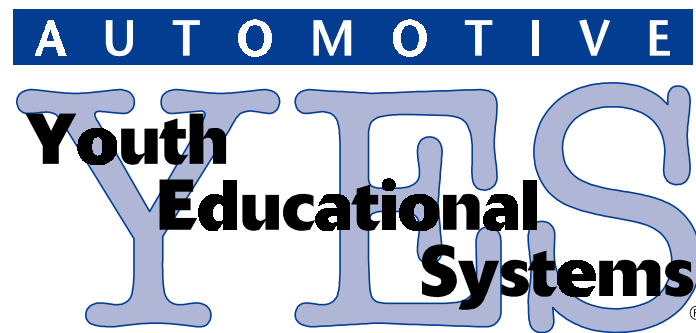


Automotive Service Technology

A8 Engine Performance



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Course Syllabus

A8 ENGINE PERFORMANCE

**A Secondary-Level Course for Students Interested in Careers
Related to Automotive Engine Performance**

This course links occupational and academic pedagogy and is built on Integrated Curriculum Standards, which incorporate state and national academic, occupational, and employability standards.

Contents

I. Course Title	2
II. Course Duration.....	2
III. Course Description	2
IV. Course Instructional Philosophy, Purpose, and Methodology	3
V. Course Objectives.....	3
VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course	4
VII. Active Learning—Ideas for Application.....	38
VIII. Active Learning—Projects/Labs (Job Sheets).....	39
IX. Active Learning—Worksite Options.....	41
X. Assessment Strategy Options and Instruments	44
XI. Suggested Textbooks/References	48
XII. Outline of Course Content (Hierarchy: I.UNIT/1.Lesson/a. ICS Topic)	49

I. Course Title

Engine Performance

II. Course Duration

One year (1 Carnegie unit) depending on the allowable school time blocks

III. Course Description

A specific technical course designed to teach the principles of automotive engine performance and diagnosis. This course builds on the essential laws of physics, thermodynamics, and chemical reactions and teaches how these principles apply to the operation and diagnosis of engine performance systems. This course will cover distributorless (electronic ignition) and distributor ignition systems, fuel management, exhaust emission control, and computer input and output signals and will identify the different types of sensors used by automotive engine computers. The student will learn strategy-based diagnostic routines, to interpret and verify customer concerns, confirm proper operation, and perform tests and inspection using special tools and scan tools to determine the causes and make corrections related to starting, running, emissions, and driveability concerns on systems with/without diagnostic trouble codes (DTC). Courseware will also cover diagnostic trouble codes (DTC), interpretation of digital multimeter (DMM) readings and access and use of electronic service information (ESI). The student will learn to locate and interpret vehicle component identification numbers (VIN, vehicle certification labels, and calibration decals), check and adjust (where applicable) ignition system timing and timing advance/retard, emission component service, and computerized engine control system data and service. Through the process of inspection, testing, or measurement of components, the student will learn to apply this knowledge to determine and accomplish needed repairs. Courseware will also include specific instructions for the worksite mentor trainer. **Prerequisite: Technology Systems, Fundamentals of Service Technology, A6 Electrical/Electronic. Corequisite: Contextual Physics.**

IV. Course Instructional Philosophy, Purpose, and Methodology

This course will focus on student mastery of selected basic principles and the use of equipment that is fundamental to engine performance systems in the automotive industry. Skill mastery will depend on performance of the listed technical competencies used as criterion references. In this course, the student will apply the theories of mechanics and physics that are learned in the corequisite course in physics and will build on the introductory work in technology systems and service technology learned in the prerequisite courses. The content of this course is intended to develop the student's understanding of complex computer-controlled engine spark and fuel management and exhaust emission systems through the contextual learning principles of transferring, relating, application, cooperation, and experience.

V. Course Objectives

The objectives for this course are as follows:

- 1. The student will master specified academic and technical content.**
- 2. The student will practice effective communication skills.**
- 3. The student will develop abilities to solve problems and think skillfully.**
- 4. The student will practice skills required for working within a system.**
- 5. The student will learn to manage resources and information.**
- 6. The student will practice skills required for being a responsible person.**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Upon completion of this course, students are expected—through system understanding—to diagnose, repair and/or service car and truck engine performance systems to original equipment manufacturer’s (OEM) specifications. These expectations are defined in terms of integrated academic, employability, and occupational standards represented by Integrated Curriculum Standards (ICS) plus detailed technical competencies.

Technical competencies specify the technical knowledge and skills that are required to diagnose, repair, and service automotive engine spark, fuel management, and emission management. ICSs incorporate the national academic, employability, and occupational standards that should be considered in this course. With use of the ICSs, integration of academic and technical content can be accomplished. The ICSs introduce topics that go beyond the technical content and address expectations for students to develop a variety of complex skills. Additional information about the ICSs can be obtained from the *Curriculum Integrator* materials. See Section XI for the reference information.

Some connections to job sheets and ideas for application are given as examples of repairs and tasks performed in the various technology areas. Students will see the connections among the ideas for application, job sheets, worksite mentored activities, and various competencies and standards listed, because all activities are task/competency based and tied to the ICSs. Information provided in this syllabus is not only for instructor use, but can also provide value to the students and should be provided to them.

