removal and oil pump replacement may be listed separately.
2. Find the procedure for oil pump replacement in the repair manual for the engine you are working on.
   NOTE: Prime the new pump with oil before installing.
3. Remove the oil pan and oil pump.
   NOTE: Test the operation of the new oil pump with a remote oil pressure gauge. (See LAP 37.08.04.02.)
4. Install the new oil pump.
5. Install the oil pan.
6. Fill the engine with oil to the correct level.
7. Ask the instructor to evaluate your work.
8. Return tools and manual to their proper places.
9. Clean your work area.
10. Take and score the LAP test.

Principal Author(s): C. Schramm/W. Osland

Student: _____ File Code: 37.08.04.02.B1-2
37.08.04.03.B1-2

Date: _____ Date Published: 3/9/76



LAP TEST: TESTING/REPLACING OIL PUMP

1. One instrument used to measure oil pump moving parts is a(n):

   a. dial indicator.
   b. rotor gear.
   c. feeler gauge.
   d. oscilloscope.

2. When you overhaul an engine, you should test an oil pump for:

   a. oil pressure.
   b. compression.
   c. torque.
   d. leaks.

3. Using adapters, you would connect the oil test gauge to the:

   a. oil sending unit.
   b. oil pickup pipe.
   c. exhaust manifold.
   d. fuel pump.

4. What other instrument do you use when you test an oil pump?

   a. hydrometer
   b. oscilloscope
   c. tachometer
   d. feeler gauge

5. To check rotor end clearance in an oil pump you would need a:

   a. straightedge.
   b. oscilloscope.
   c. dial indicator.
   d. triometer.

6. To take off the oil pan to replace the oil pump you must sometimes:

   a. disconnect the transmission.
   b. remove the vibration damper.
   c. disconnect the motor mounts.
   d. disconnect the drive shaft.

7.

8.

9. To remove an oil pump which is of the distributor gear driven type before you take off the oil pump, you must first remove the:

   a. distributor.
   b. oil pan.
   c. oil pump baffle.
   d. camshaft.

10. Oil pressure can be raised or lowered by:

   a. varying diaphragm valve spring pressure.
   b. varying relief valve spring pressure.
   c. varying vapor return valve spring pressure.
   d. varying pulsator return valve spring pressure.

LAP TEST ANSWER KEY: TESTING/REPLACING OIL PUMP

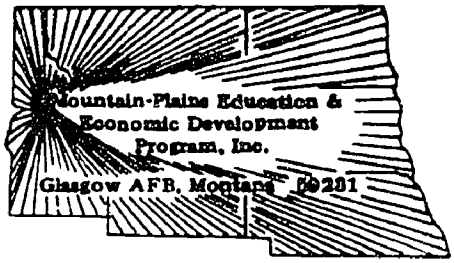
LAP

02
1. C or A
2. A
3. A
4. C
5. A

03
6. C
~~7. B~~
~~8. C~~
9. B
10. B

Student: _____ File Code: 37.08.04.00.C1-2

Date: _____ Date Published: 3/15/76



UNIT POST TEST: LUBRICATING SYSTEMS (A)

37.08.04.01.

1. When the filter in a full-flow system clogs up, the oil:

   a. cannot reach the bearings.
   b. is bypassed directly to the bearings.
   c. is shunted into the pan.
   d. forces a hole through the filter element.

*2. A spin-on filter should be tightened:

   a. one-half turn after contacting the base.
   b. two full turns after contacting the base.
   c. to 60 ft. turns.
   d. only until the gasket contacts the base.

3. The object of the pickup screen is:

   a. to send oil to the systems.
   b. to filter the dirt from the oil.
   c. to collect sludge.
   d. to prevent large particles from entering system.

4.

5. How many different classifications are there for diesel oil?

   a. 5
   b. 2
   c. 4
   d. 3

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, pp. 17-15 and 17-16, #16.)

37.08.04.02.

6. You can raise or lower oil pump pressure by:

   a. varying pulsator return valve spring pressure.
   b. varying relief valve spring pressure.
   c. varying vapor return valve spring pressure.
   d. varying diaphragm valve spring pressure.

7. Using adapters, you would connect the oil test gauge to:

   a. the oil sending unit.
   b. the oil pump.
   c. the oil pickup pipe.
   d. the exhaust manifold.

8. Badly worn bearings will cause:

   a. good engine torque.
   b. good gas mileage.
   c. low oil pressure.
   d. low water pressure.

9. One instrument used to measure oil pump moving parts is:

   a. an oscilloscope.
   b. a dial indicator.
   c. a rotor gear measuring rod.
   d. a feeler gauge.

10. To check rotor end clearance on an oil pump, you would use:

   a. an oscilloscope.
   b. a triometer.
   c. a dial indicator.
   d. a straightedge.

37.08.04.03.

11. What will happen when you take off the oil pump and gear on a distributor gear driver oil pump?

    a. your camshaft will rotate freely.
    b. timing will be thrown off.
    c. you will have to replace distributor gear.
    d. your crankshaft will rotate with little compression.

12.

13. When you overhaul an engine, you should test an oil pump for:

    a. oil pressure.
    b. torque.
    c. compression.
    d. leaks.

14. One instrument that is also used to measure oil pump moving parts is a:

    a. dial indicator.
    b. micrometer.
    c. triometer.
    d. hydrometer.

15. On some engines which of the following must be drained when the oil pump is removed:

    a. engine oil.
    b. radiator water.
    c. transmission fluid.
    d. the oil filter.

UNIT POST TEST ANSWER KEY: LUBRICATING SYSTEMS A

LAP

01 1. B
2. A
3. D
~~4. B~~
~~5. C~~

02 6. B
7. A
8. C
~~9. D~~
10. D

03 11. B
~~12. D~~
13. A
14. ~~B~~ B
15. ~~A~~ D

Mountain-Plains Education & Economic Development Program, Inc.
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UNIT POST TEST: LUBRICATING SYSTEMS (B)

37.08.04.01

1. How many different classifications are there for diesel oil?

   a. 5
   b. 2
   c. 4
   d. 3

2. The object of the pickup screen is:

   a. to send oil to the systems
   b. to filter the dirt from the oil
   c. to collect sludge
   d. to prevent large particles from entering system

3. A spin-on filter should be tightened:

   a. one-half turn after contacting the base
   b. two full turns after contacting the base
   c. to 60 ft. turns
   d. only until the gasket contacts the base

4. When the filter in a full-flow system clogs up, the oil:

   a. cannot reach the bearings
   b. is bypassed directly to the bearings
   c. is shunted into the pan
   d. forces a hole through the filter element

37.08.04.02

5. To check rotor end clearance on an oil pump, you would use:

   a. an oscilloscope
   b. a triometer
   c. a dial indicator
   d. a straightedge

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, pp. 17-15 and 17-16, #16)

37.08.04.02 cont.

6. One instrument used to measure oil pump moving parts is:

a. an oscilloscope
b. a dial indicator
c. a rotor gear measuring rod
d. a feeler guage

7. Badly worn bearings will cause:

a. good engine torque
b. good gas mileage
c. low oil pressure
d. low water pressure

8. Using adapters, you would connect the oil test gauge to:

a. the oil sending unit
b. the oil pump
c. the oil pickup pipe
d. the exhaust manifold

9. You can raise or lower oil pump pressure by:

a. varying pulsator return valve spring pressure
b. varying relief valve spring pressure
c. varying vapor return valve spring pressure
d. varying diaphragm valve spring pressure

37.08.04.03

10. On some engines which of the following must be drained when the oil pump is removed:

a. engine oil
b. radiator water
c. transmission fluid
d. the oil filter

11. One instrument that is also used to measure oil pump moving parts is a:

a. dial indicator
b. micrometer
c. triometer
d. hydrometer

12. When you overhaul an engine, you should test an oil pump for:

a. oil pressure
b. torque
c. compression
d. leaks

37.08.04.03 cont.

