Apprenticeship Manitoba

Manitoba

Automotive Service Technician
Level 1

Rev. March 2011

Apprenticeship Manitoba

Automotive Service Technician

Unit: A1 Safety and WHMIS

Level: One

Duration: 16 hours

Theory: 16 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to provide the Automotive Service Technician apprentice with the knowledge and understanding of safety-related procedures and WHMIS, along with related government policies and standards. Apprentices will also acquire basic first aid and CPR skills through the successful completion of a recognized certificate program. Note: No percentage-weightings are prescribed for the "First Aid and CPR" content and objectives (#3-7 inclusive). Assessment of the objectives and content related to "First Aid and CPR" is based on the successful completion of a recognized First Aid and CPR Certificate Program.

Objectives and Content: **Percent of Unit Mark (%)**

1. Safety, WHMIS and Government Standards **50%**

a. WHMIS legislation and regulations
- History of WHMIS
- WHMIS components
  -Evaluation of material
  -Determination of health risks
  -Monitoring of health hazards
  -Control measures
  -Prevention plans
  -Workplace record maintenance
- Components of the Health Hazard Regulation
  -Labelling
  -Material Safety Data Sheets
  -Worker training and instruction
- Duties and responsibilities of suppliers, employers and employees

b. WHMIS classes and symbols
- Class A
- Class B
- Class C
- Class F
- Product inventory: Manitoba WHIMS regulations

c. Appropriate work habits and related safety issues
- Safety boots
- Eye protection
- Face protection
- Hearing protection
- Head protection

- Masks
- Lifting techniques
- Location of safety equipment
- Long hair
- Jewelry
- Loose shirt and sleeves
- Oil soaked clothing
- Neck ties
- Horseplay

d. “Garage housekeeping” work habits and procedures
- Disposal of flammable liquids
- Dangers of exhaust fumes (ventilation)
- Electrical hazards
- Drainage and rotating devices
- Safety shields and guards
- Rag and waste disposal
- Air lines and fittings
- Interior and fender covers
- Cluttered workplace hazards
- Liquid spill hazards
- In-shop driving precautions
- Tool and equipment maintenance
- Personal grooming

e. Safety rules for using hand drills and hand grinders
- Goggles
- Materials secured
- Loose clothing, sleeves and ties, hazards
- Water hazards
- Condition of tool cords
- Power tool hazards - explosive vapors
- Unplugged when using drill chuck
- Properly grounded power equipment
- CSA approved

f. Safety rules for bench grinder and wire wheels
- Use of goggles on worksite
- Tight, clean and true abrasive stones
- Grinder at full RPM before using
- Tool rest close to wheel
- Vise-grip pliers for small objects
- Use of leather gloves for heavy grinding
- Dangers of revolving grinding wheel
- Importance of grinding wheel guard
- Hazard: grinding near explosive vapors
- New stones appropriate to grinder’s RPM
- Standing position relative to grinder

g. Fire control equipment and fire prevention procedures
- Fire extinguisher classification
- Fire blankets
- Fire classifications “A”, “B”, “C”, & “D”
- Fire extinguisher appropriate to fire class
  -Pressurized water –Class A fires
  -Soda acid- Class A fires

-Carbon dioxide ($CO_{2)}$ – Class B and C
-Dry chemical – Class B, C, and D
-Foam – Class A and B

- Potential fire hazards
- Location of fire fighting equipment
- Fire exits and observations
- Evacuation procedures
- Fire warning procedures

2. Describe government policies, procedures, guidelines and standards. 50%

a. Work-related accident reporting procedure of Workers Compensation Board (WCB)
- The Workers Compensation Act
- WCB claim procedures
- Written report: supervisor
- Examples: accident report forms

b. Legislation and regulations that govern workplace safety and health
- Workplace Safety and Health Act
- Garage keepers Act
- Information access regarding potential hazards in the workplace
- Worker participation: workplace safety conditions
- Right of refusal in dangerous working conditions
- Key definitions: safety and health laws
-"Shall"
-"May"
-"Duty"
-"Power"
-"Act"
-"Regulation"
-"Code"
-"Health"
-"Safety"
-"Welfare"
-"Discriminatory Action"

c. Material Safety Data Sheets (MSDS)
- Material Safety Data Sheets
-Definition
-Location
-Purpose
- Interpret information provided
- Storage of chemicals
- Proper labeling of containers, new and used
- Duties of suppliers, employers, employees

3. Explain the responsibilities and duties of the first aid person. n/a

a. Explain the diagnoses for
- Respiratory failure
- Burns
- Body injury

4. Explain artificial respiration. n/a

a. Explain the process of freeing the victim of breathing restrictions

b. Explain the process of applying mouth-to-mouth respiration

5. Explain emergency treatment. **n/a**

a. Describe the procedure for
   - Assessing injury
   - Moving the patient
   - Arresting bleeding
   - Completing Workers' Compensation Board forms

6. Explain the procedure for treating burns. **n/a**

a. Explain the methods of quenching firm on a victim
b. Explain treating various burns

7. Explain and demonstrate basic rescuer CPR. **n/a**

a. Explain what cardiovascular disease is and how it kills
b. Explain how to recognize cardiovascular emergencies (severe angina, heart attack, cardiac arrest, etc.) and choking by their signs and symptoms
c. Demonstrate how to respond effectively to cardiovascular and choking emergencies

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Apprenticeship Manitoba

Automotive Service Technician

Unit: A2 Tools, Shop Equipment and Fasteners

Level: One

Duration: 33 hours

Theory: 16 hours

Practical: 17 hours

Overview:

This unit of instruction is designed to provide the Automotive Service Technician apprentice with the knowledge and hands-on skills required to effectively use shop tools, equipment and fasteners.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe and use measuring tools.	**61%**
a. General purpose • Non-precision measuring • Precision measuring • History, purpose, function, types, styles, and application • Metric and imperial measurements and conversions • Tool maintenance	
b. Tool construction, selection and reading • Steel ruler • Outside and inside micrometers • Depth micrometer • Vernier caliper • Dial indicator • Torque wrench • Torque angle wrench • Hole gauge • Telescoping gauge • Feeler gauge • Valve seat runout gauge • Cylinder bore dial gauge • Pressure gauge • Vacuum gauge • Plastigauge	
2. Describe basic hand tools.	**10%**
a. Hammers • Ball peen • Brass	

- Soft faced
- Dead blow
- Rubber mallet
- Cross peen
- Sledge

b. Screwdrivers
- Standard
- Phillips
- Reed and Prince
- Robertson
- Speciality (Torx, Posidrive)

c. Socket handles
- Ratchet handle
- Flex handle
- Speed handle
- Extension

d. Sockets
- Deep
- Shallow
- 6 point
- 12 point
- 8 point
- Impact
- Flex
- Spark plug
- Screwdriver attachments (Hex driver, Phillips drive, flat tip drive, clutch, Torx, three-wing, double square).
- Types of drives (¼", 3/8", ½", ¾")

e. Wrenches
- Open end
- Box-end
- Combination
- Adjustable
- Allen
- Off-set
- Flare nut

f. Pliers
- Combination (slip joint)
- Adjustable (channel lock)
- Needle nose
- Locking (vise grip)
- Diagonal cutting
- Snap ring

g. Punches
- Center
- Starting
- Pin punch
- Aligning
- Drift – (straight shank brass)

h. Cutting tools
- Chisel (rivet buster, diamond, round nose cape, cape, cold, flat)

- Taps (taper, plug, bottoming, machine screw)
- Dies
- Hacksaw
- Jab saw
- Twist drills
- Files
- Reamers
- Countersinks

i. General shop tools
- Stud removers
- Tubing tools (flaring tool)
- Gear and bearing pullers
- Thread file (thread chaser)
- Impact wrenches
- Ratchet wrench
- Vice
- Battery strap
- Drill press
- Hydraulic press
- Battery service tool
- Cooling system service tools
- Grinders
- Drills
- Air chisel
- Die grinders

