Public and Catholic District School Board Writing Partnerships

Course Profile

Transportation Technology

Grade 11

Workplace Preparation

TTJ3E

• *for teachers by teachers*

This sample course of study was prepared for teachers to use in meeting local classroom needs, as appropriate. This is not a mandated approach to the teaching of the course. It may be used in its entirety, in part, or adapted.

Acknowledgments
Public and Catholic District School Board Writing Teams – Transportation Technology

This profile is the result of a collaborative effort between The Institute for Catholic Education (ICE) and the Simcoe County District School Board.

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Course Overview
Transportation Technology, Grade 11, Workplace Preparation, TTJ3E

Secondary Policy Document: *The Ontario Curriculum, Grades 11 and 12, Technological Education, 2000*

Course Description

This course examines the various types of land, air, and/or marine vehicles and vehicle systems found within the transportation sector. Students acquire identification, troubleshooting, repairing, and testing skills that meet industry standards and government regulations. In addition to developing employability and technical skills, they explore the broad range of career opportunities within this sector and examine the impact of the transportation sector on people, society, and the environment. Because teaching/learning activities in this course may involve moving vehicles, teachers must be aware of, and discuss in detail with students, board and school policies pertaining to safety in the operation and moving of vehicles. These should be supplemented with industry standards and provincial regulations. Regular updating will be necessary.

How This Course Supports the Ontario Catholic School Graduate Expectations

The application of gospel values and the sense of community, factor as strong elements in the expectations for the transportation technology student. The activities in this course offer broad awareness of social conscience and personal choice. The fact that the environment requires caring stewards propels conservation and wisdom in choice throughout the curriculum. Individual decision-making and collaborative processes are explored as students develop knowledge and skills that are applicable in their lives now, and as preparation for further studies or careers. The opportunity to improve the lives of others is shown as a part of success. Moral and ethical work practices should be set for lifelong implementation in learning and in working.

Course Notes

Workplace preparation courses are designed to equip students with the knowledge and skills they need to meet the expectations of employers if they plan to enter the workplace directly after graduation, or the requirements for admission to certain apprenticeship or other training programs. The activities suggested in this profile provide students with opportunities to acquire and demonstrate general transferable skills in a technical context. These skills are of both immediate and long-term value to both the student and the employer.

The content of the course provides a varied set of themes to acquire and apply skills and knowledge. Transportation is addressed in a global perspective as well as in the transportation industry's specific technical procedures.

In addition to the Grade 12 Transportation courses that follow this one (TTJ4E), students may be directed to Cooperative Education or School-Work Programs for further exploration of interest in the subject. Students interested in apprenticeship can participate in the Ontario Youth Apprenticeship Program (OYAP), which allows them to begin an apprenticeship while they are enrolled in secondary school. Students in Grades 11 and 12 can earn credits toward their secondary school diploma while accumulating hours toward the completion of an apprenticeship through the OYAP.

The activities in this course require access to a technical facility with appropriate working and storage space, tools, equipment, reference materials, and preferably a computerized automotive repair manual system. Substitutions for specific activities may be made depending on local facility situations, but the procedures should be addressed in a manner that serves the course expectations. Special considerations are made in the course to incorporate specific health and safety guidelines (such as the Workplace Hazardous Materials Information System [WHMIS] standards of practice), but additional notice should be taken from other regulatory and advising bodies that impact the working conditions of the transportation industry, and in turn the technical classroom. These may include municipal recycling agencies, fire marshal directives, and local industry task groups.

Units: Titles and Time

Unit 1	Facility Management	10 hours
* Unit 2	Engine Operations	25 hours
Unit 3	Powertrain Systems	30 hours
* Unit 4	Vehicle Electrical Systems	30 hours
Unit 5	Fuel and Energy Systems	15 hours

* These units are fully developed in this Course Profile.

Unit Overviews

Unit 1: Facility Management

Time: 10 hours

Unit Description

Students investigate several aspects of setting up, organizing, and operating a small business in the field of transportation. Students research a suitable location, physical layout, and operational procedures, i.e., work order forms. These forms and procedures are utilized while completing other activities in the course. The values of care of the environment, safety of self and others, and responsible and moral use of resources will be emphasized in this unit.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus
1.1	TFV.01, SP1.01, SP1.02, SP1.03, ICV.01, ICV.03, ICV.04, ICV.05, IC1.01, IC1.02, CGE1d, CGE1i, CGE2b	Thinking/Inquiry Communication	Facility location, layout, and set-up
1.2	TFV.01, SP1.01, SP1.02, SP1.O3, SP3.02, SP3.03, SP4.03, CGE2c, CGE4b	Knowledge/Understanding Thinking/Inquiry	Business management
1.3	SPV.02, SP2.01, SP2.02, SP2.03, SP2.04, CGE5e, CGE5h	Knowledge/Understanding Thinking/Inquiry Communication Application	Facility maintenance and daily operations

Unit 2: Engine Operations

Time: 25 hours

Unit Description

This unit involves students acquiring a comprehensive knowledge base in the concepts, terminology, and operation of single and multiple cylinder engines. Activities range from engine compression and oil pressure testing to diagnosing and repairing engine noises and faults. Developing skills in reading and applying technical information will help students become more effective communicators. Respect for the environment, and wise use of resources are identified as key responsibilities in the Christian faith throughout the unit.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus
2.1	TFV.02, TFV.03, TF2.01, TF2.02, SPV.01, SPV.02, SPV.03, SPV.05, SP1.05, SP2.01, SP2.03, SP2.04, SP4.02, ICV.02, IC2.01, IC2.02, CGE4f, CGE2b, CGE4b, CGE7i	Knowledge/ Understanding Thinking/Inquiry Application	Engine types, functions, and diagnosis
2.2	TFV.02, TFV.03, TF2.01, TF2.02, SPV.01, SPV.02, SPV.03, SPV.05, SP1.05, SP2.01, SP2.03, SP2.04, SP4.02, ICV.02, IC2.01, IC2.02, CGE4f, CGE2b, CGE4b	Knowledge/ Understanding Thinking/Inquiry Application	Identify, locate, and disassemble engine components for a complete long block
2.3	SPV.01, SPV.03, SPV.05, SP1.04, SP2.01, SP2.04, SP4.01, SP4.02, CGE4f, CGE2b, CGE4b	Applications Thinking/Inquiry	Measure, inspect, diagnose, and repair engine components
2.4	TFV.02, TFV.03, TFV.04, TF1.01, TF2.01, TF2.02, TF3.01, SPV.04, SP3.03, SP4.02, SP4.03, CGE4f, CGE2b, CGE4b	Knowledge/ Understanding Communications	Investigate engine designs using investigative and comparative techniques
2.5	SPV.01, SPV.02, SPV.03, SP1.02, SP1.04, SP1.05, SP2.01, SP2.02, SP2.03, SP2.04, SP3.01, SP3.02, SP3.03, SP4.02, ICV.01, ICV.02, IC1.01, IC1.02, IC2.01, IC2.02, IC2.03, IC2.04, IC3.02, CGE4f, CGE2b, CGE4b	Applications	Repair and reseal engine components to industry standards using a variety of gaskets, seals, and sealants