13. What will happen when you take off the oil pump and gear on a distributor gear driver oil pump?

    a. your camshaft will rotate freely
    b. timing will be thrown off
    c. you will have to replace distributor gear
    d. your crankshaft will rotate with little compression

UNIT POST TEST ANSWER KEY: LUBRICATING SYSTEMS (B)

1. [illegible]
2. D
3. A
4. B
5. D
6. [illegible]
7. C
8. A
9. B
10. [illegible] D
11. [illegible] B
12. A
13. B

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: LUBRICATING SYSTEMS (C)

37.08.04.01

1. The object of the pickup screen is:

   a. to send oil to the systems
   b. to filter the dirt from the oil
   c. to collect sludge
   d. to prevent large particles from entering system

2. How many different classifications are there for diesel oil?

   a. 5
   b. 2
   c. 4
   d. 3

3. When the filter in a full-flow system clogs up, the oil:

   a. cannot reach the bearings
   b. is bypassed directly to the bearings
   c. is shunted into the pan
   d. forces a hole through the filter element

4. A spin-on filter should be tightened:

   a. one-half turn after contacting the base
   b. two full turns after contacting the base
   c. to 60 ft. turns
   d. only until the gasket contacts the base

37.08.04.02

5. You can raise or lower oil pump pressure by:

   a. varying pulsator return valve spring pressure
   b. varying relief valve spring pressure
   c. varying vapor return valve spring pressure
   d. varying diaphragm valve spring pressure

6. Badly worn bearings will cause:

   a. good engine torque
   b. good gas mileage
   c. low oil pressure
   d. low water pressure

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, pp. 17-15 and 17-16, #16)

37.08.04.02

7. To check rotor end clearance on an oil pump, you would use:

a. an oscilloscope
b. a triometer
c. a dial indicator
d. a straightedge

8. One instrument used to measure oil pump moving parts is:

a. an oscilloscope
b. a dial indicator
c. a rotor/gear measuring rod
d. a feeler gauge

9. Using adapters, you would connect the oil test gauge to:

a. the oil sending unit
b. the oil pump
c. the oil pickup pipe
d. the exhaust manifold

37.08.04.03

10. What will happen when you take off the oil pump and gear on a distributor gear driver oil pump?

a. your camshaft will rotate freely
b. timing will be thrown off
c. you will have to replace distributor gear
d. your crankshaft will rotate with little compression

11. One instrument that is also used to measure oil pump moving parts is a:

a. dial indicator
b. micrometer
c. triometer
d. hydrometer

12. When you overhaul an engine, you should test an oil pump for:

a. oil pressure
b. torque
c. compression
d. leaks

13. On some engines which of the following must be drained when the oil pump is removed:

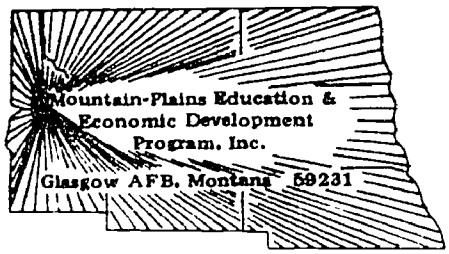
a. engine oil
b. radiator water
c. transmission fluid
d. the oil filter

UNIT POST TEST ANSWER KEY: LUBRICATING SYSTEMS (C)

1. D
2. [illegible]
3. B
4. A
5. B
6. C
7. D
8. [illegible]
9. A
10. B'
11. [illegible] B
12. A
13. [illegible] D

Student: _____ File Code: 37.08.04.00.B1-5

Date: _____ Date Published: 3/9/76



Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: LUBRICATING SYSTEMS

OBJECTIVE:

Test and replace oil pump.

TASK:

The student will be assigned a vehicle on which he must test and/or replace an oil pump.

ASSIGNMENT:

CONDITIONS:

The student may use only those materials provided for the test.

RESOURCES:

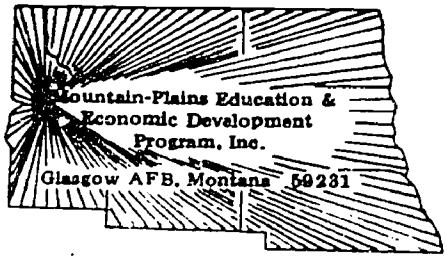
Auto needing oil pump tested.
Fender covers
Oil pressure gauge
New oil pump, if needed
Gasket set, if needed
Tachometer
Drain pan
New oil
Jack
Jack stands
Engine hoist
Repair manual
Time and parts guide

RESOURCES: (Continued)

Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: _____ File Code: 37.08.04.00.B1-5

Date: _____ Date Published: 3/9/76



Family Pay Number: _____ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION	
	Met	Not Met
Objective:		
1. Test oil pump pressure.		
Criterion: Must meet manufacturer's specifications.		
2. Replace oil pump.		
Criterion: Must pump oil when engine runs.		
3. Test pressure on new pump.		
Criterion: Must meet manufacturer's specifications.		
4. Complete test in allotted time.		
Criterion: Meet flat rate time on assigned vehicle.		
Student must satisfactorily complete 3 of 4 line items to pass test.		

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: COOLING SYSTEMS

RATIONALE:

The fundamentals and techniques in this unit will enable you to diagnose and repair the components of the cooling system.

PREREQUISITES:

None

OBJECTIVE:

Identify the components and proper operation of the cooling system.

Following correct procedure, test and repair cooling system components.

RESOURCES:

Printed Materials

Automotive Encyclopedia. Motor Services.
Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor, The Hearst Corporation, 1972 or equivalent.

Equipment

Anti-freeze
Automobile needing: cooling system inspection and repair
flushing
hose inspection and replacement
thermostat
water pump inspection and replacement
Coolant
Drain pan and funnel
Fender covers
Flush gun and water source
Pressure test
Replacement parts as needed
Source of heat
Squeegee
Thermometer
Thermostat and gasket

Principal Author(s): C. Schramm/W. Osland

Resources: Equipment: Continued

Tools, Basic Hand:
- Chisel and Punch Set
  - 5/32" Pin Punch
  - 3/16" Solid
- Gauge, feeler (.002" - .025")
- Hammer, ball peen
- Hammer, plastic tip
- Handle, speed
- Hex Key Set
- Pliers, diagonal cutting
- Pliers, needle nose
- Scraper, gasket
- Screwdriver, standard (set)
- Screwdriver, Phillips (set)
- Screw starter
- Socket Set (3/8" drive)
  - extension (3")
  - ratchet
- Socket Set (1/4" drive)
  - extension (3")
  - handle (6" flex)
  - ratchet
- Socket, spark plug
  - extension (6")
- Wrench, combination (set)
- Wrench, combination ignition (set)

Water
Water pump and gasket
Wire

GENERAL INSTRUCTIONS:

This unit consists of eight Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) In this Unit, there are some LAPs that have tests combined with other LAP tests. These combined tests are taken after completing the last LAP covered by the test.
(9) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(10) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of Cooling Systems
.02 Fundamentals of Air Cooled Engines
.03 Inspecting and Changing Hoses
.04 Inspecting Water Pump
.05 Replacing Water Pump
.06 Replacing Thermostat
.07 Thermostat Test
.08 Flush Block and Radiator

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of tne pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

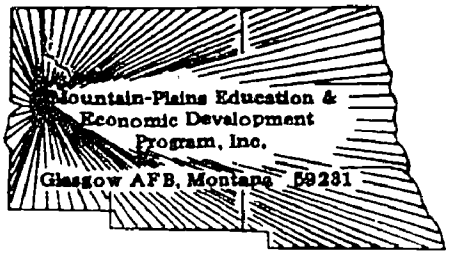
1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: _____ File Code: 37.08.05.00.B1-2

Date: _____ Date Published: 3/15/76



UNIT PRETEST: COOLING SYSTEMS

37.08.05.01.

* 1. When pressure testing the cooling systems, limit the maximum pressure to that stamped on the:

a. pressure cap.
b. radiator.
c. engine block.
d. heater hose.

2. In a pressurized cooling system, you should always use what type of a radiator cap?

a. aluminum.
b. pressurized cap.
c. non-pressurized cap.
d. 30 lbs regular cap.

* 3. During the cooling system cleaning process, the heater control should be set to what position?

a. medium.
b. off.
c. four.
d. maximum.