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Professional help during projects can show the application of this skill.	<p>ICS 004 Chemical Bonding and the Structure of Matter</p> <p>Use the periodic table to learn about and predict the properties of elements based on their atomic structure and bonding characteristics. Correlate the position of elements in the table to the following: 1) their atomic structure, 2) the way they bond to one another and to other elements based on their atomic structure, and 3) the way these bonding characteristics affect their properties. Use chemical handbooks, databases, and other resources to verify the properties of elements, compounds, and mixtures as determined by the periodic table and, where appropriate, further correlate these properties with their occurrence in cycles, such as the carbon cycle and the nitrogen cycle, and the benefits and hazards associated with them.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Recognize and identify the physical and chemical operating principles associated with automotive gasoline engines. ◆ Explain the combustion of a hydrocarbon. 	<p>ICS assessment instrument</p> <p>On-demand demonstration</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Science	Project 1	Videotapes and two-way audio/video provide safe ways to observe the correct handling of chemicals.	<p>ICS 005 Chemical Reactions</p> <p>Identify, describe, and perform basic types of chemical reactions: synthesis, redox, addition, displacement, and decomposition. Investigate selected processes that occur in these contexts. Analyze the processes in order to classify the types of reactions involved. Perform, monitor, and describe the basic types of reactions in the laboratory using appropriate equipment and giving attention to all safety and health factors in these reactions. Analyze reactions from both the “real-world” and the laboratory viewpoints. Identify reactants and products and the stoichiometric relationship between them in the balancing of equations. In all the above activities, use appropriate chemical nomenclature to name substances and describe reactions.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Differentiate between volumetric and mass efficiency. 	<p>ICS assessment instrument</p> <p>On-demand demonstration</p> <p>Structured observation</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 2	Professional help in projects, consulting with mentors, and internships can show examples of this skill.	<p>ICS 082 Gas Laws</p> <p>Demonstrate knowledge of gas laws and use them to explain the potential hazards associated with high pressure and high temperature with closed gas systems or to explain the operation of an IC engine or refrigeration system. Perform calculations associated with gas laws in engineering applications. Use and maintain equipment used in the transfer or measurement of gases.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Explain and calculate engine compression ratio. ◆ Explain the Otto or four-stroke cycle of operation. ◆ Prepare 4- or 5-gas analyzer, inspect and prepare vehicle for test, and obtain exhaust readings; interpret readings and determine necessary action. NATEF Work Skill A8/A10, P1. ◆ Explain Boyle's law of constant temperature and Charles's law of constant volume. ◆ Explain the function and identify the use of a thermometer and a pyrometer. ◆ Identify the different types and explain the operation of the Catalytic Converter. 	<p>ICS assessment instrument</p> <p>Case studies</p> <p>Simulations</p> <p>Scenarios</p> <p>ASE-style paper-and-pencil test</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		<p>Worksite learning plans should incorporate this topic.</p> <p>Students can use worksite situations as foundations for projects.</p>	<p>ICS 088 Solid-State Devices</p> <p>Identify and interpret principles and operations of solid-state devices. Apply logical and systematic approaches to analyze, design or service, fabricate/repair, test, troubleshoot, and service/repair solid-state circuits (i.e., control modules, diodes, transistors, thyristors, sensors), observing rules and techniques of accepted industry workmanship and safety standards including electrostatic discharge (ESD) safety.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Describe the types of automotive computer input and output signals. ◆ Identify the different types of sensors used by automotive computers. ◆ Identify the different types of automotive computer output devices and explain their operation. ◆ Diagnose emissions or driveability problem resulting from failure of discrete computerized engine controls with no diagnostic trouble codes stored; determine necessary action. <p>NATEF Work Skill A8/B4, P1.</p>	<p>ICS assessment instrument</p> <p>Work journal entry</p> <p>On-demand demonstration</p> <p>Structured observation</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		<p>Worksite learning plans should incorporate this topic.</p> <p>Students can use worksite situations as foundations for projects.</p>	<p>ICS 090 Digital Circuits</p> <p>Identify and interpret principles and operations of digital logic devices, circuits, and systems. Apply logical and systematic approaches to analyze, design or service, fabricate/repair, test, troubleshoot, and service/repair digital circuits and systems, observing rules and techniques of accepted industry workmanship and safety standards including electrostatic discharge (ESD) safety.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Differentiate between a digital and an analog signal. ◆ Explain why an analog/digital (A/D) converter is necessary in an automotive fuel-management computer. ◆ Inspect, test, adjust, and replace computerized engine control system sensors, power train control module (PCM), actuators, and circuits; perform necessary action. NATEF Work Skill A8/B5, P2. ◆ Practice recommended precautions when handling static sensitive devices. NATEF Work Skill A8/B10, P2. 	<p>ICS assessment instrument</p> <p>Cognitive mapping</p> <p>ASE-style paper-and-pencil test</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		<p>Worksite learning plans should incorporate this topic.</p> <p>Students can use worksite situations as foundations for projects.</p>	<p>ICS 091 Microprocessor Systems and Interfaces</p> <p>Identify and interpret principles and operations of microprocessors and external devices. Apply logical and systematic approaches to analyze, design or service, fabricate/repair, test, troubleshoot, and service/repair microprocessor circuits, observing rules and techniques of accepted industry workmanship and safety standards including electrostatic discharge (ESD) safety.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Explain the function and basic operation of a microprocessor and identify the different types of automotive computer input and output signals. ◆ Explain the following terms: read only memory (ROM), programmable read only memory (PROM), keep alive memory (KAM), and random access memory (RAM). ◆ Differentiate between volatile and nonvolatile memory and explain the term adaptive strategy. ◆ Describe and identify the two types of voltage signals produced by engine load-sensing devices. ◆ Apply logical and systematic approaches to test peripheral automotive computer circuits (microprocessor, calibrator chips, flash PROMS, and external devices). 	<p>ICS assessment instrument</p> <p>Cognitive mapping</p> <p>ASE-style paper-and-pencil test</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 4	Professional help in projects, consulting with mentors, and internships can show examples of this skill.	<p>ICS 101 Basic Physics</p> <p>Identify and interpret the meaning of basic physics concepts of mechanics, forces, thermodynamics, heat, electricity, magnetism, optics, wave motion, acoustics, and atomic and nuclear physics. Apply these concepts in technology.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Explain atmospheric pressure and identify the relationship to the term vacuum. ◆ Explain energy, heat, temperature, and pressure and how they relate to automotive gasoline spark ignition engines. 	<p>ICS assessment instrument</p> <p>ASE-style paper-and-pencil test</p>
	Projects 3 and 4	Professional help in projects, consulting with mentors, and internships can show examples of this skill.	<p>ICS 102 Mechanics / Forces</p> <p>Identify and interpret the meaning of the relevant units of mechanical forces. Apply the laws of motion, conservation of energy, types of forces, concepts of levers and torque, angular momentum, and gravitational forces.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Differentiate among bore, stroke, and displacement. ◆ Explain the following performance factors: speed, work, torque, and horsepower. 	<p>ICS assessment instrument</p> <p>ASE-style paper-and-pencil test</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Professional help in projects, consulting with mentors, and internships can show examples of this skill.	<p>ICS 103 Thermodynamics and Heat</p> <p>Identify and interpret the relevant units of thermodynamics/heat, phases of matter, the ideal gas law, temperature, heat transfer, and energy measurement.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Explain the thermal expansion of fluids and solids. ◆ Explain Boyle's law of constant temperature and Charles's law of constant volume. (Also covered in ICS 082) ◆ Identify the different types and explain the operation of the Exhaust Gas Recirculation (EGR) Valve and system. ◆ Explain the operation of the positive crankcase ventilation (PCV) system. 	<p>ICS assessment instrument</p> <p>ASE-style paper-and-pencil test</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Science	Projects 1, 2, 3, 5, and 6	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	<p>ICS 163 Engine Performance</p> <p>Identify and interpret computerized gasoline-engine controls and performance systems. Diagnose and repair driveability and emissions malfunctions.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Explain how distributor and distributorless ignition systems generate and time an ignition spark through the primary and secondary circuits. ◆ Explain the primary and secondary ignition circuits and waveforms they generate. ◆ Explain the operation of triggering devices (sensors), such as, Pick-up Coils, Hall-effect switches, PM Generators, Optical Pick-ups, and Magneto Resistive (MR). ◆ Explain the operation of the primary fuel system including fuel tank, pumps, filters, fittings, and lines. ◆ Explain the operation of an electronic fuel injection system including speed density, mass airflow, airflow meter, throttle bodies, idle controls, and injectors. ◆ Describe the uses of scan equipment in communicating with computers and interpret the data from this scan. 	<p>ICS assessment instrument</p> <p>On-demand demonstration</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
			<p>ICS 163 Technical competencies continued</p> <ul style="list-style-type: none"> ◆ Retrieve and record stored OBD I and OBD II diagnostic trouble codes (DTC); clear codes. NATEF Work Skill A8/B1, P1, B2, P3. ◆ Obtain and interpret digital multimeter (DMM) readings. NATEF Work Skill A8/B6, P1. ◆ Access and use electronic service information. NATEF Work Skill A8/B7, P3 ◆ Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, and calibration decals). NATEF Work Skill A8/B8, P1. ◆ Check and adjust (where applicable) ignition system timing and timing advance/retard. NATEF Work Skill A8/C7, P1 ◆ Check/adjust idle speed and fuel mixture. NATEF Work Skill A8/D12, P2, D13, P3. ◆ Diagnose fuel delivery and emissions problems on vehicles with electronically managed carburetor-type fuel systems. NATEF Work Skill A8/D1, P3. ◆ Perform exhaust system backpressure test; determine necessary action. NATEF Work Skill A8/D16, P1. 	