Unit 3: Powertrain Systems

Time: 30 hours

Unit Description

Students explore the various types, components, and repair procedures applied to the transfer of power, from bicycle gear sets and snowmobile clutches, to final drive gear sets and differentials found on both front-wheel and rear-wheel drive vehicles. The importance of sequenced repair procedures are emphasized along with the thorough knowledge of the components themselves. Combining theoretical knowledge and the application of skills, students recognize and diagnose a systematic flow of power on typical vehicles. The requirements of collaborative contributions throughout the unit emphasize teamwork and concern for others in the workplace.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus
3.1	SPV.05, SP4.01, SP4.02, SP4.03, CGE4f	Knowledge/Understanding	Drive types and theory
3.2	TFV.03, TF2.01, SP3.01, CGE2b	Knowledge/Understanding	System components
3.3	SPV.01, SPV.02, SPV.03, SP2.01, SP2.03, CGE4b	Application Thinking/Inquiry	Diagnosis
3.4	TFV.02, SPV.03, SP2.01, SP2.03, CGE5h	Application Thinking/Inquiry	Repair procedures

Unit 4: Vehicle Electrical Systems

Time: 30 hours

Unit Description

Students acquire fundamental knowledge and skills for use in diagnosing and repairing the electrical systems found on most vehicles. Students begin by studying basic electrical principles and troubleshooting techniques. Students complete electrical workstations, develop skills in reading wiring diagrams, and perform system diagnosis and service. The final activity requires students to utilise knowledge and skills developed in the previous activities when describing, diagnosing, and servicing the charging system. Cross-curricular opportunities exist in the areas of Science and Math. The advantages of becoming a reflective and creative thinker in this challenging subject area are stressed.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus
4.1	TFV.02, TF2.01, SPV.01, SPV.02, SPV.03, SPV.05, SP1.04, SP2.01, SP2.03, SP2.04, SP3.01, ICV.02, ICV.05, IC2.01, C2.02, IC3.02, CGE 2c, CGE 2e	Knowledge/ Understanding Thinking/Inquiry Application	Electrical theory and fundamentals
4.2	TFV.02, TF2.01, SPV.01, SPV.02, SPV.03, SP2.01, SP2.03, SP2.04, SP3.01, SP4.02, ICV.02, IC2.01, IC2.02, CGE4a, CGE 4c	Knowledge/ Understanding Thinking/Inquiry Application	Starting system service
4.3	TFV.02, TFV.03, TF2.01, SPV.01, SPV.02, SPV.03, SP1.04, SP1.05, SP2.01, SP2.03, SP2.04, SP3.01 SP4.02, SP4.03, ICV.02, IC2.01, IC2.02 CGE 4f, CGE 5f	Knowledge/ Understanding Thinking/Inquiry Application	Charging system service

Unit 5: Fuel and Energy Systems

Time: 15 hours

Unit Description

Students explore the conversion of fuels to energy through examples of transportation systems and components. Systems studied include petroleum-based and alternative energy systems. A theoretical discussion of carburetion and fuel characteristics leads to an overview of electronic fuel injection and the causes and effects of abnormal combustion. Practical activities include simple carburetor adjustments on small engines and fuel pressure tests. Safe handling of fuels and respect for the environment are included in all aspects of this unit as students experience a professional's perspective of being a responsible citizen.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus
5.1	TFV.04, TF3.01, TF3.02, SP4.03, CGE3f	Knowledge/Understanding Communication	Conventional fuel types
5.2	TFV.02, SPV.03, ICV.02, SP1.04, SP2.01, CGE5h	Knowledge/Understanding	System components
5.3	TFV.03, SPV.03, SPV.04, TF2.01, TF2.02, CGE4f	Knowledge/Understanding Application	System operation
5.4	SPV.01, SPV.02, SPV.03, SP2.01, SP2.03, CGE5a	Application Thinking/Inquiry	Diagnosis
5.5	TFV.04, TF3.01, TF3.02, SP4.03, CGE3b	Knowledge/Understanding Application	Alternate fuels and beyond

Teaching/Learning Strategies

Transportation Technology for the Workplace involves understanding concepts and applying specific technical procedures to sets of problems. Service procedures, safe working methods, and sequencing of diagnosis are taught by emphasizing technical fundamentals, which may then be applied to the broader range of applications. A student who has a broad yet solid understanding of a particular system is best equipped to adapt knowledge and skills in solving new problems. The ability to problem solve and access information efficiently is considered more valuable than the ability to memorize specifications.

In addition to this technical versatility in approaching service tasks, the workforce demands that graduates are able to work as individuals or collaboratively to create products or provide services. Community values of honesty, care for others, and care for the environment is highlighted throughout this course. Flexibility in problem solving is developed through a mix of individual and small/large group assignments.

Teaching and learning strategies in a Transportation program include:

- **Group collaboration:** students work in teams or with partners to accomplish specific tasks. Individuals with differing strengths, skills, and knowledge work together to solve problems.
- **Individual effort:** students work independently to accomplish specific tasks. This may include research, reporting, or completing individual tasks related to a group project, e.g., record keeping, tool management for the group, performing sub-procedures in repair, replacement, or diagnosis.
- **Class discussion:** students actively participate by taking turns discussing relevant topics in the units of study. Teachers may direct discussions by posing initial questions; by demonstrating specific procedures, e.g., a proper and safe tool operation, or by presenting a media topic related to the current activity, e.g., a video, service bulletin, or recall.

- **Theoretical study:** students learn concepts and theory in application through the study of appropriate texts and manuals. Theoretical concepts are taught through Socratic lessons provided by the teacher or invited guests, or through assignments that involve research and study into technical procedures that apply to the current activities, e.g., specific manufacturers' procedure for battery load testing.

Important issues such as safety must be reinforced throughout the course. Following initial discussions and testing, teachers reintroduce specific topics as required. For example, before students lift a vehicle, the teacher reviews specific hoisting safety procedures.

A key component of this course is that students be made aware of career opportunities in the field of transportation. Strategies such as inviting guest speakers, conducting field trips or industry visits, participating in community based projects, encouraging and marketing job shadowing, and participating in co-op or apprenticeship placements are highly recommended.

Assessment & Evaluation of Student Achievement

Assessment and evaluation criteria must be clearly explained to students at the beginning of the course and at the onset of each project. Performance tasks are assessed using observational checklists, e.g., student's use of correct and safe procedures) from the perspective of professional performance. Knowledge acquisition is evaluated through testing, written reports and assignments, and formal student presentations.

Teachers assess student's progress through daily observation and self and peer assessment. Evaluation of thinking/inquiry tasks may take the form of project design or problem solving. The final assessment must reflect the weighting of the assessment categories, in that students must be given opportunities to demonstrate "hands-on" skills as well as theoretical learning.

Assessment strategies must reflect the categories found in the Achievement Chart. Sample rubrics are provided to demonstrate how the levels of achievement may be applied to a specific learning task.

Teachers should distinguish between development, which occurs in the areas considered "Learning Skills" and development towards meeting the expectations for the course.

It is important for the teacher to provide multiple opportunities for all students to participate in the activities and evaluate students individually, even while working within a collaborative group. Possible strategies include:

- individual deliverables, such as a research report, or detailed work order;
- a daily job or task sheet, to be signed by the student and the teacher (**Note:** these sheets can be attached to an end report, clearly indicating each group member's respective accomplishments.);
- individual conferencing, i.e., teacher-to-student discussions to assess development and to encourage or motivate;
- development of individual portfolios, skills profiles, log books, or time cards.

Assessment Category	Methods of Assessment	Weight
Knowledge/Understanding	Written, oral and/or practical tests Student/teacher conferencing Class presentations Formal projects Teacher observation Written assignments Written reports on diagnostic tasks	70%
Thinking/Inquiry	Sequenced procedural lists Written reports on diagnostic tasks	
Communications	Report writing Class presentations Customer relations Notebook	
Applications	Teacher observation of safe work habits Student/teacher conferencing	
Final Assessment	Teacher observation of "hands-on" skills Written testing Problem-solving and/or design tasks	30%

Accommodations

Various accommodations may be made throughout the program as required. They include one-to-one teaching/conferencing, adaptation of handouts, small group learning, and/or peer tutoring. Activities are monitored and adapted to meet the needs of all learners by applying various accommodations such as allowing increased time for activities, and facilitating peer tutor assistance when possible. Teachers using the course profiles are expected to be acquainted with students' Individual Education Plans (IEPs) and the unique learning characteristics of their individual students in order to make the necessary accommodations.