4. You should never use what type of a hose between the radiator and the engine?

a. soft.
b. flexible.
c. accordion.
d. rigid.

5. Ethylene glycol antifreeze is considered:

a. more expensive.
b. poisonous.
c. not to evaporate easily.
d. extremely good when using a 180 degree or higher thermostat.

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, pp. 19-19 and 19-20 &c 1 5 7 13 14 21 26 28 31)

37.08.05.02.

*6. How can an air-cooled engine, with the cooling system in good working order, become overheated?

a. by lugging of engine.
b. by too high an engine operation.
c. by pulling too much weight.
d. by operating on too hot a day.

7. What can be done to prevent overheating in an air-cooled engine?

a. don't drive too hard on a hot day.
b. drive slowly.
c. lug down engine.
d. keep rpm up fairly high.

8. One reason why an air-cooled engine might make more noise than a comparable water cooled engine is:

a. they have no water jackets.
b. operating clearance parts are too close together.
c. they haven't as many cylinders as a water cooled engines.
d. they don't have an exhaust system comparable to a water cooled engine.

9. Cooling failure of most air-cooled engines is due to:

a. improper operation.
b. high speed operation.
c. low gear operation.
d. too great a clearance in moving parts.

10. Air movement over the engine fins at an idle is created by:

a. outside air hitting it.
b. the fan.
c. movement of vehicle.
d. wind blowing through fins.

* (From Automotive Encyclopedia, Motor Services, 1970, p. 113, #s 18 and 19.)

37.08.05.03.

11. Deterioration in hoses is checked:

    a. with a dial indicator.
    b. with an oscilloscope.
    c. visually.
    d. with a strand tension gauge.

12. When you bend heater hoses, you check for:

    a. cracking.
    b. corrosion.
    c. rust build-up.
    d. silt build-up.

13. Air bubbles in a cooling system will tell you that:

    a. your thermostat is stuck closed.
    b. your thermostat is stuck open.
    c. your top radiator hose is loose or broken.
    d. your bottom radiator hose is loose or broken.

14. When replacing a hose, you must use the correct hose by measuring the:

    a. inside of connection on engine or radiator.
    b. outside diameter and length.
    c. inside diameter and length.
    d. length.

15. What kind of hose do you use between the radiator and the engine?

    a. it doesn't matter what kind of a hose you use.
    b. rigid type.
    c. non-accordion type.
    d. flexible type.

37.08.05.04.

16. One place you visually inspect a water pump for leaks is the:

a. drive hub.
b. head.
c. impeller.
d. seal drain hole.

17. Another place you check visually on a water pump for leaks is the:

a. gasket area.
b. drive hub.
c. impeller.
d. drive assembly shaft.

18. To check bearing roughness, you:

a. use a strand tension gauge.
b. blow water through the pump and listen for sound.
c. must take it apart.
d. spin the shaft.

19. Before inspecting the inside of a water pump, you should measure:

a. the size of the shaft and bearings.
b. the coolant temperature.
c. the clearance between impeller and housing.
d. the diameter of the hub.

20. The one part you do not soak in cleaning solvent on a water pump is the:

a. hub.
b. impeller.
c. pump housing.
d. shaft and bearings.

37.08.05.05.

21. Water pumps are easily :cked by:

a. too large a fan.
b. careless tightening.
c. impeller clearance too close together.
d. impeller clearance too far apart.

22. Pulley misalignment when installing a water pump may cause:

a. rapid belt wear.
b. shaft bending.
c. impeller wear.
d. fan malfunction.

23. To remove a water pump you need to:

a. remove the thermostat.
b. drain the coolant system.
c. remove the radiator.
d. flush the coolant system.

24. For water pump gaskets and mating surfaces, heavy application of what compound is recommended?

a. rubber cement.
b. plastic cement
c. permatex
d. cleaning solvent

25. The most common type of water pump used for replacement purposes is the:

a. thermostat type.
b. rotor type.
c. belt type.
d. impeller type.

37.08.05.06.

26. To replace the thermostat you need to drain the cooling system:

    a. just the radiator.
    b. completely.
    c. below the level of thermostat housing.
    d. just the engine block.

27. When removing a thermostat, you should also check:

    a. radiator inlet.
    b. the water level compared to the antifreeze level.
    c. radiator outlet.
    d. system for rust, sludge, etc.

28. To install a thermostat, the pellet or bellows must:

    a. have an opening reading of above 180 degree F.
    b. face radiator coolant.
    c. not be placed where its pellet hits the hottest coolant.
    d. face engine block coolant.

29. When replacing a thermostat, it is important that you also replace the:

    a. radiator cap.
    b. gasket.
    c. coolant.
    d. inlet hose.

30. When replacing a thermostat and putting in coolant, you should have:

    a. the car running.
    b. the car stopped.
    c. just water in system.
    d. just added antifreeze to system.

37.08.05.07.

31. The thermostat on some engines can cause overheating by:

a. failing to open.
b. sticking in open position.
c. sticking part way open.
d. driving too hard on a hot day.

32. In a pressurized system, what kind of a thermostat do you use?

a. pellet type
b. bellows type
c. base type
d. curve type

33.

34. When testing a thermostat, it must not:

a. be placed upside down.
b. work at all.
c. touch container sides or bottom.
d. be over heated above what is stamped on thermostat.

35. A good thermostat valve should:

a. be completely open, away from the seat.
b. have a 1/16 opening between seat and valve.
c. have a 1/32 opening between seat and valve.
d. contact seal snugly.

37.08.05.08.

36. "Reverse flushing" is defined as:

a. flushing system in reverse of normal flow.
b. flushing system in some course of flow.
c. using back pressure in engine to flush.
d. using air pressure of 10 lbs to flush.

37. When flushing a system, you should have the heater control set on:

a. medium.
b. low.
c. off.
d. maximum.

38. The maximum air pressure used in flushing a system is:

a. 20 lbs.
b. 40 lbs.
c. 60 lbs.
d. 10 lbs.

39. At what temperature should the engine be when flushing?

a. hot
b. warmed
c. cold
d. it doesn't matter.

40. After flushing a coolant system, you should:

a. do a pressure test.
b. replace with a new thermostat.
c. replace with new hoses.
d. replace with a new radiator cap.

UNIT PRETEST ANSWER KEY: COOLING SYSTEMS

LAP .01

1. a
2. b
3. d
4. d
5. d

LAP .02

6. a
7. d
8. a
9. a
10. b

LAP .03

11. c
12. a
13. d
14. c
15. d

LAP .04

16. d
17. a
18. d
19. c
20. d

LAP .05

21. b
22. a
23. b
24. c
25. d

LAP .06

26. c
27. d
28. d
29. b
30. a

LAP .07

31. a
32. a
33. d
34. c
35. d

LAP .08

36. a
37. d
38. a
39. b
40. a

File Code: 37.08.05.01.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of Cooling System

OBJECTIVE:

Identify the components and describe the proper operation of the cooling system.

EVALUATION PROCEDURE:

Score 80% correct on the written test.

RESOURCES:

Auto Service and Repair, Stockel.

PROCEDURE:

1. Obtain a text copy and secure a quiet place to study.
2. Read Chapter 19, "Cooling System Service", pp. 19-1 to 19-19.
3. Study the figures 19-1 through 19-40 closely.
4. Neatly answer on a separate piece of paper the test questions on pages 19-19 and 19-20. No. 1 through 34.
5. When completed, give test answer sheet to the instructor for evaluation.
6. Return textbook to the proper shelf.
7. Obtain a copy of the LAP test. Answer all of the questions and return the test to the instructor for evaluation.
8. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.05.01.B1-2

Date: _____ Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: FUNDAMENTALS OF COOLING SYSTEMS

*1. During the cooling system cleaning process, the heater control should be set to what position?

a. low
b. maximum
c. off
d. medium

*2. The extent of radiator clogging can best be checked by:

a. looking in the filler cap.
b. draining and checking coolant color.
c. flow testing.
d. reverse flushing.