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
			<p>ICS 163 Technical competencies continued</p> <ul style="list-style-type: none"> ◆ Diagnose fuel-system-related problems, including hot or cold no starting, hard starting, poor driveability, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling, and emissions problems on vehicles with injection-type fuel systems; determine necessary action. NATEF Work Skill A8/D2, P1. ◆ Verify correct camshaft timing; determine necessary action. NATEF Work Skill A8/F2, P1. ◆ Verify engine-operating temperature; determine necessary action. NATEF Work Skill A8/F3, P1. ◆ Perform cooling system pressure tests; check coolant condition; inspect and test radiator, pressure cap, coolant recovery tank, and hoses; perform necessary action. NATEF Work Skill A8/F4, P1. ◆ Perform engine absolute (vacuum/boost) manifold pressure tests; determine necessary action. NATEF Work Skill A8/A5, P1. ◆ Perform cylinder power balance test; determine necessary action. NATEF Work Skill A8/A6, P2. ◆ Perform cylinder compression and/or leakage tests; determine necessary action. NATEF Work Skill A8/A7, A8, P1. 	

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 2: The student will practice effective communication skills.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Language Arts	Projects 5 and 6	<p>This topic can be reinforced and applied in many worksite settings.</p> <p>Job shadowing with the service manager, warranty clerk, parts manager, and the finance/ insurance staff provides important examples with this skill.</p>	<p>ICS 018 Communication</p> <p>Determine content of communication based on purpose and audience. Select and interpret appropriate references. Identify the appropriate format for communication. Convey information to audience according to accepted practices.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Using strategy-based diagnostic routines, interpret and verify complaint; determine needed repairs. NATEF Work Skill A8/A1. 	<p>ICS assessment instrument</p> <p>Simulations</p> <p>Videotaping</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 2: The student will practice effective communication skills.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 6	Using blueprints and diagrams in projects gives students firsthand experience with them.	<p>ICS 049 Blueprints and Diagrams</p> <p>Demonstrate the proper procedures for reading and interpreting blueprints and diagrams in production or service technology. Obtain representative drawings and identify dimensions, symbols, types of lines, views, and scale. Understand the logic of algebraic or service/repair procedures and geometric concepts as they relate to blueprint reading. Understand the importance of working with established industry tolerances.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ♦ Using manufacturer's diagnostic schematics, symptoms, and routines, interpret and verify complaint and determine needed repairs. NATEF Work Skill A8/A1, P1. 	<p>ICS assessment instrument</p> <p>On-demand demonstration</p> <p>Conferencing</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Projects 2 and 4	<p>These concepts are used in many worksite activities.</p> <p>Job shadowing with the service technician can provide examples of this skill.</p>	<p>ICS 040 Graphs and Charts</p> <p>Identify and interpret appropriate resources, data sources, and technology to create, represent, and present technical information in common graphs and charts.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Using the electronic service information (ESI) system, identify and locate relevant service information and interpret this information toward diagnosis. NATEF Work Skill A8/B7, P3 ◆ Determine appropriate diagnostic procedures based on available vehicle data and service information; determine if available information is adequate to proceed with effective diagnosis. 	<p>ICS assessment instrument</p> <p>Cognitive mapping</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	Projects 3 and 4	Worksite reports should include relevant math applications.	<p>ICS 042 Mathematics Formulas</p> <p>Apply combinations of algebra, geometry, trigonometry, and statistics techniques to use in formulas to solve for simple and complex equations and inequalities and to analyze data. Use graphic organizers and technology when appropriate.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Choose appropriately from a variety of mathematical techniques and use quantitative data to construct logical explanations to diagnose and repair engine driveability and exhaust emission problems related to engine performance; express mathematical ideas and concepts orally and in writing. 	<p>ICS assessment instrument</p> <p>Graphic organizer</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Have students look for problem-solving and documentation processes at the worksite during field trips, job shadowing, part-time employment, and internships.	<p>ICS 045 Problem Solving and Decision Making</p> <p>Demonstrate ability to use problem-solving and decision-making processes and to apply these processes to personal and business situations. Identify root causes. Understand the factors that influence solving problems and making decisions and use this understanding in formulating and implementing action plans. Monitor action plans and make adjustments as needed.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Use a diagnostic-strategy thought process along with OEM service manual symptom fault statements and electronic service information to reduce the list of possible causes of a customer concern in the engine performance and related fuel emission and ignition systems and to diagnose and repair those problems related to those concerns. ◆ Recognize that a problem exists; i.e., there is a discrepancy between original equipment manufacturer's definition of normal operation and what is measured and observed. Identify possible reasons for the discrepancy; devise and implement a plan of action to resolve it; evaluate and monitor progress; and revise plan as indicated by findings. 	<p>ICS assessment instrument</p> <p>Cognitive mapping</p> <p>Work journal entry</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Projects 2, 3, and 6	Professional help with projects through mentors or Internet mentoring can provide guidance with this skill.	<p>ICS 062 Measurement Tools</p> <p>Choose the appropriate specialized measurement tool, instrument, and/or test equipment to make measurements required by production processes. Use measuring tools, instruments, and test equipment, applying industry standards for precision, accuracy, and tolerance. Recognize the effects of measurement errors on calculations.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Read and apply a thermometer and a pyrometer. ◆ Obtain and interpret digital multimeter (DMM) readings. NATEF Work Skill A8/B6, P1 ◆ Use an automotive scan tool to diagnose and interpret diagnostic trouble codes (DTC), serial data, and parameter data information. ASE Task A8/E4. ◆ Perform fuel system pressure, volume, or fuel pump current draw tests; determine needed action. ASE Task A8/C3. ◆ Measure manifold and crankcase pressure using a slack-tube manometer, both mercury and water types. ◆ Read graduated-flask graduates. ◆ Read and interpret engine oscilloscope patterns. ◆ Adjust valves on engines with mechanical or hydraulic lifters. NATEF Work Skill A8/F1, P1. 	<p>ICS assessment instrument</p> <p>Structured observation</p> <p>Annotated notes</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 2	This skill is applicable in all worksite settings.	<p>ICS 078 Scientific Method</p> <p>Use the scientific method to solve problems in the laboratory or in the field. Maintain proper documentation of problems, references, and procedures. Follow procedures for gathering and analysis of data. Formulate hypotheses and conduct testing. Support conclusions with evidence.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Using strategy-based diagnostic routines, interpret and verify customer concerns regarding the proper operation of engine performance systems and perform tests and inspection to determine the causes and make corrections to problems. ◆ Interpret and verify driver's complaint, verify proper engine driveability ignition and operation; determine necessary repairs or service. NATEF Work Skill A8/A1, P1. 	<p>ICS assessment instrument</p> <p>Checklist</p> <p>Annotated notes</p> <p>On-demand demonstration</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	<p>ICS 166 Inspection Inspect the general condition of tools, equipment, systems, and inventory. Follow an inspection process. Respond to warning conditions indicated.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Inspect fuel tank and fuel cap; inspect and replace fuel lines, fittings, and hoses; perform necessary action. NATEF Work Skill A8/D3, P2. ◆ Check fuel for contaminants and quality; determine necessary action. NATEF Work Skill A8/D4, P2. ◆ Inspect engine assembly for fuel, oil and coolant levels and leaks; determine needed repairs. NATEF Work Skill A8/A2, P2. ◆ Inspect, test, adjust, repair, and or replace any emission component, computerized engine control system sensors, power train control module (PCM), actuators, circuits, and any related components. NATEF Work Skill A8/B5, P2 ◆ Inspect and test power and ground circuits and connections; service or replace as needed. NATEF Work Skill A8/B9, P1. ◆ Inspect and test ignition primary and secondary circuit wiring and components including coils, triggers, sensors, and modules; determine necessary action. NATEF Work Skill A8/C3, 5, 6, 8, 9, (P2), and 4, (P3). 	<p>ICS assessment instrument</p> <p>ASE-style paper-and-pencil test</p> <p>On-demand demonstration</p> <p>Simulations</p> <p>Structured observation</p> <p>Work journal entry</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
			<p>ICS 166 Technical competencies continued</p> <ul style="list-style-type: none"> ◆ Inspect and test fuel injectors; clean and replace. NATEF Work Skill A8/D10, P2. ◆ Inspect throttle body mounting plates, air induction and filtration system, intake manifold, and gaskets; perform necessary action. NATEF Work Skill A8/D11, P2. ◆ Remove, inspect, and test vacuum and electrical components and connections of fuel system; perform necessary action. NATEF Work Skill A8/D14, P2. ◆ Inspect and test the catalytic converter, exhaust manifold, exhaust pipes, mufflers, resonators, tail pipes, and heat shields; perform necessary action. NATEF Work Skill A8/D15, P2 and E3/4, P2. ◆ Test the operation of turbocharger/supercharger systems; determine necessary action. NATEF Work Skill A8/D17, P3. ◆ Inspect and test positive crankcase ventilation (PCV) filter/breather cap, valve, tubes, orifices, and hoses; perform necessary action. NATEF Work Skill A8/E1/2, P2. ◆ Inspect and test valve, valve manifold, exhaust passages, and pneumatic and electronic controls of exhaust gas recirculation (EGR) systems; perform necessary action. NATEF Work Skill A8/E2/2, 3, 4, P2. 	