Specific accommodations in the transportation activities include:

- additional assistance for physical tasks;
- additional language resources (especially for technical terms);
- templates to assist in completing drawings or reports;
- peer tutoring or additional help in record-keeping, diagnosing, measuring, computing or fabricating tasks;
- examples of completed assignments;
- simulated faults for service challenges;
- one-on-one assistance in sequencing tasks;
- advanced service or research requirements.

Resources

Various resources are used throughout the course including the school Library/Resource Centre, public library, research software, transportation textbooks, websites, equipment and vehicle technical manuals, instructional videos, and community industry experts. Special tools may be required for several procedures, e.g., compression testing. An electronic service manual system is a valuable asset as students locate and print specifications and procedures for work performed. These copies may be inserted in the students' notebooks. Other resources, such as a teacher-developed worksheet of procedures and observations, are to be completed by students at predetermined points in the activity.

Print

Chapman, Norm. *Principles of Electricity and Electronics for the Automotive Technician*. South Puget Sound Community College: Delmar, 2000. ISBN 0-8273-8479-3

Crouse, W., D. Anglin, and W. Crouse. *Automotive Mechanics*. Glencoe McGraw-Hill, 1993. ISBN 0028009436

Derato, Frank C. *Automotive Electrical and Electronics Systems*, 2nd ed. United States: Glencoe Division Macmillian/McGraw-Hill, 1994. ISBN 0-02-800412-4

Duffy, James E. *Auto Electricity and Electronics Technology*. Illinois: Goodheart-Wilcox, 1995. ISBN 1-56637-053-1

Erjavec, Jack . *Automotive Technology: A Systems Approach*, 3rd ed. United States: Delmar Thomas Learning, 2000. ISBN 0-7668-0673-1

Hollembeak, Barry. *Automotive Electricity, Electronics and Computer Controls*. Technical Training, Inc, Delmar, 1999. ISBN 0-8273-6566-7

Kabala, Thomas. *Electricity 1: Devices, Circuits and Materials*. Delmar: 2001. ISBN 0-7668-1917-5

Schwaller, Anthony, E. *Motor Automotive Technology*. Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

Thiessen, Frank J. and Davis N. Dales. *Automotive Principles and Service*, 4th ed. New Jersey: Prentice Hall, 1994. ISBN 0-13-336561-1

OEM Reference and Repair Manuals/CD-ROMs, available from local dealerships

Videos

Several videos are available from THE LEARNING TREE

www.autovideo2000.com

ICS Learning - www.icslearning.com

Understanding Auto Technology and Repair Video Series – Tape 3: Understanding Automotive Electricity. Delmar, 2000. ISBN 0-7668-0794-0

Understanding Auto Technology and Repair Video Series – Tape 4: How to Diagnose Automotive Electrical Problems. Delmar, 2000. ISBN 0-7668-0795-9

Understanding Auto Technology and Repair Video Series – Tape 5: Understanding Automotive Electronics. Delmar, 2000. ISBN 0-7668-0796-7

Understanding Auto Technology and Repair Video Series – Tape 6: How to Diagnose Automotive Electronics Problems. Delmar, 2000. ISBN 0-7668-0797-5

Websites

Note: The URLs for the websites have been verified by the writer prior to publication. Given the frequency with which these designations change, teachers should always verify the websites prior to assigning them for student use.

Air Quality Program – Pollution Probe http://www.pollutionprobe.org/air/index.htm

How Things Work http://www.howthingswork.com/

Industry Canada http://strategis.ic.gc.ca/sc_indps/sectors/engdoc/tran_hpg.html

Inner. Auto http://www.innerauto.com/

Catholic Conservation Centre http://conservation.catholic.org

Online Ethics Centre for Engineering and Science http://onlineethics.org

Software

Mitchell. *On Demand Computerized Service Manuals*. San Diego, CA: 1999.

OSS Considerations

The Grade 11 Workplace Transportation Technology Course is designated as a Technological Education program. All courses offered in the technological education workplace stream are destination-related; they comprise a set of expectations that are appropriate for students who plan to begin apprenticeships or enter directly into the workforce upon graduation. (See *The Ontario Curriculum, Grades 9 to 12, Program Planning and Assessment, 2000* for a description of the different types of secondary school courses.) Students can use this course as a compulsory credit, (1 additional credit from Science [Grade 11 or Grade 12] or Technological Education [Grade 9 –12]), or as an optional credit. This course is designed to provide students with a broad educational base that will prepare them for their studies in Grade 12, Co-operative Education, or the OYAP, and to instill in them the need for lifelong learning in the workforce. The service-provider skills emphasized in this profile might also be applied to the student's Community Involvement Program (see Ontario Secondary Schools Grade 9 to 12 Program and Diploma Requirements 1999 for the above applications).

Students are involved in practical and theoretical aspects of Transportation Technology. The curriculum provides opportunities for students to undertake hands-on practical activities as well as to conduct research and analysis. There is a wide range of teaching/learning strategies and accommodations to meet the needs of all students at that level. Anti-discrimination education, equity/social justice issues, career goals/cooperative education, conflict resolution/violence prevention, and community partnerships may be addressed in the day-to-day progression of the course. All of these support many of the Ontario Secondary School Policies.

Career exploration throughout all units shall be made available to students with specific reference to *Choices into Action: Guidance and Career Education Program Policy for Elementary and Secondary Schools*, 1999.

Coded Expectations, Transportation Technology, Grade 11, Workplace Preparation, TTJ3E

Theory and Foundation

Overall Expectations

TFV.01 · apply the design process to develop solutions, products, processes, or services in response to challenges or problems in transportation technology;
TFV.02 · explain the use of each component of a vehicle system;
TFV.03 · analyse and describe the interrelationships of vehicle systems;
TFV.04 · describe and evaluate the fuels used to power vehicles.

Specific Expectations

The Design Process

TF1.01 – explain how human needs or wants related to transportation can be met through a new or improved vehicle or system;
TF1.02 – apply the following steps of the design process to solve a variety of transportation technology challenges or problems:

- ❑ identify what has to be accomplished (the problem);
- ❑ gather and record information, and establish a plan of procedures;
- ❑ brainstorm a list of as many solutions as possible;
- ❑ identify the resources required for each suggested solution, and compare each solution to the design criteria, refining and modifying it as required;
- ❑ evaluate the solutions (e.g., by testing, modelling, and documenting results) and choose the best one;
- ❑ produce presentation and working drawings, sketches, graphics, mathematical and physical models, or a prototype of the best solution;
- ❑ evaluate the prototype and determine the resources, including computer applications, required to produce it;
- ❑ communicate the solution, using one or more of the following: final drawings, graphs, charts, sketches, technical reports, electronic presentations, flow charts, mock-ups, models, prototypes, and so on;
- ❑ obtain feedback on the final solution and repeat the design process if necessary to refine or improve the solution.

Vehicle Systems

TF2.01 – analyse and describe the use of each of the following components of a vehicle: the chassis, frame, and body; the engine system; the fuel system; the electrical/electronics system; the gear and power train system; the steering system; the brake system; and the suspension system;
TF2.02 – explain the interrelationship of these vehicle components.

Energy and Energy Conversion

TF3.01 – explain the types and grades of fuel used in land, air, and marine vehicles;
TF3.02 – analyse and describe the energy values of different types and grades of fuels.