3. Describe fasteners and sealing devices. 10%

a. Effects of electric current on the human body
- Bolt
- Stud
- Machine screw
- Wing nut
- Prevailing torque
- Speed nut
- Self locking nuts
- Palnut
- Cap screw
- Castle nut
- Plain hex nut
- Set screw
- Sheet metal
- Pop rivet
- Cotter pin
- Key
- Roll pin
- Snap rings (internal and external)
- Locking devices
  -Split lock
  -Tooth lock
  -Locking nuts (soft collar, slotted and pinched, distorted threaded palnut)
  -Lock plate
  -Safety wire

b. Principles and precautions in selecting bolts and screws
c. Bolt and screw terminology
   - Pitch
   - Minor diameter
   - Major diameter
   - Thread length
   - Screw length
   - Threads per inch
   - Head size
   - Root
   - Crest
   - Flank
   - Size
   - UNC
   - UNF
   - NPT
   - Metric
d. Hardware descriptions
   - E.g. ½ * 3 13 UNC 2A 10 32 2
   - Imperial (head, grade marking, length, thread pitch, nominal diameter)
   - Metric (head, property class, length, thread pitch, nominal diameter)
   - UNC and UNF threads
e. Removing and installing fasteners
   - Torque principles
     -Elasticity
     -Elastic limit
     -Yield
     -Torque to yield bolts
     -Hooke's Law
     -Tensile strength
     -Residual tension
     -Torque
     -Tension
     -Distortion
     -Compression
     -Cold flow
     -High pressure lubricant
   - Torque charts (imperial and metric)
     -Standard bolt and nut torque specifications
     -Metric bolt and nut torque specifications
     -Standard nut and bolt strength marking
     -Metric nut and bolt strength marking
     -Need for lubricating all head bolts
   - Use of torque wrench
     -Types
     -Choosing a torque wrench
     -Effects of adapter use
     -Torque wrench calibration
     -Recommended torque sequence
   - Precautions for bolts
     -Visual inspection
     -Tighten to recommended torque
     -Head tight against surface
     -Appropriate length and size
f. Safe use, operation and maintenance of threads
   - Taps and dies uses

- Broken tap removal
- External thread chasers
- Common tapping problems
- Thread repair
  -Tap to oversize
  -Heli-coil and keensert
- Broken stud removal
  -Stud slotted or filed flat
  -Nut welded on
  -Punch used to unscrew broken piece
  -Screw extractor
  -Drill and use tap to remove shell

g. Gasket construction, materials, and application
- Purpose
- Gasket materials
  -Steel
  -Aluminum
  -Copper
  -Asbestos
  -Cork
  -Rubber (synthetic)
  -Paper
  -Felt
  -Liquid silicone
- Gasket selection criteria
  -Temperature
  -Type of fluid to be confined
  -Smoothness of the mating surfaces
  -Fastener tension
  -Pressure of confined fluid
  -Material of mating parts
  -Localized unit loading (fire-ring, coating, beads, flange, neoprene)
- Adverse forces
  -Heat and cold
  -Pressure
  -Erosion
  -Corrosion
  -Moisture
- Gasket installation techniques
  -Avoidance of reuse
  -Checking of mating surface
  -Proper fit
  -Use of sealant (types and uses)
  -Holding of gasket during assembly
  -Straightening of stamped parts
  -Proper torque sequence
- Gasket failure
  -Checking of fastener torque
  -Visible signs (uneven pressure, burning, corrosion, cracks, voids)
  -Checking of mating surface (warpage and burrs)
- Seal construction and installation
- Purpose
  -Confinement of fluids
  -Stopping of foreign materials
  -Separation of two different fluids
  -Static and dynamic seals
- Material, construction and use
  -Lip seal (three part construction, single and double lip)
  -O ring seal
  -Two piece oil seal (engine rear main bearing)

-Graphite impregnated asbestos
-Synthetic rubber
- Oil seal removal
-Depth
-Removal techniques
-Not reusable
-Potential damage to seal bore
- Oil seal installation
-Proper coating
-Suitable driver
-Proper depth
-Seal sleeves and bullets
- Seal failure analysis (lip and O-ring)
-Worn
-Twisted
-Flattened
-Cut
-Swollen
-Dirty

4. Describe and use shop equipment. 19%

a. Primary shop tools and equipment
- Safety stands
- Jacks
- Frame hoist
- Chassis hoist
- Drill press
- Hydraulic press
- Shop creepers
- Air compressor
- Brake pressure bleeder
- Parts washer
- Pressure washer
- Hot tank
- Air tools
- Grinders
- Sand blaster
- Engine cranes
- Engine slings

b. Safety considerations
- Equipment capacity
- Safety stands (jack stands) – proper distance and location
- Jacks
- Frame hoist
- Chassis hoist
- Drill press
- Hydraulic press
- Shop creepers
- Air compressor
- Brake pressure bleeder
- Parts washer
- Pressure washer
- Hot tank
- Air tools

- Grinders
- Sand blaster
- Engine cranes
- Engine slings
- Creepers

c. Maintenance of hoist and lifting equipment
   - Hoist capacity
   - Use of service manual
   - Safe work practices
   - Daily visual inspection
     -Damaged or loose mounts bolts
     -Worn or damaged arms
     -Hydraulic oil leakage
     -Locks for damage
     -Hydraulic controls
     -Electrical conductors, switches and controls
   - Hoist and lifting equipment raising techniques
     -Capacity
     -Location
     -Balance
     -Use of hoist pads

d. Air compressor maintenance procedures
   - Belt tension
   - Draining
   - Inspection
   - Lubrication
   - Water traps
   - Filters
   - Oilers

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Apprenticeship Manitoba

Automotive Service Technician

Unit: A3 Welding

Level: One

Duration: 14 hours

Theory: 3 hours

Practical: 11 hours

Overview:

This unit of instruction is designed to provide the Automotive Service Technician apprentice with the knowledge, understanding and skills related to welding techniques and equipment.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Identify the components of oxy-acetylene equipment.	**12%**
a. Tanks • Oxygen • Acetylene b. Pressure regulators • Oxygen • Acetylene c. Gauges – line pressure and tank pressure • Oxygen • Acetylene d. Manual valves e. Torch tips f. Torches – cutting and welding g. Hoses • Oxygen • Acetylene h. Fittings • Oxygen • Acetylene i. Cylinder handling – storage and transport	
2. Demonstrate procedure for setting up oxy-acetylene unit.	**12%**
a. Tanks • Oxygen • Acetylene b. Pressure regulators • Oxygen • Acetylene	

c. Gauges
   - Oxygen
   - Acetylene

d. Tips

e. Torches – cutting and welding

f. Hoses
   - Oxygen
   - Acetylene

g. Fittings
   - Oxygen
   - Acetylene
   - Construction
   - Identification

3. Describe principles for using welding and cutting equipment. 12%

a. Safety precautions
   - Eye protection
   - Boots
   - Gloves
   - Face shield
   - Fire extinguisher
   - Ventilation equipment

b. Portable units
   - Bottles
   - Safety caps
   - Valves
   - Regulators
   - Hoses
   - Torch
   - Gas flow
   - Leaks (via soapy water)

c. Lighting, adjustment, shutting down and disassembly procedures
   - Adjustment of pressures
   - Ignition procedure
   - Types of flames (oxidizing, carbonizing, and neutral)
   - Shut down procedure
   - Disassembly
   - Storage

4. Perform welding, brazing and cutting procedures. 64%

a. Fusion welding
   - Welding tip (identification, selection, maintenance and size)
   - Filler rod (identification, selection and size)
   - Heat and cutting damage to surrounding material

b. Mild steel plate welding
   - Pressure settings and flame adjustments
   - Tip angle
   - Technique
   - Starting the weld
   - Welding results
   - Slow weld

- Fast weld
- Dirty tip
- Running bead with out a filler rod
- Running bead with a filler rod
- Welding joints

c. Cutting torch and cutting process
   - Cutting attachments (connections, control lever)
   - Cutting tips – orifices
   - Setting pressures
   - Flame lighting and adjusting
   - Extinguishing the flame
   - Starting the cut
   - Cutting technique
   - Tip angle
   - Cutting results
   - Slow cut
   - Fast cut
   - Dirty tip
   - Safety issues with concrete floors

d. Perform braze welding using oxy-acetylene equipment
   - Braze welding
   - Flame
   - Temperature
   - Brazing process
   - Angle
   - Technique
   - Starting the weld
   - Welding results
   - Slow weld
   - Fast weld
   - Dirty tip

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Apprenticeship Manitoba

Automotive Service Technician

Unit: A4 Computer Applications

Level: One

Duration: 11 hours

Theory: 2 hours

Practical: 9 hours

Overview:

This unit of instruction is designed to provide the Automotive Service Technician apprentice with basic computer and internet skills to support trade-related research and communications tasks.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe basic computer components and their functions.	**7%**
a. Input devices b. Output devices c. CPU d. Hard drive e. RAM f. ROM g. Auxiliary drives A, B, C, etc. h. Keyboard i. Monitor j. Mouse k. Printer – types, impact and non-impact l. Parallel port m. Series port n. Care and handling of diskettes and CD-ROM o. Aspects of Windows software p. DOS vs. Windows	
2. Perform basic word processing operations in a word processing package.	**13%**
a. Application programs b. Common commands c. File management tasks	
3. Describe internet system components.	**24%**
a. The World Wide Web b. File servers c. Network addresses	

d. URL addresses
e. Bookmarks
f. Search engines

4. Perform internet searches utilizing various search engines. 32%

a. Accessing search engines via URL addresses
b. Using key words
c. Filtering results