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
			<p>ICS 166 Technical competencies continued</p> <ul style="list-style-type: none"> ♦ Inspect and test mechanical and electrical components of secondary air injection systems; service or replace as needed. NATEF Work Skill A8/E3/2,3, P2. ♦ Inspect and test components and hoses of evaporative emissions control system; determine necessary action. NATEF Work Skill A8/E6/2, P2. ♦ Inspect and test thermostat, by-pass, and housing; perform necessary action. NATEF Work Skill A8/F5, P1. ♦ Inspect and test mechanical/electrical fans, fan clutch, fan shroud/ducting, air dams, and fan control devices; perform necessary action. NATEF Work Skill A8/F6, P2. ♦ Inspect and test mechanical and electrical fuel pumps and pump control systems; perform necessary action. NATEF Work Skill A8/D5, P2. ♦ Replace fuel filters. NATEF Work Skill A8/D6, P1. ♦ Inspect and test fuel pressure regulation system and components of injection type fuel systems; adjust or replace as needed. NATEF Work Skill A8/D7, P1. ♦ Inspect and test cold enrichment system components; adjust or replace as needed. NATEF Work Skill A8/D8, P3. ♦ Remove, inspect, clean, and reinstall throttle body; adjust related linkages. NATEF Work Skill A8/D9, P2. 	

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	<p>ICS 167 Diagnosis Research a system breakdown using technical information to determine diagnostic procedures. Follow strategy-based diagnostic routines. Generate solutions to problems and determine needed repairs while recognizing when assistance is needed. Document the diagnostic procedures and results.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Diagnose hot/cold no starting, hard starting, poor driveability, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling, and emissions problems and failures of interrelated systems (e.g., cruise control) on vehicles with fuel-injection or carburetors; determine necessary action. NATEF Work Skill A8/D1, P3 and D2, P1. ◆ Diagnose no starting, emissions/driveability problems resulting from computerized engine controls faults with/without diagnostic trouble codes (DTC) stored on vehicles with distributorless (electronic ignition) and distributor systems. NATEF Work Skill A8/B3, B4 and C1, C2, P1. ◆ Diagnose oil leaks and emissions and driveability problems resulting from positive crankcase ventilation (PCV) failures. NATEF Work Skill A8/E1/1, P1. ◆ Diagnose unusual exhaust color, odor, and sound; determine necessary action. NATEF Work Skill A8/A4, P2. ◆ 	<p>ICS assessment instrument</p> <p>ASE-style paper-and-pencil test</p> <p>On-demand demonstration</p> <p>Simulations</p> <p>Structured observation</p> <p>Work journal entry</p>
<i>A8 Engine Performance</i>				26

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
			<p>ICS 167 Technical Competencies continued</p> <ul style="list-style-type: none"> ♦ Diagnose unusual engine noise or vibration problems; determine needed repairs. NATEF Work Skill A8/A3, P2. ♦ Diagnose unusual exhaust color, odor, and sound; determine needed action. NATEF Work Skill A8/A4, P2. ♦ Diagnose emissions/driveability problems caused by failure of the following: exhaust gas recirculation (EGR) system, secondary air injection, exhaust gas treatment (catalytic converter), early fuel evaporator, PCV, and evaporative emission control systems. NATEF Work Skill A8/E2/1, P1, E3/1, P2, E4/1, P3 and E5/1, P3. ♦ Diagnose emissions and drivability problems resulting from failure of evaporative emissions control system; determine necessary action. NATEF Work Skill A8/E6/1, P2. ♦ Diagnose engine mechanical, electrical, electronic, fuel, and ignition problems with oscilloscope and/or engine diagnostic equipment; determine necessary action. NATEF Work Skill A8/A9, P1. ♦ Diagnose driveability and emissions problems resulting from failures of interrelated systems (cruise control, security alarms, torque controls, suspension controls, traction controls, torque management, A/C, automatic transmissions); determine necessary action. NATEF Work Skill A8/B11, P2. 	