Skills and Processes

Overall Expectations

SPV.01 · function effectively both as individuals and as members of a cooperative team to service and repair vehicles;

SPV.02 · apply the technological principles of input, process, and output in troubleshooting vehicle systems;

SPV.03 · use current technology (e.g., on-line information from manufacturers, CD-ROM manuals, computerized diagnostic tools) when servicing, repairing, and modifying vehicles;

SPV.04 · communicate clearly about transportation techniques and applications using appropriate transportation terms;

SPV.05 · use mathematical and language skills effectively and apply scientific principles to help solve transportation technology challenges.

Specific Expectations

Organizational Skills

SP1.01 – use brainstorming techniques to help determine the best solution to a transportation-related challenge;

SP1.02 – model and communicate product ideas, materials, and specifications;

SP1.03 – describe the individual roles of members of an effective cooperative team and explain how team members function within these roles;

SP1.04 – develop a plan of procedures that indicates the steps required when repairing or servicing a vehicle;

SP1.05 – complete a work order for a specific transportation technology task.

Applied Work Practices and Procedures

SP2.01 – use effectively, store safely, and maintain in good working order measurement, hand, power, machine, and pneumatic tools and equipment required for basic service tasks;

SP2.02 – operate a variety of heating, cutting, and welding equipment for basic service tasks;

SP2.03 – systematically troubleshoot basic service problems on vehicles by organizing the variables into the following categories: input, process, and output;

SP2.04 – access and apply information from manuals, software databases, on-line information, and computerized diagnostic tools when troubleshooting and repairing components.

Communication Skills

SP3.01 – correctly interpret assembly drawings that depict the components of a vehicle's systems;

SP3.02 – conduct an accurate cost analysis of a repair or service and communicate the results of the analysis to a customer;

SP3.03 – produce oral, written, and word-processed reports of repairs or services.

Interdisciplinary Applications

SP4.01 – use mathematics to calculate volume, ratios, and dimensions;

SP4.02 – apply correctly, within the context of transportation technology, the scientific principles related to such areas as properties and states of matter, energy, force, Newton's laws of motion, simple machines, mechanical advantage, and basic electrical theory;

SP4.03 – use appropriate technical language in technical reports and presentations.

Impact and Consequences

Overall Expectations

ICV.01 · explain the environmental impact of materials and procedures used when servicing, repairing, and recycling vehicles;

ICV.02 · follow safe work practices in the transportation sector workplace, including safety procedures and practices and the use of protective clothing and gear;

ICV.03 · identify the legislation that applies to the transportation technology sector;

ICV.04 · describe the career opportunities available in the transportation sector on graduation from high school;

ICV.05 · describe and evaluate the employability skills required to be successful in the workplace.

Specific Expectations

Impacts

IC1.01 – explain the importance of the proper disposal of waste products;

IC1.02 – explain the benefits of using environmentally friendly products in the repair and service of vehicles.

Safety and Legislation

IC2.01 – work safely when performing tasks in the transportation sector;

IC2.02 – use all required protective clothing and gear (e.g., to protect the eyes, ears, hands, head, feet, and respiratory system) when working in the transportation sector;

IC2.03 – identify which aspects of the Occupational Health and Safety Act (OHSA), the Workplace Hazardous Materials Information System (WHMIS), and the Motor Vehicle Repair Act relate specifically to a transportation technology program;

IC2.04 – use material safety data sheets (MSDS) from the WHMIS when handling materials;

IC2.05 – describe the Motor Vehicle Repair Act and explain how it affects a transportation technology program.

Education, Training, and Career Opportunities

IC3.01 – describe apprenticeship and training opportunities in the transportation sector before and after graduation from high school;

IC3.02 – explain the importance of employability skills in achieving success in the workplace.

Ontario Catholic School Graduate Expectations

The graduate is expected to be:

A Discerning Believer Formed in the Catholic Faith Community who

CGE1a -illustrates a basic understanding of the **saving story** of our Christian faith;
CGE1b -participates in the **sacramental life** of the church and demonstrates an understanding of the centrality of the Eucharist to our Catholic story;
CGE1c -actively reflects on **God's Word** as communicated through the Hebrew and Christian scriptures;
CGE1d -develops attitudes and values founded on Catholic **social teaching** and acts to promote social responsibility, human solidarity and the common good;
CGE1e -speaks the **language of life**... "recognizing that life is an unearned gift and that a person entrusted with life does not own it but that one is called to protect and cherish it." (Witnesses to Faith)
CGE1f -seeks intimacy with God and celebrates **communion** with God, others and creation through prayer and worship;
CGE1g -understands that one's purpose or **call in life** comes from God and strives to discern and live out this call throughout life's journey;
CGE1h -respects the **faith traditions**, world religions and the life-journeys **of all people of good will**;
CGE1i -integrates faith with life;
CGE1j -recognizes that "sin, human weakness, conflict and forgiveness are part of the human journey" and that the cross, the ultimate sign of forgiveness is at the heart of **redemption**. (Witnesses to Faith)

An Effective Communicator who
CGE2a -listens actively and critically to understand and learn in light of gospel values;
CGE2b -reads, understands and uses written materials effectively;
CGE2c -presents information and ideas clearly and honestly and with sensitivity to others;
CGE2d -writes and speaks fluently one or both of Canada's official languages;
CGE2e -uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life.

A Reflective and Creative Thinker who
CGE3a -recognizes there is more grace in our world than sin and that hope is essential in facing all challenges;
CGE3b -creates, adapts, evaluates new ideas in light of the common good;
CGE3c -thinks reflectively and creatively to evaluate situations and solve problems;
CGE3d -makes decisions in light of gospel values with an informed moral conscience;
CGE3e -adopts a holistic approach to life by integrating learning from various subject areas and experience;
CGE3f -examines, evaluates and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society.

A Self-Directed, Responsible, Life Long Learner who

CGE4a -demonstrates a confident and positive sense of self and respect for the dignity and welfare of others;
CGE4b -demonstrates flexibility and adaptability;
CGE4c -takes initiative and demonstrates Christian leadership;
CGE4d -responds to, manages and constructively influences change in a discerning manner;
CGE4e -sets appropriate goals and priorities in school, work and personal life;
CGE4f -applies effective communication, decision-making, problem-solving, time and resource management skills;
CGE4g -examines and reflects on one's personal values, abilities and aspirations influencing life's choices and opportunities;
CGE4h -participates in leisure and fitness activities for a balanced and healthy lifestyle.

A Collaborative Contributor who

CGE5a -works effectively as an interdependent team member;
CGE5b -thinks critically about the meaning and purpose of work;
CGE5c -develops one's God-given potential and makes a meaningful contribution to society;
CGE5d -finds meaning, dignity, fulfillment and vocation in work which contributes to the common good;
CGE5e -respects the rights, responsibilities and contributions of self and others;
CGE5f -exercises Christian leadership in the achievement of individual and group goals;
CGE5g -achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others;
CGE5h -applies skills for employability, self-employment and entrepreneurship relative to Christian vocation.

A Caring Family Member who

CGE6a -relates to family members in a loving, compassionate and respectful manner;
CGE6b -recognizes human intimacy and sexuality as God given gifts, to be used as the creator intended;
CGE6c -values and honours the important role of the family in society;
CGE6d -values and nurtures opportunities for family prayer;
CGE6e -ministers to the family, school, parish, and wider community through service.