3. When flushing a heating system, you must:

a. never reverse flush.
b. never use air pressure.
c. never flush in the normal direction of flow.
d. have an air pressure above 25 lbs.

*4. Completely removing a pressure cap when an engine is hot can cause:

a. a cracked block.
b. a sudden, violent flash of steam.
c. warped heads.
d. a bulged radiator.

*5. What type of antifreeze is referred to as permanent antifreeze?

a. wood alcohol
b. denatured alcohol
c. methyl alcohol
d. ethylene glycol

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, pp. 19-19 and 19-20, #s 1, 6, 7, 13, 14, 21, 26, 28, 31.)

*6. When an alcohol base antifreeze is used, the thermostat temperature rating should not exceed:

a. 160 F.
b. 190 F.
c. 180 F.
d. 140 F.

*7. When pressure testing the cooling system, limit the maximum pressure to that stamped on the:

a. radiator.
b. engine block.
c. pressure cap.
d. heater hose.

*8. Before working on fans, water pumps or V-belts, always disconnect the:

a. coil wire.
b. alternator.
c. ignition switch.
d. battery.

*9. Cooling systems must be protected from rust and corrosion by:

a. checking water level.
b. back flushing.
c. using antifreeze.
d. changing water regularly.

*10. In a pressurized cooling system, you should always use what type of radiator cap?

a. non-pressurized cap.
b. aluminum.
c. 30 lbs. regular cap.
d. pressurized cap.

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, pp. 19-19 and 19-20, #s 1, 6, 7, 13, 14, 21, 26, 28, 31.)

LAP TEST ANSWER KEY: FUNDAMENTALS OF COOLING SYSTEMS

1. B
2. C
3. A
4. B
5. D
6. A
7. C
8. D
9. C
10. D

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Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Fundamentals of Air-Cooled Engines

OBJECTIVE:

Identify the components and the proper operation of the air-cooled engine.

EVALUATION PROCEDURE:

Score 80% correct or more on the written test.

RESOURCES:

"Automotive Encylopedia," Toboldt & Johnson.

PROCEDURE:

1. Obtain a text copy and secure a quiet place to study.
2. Read "Air-Cooled Engines" pages 119-122.
3. Study the figures 11-30 through 11-36 closely.
4. Neatly answer on separate paper test questions 18 through 22 on page 124.
5. Upon completion, give test answer sheet to the instructor for evaluation.
6. Return textbook to the proper shelf.
7. Obtain a copy of the LAP test. Answer all of the questions and return the test to the instructor for evaluation.
8. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.05.02.B1-2

Date: _____ Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

LAP TEST: FUNDAMENTALS OF AIR-COOLED ENGINES

1. Air cooling is more efficient when applied to engines which are constructed of:

   a. aluminum
   b. bronze.
   c. special steel alloys.
   d. cast iron.

2. One reason why an air-cooled engine might make more noise than a comparable water-cooled engine is:

   a. they haven't as many cylinders as water-cooled engines.
   b. they don't have an exhaust system comparable to a water-cooled engine.
   c. they have no water jackets.
   d. operating clearance parts are too close together.

3. Temperature in an air-cooled engine which has forced air circulation is controlled by:

   a. dorsal fins.
   b. air jackets.
   c. water jackets.
   d. a thermostat.

4. What can be done to prevent overheating in an air cooled engine?

   a. drive slowly.
   b. lug down engine
   c. keep rpm up fairly high
   d. don't drive too hard on a hot day.

*5. How can an air-cooled engine, with the cooling system in good working order, become overheated?

   a. too high engine operation
   b. lugging of engine
   c. pulling too much weight
   d. operating on too hot a day

* (From Automotive Encyclopedia, Motor Services, 1970, p. 113, #s 18 and 19.)

6. Air movement over the engine fins is created by:

   a. wind blowing through fins.
   b. movement of the vehicle.
   c. outside air hitting it.
   d. the fan.

7. One advantage of an air-cooled engine is:

   a. it can operate with less clearance between parts.
   b. it doesn't have water to overheat under any operating conditions.
   c. it doesn't heat up as fast as water cooled engines do.
   d. it doesn't make as much noise.

~~8.~~ In an air-cooled engine, how much of the total volume of cooling air is usually directed to the cylinders?

   a. 40%
   b. 20%
   c. 60%
   d. 80%

*9. In an air cooled engine, how much of the total volume of cooling air is usually directed to the cylinder heads?

   a. 60%
   b. 80%
   c. 50%
   d. 40%

10. Cooling failure of most air-cooled engines is due to:

   a. too great a clearance in moving parts.
   b. high speed operation.
   c. low gear operation.
   d. improper operation.

* (From Automotive Encyclopedia, Motor Services, 1970, p. 113, #s 18 and 19.)

LAP TEST ANSWER KEY: FUNDAMENTALS OF AIR-COOLED ENGINES

1. A
2. C
3. D
4. C
5. B
6. D
7. B
8. ~~A~~
9. ~~A~~
10. D

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Inspecting and Changing Hoses

OBJECTIVE:

Following proper procedure, inspect and change cooling system hoses.

EVALUATION PROCEDURE:

80% correct on LAP written test.

RESOURCES:

Automobile needing hose inspection and hose change
Drain pan and funnel
Fender covers
Hoses as needed
Hose clamps as needed
Squeegee
Tools, Basic Hand: (See Unit LEG)

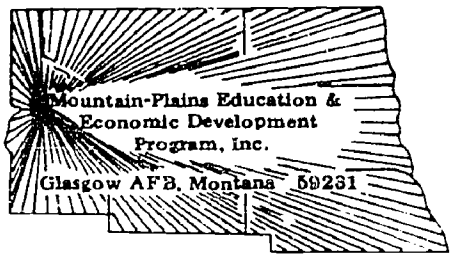
PROCEDURE:

1. Place fender covers.
2. Check all hoses for: a. Hardness, b. Cracking, c. Small leaks, d. Bottom radiator hose for excessive softness which may collapse causing restrictions, e. Looseness at joints, f. Wear due to rubbing.
3. If a hose needs to be replaced, drain the coolant into a drain pan.
4. Remove and replace the defective hose with the new hose.
   NOTE: Sometimes the factory hose clamps are unsatisfactory and must be replaced with new hose clamps to seal the connection.
5. Close the drain pet cock and refill the cooling system.
6. Run the engine until it reaches operating temperature and watch for leaks.
7. Check coolant level at operating temperature. Contact instructor for evaluation.
8. Clean and return all equipment.
9. Clean work station area.
10. Squeegee water on floor into drain.
11. Take and score the LAP test.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.05.03.B1-2

Date: _____ Date Published: 3/9/76



LAP TEST: INSPECTING AND CHANGING HOSES

37.08.05.03

1. Air bubbles in a cooling system will tell you that:

   a. your bottom radiator hose is loose or broken.
   b. your thermostat is stuck closed.
   c. your thermostat is stuck open.
   d. your top radiator hose is loose or broken.

2. The bottom radiator hose is under:

   a. vacuum.
   b. air pressure.
   c. water pressure.
   d. less heat than top hose.

3. Deterioration in hoses is checked by:

   a. a dial indicator.
   b. a strand tension gauge.
   c. an oscilloscope.
   d. visual inspection.

4. When you bend heater hoses, you check for:

   a. silt build-up.
   b. corrosion.
   c. cracking.
   d. rust build-up.

5. When replacing a hose, you obtain the correct measurement from the:

   a. inside diameter and length.
   b. outside diameter and length.
   c. the part the hose is to be connected to.
   d. it depends on which hose you're changing.

LAP TEST ANSWER KEY: INSPECTING AND CHANGING HOSES

1. a
2. a
3. d
4. c
5. a

File Code: 37.08.05.04.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Inspecting Water Pump

OBJECTIVE:

Following correct procedure, inspect water pumps.

EVALUATION PROCEDURE:

80% correct on LAP written test to be taken after LAP 37.08.05.05.