5. Use email to send and receive messages with available email software. 24%

a. Public domain email services
b. Email addresses
c. Sending email
d. Replying to email inquiries
e. Email attachments (text, graphics)
f. Email website links

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Apprenticeship Manitoba

Automotive Service Technician

Unit: A5 Information Retrieval and Introduction to Scan Tools

Level: One

Duration: 14 hours

Theory: 3 hours

Practical: 11 hours

Overview:

This unit of instruction is designed to teach the Automotive Service Technician apprentice how to use current technology in searching and locating information essential to servicing and repairing vehicles.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Interpret vehicle identification numbers (VIN) and manufacturers' labels.	**10%**
a. VIN/manufacturers label information • Make • Model • Year • Place of manufacture • Type of engine • Type of fuel • Type of emission control	
b. VIN	
2. Interpret service manuals and service bulletins.	**10%**
a. Sequential layout operation b. Diagrams c. Flow charts d. Schematics e. Tool specifications f. Selecting test equipment and replacement parts	
3. Access service-related information from automated information retrieval systems.	**40%**
a. Information resources available • CD-ROM • Fax-back retrieval system • On-line system update	
b. Procedure for operating microfiche	
c. Procedure for operating computerized information service systems • Mitchell On-demand • All Data	

- On-line updates

d. Procedure for accessing on-line manufacturer assistance and on-line assistance

4. Describe scan tool fundamentals and how to use them. 40%

a. Principles of digital computers
   - Analogue and digital signals
   - Digital computers
   - Analogue to digital converters
   - Data storage

b. Overall purpose and concept of scan tools
   - Trouble codes retrieved
   - Identification of stored DTCs
   - Clearing of DTCs
   - Performing output control tests
   - Reading of serial data

c. Data link connectors (DLCs)
   - Location and purpose

d. Scan tool usage
   - Monitoring of data streams
   - Access to freeze frame data
   - Obtaining stored DTCs
   - Clearance of stored DTCs
   - Bi-directional functions
   - “Snapshot” data recording

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Apprenticeship Manitoba

Automotive Service Technician

Unit: B1 Engine Fundamentals

Level: One

Duration: 45 hours

Theory: 45 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to provide the Automotive Service Technician apprentice with the knowledge of engine construction and principles of operation.

Objectives and Content: **Percent of Unit Mark (%)**

1. Explain engine principles. **20%**

a. Internal combustion principles
- Internal combustion engine
  -Burning inside engine
  -Combustion requirements
- Combustion by-products
  -Ideal (CO_2 , H_2O)
  -Actual (CO, NOX)
- Engine purpose

b. Major engine components
- Cylinder head
- Valves
- Valve spring
- Piston
- Piston pin
- Cylinder
- Connecting rod
- Crankshaft
- Block
- Camshaft
- Cam lobe
- Valve lifter
- Camshaft gear
- Crankshaft gear
- Valve guide

c. Engine terminology
- Bore and stroke
- Square, over and under square engine
- Calculation of engine displacement

- Calculation of compression ratio
- TDC
- BTDC
- BBDC
- ATDC

d. Engine classification
- Key classifications
  -Valve arrangement
  -Number of cylinders
  -Cylinder arrangement
  -Cycle
  -Type of Cooling
  -Type of fuel
- Two-stroke vs. four-stroke cycle
- Stroke order: four stroke cycle engine
  -Intake
  -Compression
  -Power
  -Exhaust
- Exhaust and intake valve operation during four strokes
- Valve operational terms
  -Overlap
  -Duration and overlap from a chart
  -Two cycle engine operation (reed valve or ported type)
- Valve arrangements
- Cylinder arrangements
  -Inline
  -V
  -Opposed

e. Fuel types
- Gasoline
- LPG
- Diesel

f. Cooling systems
- Liquid
- Air

2. Explain engine performance. 25%

a. Key terms
- Work
- Power
- Torque

b. Friction force/lubrication
- Dry – metal to metal
- Greasy – cam lobe and lifter
- Viscous – engine bearing

c. Engine efficiency
- Volumetric efficiency
  -Maximum filling of cylinder
  -Cylinder intrusions
- Causes of volumetric efficiency decrease
  -Altitude
  -Dirty air filter
  -Temperature
  -RPM
  -Atmospheric pressure

-Exhaust restriction
-Intake runners configuration

- Engine innovations re: volumetric efficiency
  -Polishing intake port
  -Less exhaust back pressure
  -High lift cam
  -Variable valve timing
  -Superchargers
  -Turbochargers
- Thermal efficiency
- Mechanical efficiency
  -Relationship between Indicated Horsepower (IHP) and Brake Horse Power(BHP)
  -Calculation of mechanical efficiency

d. Engine horsepower and torque

- Engine's work production ability
- Indicated horsepower
  -Definition
  -Calculation
- Brake horsepower (BHP)
  -Measure
  -Relationship of BHP to speed
  -Measurement
  -Gross vs. net BHP
- Frictional horsepower (FHP)
  -Measurement
  -Calculation
- Graphing BHP, torque and FHP curves
- Relationship between IHP, BHP and FHP
  IHP = BHP + FHP
- Use of chassis dynamometer

e Normal and abnormal combustion

- Pre-ignition and causes
  -Over-heated engine
  -Glowing piece of carbon
  -Spark plugs overheating
  -Sharp valve edge
  -Glowing exhaust valve
- Detonation and causes
  -Ignition timing advanced
  -Engine temperature too high
  -Carbon build: raising of compression ratio
  -Low octane fuel
  -Stuck exhaust heat control
  -Removal of excessive block or head metal (increase of compression or truing of warped head or block surface)
  -No EGR flow
- Stages of normal combustion
  -Nucleus
  -Hatching-out
  -Propagation

3. Explain engine construction. 25%

a. Cylinder block construction

- Construction methods
  -Drop forging
  -Casting
- Drop-forging advantages
- Block materials
  -High grade cast iron

-Cast or die cast aluminum alloy

- Casting and die-casting processes
  -Oil-sands cores
  -Use of core box
- Finishing of operations to block after casting
  -Cylinders bored and finished to size
  -Holes drilled, oil, coolant threads etc.
  -Bearing caps
  -Lining of bored caps
- Crankshaft finishing (lathe) operations
  -Drilling of oil holes
  -Filleting of radius
  -Correction of diameter
  -Grinding
  -Polishing
- Crankshaft parts
  -Throw
  -Main journal
  -Connecting rod journal
  -Flywheel flange
  -Web
  -Fillet radius
  -Crank cheek
  -Balance hole
  -Counterweight
  -Snout
- Crankshaft throw arrangements
  -Purpose
  -4 cylinder
  -6 cylinder
  -8 cylinder
  -Throw arrangements vs. firing order
- Camshafts construction methods
  -Cast
  -Forged
- Camshaft lobe parts
  -Base circle
  -Ramp
  -Lobe
  -Nose
  -Heel
  -Cam lobe lift
- Cam shape differences
  -Rotation of lifter
  -Even wear pattern
  -Drive fuel pump
- Graduated camshaft journal diameter
  -Installation
  -Damage prevention of bearings
- Camshaft drive
  -Gear, chain, belt
- Camshaft location advantages and disadvantages
- Operation of valve mechanism
  -Less weight
  -Less valve float at high speeds

b. Construction of cylinder heads, combustion chambers as well as intake and exhaust systems

- Cylinder head construction
- Finishing operation
  -Deck surface finishing operation

-Holes drilled for oil, bolt holes, push rods, etc.
-Cooling nozzle and deflectors installed

- Integral vs. removable guides
- Induction hardening of seats
- Coolant distribution tube
- Combustion chamber shapes
  -Hemisperical

c. Bearings

- Friction bearings
  -Split
  -Full round
- Materials used in construction
  -Steel back
  -Copper alloy lining
  -Barrier plate
  -Tin-lead alloy over-plate
  -Pure tin flash plate
- Construction of bearings
  -Steel back
  -Copper alloy lining
  -Barrier plate
  -Tin-lead alloy over-plate
  -Pure tin flash plate
- Bearing terms
  -Crush
  -Spread
  -Clearance
  -Thrust flange
- Precision insert bearings
  -Conformability
  -Corrosion resistance
  -Embedability
  -Performance – fatigue resistance
  -Score resistance

d. Piston and rod assembly

- Materials
  -Aluminum
  -Tin plated
  -Cast iron
- Piston terminology
  -Head
  -Lands
  -Oil ring drain hole
  -Oil ring groove
  -Skirt
  -Compression rings grooves
  -Pin hole
  -Pin boss
- Piston design and construction
  -Cam ground
- Piston construction features
  -Heat dams (location)
  -Thrust struts (diagonal, horizontal, vertical)
  -Steel struts and inserts
  -Cam ground
  -Head shapes
- Piston major and minor thrust side
- Attaching pistons to connecting rods
  -Fully floating