A Responsible Citizen who

CGE7a -acts morally and legally as a person formed in Catholic traditions;
CGE7b -accepts accountability for one's own actions;
CGE7c -seeks and grants forgiveness;
CGE7d -promotes the sacredness of life;
CGE7e -witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful and compassionate society;
CGE7f -respects and affirms the diversity and interdependence of the world's peoples and cultures;
CGE7g -respects and understands the history, cultural heritage and pluralism of today's contemporary society;
CGE7h -exercises the rights and responsibilities of Canadian citizenship;
CGE7i -respects the environment and uses resources wisely;
CGE7j -contributes to the common good.

Unit 2: Engine Operations

Time: 25 hours

Unit Description

Students acquire a comprehensive knowledge base in the concepts, terminology, and operation of single and multiple cylinder engines. Activities range from engine compression and oil pressure testing to diagnosing and repairing engine noises and faults. Developing skills in reading and applying technical information will help students become more effective communicators. Respect for the environment and wise use of resources are identified as key responsibilities in the Christian faith throughout the unit.

Unit Synopsis Chart

Activity	Time	Expectations	Assessment	Tasks
2.1 Internal Engine Diagnosis	180 min	TFV.02, TFV.03, TF2.01, TF2.02, SPV.01, SPV.02, SPV.03, SPV.05, SP1.05, SP2.01, SP2.03, SP2.04, SP4.02, ICV.02, IC2.01, IC2.02, CGE4f, CGE2b, CGE4b, CGE7i	K/U; T/I; A	Students: - determine appropriate testing procedures for engine analysis; - apply knowledge to interpret the results; - compare sets of results to establish a benchmark for running engine conditions.
2.2 Long Block Examination	540 min	TFV.02, TFV.03, TF2.01, TF2.02, SPV.01, SPV.02, SPV.03, SPV.05, SP1.05, SP2.01, SP2.03, SP2.04, SP4.02, ICV.02, IC2.01, IC2.02,	K/U; T/I; A	Students: - identify, locate, and disassemble engine components for a complete long block; - implement a system and sequence for disassembly to facilitate successful re-assembly.
2.3 Measuring Engine Components	180 min	SPV.01, SPV.03, SPV.05, SP1.04, SP2.01, SP2.04, SP4.01, SP4.02, CGE4f, CGE2b, CGE4b	K/U; A	Students: - use technical specifications in pass/fail evaluations of wear and tolerances; - use proper techniques and choose appropriate tools for examining various components.
2.4 Engine Design	360 min	TFV.02, TFV.03, TFV.04, TF1.01, TF2.01, TF2.02, TF3.01, SPV.04, SP3.03, SP4.02, SP4.03, CGE4f, CGE2b, CGE4b	K/U; C	Students: - use investigative and comparative techniques to identify traits of engine types and design; - report on various findings using the correct technical language.

2.5 Gaskets, Seals, and Sealants	300 min	SPV.01, SPV.02, SPV.03, SP1.02, SP1.04, SP1.05, SP2.01, SP2.02, SP2.03, SP2.04, SP3.01, SP3.02, SP3.03, SP4.02, ICV.01, ICV.02, IC1.01, IC1.02, IC2.01, IC2.02, IC2.03, IC2.04, IC3.02, CGE4f, CGE2b, CGE4b	A	Students: - reference technical manuals, sequence operations, and labour guides to assist in engine repair; - use appropriate tools and materials safely; - effect proper repairs and resealing, to industry standards; - use correct procedures for handling and disposing of "out of specification" parts and materials.

Activity 2.1: Internal Engine Diagnosis

Time: 180 minutes

Description

Students develop an understanding of the internal operation of the internal combustion engine. Students develop the necessary skills in the diagnosis of internal engine faults. Students use tools such as the stethoscope and compression tester. These observations, combined with an analysis of the spark plug electrodes, determine various engine running conditions. This activity promotes broad thinking and mutual respect through small group learning, as well as promoting the responsibilities of providing stewardship over the environment.

Strand(s) & Learning Expectations

Strand(s): Theory and Foundation, Skills and Processes, Impact and Consequences

Theory and Foundation

Overall Expectations

TFV.02 - explain the use of each component of a vehicle system;
TFV.03 - analyse and describe the interrelationships of vehicle systems.

Specific Expectations

TF2.01 - analyse and describe the use of each of the following components of a vehicle: the chassis, frame, and body; the engine system; the fuel system; the electrical/electronics system; the gear and power train system; the steering system; the brake system; and the suspension system;
TF2.02 - explain the interrelationship of these vehicle components.

Skills and Processes

Overall Expectations

SPV.01 - function effectively both as individuals and as members of a cooperative team to service and repair vehicles;
SPV.03 - use current technology (e.g., on-line information from manufacturers, CD-ROM manuals, computerized diagnostic tools) when servicing, repairing, and modifying vehicles;
SPV.05 - use mathematical and language skills effectively and apply scientific principles to help solve transportation technology challenges.

Specific Expectations
SP1.05 - complete a work order for a specific transportation technology task;
SP2.01 - use effectively, store safely, and maintain in good working order measurement, hand, power, machine, and pneumatic tools and equipment required for basic service tasks;
SP2.03 - systematically troubleshoot basic service problems on vehicles by organizing the variables into the following categories: input, process, and output;
SP2.04 - access and apply information from manuals, software databases, on-line information, and computerized diagnostic tools when troubleshooting and repairing components;
SP4.02 - apply correctly, within the context of transportation technology, the scientific principles related to such areas as properties and states of matter, energy, force, Newton's laws of motion, simple machines, mechanical advantage, and basic electrical theory.

Impact and Consequences

Overall Expectations
ICV.02 - follow safe work practices in the transportation sector workplace, including health and safety procedures and practices and the use of protective clothing and gear.

Specific Expectations
IC2.01 - work safely when performing tasks in the transportation sector;
IC2.02 - use all required protective clothing and gear (e.g., to protect the eyes, ears, hands, head, feet, and respiratory system) when working in the transportation sector.

Ontario Catholic School Graduate Expectations
CGE4f - applies effective communication, decision-making, problem-solving, time, and resource management skills;
CGE2b - reads, understands, and uses written materials effectively;
CGE4b - demonstrates flexibility and adaptability;
CGE7i - respects the environment and uses resources wisely.

Prior Knowledge & Skills

- Basic awareness of the operation of a 4-stroke cycle engine
- Awareness of basic hand tools and their uses
- Awareness of acceptable personal conduct standards and basic group working skills.

(**Note:** safety procedures and safe use of the shop must be reinforced)

Planning Notes

- Students are advised to wear proper work attire (shop coat or coveralls) and safety boots are recommended.
- Safety eyewear is mandatory.
- Recommended materials for this activity include:
  - service manuals or other means of researching procedures and specifications
  - compression tester, stethoscope, ratchet/spark plug socket, and engine oil
  - one 4-stroke cycle engine mounted on a stand
  - spark plug electrode condition sheet
  - task sheet of procedures and observations to be completed by students
  - exhaust gas ventilation/removal system
- Time should be allocated for student reflections on ethical respect for environmental considerations (e.g., fuel consumption, pollution: how it is produced and controlled), and moral choices in technical pursuits in the workplace (e.g., helping others, care and respect for customer needs, ethical business practices).