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	<p>ICS G06 Career Decision-Making Skills</p> <p>Assess and use accurate information to develop a lifelong career plan. Identify problems that may interfere with this plan. Identify strategies to use during any transitional period.</p>	ICS assessment instrument

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 4: The student will practice skills required for working within a system.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Language Arts		<p>Students identify appropriate regulations affecting the worksite.</p> <p>Job shadowing with the warranty clerk gives examples of this skill.</p>	<p>ICS 002 Regulations</p> <p>Demonstrate the ability to locate, apply, and take part in dialogue concerning the impact of government regulations and business/industry procedures on the performance of particular job functions and services. Differentiate among federal, state, and local regulations; the various agencies involved in government oversight; and local business and industry procedures and services. Recognize the process and impact of regulations on the management of resources and delivery of services.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Be familiar with “right to know” legislation. ◆ Apply federal, state, and local regulations when storing and disposing of chemical materials and waste and know where to find current information about implementing these regulations. ◆ Explain the purposes of the U.S. Occupational Safety and Health Act. ◆ Identify the Clean Air Act Amendment and explain the OBD II provision. ◆ Follow state and federal regulations with regard to compliance with exhaust emission laws. 	<p>ICS assessment instrument and checklist</p> <p>ASE-style paper-and-pencil test</p> <p>Work journal entry</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 4: The student will practice skills required for working within a system.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		<p>Worksite learning provides a powerful reinforcement of safety issues.</p> <p>Job shadowing with a service technician should always emphasize safety.</p>	<p>ICS 034 Safety</p> <p>Identify safety requirements and recognize safety signs and symbols. Apply appropriate information to respond, use safety equipment correctly, and take appropriate actions. Implement safety programs and document results.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Identify the location of first aid supplies. ◆ Use appropriate safety procedures and guidelines. ◆ Use protective equipment. ◆ Maintain, understand, and follow material safety data sheets (MSDS). ◆ Maintain safety equipment. ◆ Recognize safety symbols/signs. ◆ Demonstrate an understanding of and comply with relevant OSHA safety standards. 	<p>ICS assessment instrument</p> <p>Extended paper-and-pencil test</p> <p>Checklist</p> <p>Structured observation</p> <p>Project portfolio</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 4: The student will practice skills required for working within a system.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 5	<p>This skill can be reinforced with worksite experiences.</p> <p>Job shadowing with the parts manager provides examples of this skill.</p>	<p>ICS 079 Teamwork</p> <p>Participate as an effective member of a team by contributing to the group effort of accomplishing goals. Identify and employ the appropriate role within the group. Use effective communication, interpersonal skills, and learning techniques while working with others of diverse backgrounds. Participate in group decision-making processes incorporating the appropriate role within the group. Evaluate the team's efforts.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Participate as an effective member of a dealership business or work team by contributing to the team efforts of fixing vehicles right the first time and reducing repair cycle time. ◆ Demonstrate understanding of the role of a professional automotive technician and other dealership personnel and how the effective communication processes and individuals contribute to the whole organization. 	<p>ICS assessment instrument</p> <p>Conferencing</p> <p>Project-based learning</p> <p>Simulations</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 5: The student will learn to manage resources and information.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 2	<p>This topic can be reinforced and applied in many worksite settings.</p> <p>Job shadowing with the warranty clerk and service technicians gives examples of this skill.</p>	<p>ICS 009 Reference Materials</p> <p>From a wide range of resources, obtain materials appropriate to a given problem, topic, or situation. Collect and organize information from the materials for use in communication.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Apply and explain the use of the original equipment manufacturer (OEM) service manual and electronic service information as an information resource in locating engine performance information and symptom diagnosis. ◆ Apply the OEM service manual and ESI as diagnostic aids in locating causes of engine performance concerns. ◆ Locate, understand, and interpret written information in prose and documents – including manuals, graphs, and schedules – to perform tasks; learn from text by determining the main idea or essential message. ◆ Identify relevant details, facts, and specifications, infer or locate the meaning of unknown or technical vocabulary; and judge the accuracy and appropriateness. ◆ Collect and organize information from library resources, reference books, and electronic databases. 	<p>ICS assessment instrument</p> <p>Scenarios and simulations</p> <p>On-demand demonstration</p> <p>Structured observation</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 5: The student will learn to manage resources and information.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	<p>ICS 055 Hazard Prevention Train or participate in training in safety and hazard prevention. Implement methods of preventing accidents in a production, service, and/or laboratory environment. Identify the costs and trade-offs associated with accidents.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Demonstrate the appropriate use of safety devices and equipment such as fire extinguishers and power shut-off controls. ◆ Maintain a neat, clean, and safe work environment for self and fellow workers. ◆ Ensure that all safeguards are in place and used properly. ◆ Practice recommended precautions when handling static-sensitive devices. NATEF Work Skill A8/B10, P2 	<p>ICS assessment instrument</p> <p>Structured observation</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 5: The student will learn to manage resources and information.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 6	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	<p>ICS 076 Documentation</p> <p>Record the critical data of work activities for various situations according to prescribed procedures. Identify, locate, access, analyze, and respond to previous records of documentation to determine actions for specific situations.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Retrieve and record stored diagnostic trouble codes. ◆ Record work journal entries. ◆ Explain the components of an automotive repair order (RO). ◆ Record information related to an exhaust emission inspection. 	<p>ICS assessment instrument</p> <p>Work journal entry</p>
		Mentoring and Internet mentoring can help students network to employment opportunities.	<p>ICS G12 Entry or Reentry into Workforce</p> <p>Recognize and implement effective skills for networking and for locating and acquiring employment at entry or reentry level, including opportunities regionally, nationally, and globally. Maintain a portfolio demonstrating job competency and containing job-seeking tools.</p>	<p>ICS assessment instrument</p> <p>Conferencing</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 6: The student will practice skills required for being a responsible person.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		This topic can be reinforced and applied in many worksite settings.	<p>ICS 012 General Housekeeping</p> <p>Implement general housekeeping practices to maintain a neat and orderly work area while recognizing the connection to successful job performance.</p> <p>Technical Competencies</p> <ul style="list-style-type: none"> ◆ Keep work area free from clutter. ◆ Maintain organized and neat work place. ◆ Clean work area according to shop standard and be familiar with a variety of cleanup and emergency response procedures. 	<p>ICS assessment instrument</p> <p>Structured observation</p>

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 6: The student will practice skills required for being a responsible person.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 5	Interviewing can provide practice for this skill. Mentors and job shadowing with various dealership managers and personnel can give examples of the importance of this skill.	ICS G01 Self-Expression Demonstrate skills of self-expression appropriate to the situation. Identify styles of self-expression and tailor them to the situation.	ICS assessment instrument On-demand demonstration Simulation Structured observation
	Projects 3 and 4	Mentors can give the students a point of view of the impact of this skill.	ICS G04 Knowledge of Self-Concept Demonstrate a realistic awareness of one's own capacity, needs, and achievements while recognizing the impact on self and others both personally and professionally.	ICS assessment instrument

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 6: The student will practice skills required for being a responsible person.				
Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Mentors can provide guidance and advice in this area.	<p>ICS G11 Develop a Plan for Career Transition</p> <p>Demonstrate strategies to support career transition. Display skills in gathering information regarding the labor market as well as information about the changes and strategies that influence success. Update the portfolio.</p>	<p>ICS assessment instrument</p> <p>Scenarios and simulations</p> <p>Conferencing</p>
		Mentors can provide guidance and advice in this area.	<p>ICS G16 Upgrading Job Skills</p> <p>Display skills in lifelong learning that allow for upgrading of job skills and revised career goals. Identify development opportunities both on and off the job and the means to access them.</p>	<p>ICS assessment instrument</p> <p>Conferencing</p>
	Project 6	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	<p>ICS G18 Self-Management in the Workplace</p> <p>Display skills of organization, time management, and stress management.</p>	<p>ICS assessment instrument</p> <p>Structured observation</p>

VII. Active Learning—Ideas for Application

SCIENCE

A 3800 Series II engine develops 220 ft-lb of torque at 4000 rpm in Houston with the barometric pressure at 29.5 inches of mercury and an air temperature of 90°F. Estimate the torque the same engine could produce in Denver with a barometric pressure of 24.5 inches of mercury and the same air temperature.