-Piston pin locked to rod
-Piston pin locked to piston

- Piston pin construction
  -Hollowed
  -Case-hardened
- Construction of rings
  -Cast iron with coating of chrome
  -Molybdenum, graphite and phosphate
- Compression ring joints
  -Butt
  -Lap
  -Bevel
- Ring shapes (cross-sectional)
  -Tapered face
  -Counter-bored – barrel faced
  -Outer grooved-scraper type bevel
  -Plain rectangular
  -Inner grooved – bevel
  -Center grooved
- Action of counter-bored, taper faced or grooved ring
  -Intake stroke – ring twist
  -Compression stroke – ring twist
  -Power stroke – full face contact with cylinder wall
  -Exhaust stroke – ring twist
- Oil control ring construction
  -Three piece oil control ring
  -One piece
- Expander devices
  -Location of fit: bottom of the ring groove
  -Force ring against cylinder
- Connecting rod construction
  -Alloy steel
  -Drop-forged then machined
  -I-beam construction
  -Aluminum and special aluminum
- -Finishing operations
  -Boring bearing hole
  -Honed
  -Splitting of lower end
  -Possible drilling oil hole
- Rifle drilling
- Oil spit hole
  -Lubrication of: piston pin, cylinder and opposite cylinder

e. Construction and operation of intake and exhaust valve train mechanism

- Valve lifters
  -Hydraulic (could be roller type)
  -Solid
  -Solid adjustable
- Hydraulic valve lifter operation
  -Valve close position
  -Valve open position
  -Metering valve
- Push rod construction
  -Hollow
  -Solid
- Rocker arms
  -Shaft and stud
  -Shaft and ball stud
  -Cam followers
- Rocker arm construction

-Individual
-Shaft mounted
-Roller arms

- Materials re: valve construction
  -Alloy steel, case hardened
- Head shape designs
  -Poppet valves
  -Rigid head
  -Elastic head design
- Valve terminology
  -Head
  -Face
  -Stem
  -Keeper or lock groove
  -Margin
- Sodium cooled valves
  -Purpose
  -Concerns with sodium
  -Safety issues with valve stems
- Close coil spring construction
  -Dampen out vibration
  -Prevents valve float
- Damper spring
- Valve rotators
  -Positive with ball and spring
  -Release type
- Valve spring retainers

f. Construction of the timing cover, oil pan, valve cover, seals and gasket

- Timing cover, oil pan and valve covers
  -Stamped steel
  -Cast aluminum
- Head gasket
  -Localized unit loading
  -Thin steel, copper and asbestos
  -Fire rings
- Head gasket types
  -Embossed steel (shim gasket)
  -Metal clad sandwich gasket
  -Soft-seal surface composition gasket – steel core, encapsulated
- Seals
  -One piece
  -Two piece
  -Wick type

g. Flywheel and harmonic balancers

- Flywheel purpose
  -Reduction of power impulses
  -Mounting for clutch
  -Gear for starter operation
- Flywheel construction
  -Machined steel
  -Bolted to crankshaft
  -Smooth surface to provide a friction surface
  -Hole in center for pilot bearing
  -Starter ring gear welded or interference fit to flywheel
  -Flex plates
- Harmonic balancer purpose
  -Absorption of torsional vibration
  -Timed to size of engine
  -Marks for timing of engine
- Harmonic balancer construction

-Rubber plugs
-Spring loaded friction disc
-Fluid filled

h. Engine mounts and bell housing
- Construction of the bell housing
  -Aluminum
  -Cast iron
- Integral with and separated from transmission housing
  -Bolted to engine block
- Alignment of bell housing to engine block
  -Dowel pin
  -Shims
- Engine mount
  -Rubber pads
  -Three point suspension
  -Shock absorbers
  -Location
  -Liquid-filled mount

4. Describe engine lubrication operation and service. 15%

a. Construction and operation
- Purpose
  -Cleans engine
  -Reduction of friction
  -Hydrodynamic suspension
  -Cools
  -Absorbs shock
  -Seals between rings and block
- Oil pumps
  -Gear
  -Rotor or lobe
- Oil pump pickup
  -Pipe or cast metal
  -Floating pickup type
  -Filter screen
  -Valve for oil bypass
- Baffles anti-splash pans
  -Prevention of oil displacement
  -Prevention of aeration or foaming
- Pressure regulating (relief) valve
  -Purpose
  -Operation
- Lubrication systems
  -Full pressure system
  -Splash
  -Oil mixed with fuel
- Lubrication systems operation
  -Crankshaft bearing: pressure
  -Rocker arm: pressure and splash
  -Piston: splash
  -Cylinder walls: connecting rod squirthole
  -Camshaft lobe: splash
  -Camshaft bearing: pressure
- Oil filtering systems operation
  -Full flow
  -By pass
  -Shunt
- Oil coolers

b. Oil-filters

- Types
  -Cartridge
  -Spin on or throw away
- Construction of filtering media
  -Surface
  -Depth

c. Engine oils
- Purpose and functions
- SAE and viscosity ratings
- API service classifications
- Oil additives
- Synthetic oils

d. SAE viscosity oil grades and rating systems

e. Oil change intervals
- Formation of sludge
- Formation of varnish
- Oil change intervals

5. Describe cooling system operation and service. 15%

a. Cooling systems construction and operation
- Purposes of cooling system
  -Removal of surplus heat
  -Efficient operating temperature under all conditions
  -Efficiency in reaching operation temperature
- Cooling system types
  -Air
  -Liquid
- Flow of coolant: cross and down-flow radiator
  -Radiator
  -Hoses
  -Water pump
  -Thermostat
  -Thermostat bypass
  -Bypass circuit
  -Fan
  -Water jackets
  -Radiator cap
- Construction and operation of a water pump
  -Centrifugal pump
  -Circulation of water
  -Placement of impeller in closed housing
  -Minimization of pressure
  -Belt driven
- Key parts and systems
  -Water jacket
  -Thermostat bypass
  -Thermostats (pellet, bi-metal spring, bellow)

b. Construction of radiators, caps, hoses, shrouds and fans
- Radiator cores
  -Round tube and flat fin
  -Flat fin and corrugated fin
  -Flat tube and flat fin
- Radiator cap pressure and vacuum valves
  -Pressure valve springs
  -Vacuum valve
  -Pressurization of system
  -Relationship between pressure on a liquid and boiling point
- Construction of radiator hoses

-Rubber –single or double ply construction
-Straight, curved or flexible
-Reinforcement in lower radiator hose
-Hose clamps types (worm drive, screw type, twin-wire, spring)

- Fan shroud
  -Efficiency
  -Air flow shape
  -Problems with missing shrouds
- Radiator fans
  -Rigid
  -Flex blade
  -Clutch drive
  -Electric

c. Block heaters and antifreeze additives

- Block heaters and installation procedure
  -Frost plug
  -Inline type
- Antifreeze
  -Glycol based type
  -Other types
  -Levels of protection when mixed with water
  -Freeze protection (ethylene glycol)
  -Anti-boil protection (ethylene glycol)
  -Lubrication protection of water pump seal (ethylene glycol)
  -Anti-scale protection
  -Acidity protection
  -Anti-foam protection
  -Corrosion protection

d. Cooling system service

- External leaks
  -Pressure testing method
  -Black light and dye
  -Hot or cold leak
- Internal leaks
  -Pump gauge method
  -Leaking cylinder bank
  -Chemical method
  -Other internal leak tests
- Service procedures for cooling system parts
  -Safety precautions
  -Servicing radiator leaks
  -Radiator cap check using testing equipment
  -Improper radiator cap vacuum valve operation
  -Cooling system flush methods (pressure, reverse)
  -Precautions when flushing radiators
  -Replacement of water pump
  -Testing procedure for thermostat
  -Cooling system hose deterioration signs
  -Antifreeze change intervals
  -Diagnosis of belt problems
  -Belt types (V belts, serpentine)
  -Belt installation procedures
  -Block heater servicing, testing and replacement

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Apprenticeship Manitoba

Automotive Service Technician

Unit: C1 Basic Brake Systems

Level: One

Duration: 40 hours

Theory: 26 hours

Practical: 14 hours

Overview:

This unit of instruction is designed to provide the Automotive Service Technician apprentice with the knowledge to understand brake system components and operation. The unit will also provide the apprentice with the basic skills to repair braking systems.