Teaching/Learning Strategies

1. Teachers remind students that as stewards of the earth and society (as outlined in the social teachings of the church) they should be aware of the negative impact on the environment caused by a poorly running engine. Students brainstorm and create a list of the ways the environment is impacted, e.g., pollution, increased fossil fuels depletion, noise pollution, and health problems.
2. Teachers discuss with students the health and safety concerns of working around a running engine. Special attention must be paid to the proper ventilation of exhaust fumes.
3. Students can be organized into groups of two to four.
4. The teacher conducts a brief review on the theory of the 4-stroke cycle engine operation and discusses the observable and measurable means by which one can determine an internal engine fault.
5. A shop, donated, or private operating vehicle can be easily obtained.
6. The teacher assists students in researching correct servicing procedures and using print or electronic sources.
7. Students remove spark plugs and do a visual inspection and comparison, using the spark plug electrode condition sheet as found in automotive texts.
8. The teacher introduces supporting spark plug theory and assists in the analysis. Students record the results on the task sheet.
9. Students conduct a dry, then wet compression test according to recommended procedure and results are recorded and compared to manufacturers specification.
10. Variances in test pressures can be discussed with probable faults reviewed.
11. The teacher demonstrates the use of a stethoscope in observing engine noise beginning with the head and then the block, referring to a 4-stroke cycle model as a visual aid. Emphasis should be given to safety procedures in the process.
12. Students must complete task sheets and hand them in for evaluation. Teachers may quiz the students on terminology and procedures.

Assessment & Evaluation of Student Achievement

Students are assessed and evaluated by the use of an evaluation rubric outlined below. A summative evaluation based on student demonstration is also conducted. Teachers may also elect to provide a written test on spark plug theory. Daily observation of students' work, safety practices, and organizational skill as the tasks are being performed are to be noted (see Appendix 2A and 2B for tracking sheets of student performance).

Sample Assessment Rubric Content for Unit 2 Activities – Engine Operations

Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Knowledge Describe the engine system and it's connections to the vehicle	- demonstrates limited knowledge of vehicle systems	- demonstrates adequate knowledge of vehicle systems	- demonstrates considerable knowledge of vehicle systems	- demonstrates insightful knowledge of vehicle systems and environmental impact of vehicles
Thinking/Inquiry Determine the correct vehicle system and the component, and use a proper removal and replacement procedure for a given repair	- demonstrates limited ability to determine system or component location and only suggest removal methods	- sometimes determines the component location, and removes/replaces properly	- usually determines the component location, and efficiently removes following direct instructions	- can independently and correctly locate and remove/replace the component in a timely and workman-like fashion
Application Uses tool and equipment correctly and safely	- demonstrates limited ability to select and safely use and cares for some hand tools	- sometimes selects and safely uses most hand tools correctly and cares for them appropriately	- usually selects and safely uses all tools correctly and cares for them appropriately	- selects and safely uses all tools correctly and cares for them appropriately and advises group members on correct tool usage
Knowledge Thinking/Inquiry Spark plug diagnosis	- demonstrates limited knowledge of spark plug analysis and supporting technical data	- demonstrates adequate knowledge of spark plug analysis and/or supporting technical data	- demonstrates considerable knowledge of spark plug analysis procedure, but not conclusive in diagnosis	- demonstrates mastery of spark plug analysis, using charts as proof of diagnosis
Application Task sheet report	- records limited information on task sheet	- records some information on task sheet	- completes most of task sheet	- fully completes task sheet with all key information noted

Note: A student whose achievement is below level 1 (50%) has not met the expectations for this assignment or activity.

Accommodations

Teachers may elect to give more or less guidance and directions in performing specific tasks. Students with strengths in one area of the activity should be encouraged to participate as team leaders, and as active group members in the other areas. This will provide an opportunity to exercise true teamwork in the activity.

As an extension, teachers may ask students to formally develop a set of inspection documents or posters for following classes.

Accommodations for students with special needs should be made as required to ensure the safety of individuals and others, while participating in course activities.

Resources

Print

Crouse. W., D. Anglin, and W. Crouse. *Automotive Mechanics*. Glencoe McGraw-Hill, 1993. ISBN 0028009436

Duffy, James E. *Auto Engines Technology*. The Goodheart-Wilcox Company, Inc., 1997. ISBN 1-56637-363-8

Halderman, James D. and Chase D. Mitchell. *Automotive Technology: Principles, Diagnosis, and Service*. Prentice Hall, 1999. ISBN 0133599698

Pulkrabek, Willard W. *Engineering Fundamentals of the Internal Combustion Engine*. Prentice Hall, 1997. ISBN 0135708540

Stockel, Martin W., Martin T. Stockel, and Chris Johnston. *Auto Fundamentals: How and Why of the Design, Construction, and Operation of Automobiles: Applicable to all Makes and Models*. Goodheart-Wilcox Co., 2000. ISBN 1566375770

Thiessen, F. and D. Dales. *Automotive Principles and Service*, 4th ed. Prentice Hall, 1994. ISBN 0-13-336561-1

Websites

Auto Technology - http://www.indiamart.com/autotechnology/auto-tech-engine.html.

Canadian Driver - http://www.canadiandriver.com

How Things Work - http://www.howthingswork.com/

Inner. Auto - www.innerauto.com

Software

Mitchell. On Demand Computerized Service Manuals. San Diego, CA: 1999.

Motive Power Applied Work Practices, Various Titles Produced by Algonquin College, Canadore College, and La Cite Collegiale in cooperation with the Ministry of Education and Training.

Other

Computerized Service Manuals

Ministry of Transportation Emission Publications

OEM Reference and Repair Manuals

Ontario Health and Safety Act

Activity 2.2: Long Block Examination

Time: 540 minutes

Description

Students disassemble a complete automotive engine into its various component building blocks, inspecting parts for signs of wear or damage. While acquiring the necessary skills and knowledge to service and repair engines, students make connections between the various types of engine designs. Students demonstrate ethically and morally sound work practices, both as a service provider in a consumer industry, and as a responsible person dealing with environmental issues.

Strand(s) & Learning Expectations

Strand(s): Theory and Foundation, Skills and Processes, Impact and Consequences

Theory and Foundations

Overall Expectations

TFV.02 - explain the use of each component of a vehicle system;
TFV.03 - analyse and describe the interrelationships of vehicle systems.

Specific Expectations

TF2.01 - analyse and describe the use of each of the following components of a vehicle: the chassis, frame, and body; the engine system; the fuel system; the electrical/electronics system; the gear and power train system; the steering system; the brake system; and the suspension system;
TF2.02 - explain the interrelationship of these vehicle components.

Skills and Processes

Overall Expectations

SPV.01 - function effectively both as individuals and as members of a cooperative team to service and repair vehicles;
SPV.03 - use current technology (e.g., on-line information from manufacturers, CD-ROM manuals, computerized diagnostic tools) when servicing, repairing, and modifying vehicles;
SPV.05 - use mathematical and language skills effectively and apply scientific principles to help solve transportation technology challenges.

Specific Expectations

SP1.05 - complete a work order for a specific transportation technology task;
SP2.01 - use effectively, store safely, and maintain in good working order measurement, hand, power, machine, and pneumatic tools and equipment required for basic service tasks;
SP2.03 - systematically troubleshoot basic service problems on vehicles by organizing the variables into the following categories: input, process, and output;
SP2.04 - access and apply information from manuals, software databases, on-line information, and computerized diagnostic tools when troubleshooting and repairing components;
SP4.02 - apply correctly, within the context of transportation technology, the scientific principles related to such areas as properties and states of matter, energy, force, Newton's laws of motion, simple machines, mechanical advantage, and basic electrical theory.

Impact and Consequences

Overall Expectations

ICV.02 - follow safety practices used in the transportation sector workplace, including safety procedures and practices and the use of protective clothing and gear.

Specific Expectations
ICV.02 - follow safe work practices in the transportation sector workplace, including safety procedures and practices and the use of protective clothing and gear;
IC2.01 - work safely when performing tasks in the transportation sector;
IC2.02 - use all required protective clothing and gear (e.g., to protect the eyes, ears, hands, head, feet, and respiratory system) when working in the transportation sector.