MATH

Perry thinks the tachometer on his car is not working correctly. To test the tachometer, he takes the car on a test drive. When he is traveling at 60 mph, the tachometer shows a reading of ≈ 3050 rpm. Perry knows that he can use the formula

$$\text{rpm}_{\text{engine}} = [(\text{Velocity}_{\text{fpm}}) \div (\text{tire circumference in feet})] \times (\text{rear axle ratio})$$

The rear axle ratio is 3.25:1 and the tire diameter is 27.7 inches.

- The velocity must be expressed in feet per minute. How many feet per minute are equivalent to 60 mph?
- What is the circumference of a tire? Express the circumference in feet.
- What should the tachometer reading be on Perry's car when it is traveling at 60 mph?
- Is the tachometer displaying the correct reading? If it is not, how much too low or too high is the reading?

Answer:

$$\text{A. } 60 \text{ mph} = \frac{60 \text{ mi}}{\text{hr}} \times \frac{\text{hr}}{60 \text{ min}} \times \frac{5280 \text{ ft}}{\text{mi}} = 5280 \text{ ft per min}$$

$$\text{B. } C = \pi \times d$$

$$C = \pi \times 27.7 \text{ in.}$$

$$C \approx 87 \text{ in.}$$

$$C \approx 87 \text{ in.} \div 12 \text{ in. per ft} = 7.25 \text{ feet}$$

$$C. \text{ [(Velocity}_{\text{fpm}}) \div (\text{Tire circumference in feet})] \times (\text{Rear axle ratio})$$

$$\text{rpm}_{\text{engine}} = (5280 \text{ ft per min} \div 7.25 \text{ ft}) \times 3.25$$

$$\text{rpm}_{\text{engine}} \approx 2367 \text{ rpm}$$

D. No. It is registering high by approximately 700 rpm.

LANGUAGE ARTS

Students can critically read the warranty papers for engine parts. They should look for duration of warranty, terms and conditions, owner responsibility, and so on. Using the warranty papers as examples, have students write similar warranty papers for products typically used in the classroom, such as overhead projectors, VCR monitors, chalkboards, computers, and pencil sharpeners.

VIII. Active Learning—Projects/Labs (Job Sheets)

- 1. (SCIENCE)** Have the learner teams monitor exhaust manifold temperature close to the block with an infrared thermometer. Put the engine under load until the temperature stabilizes. Disable the exhaust gas recirculator system and monitor any change in manifold temperature. Explain the cause of any temperature variation.
- 2. (SCIENCE "Compression Ratio")** The learner teams will estimate the compression ratio of an engine from measurements, compare the estimate with the engine specifications, determine how the ratio would change if the cylinder head were milled, and consider the effect on other engine parameters. **(Project Provided.)**
- 3. (MATH)** Have students determine the rear axle ratio by raising a tire and putting a chalk mark on the raised tire and drive shaft. Turn the tire two revolutions and count the turns of the drive shaft. This is the rear axle ratio. Measure the outside tire diameter of the vehicle. Use this information to convert

the speed of the vehicle in mph to engine rpm as follows. Convert velocity in mph to feet per min. Divide velocity in feet per min by the circumference of the tire to get the rpm of the tire at that velocity. Then multiply the tire rpm by the rear axle ratio to get engine rpm.

$$\text{Velocity}_{\text{mph}} = \text{Velocity}_{\text{fpm}}$$

$$\text{rpm}_{\text{tire}} = \text{Velocity}_{\text{fpm}} \div (\text{Tire circumference})$$

$$\text{rpm}_{\text{engine}} = \text{rpm}_{\text{tire}} \times \text{Rear axle ratio}$$

Ask students to reflect on their capacity to be automotive technicians.

4. **(MATH "The Little Car That Could and Couldn't")** Students will work in teams to use mathematics skills to manipulate physics formulas and equations. Students will use their results to show how vehicle speed, engine speed, and engine torque impact a vehicle's ability to go up a hill without the transmission down shifting. **(Project Provided.)**
5. **(LANGUAGE ARTS)** Students should arrange a visit to a local dealership to collect examples of various types of gasoline filters: in-carburetor filters (pleated paper, sintered bronze, and screw-in), inline filters, and outpump filters. With students working in groups of three, have them create a display of the various types of filters with labels and detailed annotations on the significance of their differences. The purpose of this display will be to teach a group of "would-be" automotive service technicians.
6. **(LANGUAGE ARTS " Spotting It and Naming It")** The learner will demonstrate ability to recognize and name major systems in the engine by identifying each part in the system as viewed in an engine and recording the label for that part on a diagram of the system, and will use this information to perform a task required on an ASE test. **(Project Provided.)**

IX. Active Learning—Worksite Options

This course can be strongly supported by worksite learning activities. Both the technical competencies and the integrated standards offer numerous opportunities for worksite application. The objectives for the worksite activities should incorporate the objectives for this course wherever possible. Students and employers should be oriented to these objectives, and the students should be required to report back in terms of the objectives. Worksite learning involves a partnership between local companies and the local school for students to work, or at least to observe, in a short-term situation. Some suggested worksite experiences follow. These experiences are presented in order of increasing activity and involvement on the part of the student.

1. **Field trips**

Field trips are a useful teaching aid only when they are carefully planned and orchestrated. All logistical and scheduling criteria should be shared with the administration and/or management of the site to be visited. The visitation site should be appropriate to demonstrate a working environment that can be definitive for students in specific career paths. AYES automotive dealers are encouraged to initiate and conduct field trips from the local elementary or middle schools to their dealerships. An AYES awareness package provides all of the details.

2. **Interviewing**

Interviewing is a powerful tool for allowing students to establish contact with the workplace. Initially, students should be prompted with appropriate questions. They should then be encouraged to script their questions and to work with classmates and the teacher for validation. Further, students might work on a variety of possible scenarios for answers to their initial questions and their considered responses and further questions. Some interviewing can be done during field trips to appropriate worksites.