RESOURCES:

Automobile needing water pump inspection
Fender covers
Tools, Basic Hand: (See Unit LEG)

PROCEDURE:

1. Place fender covers.
2. Inspect the water pump gasket for signs of leakage.
3. Inspect the pump seal drain hole at the bottom side of the pump for signs of leakage.
4. Loosen and remove the fan belt.
5. Grab hold of the fan blade and attempt to move the pump shaft from side to side. There should be little or no play at all in the shaft or shaft bearing.
6. Spin the pump shaft and listen for bearing noise. There should be no bearing noise.
7. If any leakage or bearing noise exists, the pump should be replaced.
   NOTE: See LAP 37.08.05.05.B1-0, "Replacing Water Pump".
8. Ask the instructor to evaluate your work.
9. Re-install the fan belt and tighten properly.
10. Clean and return all tools and equipment.
11. Clean work station area.
12. Proceed to next LAP.

Principal Author(s): J. Anderson/W. Osland

File Code: 37.08.05.05.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Replacing Water Pump

OBJECTIVE:

Following correct procedure, replace water pumps.

EVALUATION PROCEDURE:

80% correct on LAP multiple-choice test.

RESOURCES:

Motor's Auto Repair Manual.

Automobile needing water pump relacement
Drain pan
Fender covers
Water pump and gasket
Tools, Basic Hand: (See Unit LEG)

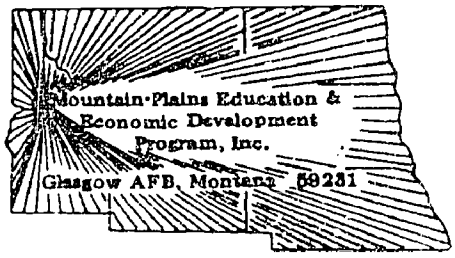
PROCEDURE:

1. Place fender covers.
2. Drain coolant into pan.
3. Refer to the manual's section of water pump removal and replacement procedure.
4. Follow the procedure for removal and replacement.
5. After replacement fill the system with the coolant to the correct level. Use the recommended refill procedure.
6. Run engine up to operating temperature while watching closely for any possible leaks.
7. Inspect coolant level at operating temperature.
8. Ask the instructor to evaluate your work.
9. Clean and return all tools and equipment.
10. Clean work station area.
11. Take and score the LAP test.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.05.04.B1-2
37.08.05.05.B1-2

Date: _____ Date Published: 3/9/76



LAP TEST: INSPECTING/REPLACING WATER PUMP

37.08.05.04.

1. One place you check visually on a water pump for leaks is the:

   a. gasket area.
   b. impeller.
   c. drive assemble shaft.
   d. drive hub.

2. One place you usually inspect a water pump for leaks is the:

   a. seal drain hole.
   b. impeller.
   c. drive hub.
   d. head.

3. To remove the hub you need to:

   a. tap it off.
   b. press it off.
   c. first remove bearing assembly shaft.
   d. screw it off.

4. How much up and down play should there be in the drive hub?

   a. 1/16 in.
   b. 1/4 in.
   c. little or none.
   d. 1/18 in.

5. Before inspecting the inside of water pump, you should measure:

   a. the coolant temperature.
   b. the size of the shaft and bearings.
   c. the size of the diameter of the hub.
   d. the clearance between impeller and housing.

37.08.05.05.

6. To check bearing roughness you:

   a. must take it apart.
   b. blow water through pump and listen for sound.
   c. spin the shaft.
   d. use a strand tension gauge.

7. The most common water pump used for replacement is the:

   a. belt type.
   b. rotor type.
   c. impeller type.
   d. thermostat type.

8. Water pumps are easily cracked by:

   a. impeller clearance too far apart.
   b. impeller clearance too close together.
   c. careless tightening.
   d. too large a fan.

9. To remove a water pump you need to:

   a. remove the radiator.
   b. drain coolant system.
   c. remove the thermostat.
   d. flush coolant system.

10. Pulley misalignment when installing a water pump may cause:

   a. impeller wear.
   b. fan malfunction.
   c. shaft bending.
   d. rapid belt wear.

LAP TEST ANSWER KEY: INSPECTING/REPLACING WATER PUMPS

LAP

07
1. A
2. A
3. B
4. C
5. D

08
6. C
7. C
8. C
9. B
10. D

File Code: 37.08.05.06.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Replacing Thermostat

OBJECTIVE:

Following correct procedure, replace a thermostat.

EVALUATION PROCEDURE:

80% correct on LAP test.

RESOURCES:

Motor's Auto Repair Manual.

Automobile needing new thermostat
Coolant
Drain pan and funnel
Fender covers
Thermostat gasket
Tools, Basic Hand: (See Unit LEG)

PROCEDURE:

1. Place fender covers over fenders.
2. Drain coolant into drain pan down below level of thermostat housing.
3. Obtain the correct repair manual and locate the thermostat removal and replacement section.
4. Follow the removal procedure to remove thermostat.
5. Clean mating surfaces of the housing thoroughly.
6. Install the thermostat and new gasket.
   NOTE: Be sure of which position the thermostat should fit.
7. Follow the installation procedure to replace everything.
8. Fill the cooling system with coolant.
   NOTE: To properly remove entrapped air within the engine, disconnect one of the heat hoses to allow air to escape. Reconnect hose when coolant appears.
9. Start engine and watch temperature to be sure thermostat is functioning properly. Check coolant level.
10. Ask the instructor to evaluate your work.
11. Clean and return all tools and equipment.
12. Take and score the LAP test.
13. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

File Code: 37.08.05.07.B1-0

Date Published: 3/9/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Thermostat Test

OBJECTIVE:

Following correct procedure, test the thermostat.

EVALUATION PROCEDURE:

80% correct on LAP test.

RESOURCES:

Container of Water
Source of Heat
Thermometer
Thermostat
Wire

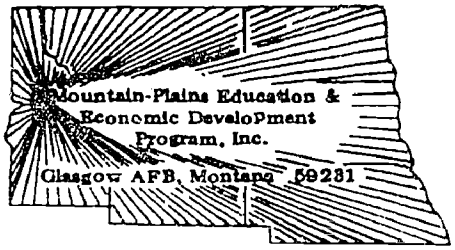
PROCEDURE:

1. Clean and locate temperature rating on edge of thermostat. Record on work order.
2. Place container of water (enough water to submerge thermostat) over a source of heat.
3. With wire, suspend thermostat in the water completely without touching the container.
4. Suspend thermostat in the water to easily read the temperature of the heating water.
5. Watch the thermometer and thermostat. The thermostat should open when the thermometer reads the rated temperature.
6. If the thermostat fails to open at the rated temperature, it should be replaced.
7. Ask the instructor to evaluate your work.
8. Clean and return all tools and equipment.
9. Clean work area.
10. Proceed to next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: _____ File Code: 37.08.05.06.B1-2
37.08.05.07.B1-2

Date: _____ Date Published: 3/9/76



LAP TEST: THERMOSTAT TEST/REPLACING THERMOSTAT

37.08.05.07.

1. In a pressurized system what kind of a thermostat do you use?

   a. bellows type
   b. base type
   c. pellet type
   d. curve type

2. To do an accurate test on a thermostat you need a:

   a. thermometer.
   b. hydrometer.
   c. dial indicator.
   d. flow tester.

3. In a non-pressurized system what kind of a thermostat do you use?

   a. bellows type
   b. base type
   c. curve type
   d. pellet type

4. A good thermostat valve should:

   a. contact seat snugly.
   b. be completely open, away from the seat.
   c. have a 1/32 opening between seat and valve.
   d. have a 1/10 opening between seat and valve.

5. You inspect the thermostat valve by:

   a. using a pressure tester.
   b. boiling it.
   c. looking at it.
   d. putting it over an open flame.

37.08.05.06.

6. The thermostat on some engines can cause overheating by:

   a. failing to open.
   b. sticking in open position.
   c. driving too hard on a hot day.
   d. sticking part way open.

7. When replacing a thermostat, it is important that you also replace the:

   a. inlet hose.
   b. radiator cap.
   c. gasket.
   d. coolant.

8. When replacing a thermostat and putting in coolant, you should have:

   a. the car stopped.
   b. just water in system.
   c. just add antifreeze.
   d. the car running.