Catholic Graduate Expectations
CGE4f - applies effective communication, decision-making, problem-solving, and time and resource management skills;
CGE2b - reads, understands, and uses written materials effectively;
CGE4b - demonstrates flexibility and adaptability.

Prior Knowledge & Skills

- Safety passport method of tracking safety instruction
- Familiar with the safe use of basic hand tools

Planning Notes

Students disassembling an engine must have the necessary space available. All removed parts must be neatly laid out on a bench. The instructor is encouraged to demonstrate an orderly workplace at all times. Furthermore, the engine should be mounted on an engine stand for reasons of safety and ease of disassembly. All fluids such as engine oil, coolant, and gasoline should be drained prior to the students commencing the activity. The tools needed for this activity should be readily available for the students at the project workstation. All safety equipment must be worn according to school board policy.

Project groups may consist of two to three students at maximum. Teachers should review appropriate conduct during group work. It should be noted here that the engines available for this activity might differ from school to school. It is recommended that the minimum project engine be gasoline powered with four cylinders and mechanical valve lifters. If possible, the engine should have some sort of internal damage to make this as realistic a project as possible. Teachers should provide step-by-step instructions for completing the various tasks prior to beginning.

Teaching/Learning Strategies

1. An initial lesson must be given by the teacher to introduce the activity to students. Students are given a briefing on the various tools needed in this activity. An automotive textbook that depicts all tools needed for the activity may serve as a point of reference for students during the activity. As the activity requires the use of several special tools to complete this task, the teacher must clearly explain and demonstrate the application of each tool.
2. Project work commences by having students remove engine components such as rocker arm covers and oil pans. All parts and fasteners must be cleaned in the parts washer and neatly organized for easy reassembly. Old gaskets may be removed and gasket-mating surfaces are thoroughly cleaned.
3. Timing belt removal, replacement, and installation requires students to pay particular attention to timing marks. It is recommended to follow manufacturer's procedures at all times. This is a good time for the instructor to discuss the purpose and the importance of the timing belt/chain with the project group. Removing and replacing a timing belt on an engine mounted on a stand provides students with the necessary practise to gain the confidence of being able to perform this service operation at a later point with little supervision. Once students have correctly reinstalled the timing belt, the teacher may instruct students to properly adjust the valve lash. Despite an increasing number of vehicles that require no adjustments to the valve train, many automobiles still require periodic adjustments to guarantee optimal engine performance.

4. Once students have mastered the timing belt/chain settings and valve lash adjustment, the cylinder heads may be removed.
5. Next is the disassembly of the short block, which consists of a cylinder block, crankshaft, crankshaft bearings, connecting rods, pistons, and piston rings. In some cases, a short block may also include a camshaft and timing gear. Prior to the piston removal, the ridge on the cylinder may have to be reamed with a ridge reamer. Once the ridges are removed, students proceed to remove the pistons by removing the connecting rod caps. At this point, the connecting rod cap studs should be covered with a rubber hose. This in turn prevents possible damage to the crankshaft and cylinder walls due to scratching during removal. It is of utmost importance that rod bearing caps and the corresponding piston and the connecting rod for each individual cylinder are kept together as an assembly. They cannot be interchanged with any identical parts belonging to a different cylinder. The piston, piston pin, and connecting rod may be disassembled. Finally, students remove the compression and oil rings as outlined in the manufacturers specifications.
6. Students remove the main bearing caps and remove the crankshaft. All bearings and caps must be organized in corresponding pairs and labelled to ensure that identical parts are not "mixed up."
7. All parts are thoroughly cleaned, air dried, and neatly laid out for visual inspection and measuring. At this point, teachers discuss the evidence of component failure to make students aware of parts failure identification diagnostic techniques. Teachers also take this opportunity to explain the inner workings of an engine.

Assessment & Evaluation of Student Achievement

The teacher may evaluate a student's performance on each individual task in this activity as outlined in the sample rubric. In addition, written tests may determine a student's retention of theoretical aspects of this activity. See Appendix 2A and 2B for tracking sheets of student progress.

Sample Assessment Rubric for Long Block Examination

Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Knowledge Application To correctly remove and reinstall a timing belt	- seldom removes and reinstalls a timing belt correctly	- sometimes removes and reinstalls a timing belt correctly	- usually removes and reinstalls a timing belt	- always removes and reinstalls a timing belt as outlined in the service/repair manual
Knowledge Application To correctly adjust valve lash according to manufacturer's specifications	- seldom adjusts valve lash	- sometimes adjusts valve lash correctly	- usually adjusts valve lash correctly	- always adjusts valve lash as outlined in the service/repair manual
Knowledge Communication To correctly describe the four-stroke cycle and the functions of all engine parts	- has limited ability to describe the four-stroke cycle and function of all engine parts	- sometimes is able to describe the four-stroke cycle and function of all engine parts correctly	- often is able to describe the four-stroke cycle and function of all engine parts correctly	- is able to describe the four-stroke cycle and function of all engine parts independently

Knowledge **Thinking/Inquiry** To correctly disassemble a long block (short block, cylinder heads, and	- experiences limited ability to disassemble a long block	- sometimes disassembles the long block and performs most of the tasks correctly	- often disassembles the long block and performs the tasks correctly	- always disassembles long block and performs the tasks correctly as outlined in the service/repair manual
Knowledge **Thinking/Inquiry** To recognize possible causes of engine failure	- demonstrates limited ability to examine engine parts and recognize possible causes of engine failure	- sometimes examines engine parts and recognizes possible causes of engine failure correctly	- usually examines engine parts recognizes possible causes of engine failure correctly	- examines engine parts and recognizes possible causes of engine failure correctly and independently

Note: A student whose achievement is below level 1 (50%) has not met the expectations for this assignment or activity.

Accommodations

The teacher may provide students who experience difficulties performing the tasks with additional instructional time and repeat demonstrations. Students may also watch an instructional video on an engine disassembly to become more familiar with the activity in both remedial and supplementary situations. For enrichment, students who demonstrate excellent insight and workmanship may be further challenged by additional tasks, such as a research assignment on the topic of how to increase the performance of a engine.

Resources

Print

Erjavec, J. and R. Scharff. *Automotive Technology - A Systems Approach*, 2nd ed. Delmar Publisher, 1996. ISBN 0-8273-6724-4 (case)

Thiessen, Frank J. *Automotive Engine Repair And Rebuilding*. Prentice Hall, 1992. ISBN 0-13-051012-2

Hollembeak, Barry. *Today's Technician-Automotive Engine Repair and Rebuilding*. Delmar Publisher, 1997. ISBN 0-8273-6187-4

OEM Reference and Repair Manuals

Software

Mitchell. *On Demand Computerized Service Manuals*. San Diego, CA: 1999.

Video

Administration Information Media. *Rebuilding A Small Block Engine*. Valesmith, 1987. 103 min

Activity 2.3: Measuring Engine Components

Time: 180 minutes

Description

This activity provides students with the opportunity to measure dimensions of various engine components of a disassembled engine. Students are introduced to several precision measuring tools and measure a variety of engine components. These measurements are then compared with those recommended by the manufacturer.

Strand(s) & Learning Expectations

Strand(s): Skills and Processes

Skills and Processes

Overall Expectations

SPV.01 - function effectively both as individuals and as members of a cooperative team to service and repair vehicles;
SPV.03 - use current technology (e.g., on-line information from manufacturers, CD-ROM manuals, computerized diagnostic tools) when servicing, repairing, and modifying vehicles;
SPV.05 - use mathematical and language skills effectively and apply scientific principles to help solve transportation technology challenges.