3. **Professional help during the development of a project**

During field trips or in the interviewing process described above, students may have made valuable contacts in the workplace. If so, these contacts might be cultivated and called upon to act in the role of informal consultants for student projects. These consultants can help during the inception, development, and implementation phases of student projects. Students should be briefed on telephone etiquette and the need to respect the consultants' time constraints. Interviewing skills developed earlier in the worksite learning sequence should be emphasized here.

4. **Internet mentoring (E-mail)**
Another interesting method of linking with informal consultants who can help students in problem solving and project planning and implementation is Internet mentoring. Again, students should be briefed on how to ask questions succinctly and on the importance of using correct grammar and E-mail etiquette. They should give the consultants plenty of time to respond to their questions.
5. **Videotapes of dangerous or sterile environments and/or two-way audio and video**
The hazards inherent in the occupations at some worksites make it unreasonably dangerous for students to take field trips to the worksites to observe technicians and practitioners or to interview them. An alternate method for introducing students to these worksites is through the use of videotapes of the worksites. After this initial, passive introduction, students can be brought more into real-time communication with technicians and practitioners through the use of two-way audio and video communication. For example, it is prohibitively dangerous for students wanting to study nuclear technology to visit a power plant's containment unit. Through the use of two-way audio and video communication, however, these students can "see" the containment area and conduct interviews with prospective mentors and occupational consultants.
6. **Shadowing**
Career shadowing can be a very effective tool for introducing students to the general parameters of activity involved with specific occupations. Care must be taken in choosing both the worksite and the worker to be shadowed. Students should be briefed so that they understand that the experience gained during the shadowing process may not include exposure to every aspect of a particular job. Shadowing must be as active as it is passive. The worker to be shadowed should be ready for questions and be ready to explain the general parameters of the job. The shadowing student should be prepared to be attentive and inquisitive and should realize that he or she is also being observed. The AYES initiative requires career shadowing prior to internship.
7. **Part-time employment**
Students should not be allowed to participate in part-time employment arrangements until they have acquired skills that apply to the workplace, even if only marginally. It is understood that part-time employment will be at the job-entry level. It is, however, incumbent upon the educational institution sponsoring a student for part-time employment to ensure that prospective part-time student workers possess those prerequisite skills specified in the Student Development Plan and AYES Work Journal.

8. **Mentoring**

Mentors and students to be mentored should be carefully selected and matched. All mentors and interns are required to attend the AYES Mentor Training Course prior to beginning the internship. This course covers in detail the attitudinal, employability, and interpersonal issues in the workplace. Each technical course will contain mentor training units that detail the process of teaching the technical competencies at the worksite. A mentor should be patient, willing to teach, and knowledgeable of the job. The mentor should be organized, should have a work ethic that is worthy of being imitated, and should have no agenda that exceeds the scope of the job and the student he or she is mentoring. Students to be mentored should be made aware that they represent not only the school where they are enrolled, but themselves and their families as well. Students must also realize that the mentor has agreed to take on the added responsibility of mentoring and should be treated with respect.

9. **Internships**

Internships are usually associated with short-term, but full-time, exploratory employment. This temporary full-time status generally allows the student greater opportunities to observe and internalize the complex of activities within a firm and specifically to observe more closely and actually perform the duties associated with a specific job. It can even include the student's becoming involved in, and contributing to, an ongoing project. Students launched into internships should have fairly advanced prerequisite job skills and should have been well trained in job-retention techniques. AYES summer internships are paid.

X. Assessment Strategy Options and Instruments

Numerous strategies are available to assess student learning. The use of multiple strategies is encouraged to provide measures of complex skills and varying student strengths and learning styles. Following are suggested strategies.

Annotated notes

Students can annotate the notes taken from classroom discussions, lectures, readings, or their own research. Reflection is the key with this type of assessment. You should look for (1) new insights that are generated as a result of the previously taken notes, (2) ideas that are extensions of previously expressed ideas, and/or (3) comments and questions stemming from previously stated ideas. The thinking represented should be more in the higher-level categories of application, synthesis, and evaluation than a simple restatement or summary.

Case studies, scenarios, and simulations

Case studies, scenarios, and simulations are used to assess a student's ability to analyze events and individuals in light of established criteria. Using this type of situation-specific format, students will be able to reveal their ability to synthesize evidence to support generalizations based on individual cases. Students can choose a variety of formats for presentation of case studies, scenarios, and simulations—videotaping, role playing, written or oral presentations, plays, debates, movements, songs, poetry, and so on.

Charts for information gathering

As information is gathered for projects or individual assignments, students can create matrices or charts to organize the data. Assessment of a chart or matrix should be based on its appropriateness and design and the accuracy and thoroughness of the data collected. Charts and matrices can be included in portfolios.

Checklist

A checklist is used when specific tasks or functions can be predetermined. Sources of checklists include teacher-made lists based on content and/or processes of knowledge, skill, or attitudes; student-made lists as the initial step in the completion of a project; and employer-made lists that reflect expectations for performance in a specific occupational area. Each item in the checklist should have a single focus. This will allow each element of a task to be isolated and “checked off.”

Cognitive mapping

Like graphic organizers, cognitive mapping is a visual representation of relationships among ideas. Cognitive mapping does not have a specific format. The map is generated by the student as a picture of the way he or she sees the ideas fitting together. Common shapes, lines, colors, symbols, and so on can be employed, but the map itself is idiosyncratic. You will still be able to use general evaluation guidelines such as accuracy, thoroughness, and appropriateness, but determining the final outcome of the evaluation requires greater latitude. Using a cognitive map for conferences will reveal a great deal about a student's understanding as well as help the student to clarify his or her thoughts in preparation for the conference.

Conferencing

Collecting information about students' understanding of knowledge, skills, and attitudes on a one-on-one basis is typically referred to as "conferencing." This is more than a "talk." The student should bring a portfolio, a visual representation, or some other piece of work to the conference to support the topic of the conference.

ASE-style criterion-referenced multiple-choice paper-and-pencil tests

Criterion-referenced multiple-choice tests focus on specific technical competencies to determine whether a student has the necessary skills to do a particular task. These tasks pertain to the required knowledge, skills, and actions for meeting automotive industry standards. The tests measure the knowledge and skills the technician must have for performing under certain conditions against the standard of determining needed repair. Criterion-referenced tests measure mastery or lack of mastery. These tasks demonstrate the way the student or employee receives data and solves problems in real life instead of asking him or her to recite memorized answers. The data built in to the questions are based on real work experiences. For example, a question may give a gauge reading and describe visual clues and then ask, "What do you do next?" Six types of questions are asked. They are standard multiple-choice questions, "except" questions, technician A/technician B questions, questions using illustrations, "most likely" questions, and "least likely" questions. In addition, you can ask students to "draw out their thinking" in visual representations using cognitive maps or graphic organizers. Another variation on extended response is to ask students to formulate the questions for a given piece of information. Students choose the most appropriate answer. This process will reveal a great deal about the students' levels of knowledge and skills.

Graphic organizer

Visual representations are considered graphic organizers when they are formatted into a shape that reveals the flow of ideas, the connection among ideas, and the application of ideas. You can use graphic organizers to assess a student's level of understanding by examining the accuracy, thoroughness, and appropriateness of the graphic to represent a given concept, skill, or process. This assessment tool is especially powerful as a nonverbal mechanism for making inferences about what students know.