Objectives and Content:	**Percent of Unit Mark (%)**

1. Explain operation and service of master and wheel cylinders. **13%**

a. Pascal's Principle
- P=F/A
- Area of piston calculation
- Cylinder volume
- Calculation of unknown quantities
- Calculation of piston distance movement
- Small vs. large cylinders

b. Levers
- First class
- Second class
- Third class
- Mechanical Advantage (Load or Resistance / Effort or MA=R/E)

c. Liquid under confinement
- Transmission of pressure
- Increase in force
- Decrease in force
- Transmission of motion

d. Simple hydraulic system
- Reservoir
- Piston and ramp
- Handle
- Piston
- Two check valves
- Liquid
- Check valve springs

e. Simple vehicle hydraulic braking system

- Foot pedal with linkage
- Master cylinder
- Master cylinder piston
- Steel lines
- Four (4) wheel cylinders
- Distribution block
- Brake fluid

f. Small vs. large cylinders
- Pressure required
- Force required

g. Master cylinders
- Conventional (Single piston)
- Tandem (Dual)
- Quick take-up

h. Single piston master cylinder
- Residual check valve
- Return spring
- Piston
- Primary cup
- Secondary cup
- Stop ring
- Push rod
- Dust boot
- Breather port
- Compensating port

i. Operation of single piston master cylinders
- Release position
- Brakes applied
- Brakes release (start and end)

j. Tandem (dual) master cylinder
- Residual check valve
- Primary spring
- Primary piston
- Primary cups
- Secondary cups
- Stop ring
- Push rod
- Dust boot
- Secondary piston
- Breather port
- Compensating port
- Secondary spring

k. Tandem (dual) master cylinder
- Release position
- Brakes applied
- Brakes release (start and end)

l. Tandem (dual) master cylinder (single piston)
- Line rupture (front or rear)
- Blown wheel cylinder (front or rear)
- Protection-oriented design

m. Quick take-up master cylinder

- Residual check valve
- Primary spring
- Primary piston
- Primary cups
- Secondary cups
- Stop ring
- Push rod
- Dust boot
- Secondary piston
- Breather port
- Compensating port
- Secondary spring
- Quick take-up valve
- Primary high pressure chamber
- Primary low pressure chamber
- Proportioning valve
- Warning switch
- Release position
- Brakes applied
- Brakes release (start)
- Brakes release (end)

n. Residual pressure valve
- Line pre-charged
- Prevention of air entry
- Effect on the wheel cylinder lip
- Alternatives (including cup expanders)

o. Wheel cylinders
- Single piston
- Double pistons
- Stepped

2. Describe lines, fluid and bleeding. 10%

a. Brake lines
- Steel tubing
- Flexible hose

b. Steel lines and protection methods
- Double wrapped
- Brazed and tin-plated
- High pressure exceeding 1000 psi (6895 kPa)
- Straight run avoidance
- Long run support
- Detour around hot spots
- Use of rubber grommet

c. Flexible hoses and protection methods
- Multiple-ply
- Able to exceed 8000 psi (55,160 kPa)
- Avoidance of sharp or double bends and twisting
- Allowance of slack for connections
- Flats or flange shapes on mounting brackets
- Clips to secure in place

d. Fittings

- Connectors
- Unions
- Elbows
- T-fittings
- Junction or distribution block
- ISO
- Metric

e. Brake line flares
- Double
- Flare angles

f. Brake fluids and their limitations
- Disc brake fluid
- Conventional (glycol-based)
- Silicone based

g. Brake fluid characteristics
- Even viscosity throughout temperature range
- High boiling point
- Hydroscopic and non-hydroscopic
- Use as lubricant
- No corrosion of metal parts
- No deterioration of rubber parts

h. Brake fluid precautions
- No mixing of different brake fluids
- Avoidance: skin contact
- Avoidance of paint
- Lids on containers
- Effect of contaminated fluid

i. Brake fluid purpose
- Transmission of motion
- Transmission of force

j. Flushing and changing brake fluid
- Moisture accumulation
- Rust and corrosion
- Change in boiling temperature
- Change in freezing temperature

k. Disc brakes bleeding
- Blocked open
- Spring-like, hold-open tool
- Removal of pressure differential warning light switch terminal and plunger

l. ABS systems precautions

3. Describe drum brakes. 6%

a. Brake drum construction
- Brake drum functions
- Frictional area
- Heat dissipation

b. Brake drum checks
- Over size
- Out of round
- Taper
- Physical damage

- Concave
- Convex
- Machining limits

c. Energy conversion process
- Inertia
- Kinetic energy
- Heat transfer

d. Friction
- Static
- Kinetic

e. Coefficient of friction
- Calculation
- Calculation of unknown quantity

f. Areas of friction
- Shoe and drums

g. Frictional influences
- Type of materials in contact
- Areas of material
- Weight
- Friction coefficient
- Oil
- Grease
- Brake fade

h. Weight transfer
- Shifting of weight to front
- Front brakes (2/3 of braking)
- Front/rear split
- Diagonally split

i. Brake shoe materials
- Asbestos compound (safety issues)
- Special metallic linings (heavy duty, resistant to brake fade)
- Asbestos threads with fine copper wire (safety issues)
- Synthetic substances
- Ceramic

j. Backing plate

k. Platform on backing plate
- Plate mounting fasteners
- Shoe pads
- Brake shoe hold-down pin holes
- Use of high temperature grease
- Brake shoe anchor

4. Describe shoe arrangements and frictional materials. 10%

a. Brake shoe terms
- Web
- Platform
- Heel
- Toe

b. Drum brakes primary lining

c. Drum brakes secondary lining

d. Brake shoe action

- Servo action
- Self-energizing
- Double anchor
- Single anchor, self-centering
- Double anchor, double cylinder
- Single anchor, self-centering, duo-servo acting
- Self-adjusting brakes

e. Checks to linings and shoes
- Worn
- Loose
- Oil or grease soaked
- Twisting
- Cracked web
- Broken weld

f. Fixed single-anchor, duo-servo, and self-adjusting rear brake design
- Primary shoe
- Secondary shoe
- Anchor
- Retraction springs
- Hold down springs
- Shoe pins
- Shoe guide
- Star wheel adjuster assembly
- Parking brake cable
- Emergency brake strut and spring
- Automatic adjuster system

g. Automatic adjusting servo drum brake
- Cable
- Cable with over-travel spring
- Lever with override
- Lever and pawl

h. Faulty brake performances – causes and corrections
- No pedal – no brakes
- Spongy pedal
- Hard pedal (excessive foot pressure required)
- Brakes grab (one or more wheels)
- Brakes fade
- Brakes pulling to one side
- Brakes drag
- Pulsating pedal (rapid “up and down” movement)
- Brakes chatter
- Brakes squeal
- Shoe “click”
- Onset of brake warning light
- Non-function of automatic shoe adjuster

5. Explain disc brake operation. 10%

a. Disc vs. drum brakes
- Resistance to heat and fade
- Resistance to water fade
- More straight line stops

- Automatically adjusts
- No servo action (disadvantage)
- Bigger piston and larger reservoir (disadvantage)

b. Rotors
- Solid rotor
- Ventilated rotor
- Directional

c. Calipers
- Fixed
- Floating
- Sliding

d. Caliper parts
- Caliper assembly
- Piston
- Piston seal
- Dust boot
- Pad
- Inner shoe
- Outer shoe
- Wear indicator tab

e. Caliper operations
- Seal elasticity
- Brake applied (seal stretches)
- Brake released (seal relaxed)
- Self adjusting feature

f. Disc brake pistons
- Steel
- Aluminum
- Fiberglass reinforced Phenolic piston resin

g. Pad knockback
- Excessive rotor run-out
- Loose wheel bearings

6. Describe brake valves and parking brakes. 6%

a. Valve types
- Metering valve
- Proportioning valve

b. Pressure differential valve

c. Brake-metering valve
- Brake released
- Light brake pedal application
- Heavy brake pedal application

d. Brake-proportioning valve
- Brake released
- Light brake pedal application
- Heavy brake pedal application

e. Pressure differential switch
- When working
- During system failure

f. Brake light switches
- Hydraulic

- Mechanical

g. Parking brakes
   - Rear brake shoe type
   - Drive line type
   - Disc brake type

h. Rear wheel parking brake
   - Parking brake apply pedal
   - Parking brake assembly
   - Equalizer
   - Parking brake front cable
   - Parking brake conduit
   - Strut rod
   - Parking brake cable (left of right rear)

7. Describe brake booster operation. 10%

a. Hydroboost and vacuum operation
   - Hydraulic
   - Vacuum

b. Vacuum booster installations
   - Linkage
   - Integral
   - Multiplier

c. Power booster
   - Vacuum suspended
   - Atmospheric suspended (air suspended)

d. Power booster unit components
   - Front shell
   - Rear shell
   - Power piston diaphragm
   - Support plate
   - Reaction retainer
   - Power piston insert
   - Reaction lever
   - Reaction spring
   - Air valve
   - Floating control valve
   - Push rod
   - Power piston return spring
   - Reaction plate
   - Master cylinder push rod
   - Vacuum check valve

e. Vacuum power booster operation
   - Internal valve (vacuum and atmospheric) operation
   - Released position
   - Applied position
   - Holding position
   - Brake feel

f. Vacuum booster tests
   - Pressure check
   - Pedal travel
   - Vacuum reading