9. To install a thermostat, the pellet or bellows must:

   a. have an opening reading of above 180 F.
   b. face engine block coolant.
   c. not be placed where its pellet hits the hottest coolant.
   d. face radiator coolant.

10. When replacing a thermostat, how far should you drain the cooling system?

   a. below the level of the thermostat housing
   b. completely
   c. until the radiator is empty
   d. until both the block and radiator are empty

LAP TEST ANSWER KEY: THERMOSTAT TEST/REPLACING THERMOSTAT

LAP

03	1.	C
	2.	A
	3.	A
	4.	A
	5.	C
04	6.	A
	7.	C
	8.	D
	9.	B
	10.	A

File Code: 37.08.05.08.B1-0

Date Published: 8/17/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Flush Block and Radiator

OBJECTIVE:

Following correct procedure, perform a block and radiator flush.

EVALUATION PROCEDURE:

80% correct on LAP written test.

RESOURCES:

Automobile needing flushing
Anti-freeze
Fender covers
Flushing equipment
Tools, Basic Hand: (See Unit LEG)

PROCEDURE:

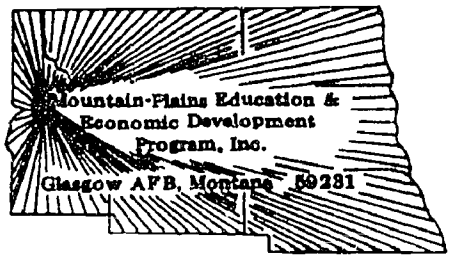
1. Park the vehicle over a floor drainage area.
2. Place fender covers over fenders.
3. Drain radiator through pet cock drain.
4. Disconnect the following hoses: a. Bottom radiator hose at radiator, b. Top radiator hose at radiator, c. Both heater hoses at fire wall.
5. With the flush gun equipped with the proper adapter, flush the system through all the disconnected openings until clear flush water appears.
6. Reverse the direction of the flushing through disconnected openings.
7. When you are positive that the system is clear, demonstrate to the instructor that the flushing water is coming through clear for evaluation.
8. When the flushing water has drained out, reconnect all hoses except one of the heater hoses.
   NOTE: Entrapped air in the engine can easily escape through the open heater hose as the block is filled with new coolant.
9. Fill the cooling system with new anti-freeze as recommended until the coolant appears at the disconnected heater hose.

Principal Author(s): J. Anderson/W. Osland

10. Reconnect heater hose and fill the radiator to the required level. (See manual for required level.)
11. Start engine and let idle until engine reaches operating temperature. Check coolant level. (Use caution when removing radiator cap.)
12. Ask the instructor to evaluate your completed work.
13. Clean and return all equipment.
14. Take LAP test.

Student: _____ File Code: 37.08.05.08.B1-2

Date: _____ Date Published: 3/3/76



LAP TEST: FLUSH BLOCK AND RADIATOR

1. When flushing the block on some cars you need to remove the water pump because:

   a. you need to hook flushing system there.
   b. it restricts flow.
   c. it collects rust particles.
   d. the pressure can ruin the seal.

2. After flushing a cooling system, you should:

   a. replace with new hoses.
   b. replace with a new thermostat.
   c. do a pressure test.
   d. replace with a new radiator cap.

3. At what temperature should the engine be when flushing?

   a. hot
   b. cold
   c. it doesn't matter
   d. normal

4. When flushing a system, you should have the heater control set on:

   a. off.
   b. low.
   c. maximum.
   d. medium.

5. "Reversed flushing" is defined as:

   a. using back pressure in engine to flush.
   b. flushing system in same course of flow.
   c. using air pressure of 40 lbs to flush.
   d. flushing system in reverse of normal flow.

LAP TEST ANSWER KEY: FLUSH BLOCK AND RADIATOR

1. d
2. c
3. ~~c~~ D
4. c
5. d

UNIT POST TEST ANSWER KEY: COOLING SYSTEMS

LAP .01

1. a
2. b
3. b
4. c
5. a

LAP .02

~~6. d~~
7. b
8. b
~~9. d~~
10. d

LAP .03

11. a
12. d
13. d
14. c
15. b

LAP .04

16. a
17. c
18. c
19. b
20. d

LAP .05

21. b
22. a
23. b
24. c
25. d

LAP .06

26. c
27. d
28. d
29. b
30. a

LAP .07

31. c
32. c
~~33. d~~
34. b
35. b

LAP .08

36. a
37. d
38. b
39. b
40. a

Student: _____ File Code: 37.08.05.00.E1-2

Date: _____ Date Published: 3/15/76

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: COOLING SYSTEMS

37.08.05.01.

*1. Cooling systems must be protected from rust and corrosion by using:

a. antifreeze.
b. back flushing.
c. checking water level.
d. changing water regularly.

2. Scale deposits can be minimized by using:

a. tap water.
b. soft water.
c. lime water base.
d. mineral concentrate water.

*3. When an alcohol-base antifreeze is used, the thermostat temperature rating should not exceed:

a. 180 degrees F.
b. 160 degrees F.
c. 140 degrees F.
d. 190 degrees F.

*4. The extent of radiator clogging can best be checked by:

a. looking in the filter cap.
b. draining and checking coolant color.
c. flow testing.
d. reverse flushing.

5. When reverse flushing a radiator, the maximum air pressure you can use is:

a. 20 lbs.
b. 25 lbs.
c. 50 lbs.
d. 30 lbs.

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, pp. 19-19 and 19-20, #s 1, 6, 7, 13, 14, 21, 26, 28, 31.)

37.08.05.02.

*6. In an air-cooled engine, how much of the total volume of cooling air is usually directed to the cylinder heads?

a. 80%
b. 40%
c. 50%
d. 60%

7. One advantage of an air-cooled engine is:

a. it doesn't make as much noise.
b. it doesn't have water to overheat under any operating condition.
c. it doesn't heat up as fast as water-cooled engines do.
d. it can operate with less clearance between parts than a water-cooled engine does.

8. Temperature in an air-cooled engine which have forced air circulation is controlled by a:

a. dorsal fins.
b. thermostat.
c. water jackets.
d. air jackets.

9. In an air-cooled engine, how much of the total volume of cooling air is usually directed to the cylinders?

a. 20%
b. 60%
c. 80%
d. 40%

10. Air cooling is more efficient when applied to engines which are constructed of:

a. bronze.
b. cast iron.
c. special steel alloys.
d. aluminum.

* (From Automotive Encyclopedia, Motor Services, 1970, p. 113, #s 18 and 19.)

37.08.05.03.

11. When you bend heater hoses, you check for:

    a. cracking.
    b. corrosion.
    c. rust build-up.
    d. silt build-up.

12. The bottom radiator hose is under a:

    a. air pressure.
    b. water pressure.
    c. less heat than top hose.
    d. vacuum.

13. Air bubbles in a cooling system will tell you that:

    a. your thermostat is stuck open.
    b. your top radiator hose is loose or broken.
    c. your thermostat is stuck closed.
    d. your bottom radiator hose is loose or broken.

14. When replacing a hose, you must use the correct hose by measuring the:

    a. inside of connection on engine or radiator.
    b. outside diameter and length.
    c. inside diameter and length.
    d. length.

15. When putting on a sealing cement, you put it on the:

    a. hose.
    b. metal hose fitting.
    c. both hose and fitting.
    d. it doesn't matter, just so you have some on.

37.08.05.04.

16. A place you check visually on a water pump for leaks is the:

a. gasket area.
b. drive hub.
c. impeller.
d. drive assembly shaft.

17. Have much up and down play should there be in the drive hub?

a. 1/8"
b. 1/16"
c. little or none.
d. 1/4"

18. Before inspecting the inside of a water pump, you should measure:

a. the size of the shaft and bearings.
b. the coolant temperature.
c. the clearance between impeller and housing.
d. the diameter of the hub.

19. To remove the hub, you need to:

a. screw it off.
b. press it off.
c. tap it off.
d. first remove bearing assembly shaft.

20. The one part you do not soak in cleaning solvent on a water pump is the:

a. hub.
b. impeller.
c. pump housing.
d. shaft and bearings.