AYES Work Journal

Students will use work journals to keep records of their learning experiences using the AYES technical competencies (NATEF task list). Journal entries can serve as accountability pieces. Every repair that an intern works on requires he or she to fill out a **“Work Journal Diagnostic Report.”** This report states customer complaint, the cause, and the correction. Once a week, the intern selects one diagnostic report and fills out an **“Applied Education Summary”** that details the technical competencies (NATEF tasks) involved and how they connect to foundation skills—such as reading, writing and math—and employability skills—such as time use or teamwork. The work journal also provides a **“Time-on-Task Tracking Sheet”** to check the repetitiveness of the technical competencies. Work journals allow students to reflect on the meaning of their learning and the attitudes connected to the experiences. Work journal entries can be checked as having been made—yes or no. They reflect the work of the intern in school and at the worksite. AYES students are required to answer specific questions, write specific amounts, and use these specific forms.

Narrative writing

Translating factual information into a narrative format requires students to shift their thinking from comprehension to application. Look for evidence in the narratives that students have internalized the knowledge, skills, or attitudes by being able to represent the information in real-world situations.

On-demand demonstration

When performance of a hands-on skill or solution of a real-life problem is assessed, an on-demand demonstration can be used to determine level of accuracy, flexibility in application of skill, recognition of appropriate choice of skill for a specific task, and so on. Criteria should be identified prior to the learning experience and then applied during the assessment phase of the demonstration. Students should be prepared to complete this type of assessment with little, if any, prior notification, i.e., “on-demand.” Students should be encouraged to keep records of hands-on performances that illustrate habits of mind and levels of knowledge and skills.

Portfolio

A portfolio is a collection of pieces of evidence of a student's knowledge, skills, and attitudes. Used to showcase the student's best work or work in progress, the portfolio serves as a record of progress over time. The content is selected by the student in collaboration with the teacher. The portfolio becomes the centerpiece for review conferences with experts in the field, parents, administrators, other teachers, and even peers. The most effective use of the portfolio is for students to take it to the workplace to showcase competencies and employability skills to employers. Evidence of learning can take various forms such as journals, charts for information gathering, visual representations, narrative writing, photographs, and videotapes.

Project-based learning

Project-based learning provides a hands-on demonstration of knowledge, skills, and attitudes that reveals a student's ability to plan, organize, and create a product or an event. Examples of criteria are timeliness of completion, demonstration of skills needed to complete the experience, documentation of processes used in project development, presence of evidence to support conclusions, relevance and thoroughness of presentation, accuracy of content and processes used, and level of performance as a team member in the completion of the project-based learning experience. Tools used to collect data for evaluation could be computer programs, checklists of the development process from initial to final steps, annotated notes, and conferencing.

Rubrics

A rubric is an expandable scoring guide that specifies the criteria for performance along a continuum. The rubrics provided for the Integrated Curriculum Standards (ICS) from the *Curriculum Integrator* are set along a four-point scale. The key indicators for each component of the ICS are specified with frequency of occurrence and quality of performance or product varying along the scale from 4 through 1. The rubric is distributed to or constructed by the students at the beginning of the course. The purpose is to make the target of learning clear by revealing the critical features of mastery-level performance from the beginning. Students can learn to monitor and adjust their own levels of performance based on the rubric rather than passively depending on the teacher to "give a grade."

Structured observation

Observation of events, groups, and individuals that focuses on the salient traits of the skill or attitude being displayed is one of the most powerful assessment strategies. When observation is “structured,” the key behaviors or attitudes to be observed are predetermined with a focus on “observable” behaviors. Using a scale of frequency of occurrence such as *often–sometimes–seldom–not yet* allows you to collect evidence of student performance in an objective, systematic manner. This information can then be shared in conferencing with students and/or parents. Videotaping can be used to complete the picture of observed behaviors. View the videotape with the student, allowing the student to “unpack” his or her thinking during the taped event.

Videotaping and photography

Composition of the videotape or photograph should reveal what a student considers representative of the knowledge, skill, or attitude. By inference, then, you are able to draw tentative conclusions about his or her level of understanding and ability to appropriately apply the learning. This type of assessment can become a vital piece of the portfolio or a conferencing experience.

XI. Suggested Textbooks/References

A5 Automotive Engine Performance Curriculum Module, AYES Corporation

A8 Engine Performance, CD-ROM, Interactive Computer Based Training, DVP/CDX 1-888-873-2239

Chrysler Engine Performance Systems, Daimler-Chrysler AG

Curriculum Integrator, CORD Communications, Waco, Texas, 1998

Engine Performance Specialist, Service Series Curriculum and Instructional Materials Center (CIMC), Oklahoma Department of Vocational and Technical Education

GM Fuel Injection Diagnosis (16009.10-6), GM Corporation/Raytheon

GM Engine Performance Diagnosis (16003.01-1), GM Corporation/Raytheon

Module 3 Engine Performance, Instructional Materials Laboratory (IML), University of Missouri

Today's Technician Automotive Engine Performance, Knowles, Delmar Publishing

Toyota Engine Performance Systems, Toyota Motor Sales, Inc.

XII. Outline of Course Content (Hierarchy: I.UNIT/1.Lesson/a. ICS Topic)

- I. Spark Ignition Engine Basics
 - 1. Basic Engine Operation
 - a) Chemical bonding and reactions
 - b) Mathematical formulas
 - c) Thermodynamics
 - d) Gas laws
 - e) Basic Physics and Mechanics
 - 2. Fuel Delivery System
 - a) Components and Operation
 - b) Fuel Flow
 - c) Safety
 - d) General housekeeping
- II. General Engine Diagnosis
 - 1. Engine Diagnosis
 - a) Inspection
 - b) Diagnosis
 - 2. Engine Related Service
 - a) Inspection

III. Emission Systems

1. Emission Components
 - a) Engine Performance
2. Diagnosis and Repair
 - a) Inspection
 - b) Diagnosis

IV. Electronic Engine Controls

1. Microprocessor components and functions
 - a) Voltage signals
 - b) Data communication and measurement tools
2. Microprocessor Input Sensors
 - a) Solid-state devices
 - b) Digital circuits
 - c) Schematics, charts, and graphs
 - d) Inspection
 - e) Diagnosis
3. Microprocessor Output Sensors
 - a) Solid-state devices
 - b) Digital circuits
4. OBD II Diagnosis and Repair
 - a) Problem Solving/Decision Making
 - b) Scientific Method
 - c) Reference materials
 - d) Inspection
 - e) Blueprints and diagrams

V. Ignition Systems

1. Electronic Ignition Systems
2. Ignition System Diagnosis and Repair

VI. Working with Others/Mentor Unit

1. Self-Management in the Workplace
 - a) Teamwork
 - b) Communication
 - c) Self-Expression
 - d) Knowledge of self-concept
 - e) Career decision-making skills
 - f) Career planning
2. Workforce entry
 - a) Work Journal
 - b) Upgrading Skills
 - c) Task Lists
 - d) Documentation