- Release problems
- Hard pedal
- Grabbing brakes
- Check of internal binding

g. Hydraulic boost systems
- Pump
- Accumulator
- Master cylinder
- Pressure switch
- Reservoir

8. Explain and demonstrate measuring, machining and repairing components. 35%

a. Repair of master cylinder
- As outlined in service manual
- Clearance between piston and cylinder
- Replacement of parts
- Pitting as it affects cylinder replacement
- Honing procedures
- Removing tube seal insert
- Bench bleeding
- Fluid level

b. Final checks and adjustment to master cylinder
- Adjustment procedures as outlined in service manual
- Brake pedal height adjustment
- Brake pedal free travel
- Procedure for adjusting master cylinder push-rod for vacuum booster unit

c. Disassembly, inspection and repair of the wheel cylinders
- As outlined in service manual
- Clearance between piston and cylinder
- Replacement of parts
- Pitting: need for cylinder replacement
- Honing procedures
- Bleeder screws for being free and open

d. Double flare and ISO
- Proper cutting tubing
- Removing burrs
- Proper use of flaring tool
- Proper flare – full contact
- Improper flare
  -Uneven
  -Cocked
  -Split
  -Flare
  -Shoulder
  -Narrow contact
- Square with centerline
- Correct size

e. Bleeding brakes
- Use of shop manual
- Manual
- Pressure
- Vacuum

- Series connected cylinders
- Parallel connected cylinders

f. Measurement of brake drum
- Drum micrometer
- As indicated by manufacturers' specifications

g. Machining of brake drum
- Use of safety goggles
- Grinding
- Lathing
- Turning of drums in pairs
- Minimal removal of metal
- Light cut - fed slow
- Need for damper

h. Service and adjustment procedures for drum brake assemblies
- Brake shoe removal
- Installation of brake shoes
- Installation of all other parts
- Adjustment of brakes
- Use of shop manual

i. Removal and reinstallation of brake disc assembly
- Use of shop manual
- Piston
- Piston seal
- Dust boot
- Inner pad (wear limit)
- Outer pad (wear limit)
- Caliper assembly
- Bushings

j. Inspection of disc brake rotor
- Lateral run-out
- Heavy scoring
- Parallelism
- Minimum thickness

k. Demonstration of disc brake rotor machining
- Machine set up
- Speed of cut
- Depth of cut
- Need for damper
- Use of safety goggles
- Use of shop manual

l. Disc brake caliper disassembly, repair and assembly
- Removal of piston boot
- Careful use of compressed air to remove piston
- Honing cylinder bore
- Installing boot on clean and lubricated piston
- Installing piston in clean, lubricated bore
- Use of small C-clamp
- Use of shop manual

m. Pad replacement (rear disc brakes)
- Use of special tool to retract piston
- Use of shop manual

n. Adjustment of cable-actuated park brake
   - Relation of drum brake adjustment to parking brake adjustment
   - Setting parking brake
   - Raising the car
   - Proper adjustment of equalizer
   - Releasing of brake
   - Free turning of wheels
   - Use of shop manual

o. Vacuum booster tests
   - Pressure check
   - Pedal travel
   - Vacuum reading
   - Release problems
   - Hard pedal
   - Grabbing brakes

p. Repair of single diaphragm vacuum booster
   - Manufacturers' guidelines
   - Pushrod adjustment (gauge and air methods)
   - Vacuum hose and engine condition
   - Parts cleaning solutions
   - Safety precautions
   - Cost feasibility of repair and replacement

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Apprenticeship Manitoba

Automotive Service Technician

Unit: E1 Batteries

Level: One
Duration: 11 hours
Theory: 8 hours
Practical: 3 hours

Overview:

This unit of instruction is designed to provide the Automotive Service Technician apprentice with the knowledge of how batteries work and how to service them.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Explain the function of a battery.	**12%**
a. Starting motor, ignition and other electrical devices b. Supplies electrical power when required c. Use as capacitor d. Stores energy	
2. Identify service ratings of batteries.	**20%**
a. Battery rating • Amp hour • Reserve capacity • Cold crank b. Battery capacity • Condition of charge • Temperature • Internal structure – surface area of plates c. Tests • Parasitic drains • Hydrometer • Load • Three minute charge • Open-circuit voltage • Capacitance testing d. Diagnosis of battery condition • Hydrometer test • Load test • Three minute charge test • Hydrometer reading • Hydrometer reading temperature correction	

3. Explain construction and identify parts of a lead acid battery. 24%

a. Electrolyte
b. Cell construction
c. Other types
   - Maintenance free
   - Hybrid batteries
d. Operation and chemical reactions
e. Charging and discharging

4. Explain battery charging. 20%

a. Charging methods
   - Slow charging
   - Fast charging
   - Charging of low-maintenance batteries
   - Filling batteries
b. Precautions for fast-charging batteries
   - Temperature
   - Charger off, cables disconnected
   - Use of manufacturer-operating instructions
   - Exposure to hydrogen gas
   - Removal of jewelry
   - Disconnection of ground cable
   - Use of well ventilated area
   - Care with metal tools or other objects

5. Describe battery boosting procedures 4%

a. Procedures and precautions of battery boosting

6. Diagnose battery problems and service batteries. 8%

a. Battery problems
   - Physical condition
   - Undercharged
   - Overcharged
   - Discharge due to parasitic draw
b. Battery removal and installation
   - Cable removal
   - Battery mounting
   - Cleaning and repairing terminals and cables
   - Proper polarity connections and multiple battery set-up
   - Cleaning of battery
c. Special safety precautions
   - Acid to water
   - Wearing of safety glasses
   - Medical attention after contact with electrolyte

7. Describe factors that will affect the service life of a battery. 12%

a. Improper electrolyte level
b. Poor mounting (loose battery causing vibration)
c. Overcharging
d. Cycling (discharging and charging)
e. Undercharging (sulfation)

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Apprenticeship Manitoba

Automotive Service Technician

Unit: E2 Electrical Fundamentals, Circuits and Test Equipment

Level: One

Duration: 48 hours

Theory: 24 hours

Practical: 24 hours

Overview:

This unit of instruction is designed to provide the Automotive Service Technician apprentice with a working knowledge of fundamental electrical theory, along with key electronic components essential to diagnose and repair an automobile's overall electrical system.

Objectives and Content: **Percent of Unit Mark (%)**

1. Describe electrical fundamentals. **5%**

a. Safety practices and procedures

b. Electron theory
- Matter
- Element
- Atom
- Compound
- Molecule
- Proton
- Neutron
- Electron
- Chemical reaction
- Conductor
- Insulator
- Semi-conductor
- Positive charge
- Negative charge
- Neutral charge
- Permeability
- Inductance
- Insulators
- Holes

c. Sources of electricity and Electromotive Force (EMF)
- Chemical
- Magnetic
- Heat
- Light

- Piezo crystals
- Static electricity
- Vehicle EMF sources

d. Practical electrical concepts
   - Water system operation vs. electricity
   - Electromotive force vs. water pressure
   - Current flow vs.water flow
   - Resistance vs.water tap
   - Electron movement vs.current flow
   - Electron and current flow and current flow theories
   - Conductor failures occur
   - Insulators
   - Danger of damage from static electricity

2. Describe magnetism and inductance. 5%

a. Inductance
b. Magnetic field
c. Permeability
d. Retentivity
e. Natural magnet
f. Electromagnet construction
g. Electron flow and magnetism
h. The right hand rule
i. Use of electromagnets on vehicles
j. Conversion of energy by magnetism
   - Electrical energy into mechanical energy
   - Mechanical energy into electrical energy
   - Electrical energy into other forms
k. Self-induction
l. Mutual induction
m. Examples of induction, self-induction and mutual induction
   - Ignition coil
   - Alternator
   - Starter

3. Describe OHM's Law. 5%

a. Key concepts
   - Volt
   - Ohm
   - Amp
   - Watt
b. Units and symbols, conversion between units
   - mega – M
   - kilo – k
   - milli – m
   - micro - μ
c. OHMS Law/formula (E=I*R)
d. OHMS Law calculations: voltage, amperage and resistance
e. Calculation of electrical power (W=E*I)