37.08.05.05.

21. Water pumps are easily cracked by:

    a. too large a fan.
    b. careless tightening.
    c. impeller clearance too close together.
    d. impeller clearance too far apart.

22. Pulley misalignment when installing a water pump may cause:

    a. rapid belt wear.
    b. shaft bending.
    c. impeller wear.
    d. fan malfunction.

23. To remove a water pump you need to:

    a. remove the thermostat.
    b. drain the coolant.
    c. remove the radiator.
    d. flush the coolant system.

24. For water pump gaskets and mating surfaces, heavy application of what compound is recommended?

    a. rubber cement
    b. plastic cement
    c. permatex
    d. cleaning solvent

25. The most common type of water pump used for replacement purposes is the:

    a. thermostat type.
    b. rotor type.
    c. belt type.
    d. impeller type.

37.08.05.06.

26. To replace the thermostat you need to drain the cooling system:

    a. just the radiator.
    b. completely.
    c. below the level of thermsotat housing.
    d. just the engine block.

27. When removing a thermostat, you should also check:

    a. radiator inlet.
    b. the water level compared to the antifreeze level.
    c. radiator outlet.
    d. system for rust, sludge, etc.

28. To install a thermostat, the pellet or bellows must:

    a. have an opening reading of above 180 degree F.
    b. face radiator coolant.
    c. not be placed where its pellet hits the hottest coolant.
    d. face engine block coolant.

29. When replacing a thermostat, it is important that you also replace the:

    a. radiator cap.
    b. gasket.
    c. coolant.
    d. inlet hose.

30. When replacing thermostat and putting in coolant, you should have:

    a. the car running.
    b. the car stopped.
    c. just water in system.
    d. just added antifreeze to system.

37.08.05.07.

31. In a non-pressurized system what kind of a thermostat do you use?

a. base type
b. pellet type
c. bellows type
d. curve type

32. When an alcohol-base antifreeze will be used, the thermostat must have a temperature rating below:

a. 210 degrees F.
b. 180 degrees F.
c. 160 degrees F.
d. 200 degrees F.

33.

34. You inspect the thermostat valve by:

a. boiling it.
b. looking at it.
c. putting it over an open flame.
d. a pressure tester.

35. To do an accurate test on a thermostat, you need a:

a. dial indicator.
b. thermometer
c. hydrometer.
d. flow tester.

37.08.05.08.

36. "Reverse flushing" is defined as:

a. flushing system in reverse of normal flow.
b. flushing system in same course of flow.
c. using back pressure in engine to flush.
d. using air pressure of 10 lbs to flush.

37. When flushing a system, you should have the heater control set on:

a. medium.
b. low.
c. off.
d. maximum.

38. When flushing an engine, you must remove the:

a. water pump.
b. thermostat.
c. heater hoses.
d. drain plugs.

39. On some cars you need to remove the water pump because:

a. it restricts flow.
b. pressure can ruin the seal.
c. it collects rust particles.
d. you need to hook flushing system there.

40. After flushing a coolant system, you should:

a. do a pressure test.
b. replace with a new thermostat.
c. replace with a new hose.
d. replace with a new radiator.

UNIT POST TEST ANSWER KEY: COOLING SYSTEMS (A)

LAP .01

1. a
2. b
3. b
4. c
5. a

LAP .02

6. [illegible]
7. b
8. b
9. [illegible]
10. d

LAP .03

11. a
12. d
13. d
14. c
15. b

LAP .04

16. a
17. c
18. c
19. b
20. d

LAP .05

21. b
22. a
23. b
24. c
25. d

LAP .06

26. c
27. d
28. d
29. b
30. a

LAP .07

31. c
32. c
33. [illegible]
34. b
35. b

LAP .08

36. a
37. d
38. b
39. b
40. a

Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: COOLING SYSTEMS (B)

37.08.05.01

1. When reverse flushing a radiator, the maximum air pressure you can use is:

   a. 20 lbs.
   b. 25 lbs.
   c. 50 lbs.
   d. 30 lbs.

2. *The extent of radiator clogging can best be checked by:

   a. looking in the filter cap
   b. draining and checking coolant color
   c. flow testing
   d. reverse flushing

3. *When an alcohol-base antifreeze is used, the thermostat temperature rating should not exceed:

   a. 180 degrees F
   b. 160 degrees F
   c. 140 degrees F
   d. 190 degrees F

4. Scale deposits can be minimized by using:

   a. tap water
   b. back flushing
   c. checking water level
   d. changing water regularly

5. *Cooling systems must be protected from rust and corrosion by using:

   a. antifreeze
   b. back flushing
   c. checking water level
   d. changing water regularly

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, pp. 19-19 and 19-20, #s 1, 6, 7, 13, 14, 21, 26, 28, 31)

37.08.05.02

6. Air cooling is more efficient when applied to engines which are constructed of:

   a. bronze
   b. cast iron
   c. special steel alloys
   d. aluminum

~~7. In an air cooled engine, how much of the total volume of cooling air is usually directed to the cylinders?~~

~~a. 80%~~
~~b. 60%~~
~~c. 20%~~
~~d. 40%~~

8. Temperature in an air-cooled engine which have forced air circulation is controlled by a:

   a. dorsal fins
   b. thermostat
   c. water jackets
   d. air jackets

9. One advantage of an air-cooled engine is:

   a. it doesn't make as much noise
   b. it doesn't have water to overheat under any operating condition
   c. it doesn't heat up as fast as water-cooled engines do
   d. it can operate with less clearance between parts than a water-cooled engine does

~~10. In an air cooled engine, how much of the total volume of cooling air is usually directed to the cylinder heads?~~

~~a. 80%~~
~~b. 40%~~
~~c. 50%~~
~~d. 60%~~

37.08.05.03

11. When putting on a sealing cement, you put it on the:

   a. hose
   b. metal hose fitting
   c. both hose and fitting
   d. it doesn't matter, just so you have some on

* (From Automotive Encyclopedia, Motor Services, 1970, p. 113, #s 18 & 19)

37.08.05.03 cont.

12. When replacing a hose, you must use the correct hose by measuring the:

    a. inside of connection on engine or radiator
    b. outside diameter and length
    c. inside diameter and length
    d. length

13. Air bubbles in a cooling system will tell you that:

    a. your thermostat is stuck open
    b. your top radiator hose is loose or broken
    c. your thermostat is stuck closed
    d. your bottom radiator hose is loose or broken

14. The bottom radiator hose is under a:

    a. air pressure
    b. water pressure
    c. less heat than top hose
    d. vacuum

15. When you bend heater hoses, you check for:

    a. cracking
    b. corrosion
    c. rust build-up
    d. silt build-up

37.08.05.04

16. The one part you do not soak in cleaning solvent on a water pump is the:

    a. hub
    b. impeller
    c. pump housing
    d. shaft and bearings

17. To remove the hub, you need to:

    a. screw it off
    b. press it off
    c. tap it off
    d. first remove bearing assembly shaft

18. Before inspecting the inside of a water pump, you should measure:

    a. the size of the shaft and bearings
    b. the coolant temperature
    c. the clearance between impeller and housing
    d. the diameter of the hub

37.08.05.05 cont.

19. How much up and down play should there be in the drive hub?

a. 1/8"
b. 1/16"
c. Little or none
d. 1/4"

20. A place you check visually on a water pump for leaks is the:

a. gasket area
b. drive hub
c. impeller
d. drive assembly shaft

37.08.05.05

21. The most common type of water pump used for replacement purpose is the:

a. thermostat type
b. rotor type
c. belt type
d. impeller type

22. For water pump gaskets and mating surfaces, heavy application of what compound is recommended?

a. rubber cement
b. plastic cement
c. permatex
d. cleaning solvent

23. To remove a water pump you need to:

a. remove the thermostat
b. drain the coolant
c. remove the radiator
d. flush the coolant system

24. Pulley misalignment when installing a water pump may cause:

a. rapid belt wear
b. shaft bending
c. impeller wear
d. fan malfunction

25. Water pumps are easily cracked by:

a. too large a fan
b. careless tightening
c. impeller clearance too close together
d. impeller clearance too far apart

37.08.05.06

26. When replacing thermostat and putting in coolant, you should have:

a. the car running
b. the car stopped
c. just water in system
d. just added antifreeze to system

27. When replacing a thermostat, it is important that you also replace the:

a. radiator cap
b. gasket
c. coolant
d. inlet hose

28. To install a thermostat, the pellent or bellows must:

a. have an opening reading of above 180 degrees F
b. face radiator coolant
c. not be placed where its pellet hits the hottest coolant
d. face engine block coolant

29. When removing a thermostat, you should also check:

a. radiator inlet
b. the water level compared to the antifreeze level
c. radiator outlet
d. system for rust, sludge, etc.

30. To replace the thermostat you need to drain the cooling system:

a. just the radiator
b. completely
c. below the level of thermostat housing
d. just the engine block

37.08.05.07

31. To do an accurate test on a thermostat, you need a:

a. dial indicator
b. thermometer
c. hydrometer
d. flow tester

32. You inspect the thermostat valve by:

a. boiling it
b. looking at it
c. putting it over an open flame
d. a pressure tester

37.08.05.07 cont.

33. When an alcohol-base antifreeze will be used, the thermostat must have a temperature rating below:

a. 210 degrees F
b. 180 degrees F
c. 160 degrees F
d. 200 degrees F

34. In a non-pressurized system what kind of a thermostat do you use?

a. base type
b. pellet type
c. bellows type
d. curve type

37.08.05.08

35. After flushing a coolant system, you should:

a. do a pressure test
b. replace with a new thermostat
c. replace with a new hose
d. replace with a new radiator

36. On some cars you need to remove the water pump because:

a. it restricts flow
b. pressure can ruin the seal
c. it collects rust particles
d. you need to hook flushing system there

37. When flushing an engine, you must remove the:

a. water pump
b. thermostat
c. heater hoses
d. drain plugs

38. When flushing a system, you should have the heater control set on:

a. medium
b. low
c. off
d. maximum

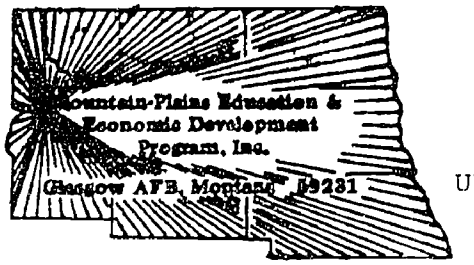
39. "Reverse flushing" is defined as:

a. flushing system in reverse of normal flow
b. flushing system in same course of flow
c. using back pressure in engine to flush
d. using air pressure of 10 lbs. to flush

UNIT POST TEST ANSWER KEY:: COOLING SYSTEMS (B)

1. A
2. C
3. B
4. B
5. A
6. D
7. ~~D~~
8. B
9. B
10. ~~D~~
11. B
12. C
13. D
14. D
15. A
16. D
17. B
18. C
19. C
20. A
21. D
22. C
23. B
24. A
25. B
26. A
27. B
28. D
29. D
30. C
31. B
32. B
33. C
34. C
35. A
36. B
37. B
38. D
39. A

Date: _____ Date Published: 5/13/77



UNIT POST TEST: COOLING SYSTEMS (C)

37.08.05.01

1. Scale deposits can be minimized by using:

   a. tap water
   b. soft water
   c. lime water base
   d. mineral concentrate water

2. When reverse flushing a radiator, the maximum air pressure you can use is:

   a. 20 lbs
   b. 25 lbs
   c. 50 lbs
   d. 30 lbs

3. *The extent of radiator clogging can best be checked by:

   a. looking in the filter cap
   b. draining and checking coolant color
   c. flow testing
   d. reverse flushing

4. *Cooling systems must be protected from rust and corrosion by using:

   a. antifreeze
   b. back flushing
   c. checking water level
   d. changing water regularly

5. *When an alcohol-base antifreeze is used, the thermostat temperature rating should not exceed:

   a. 180 degrees F
   b. 160 degrees F
   c. 140 degrees F
   d. 190 degrees F

* (From Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, pp. 19-19 and 19-20, #s 1, 6, 7, 13, 14, 21, 26, 28, 31)

37.08.05.02

6. *In an air-cooled engine, how much of the total volume of cooling air is usually directed to the cylinder heads?

a. 20%
b. 40%
c. 50%
d. 60%

7. Air cooling is more efficient when applied to engines which are constructed of:

a. bronze
b. cast iron
c. special steel alloys
d. aluminum

8. *In an air-cooled engine, how much of the total volume of cooling air is usually directed to the cylinders?

a. 20%
b. 30%
c. 80%
d. 40%

9. Temperature in an air-cooled engines which have forced air circulation is controlled by:

a. dorsal fins
b. thermostat
c. water jackets
d. air jackets

10. One advantage of an air-cooled engine is:

a. it doesn't make as much noise
b. it doesn't have water to overheat under any operating conditions
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37.08.05.03

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37.08.05.04

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37.08.05.04 cont.

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37.08.05.05

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37.08.05.06

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37.08.05.07

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37.08.05.08 cont.

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a. medium
b. low
c. off
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39. When flushing an engine, you must remove the:

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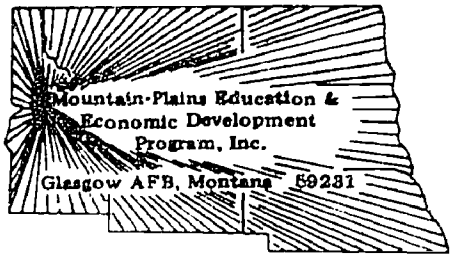
b. thermostat
c. heater hoses
d. drain plugs

UNIT POST TEST ANSWER KEY: COOLING SYSTEMS (C)

1. B
2. A
3. C
4. A
5. B
6. [illegible]
7. D
8. [illegible]
9. B
10. B
11. A
12. B
13. D
14. D
15. C
16. B
17. C
18. D
19. C
20. A
21. C
22. D
23. B
24. A
25. B
26. D
27. A
28. D
29. C
30. B
31. C
32. C
33. B
34. B
35. A
36. B
37. A
38. D
39. B

Student: _____ File Code: 37.08.05.00.B1-5

Date: _____ Date Published: 3/9/76



Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: COOLING SYSTEMS

OBJECTIVE 1:

Test temperature and circulation of cooling system.

OBJECTIVE 2:

Repair cooling system.

TASK:

The student will be assigned a vehicle on which he must test the thermostat, cooling system hoses, and water pump. He must replace any defective parts found.

ASSIGNMENT:

CONDITIONS:

The student may use only those materials provided for the test and must perform the test in the auto shop.

RESOURCES:

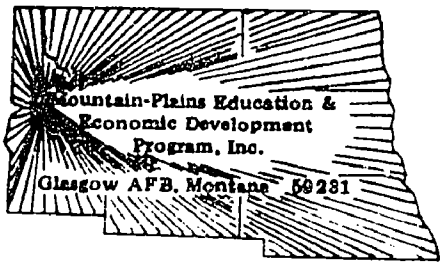
Repair manual
Time and parts manual
Auto needing cooling system repair
Thermostat, if needed
Thermometer
Water pump, if needed
Hoses, if needed
Pressure tester

RESOURCES: (Continued)

Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: _____ File C ...: 7.08.05.00.B1-5

Date: _____ Date Published: 3/9/76



Family Pay Number: _____ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION Met	Not Met
Objective 1:		
1. Inspect hoses.		
2. Check thermostat opening.		
3. Check water pump.		
Criterion: Compare to manufacturer's specifications.		
Objective 2:		
4. Replace defective hoses.		
Criterion: Must meet manufacturer's specifications.		
5. Replace thermostat.		
Criterion: Must open at specified degree.		
6. Replace water pump.		
Criterion: Must circulate water, have a smooth bearing, and not leak.		
7. Complete test in allotted time for assigned vehicle.		

(Checklist continued)

	CRITERION Met	Not Met
Criterion: Meets flat rate time on assigned vehicle.		
Student must satisfactorily complete 5 of 7 line items to		
pass test.		