4. Describe series and parallel circuits s used on automobiles. 8%

a. Series circuit characteristics
   - Voltage
   - Current
   - Resistance

b. Total resistance (R_T) of a series circuit

c. Current flow in a series circuit

d. Voltage drop
   - Calculation in series circuit

e. Electrical problems, terms and their effects on a series circuit
   - Open circuit
   - Short circuit
   - Ground circuit

f. Parallel circuit characteristics
   - Voltage
   - Current
   - Resistance

g. Total resistance (R_T) of a parallel circuit

h. Total current and branch current flow
   - Calculation

i. Branch voltage drops

j. Electrical problems, terms and their effects on a series circuit
   - Open circuit
   - Short circuit
   - Ground circuit

k. Series and parallel circuit characteristics

l. Total resistance (R_T) of a series and parallel circuits

m. Current flow and individual branch amperages

n. Calculation: voltage drop in series and parallel circuits

5. Describe electrical components. 8%

a. Resistors
   - Limit current flow
   - Protect electrical parts
   - Protect electrical circuits

b. Resistor types
   - Fixed resistor
   - Ballast resistor
   - Tapped resistor
   - Variable resistors
   - Rheostat
   - Potentiometer – three wire resistor

c. Switches
   - Toggle
   - Single-pole, single-throw
   - Single-throw, double-pole
   - Double-throw, double-pole
   - Normally closed
   - Push-pull
   - Rotary
   - Thermal

- Pressure
- Mercury

d. Types and uses of capacitors
   - Purpose (construction, charge, discharge cycle)
   - Uses (noise suppressor, counter voltage spikes)
   - Types (fixed, variable)
   - Identification (size, farads)

e. Fuses
   - Purpose
   - Types (cartridge, blade, inline, fuse and fusible link)
   - Rating
   - Role of service manuals

f. Operation of electrical components
   - Circuit breakers vs. fuse
   - Flashers
   - Light bulbs
   - Coils
   - Transformers
   - Relays
   - Buzzers
   - Solenoids
   - Motors

g. Electrical components in service manual
   - Circuit breakers – state advantage over a fuse
   - Flashers
   - Light bulbs
   - Coils
   - Transformers
   - Relays
   - Buzzers
   - Solenoids
   - Motors

6. Describe lighting systems. 5%

a. Exterior lighting
   - Bulb identification
   - Sealed housing headlamp
   - Sealed halogen headlamp
   - Halogen insert bulb
   - Single contact bulb
   - Double contact bulb
   - Headlights and circuits
   - Lamp delay and auto dimming system
   - Park lights
   - Brake lights
   - Signal lights
   - Emergency flashers
   - Fuses and circuit breakers
   - Fusible links

b. Interior lighting
   - Dome lights

- Dash lights
- Glove compartment lights
- Courtesy lights
- Illuminated entry

c. Accessory lighting
- Trailer lights
- Roof lights
- Fog lights

d. Daytime running lights
- Light sensor
- Electronic controller
- Relay

e. Lighting system schematic diagram

f. Simple interior light diagram

g. Electrical lighting circuits and components
- Park lights
- Brake lights
- Signal lights
- Emergency flashers
- Fuses and circuit breakers
- Fusible links
- Dome lights
- Dash lights
- Glove compartment lights
- Courtesy lights
- Illuminated entry
- Trailer lights
- Roof lights
- Fog lights
- Light sensor
- Electronic controller
- Relay

h. Test equipment
- Aiming of headlights
- Inspection regulations
- Aiming equipment
- Aiming procedures
- Replacement procedures

i. Lighting systems repair procedures
- Meters and test lights
- Trim component removal
- Special tools
- Service manual

j. Lighting system problem diagnosis
- Wiring diagrams
- Wire and terminal connection

k. Electrical components in service manuals

7. Describe and apply wiring diagrams. 22%

a. Repair manuals and troubleshooting charts
- Common abbreviations

- Service manual illustrations section
- Reference section
- Diagnosis charts (flow chart, troubleshooting, fishbone, component location)

b. Role of wiring diagrams
   - Electrical road map
   - Wire connections
   - Component locations

c. Common automotive electrical symbols
   - Battery
   - Capacitor (condenser)
   - Coil, solenoid or winding
   - Connections
   - Non-connections
   - Diode
   - Fuse
   - Ground
   - Lamp
   - Relay
   - Resistor
   - Rheostat
   - Solenoid (magnetic switch)
   - Switch
   - Transistor, PNP
   - Transistor, NPN
   - Zener diode
   - Variable resistor
   - Fixed resistor
   - Junction block
   - Wiring splices

d. Wires and terminals

e. Wire types and sizes
   - Solid and stranded
   - Number vs. size
   - American Wire Gauge System
   - Number = conductor diameter
   - Metric size = cross-sectional area = (mm^2)

f. Wire colour code
   - Solid colour
   - Stripe
   - Spiral stripe
   - Hashmark
   - Marker band

g. Cutting and stripping of wires
   - Wire protection devices
   - Tubing
   - Retainer
   - Tie strap
   - Sleeve
   - Clip
   - Boot
   - Clip

- Vinyl plastic electrical tape
- Wiring harness
- Soldering of wires and terminals
- Use of rosin core
- Tinning
- Connector types (eye, tab, spade, hook, butt, mid-line splice, spade, secondary)
- Crimp type connector and tool
- Proper wire repair
- Proper removal of terminal ends from connectors

8. Describe and use test equipment. **42%**

a. Meters (digital, analog)
b. Moving coil
c. Measure of current
d. Meter shunt
e. Voltmeter
f. Load effects of a voltmeter
g. Ohmmeters
h. Multimeters
i. Digital meters (DMM)
j. Voltmeter
k. Ohmmeter
l. Applications ammeters
m. Meter ranges
n. Meter hookup
o. Test lights
p. Steps in reading voltage
q. Circuit and testing problems
    - Short, open and grounds
    - Diagnostic trouble-shooting procedures
    - Testing procedures and equipment

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Apprenticeship Manitoba

Automotive Service Technician

Unit: F1 Chassis Lubrication and Inspection

Level: One

Duration: 23 hours

Theory: 18 hours

Practical: 5 hours

Overview:

This unit of instruction is designed to provide the Automotive Service Technician apprentice with the theoretical and hands-on skills required to diagnose and repair problems related to undercar inspection, along with wheels and tires.

Objectives and Content:	**Percent of Unit Mark (%)**

1. Describe front and rear wheel bearings, seals and lubricants. **20%**

a. Front or rear wheel bearings disassembly and inspection
- Types of anti-friction bearing
- Application of different bearing design
- Use of manufacturer procedure
- Removal of bearing assembly parts
- Potential bearing problems
  -Chipping
  -Galling
  -Wear
  -Discoloration
  -Corrosion
  -Electrical pitting
  -Poor lubrication
  -Dirt
  -Perform bearing rotational check
  -Bearing looseness and clearance

b. Bearing handling and installation
- Air spin problems
- Problems with heating bearings
- Application of force on tight ring

c. Bearing installation, repacking and adjustment
- Use of grease recommended by manufacturer
- Clean and dry before packing
- Use of grease packer
- Procedure for hand packing
- Use of new grease only
- Adjustments determined by manufacturers' specifications

d. Chassis lubricants

- Lithium grease
- Sodium soap
- Use of grease in chassis parts
  -Drive shaft
  -Steering linkages
  -Ball joints
- Gear oils
  -Petroleum based
  -Extreme pressure (EP)
  -Steering gear lubricants(manual)
  -Steering gear lubricant (power)
- Specialty lubricants
  -Transmissions
  -Transfer case
  -Rear differentials

2. Describe and perform underbody inspection (suspension, steering, driveline) 34%

a. Fluid check of underbody parts
- Automatic transmission fluid level
  -Temperature
  -Level ground
  -Engine running
  -Gear shifter position
- Manual transmission
  -Fluid level
  -Seal leaks
- Transfer case
  -Fluid level
  -Seal leaks
- Rear axle
  -Fluid level
  -Seal leaks

b. General inspection of suspension, steering and drive axle
- Inspection procedures for tires
  -Proper inflation
  -Evidence of improper front-end alignment, imbalance and physical damage
- Inspection procedures for suspension and wheel bearings
  -Over loading and sagging of suspension; chassis height
  -Tire shake test for worn wheel bearings
  -Ball joint looseness
  -Shock absorbers, struts, and attaching parts
  -Shocks or struts: proper action or leakage
- Inspection procedures for steering system
  -Steering gear mountings
  -Steering linkage: looseness and binding
- Inspection procedure for driveline
  -Boots and clamps
  -Seals for leaks (oil wetness around shaft)
  -Cardan joints
  -Hanger bearing and bracket assembly
  -Signs of rubbing

3. Describe tire construction and classification. 16%

a. Wheel construction
- Types of wheels
  -Drop center, steel disc
  -Drop center, cast or forged aluminum
  -Offset, width, diameter etc.
  -Directional wheels

- Parts and purpose of wheel sections
  -Mounting holes
  -Spider (center section)
  -Drop center section
  -Bead area
  -Rim
  -Safety ridges

b. Tire construction
- Tire function
- Types of tire materials
  -Rubber
  -Fabric casting plies: rayon, nylon, polyester
  -Wire
- Parts of tire
  -Tread
  -Bead wires
  -Soft rubber liner
  -Rubbing strip
  -Width
  -Height
  -Piles
- Construction of tire plies
  -Bias ply
  -Radial
  -Advantages of radial as compared to bias
  -Run flat
- Tire and wheel size designations
- Tire rating systems
  -Ply rating
  -Load range
  -Tubeless tire
  -Tire grade
  -Tread wear
  -Traction
  -Temperature resistance
  -Load index and speed rating
- Tire size designation
  -Tire types – P/passenger; T/temporary; LT/light truck
  -Sectional width – 185; 195; 205mm etc.
  -Aspect ratio – 70%, 75%, 80% etc.
  -Rim diameter – 13; 14; 15 inches etc.
- Non metric (alpha-numeric system) tire sizes
  -Tire letter size – F etc.
  -Tire types - R etc./series – 78 etc.
  -Rim diameter – 15 etc.

4. Describe and perform tire maintenance and service. 30%

a. Service requirements for wheels and tires
- Radial and lateral runout
  -Use of dial indicator
  -Use of shop manual
  -Acceptable limits (runout not exceeding 1/16 inch or 1.59mm)
- Location of tire inflation specifications
- Causes of abnormal tire wear
  -Over inflation
  -Under inflation
  -Camber wear
  -Multi problem – cupping
  -Toe wear

- Problems caused by mixing radial and bias tires
  -Handling problems – steering wheel pull
- Removal and installation of tires
  -Proper mounting technique
  -Installation of tube tires
  -Use of tire lubricant
  -Safety precautions
  -Reasons for torquing wheel nuts to specification
- Tire rotation
  -Purpose
  -4/5 wheel bias
  -4/5 wheel radial

b. Wheel balancing

- Wheel balancers
  -Dynamic balancers (on car; off car)
  -Static balancers (bubble)
  -Compare static to dynamic wheel imbalance
- Wheel balancing procedures
  -Tire pressure check
  -Tool manufacturers' procedures
  -Safety and verification procedures for wheel weight types

c. Radial force variation

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Apprenticeship Manitoba

Automotive Service Technician

Unit: H1 Fuel System Components and Exhaust Systems

Level: One

Duration: 18 hours

Theory: 14 hours

Practical: 4 hours

Overview:

This unit of instruction is designed to show the Automotive Service Technician apprentice how to identify, describe, service and repair fuel tanks, fuel lines, fuel filters, fuel pumps, pressure regulators, air intake systems and exhaust systems.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe fuel types.	**17%**

a. List types of fuels
- Gasoline
- Diesel
- Alternate fuels (LP, natural gas)
- Safety considerations

b. Relative heat produced by various fuels
- Gasoline
- Diesel
- Alternate fuels

c. Advantages and disadvantages of various fuels
- Diesel
- Alternate fuels

d. Performance characteristics of gasoline
- Anti-knock quality and octane rating
- Volatility and its effects

e. Gasoline additives
- Anti-icing or de-icer
- Metal deactivators and rust inhibitors
- Gum or oxidation inhibitors
- Detergents
- Ethanol
- Methanol
- Methyl tertiary butyl ether (MTBE)
- MMTs

f. Characteristics of diesel fuel
- Viscosity and volatility

- Cetane number
- Diesel fuel grades (summer and winter)

2. Describe tank, lines and filter. 17%

a. Fuel tank construction
   - Plated pressed steel, aluminum or molded plastic polyethylene
   - Baffles
   - Filler neck
   - Passage for fuel transfer
   - Ridges
   - Drain (optional)

b. Pressure and vacuum filler cap
   - Normal operating conditions
   - Pressure or vacuum conditions
   - Relief of vacuum pressure

c. Venting of fuel tanks
   - Vapour separator
   - Vapour storage canister
   - Rollover protection (valve; inertia switch)

d. Fuel re-circulating system
   - In-pump
   - In-line

e. Fuel tank inspection
   - Fuel leaks
   - Road damage
   - Corrosion
   - Rust
   - Loose
   - Defective seams

f. Safety precautions for gas tanks
   - Disconnection of negative battery
   - Danger of heating bolts on fuel tank
   - Appropriate disposal of used rags and fuel
   - Leaks in steel tubing
   - Fuel line fittings to torque specifications
   - Proper fuel transfer system
   - Static electricity precautions

3. Describe fuel pumps, filters and delivery systems. 17%

a. Main parts of mechanical fuel pump
   - Check valve
   - Diaphragm spring
   - Diaphragm
   - Rocker arm
   - Rocker arm spring
   - Pulsator diaphragm
   - Pump body (valve and lower body)

b. Mechanical fuel pump
   - Intake stroke
   - Outlet stroke
   - Rest stroke (chamber full, needle valve closed)

- Pulsation damper principle and operation

c. Electrical fuel pump
   - Impeller – rotor type
   - Pulsating – bellows type
   - Diaphragm
   - Plunger
   - Demand-style fuel pumps
     -Operation
     -Purpose of inertia switch

d. Fuel filters
   - In-tank
   - In-carburetor filter
   - Pleated paper
   - Screen
   - Stone or ceramic filter – sintered bronze
   - In-line filters

e. Fuel system problems
   - Low fuel pump pressure
   - High fuel pump pressure
   - Fuel pump leaks (fuel)
   - Fuel pump leaks (oil)
   - Fuel pump noise

f. Precautions in the replacement of fuel filters
   - Use of drain pan
   - Direction of flow and leaks in fuel line connections
   - Proper start of nuts threads

4. Describe exhaust systems. **17%**

a. Manifolds
b. Mufflers and resonators
   - Reverse
   - Through flow
   - Heat rise valve and operation
     -Butterfly valve
     -Thermostatic spring operated
     -Vacuum operated

c. Catalytic converters
d. Pipes, supports, clamps
e. Oxygen sensors
f. Exhaust problems

5. Service exhaust system components. **22%**

a. Tools
b. Alignment
c. Sealers
d. Removal and replacement procedures
e. Torquing of bolts to defined specifications
f. System checks for leaks and/or restrictions
g. Safety precautions (carbon monoxide)

6. Describe air intake systems. **10%**

a. Intake system concepts

- Principles
- Control
- Design
- Intercoolers
- Volumetric efficiency
- Comparison of manifold vacuum to ported vacuum

b. Intake system components
- Air intake ductwork
- Air cleaner assembly
- Air filters
  -Principles
  -Types: paper and polyurethane
- Intake manifold
- Super chargers (engine driven)
  -Service precautions
- Turbo chargers (exhaust driven)
  -Service precautions
- Naturally aspirated
- Positive filters
- Pre-cleaners
- After-coolers and inter-coolers
- Pressure waves

c. Intake manifold (in line and V-type engines)
- Cast iron or aluminum
- Prevention condensation
- Assistance in vapourization
- Efficiency in mixing of fuel
- Air speed to reduce condensation
- Inline engines runner configuration
- V configurations (open and closed intakes; coolant and heat riser passage)
- Attached sensor
- Tuned intake system

d. Intake manifolds operating principles
- Cold air
- Hot air
- Control
- Distribution
- Tuning
- Variable induction
- Tuned port induction

e. V-type intake manifold vs. in-line type
- Shorter runners
- Better fuel distribution to cylinder

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Apprenticeship Manitoba

Automotive Service Technician

Unit: Introduction to Hybrid Vehicle Systems

Level: 1

Duration: 7 hours

Theory: 7 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to provide the Automotive Service Technician apprentice with an introduction to the knowledge about current-generation hybrid vehicle systems.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe the fundamentals of hybrid technology.	**20%**
a. Differences compared to traditional non-hybrid technologies • Advantages • Disadvantages b. Types of hybrid powertrain designs • Series • Parallel • Series-parallel c. Levels of hybrid vehicles • Mild hybrid • Medium hybrid • Full hybrid	
2. Describe hybrid vehicle safety hazards.	**50%**
a. Properly tag out the vehicle b. Fire hazards c. Electrocution hazards d. Electrolyte hazards e. Use of hybrid identification markers f. Working environment • Dry floor • With a partner	
3. Describe tools for hybrid vehicle safety.	**10%**
a. Personal protective equipment • High voltage gloves • Testing high voltage gloves • Safety glasses	

- Insulated steel-toed boots

b. High voltage multimeters and leads (Cat III)
c. Warning pylons
d. Insulated tools
e. Engine crane for battery removal
f. Hook or gaff for electrocution

4. Describe differences with high voltage batteries. 20%

a. Safety precautions for working on high voltage battery
   - Personal protective equipment
   - One hand rule

b. Different types of hybrid batteries
   - Lead-acid batteries in series
   - Nickel-metal hydride
   - Lithium-ion

c. Safety procedures
   - Different disconnect procedures
   - Verify voltage

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