Specific Expectations

SP1.04 - develop a plan of procedures that indicates the steps required when repairing or servicing a vehicle;
SP2.01 - use effectively, store safely, and maintain in good working order measurement, hand, power, machine, and pneumatic tools and equipment required for basic service tasks;
SP2.04 - access and apply information from manuals, software databases, on-line information, and computerized diagnostic tools when troubleshooting and repairing components;
SP4.01 - use mathematics to calculate volume, ratios, and dimensions;
SP4.02 - apply correctly, within the context of transportation technology, the scientific principles related to such areas as properties and states of matter, energy, force, Newton's laws of motion, simple machines, mechanical advantage, and basic electrical theory.

Ontario Catholic School Graduate Expectations

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;
CGE2b - reads, understands, and uses written materials effectively;
CGE4b - demonstrates flexibility and adaptability.

Prior Knowledge & Skills

- Familiarity with the safe use of basic hand tools

Planning Notes

- Prior to the activity, the teacher must ensure that students clean and neatly lay engine components out on a bench.
- Measuring tools such as micrometers, dial indicators, feeler gauges, vernier calipers, etc., should be readily available to the student.

Teaching/Learning Strategies

1. The teacher introduces the activity with a lesson on measuring tools. Teachers first provide students with handouts that depict the various measuring tools and label each important part of a specific measuring tool, e.g., anvil, ratchet stop, lock, frame, thimble, and the sleeve of a micrometer. Measuring tools used in this activity are various micrometers, vernier callipers, feeler gauges, and dial indicators. It is important that students first acquire the skill of accurately reading a measuring tool. Students are taught step by step how to read a micrometer to its smallest indication level. Other measuring tools are introduced to students in a similar fashion.

2. Students are presented with a variety of engine components such as a piston, engine block, camshaft, and crankshaft. For each of these engine components, students must make accurate measurements in accordance with the manufacturer's recommended procedures and specifications. The following measurements are taken for each engine part:
   - **Pistons:** Pistons are measured to determine piston size and skirt collapse. These measurements are performed with an outside micrometer. As part of the piston measurement students may also measure to determine ring groove wear. These measurements may be performed with a feeler gauge or a piston ring groove gauge.
   - **Engine Cylinders:** Engine cylinders are measured for bore size, cylinder taper, out-of-round, and surface finish. These measurements may be taken with a cylinder taper gauge, an inside micrometer, or a telescopic gauge and outside micrometer.
   - **Crankshaft:** The crankshaft is measured for runout, journal size wear, taper, "out of round", and thrust surface wear. The measuring tools used are outside and inside micrometers.
   - **Connecting Rods:** Connecting rods are measured to determine if they are bent or twisted. Also, the connecting rod big-end bore is measured for "out-of-round" with a dial bore gauge.
   - **Camshafts:** Camshafts are measured for camshaft bearing journal wear, camshaft runout, and camshaft lobe wear. The measuring tools required are an outside micrometer and a dial indicator.
   - **Cylinder Head and Block Deck Surface:** Both of these surfaces are initially inspected for damage such as scoring, etching, or erosion. Any visible damage to these surfaces requires the block deck and cylinder head to be resurfaced. The cylinder head and block deck should also be inspected for warpage. The measuring tools used are a straightedge and feeler gauge.

Assessment & Evaluation of Student Achievement

Students' knowledge of the various measuring tools and how to read the measurement may be assessed in the following ways: written tests requiring students to label pictures of measuring tools will determine if the student has retained the names of the parts of the various measuring tools; observation of student performance of practical measuring tests on a variety of engine parts and reporting the results in written and/or verbal form to the instructor. (See Appendix 2A and 2B for tracking forms.)

Sample Assessment Rubric for Measuring Engine Components

Expectations	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Application To follow manufacturers' recommended measuring procedures	- has limited ability to follow recommended measuring procedures as outlined in the service/repair manual	- has some ability to follow recommended measuring procedures as outlined in the service/repair manual	- has considerable ability to follow recommended measuring procedures as outlined in the service/repair manual	- is always able to follow recommended measuring procedures as outlined in the service/repair manual
Application Knowledge To make accurate measurements on engine parts	- has limited ability to make accurate measurements	- has some ability to make accurate measurements	- has considerable ability to make accurate measurements	- always makes accurate measurements
Knowledge Communication To name the parts of measuring tools used in this activity	- has limited ability to name parts of the measuring tools used in this activity	- can name some parts of the measuring tools used in this activity	- can name many parts of the measuring tools used in this activity	- can name all parts of the measuring tools used in this activity

Note: A student whose achievement is below level 1 (50%) has not met the expectations for this assignment or activity.

Accommodations

The teacher may provide students who experience difficulties performing the tasks with additional instructional time, repeat demonstrations, or assistance in lifting heavy engine components. For enrichment, students may investigate the probable causes of excessive wear on components which are no longer within the required dimension tolerance of the manufacturer.

Resources

Print

Erjavec, J. and R. Scharff. *Automotive Technology - A Systems Approach*, 2nd ed. Delmar Publisher, 1996. ISBN 0-8273-6724-4 (case)

Thiessen, Frank J. *Automotive Engine Repair And Rebuilding*. Prentice Hall, 1992. ISBN 0-13-051012-2

Hollembeak, Barry. *Today's Technician-Automotive Engine Repair and Rebuilding*. Delmar Publisher, 1997. ISBN 0-8273-6187-4

OEM Reference and Repair Manuals

Software

Mitchell. *On Demand Computerized Service Manuals*. San Diego, CA: 1999.

Activity 2.4: Engine Design

Time: 300 minutes

Description

Students analyse the rationale behind modern internal combustion engine design. Students, already having a base knowledge of the inner workings of an internal combustion engine, investigate a variety of power plants: gasoline, diesel, alternative fuels, air/liquid cooled, and high performance. Individually or with a partner, students research aspects of one type of power plant and present their findings to the class. Students describe environmental issues related to motive power production, and how careful stewardship can improve our world.

Strand(s) & Learning Expectations

Strand(s): Theory and Foundation, Skills and Processes

Theory and Foundation

Overall Expectations

TFV.02 - explain the use of each component of a vehicle system;
TFV.03 - analyse and describe the interrelationships of vehicle systems;
TFV.04 - describe and evaluate the fuels used to power vehicles.

Specific Expectations

TF1.01 - explain how human needs or wants related to transportation can be met through a new or improved vehicle or system;
TF2.01 - analyse and describe the use of each of the following components of a vehicle: the chassis, frame, and body; the engine system; the fuel system; the electrical/electronics system; the gear and power train system; the steering system; the brake system, and the suspension system;
TF2.02 - explain the interrelationship of these vehicle components;
TF3.01 - explain the types and grades of fuel used in land, air, and marine vehicles.

Skills and Processes

Overall Expectations

SPV.04 - communicate clearly about transportation techniques and applications using appropriate transportation terms.

Specific Expectations

SP3.03 - produce oral, written, and word-processed reports of repairs or services;
SP4.02 - apply correctly, within the context of transportation technology, the scientific principles related to such areas as properties and states of matter, energy, force, Newton's laws of motion, simple machines, mechanical advantage, and basic electrical theory;
SP4.03 - use appropriate technical language in technical reports and presentations.

Ontario Catholic School Graduate Expectations

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;
CGE2b - reads, understands and uses written materials effectively;
CGE4b - demonstrates flexibility and adaptability.

Prior Knowledge & Skills

- Basic understanding of the operation of a 4-stroke cycle engine.
- Awareness of personal conduct standards
- General library and/or Internet research skills. Students should be aware of "acceptable use" policies as established by the school board.
- Basic keyboarding skills
- Knowledge of how to work cooperatively during group situations

Planning Notes

- This activity may be spread over the duration of the course to allow students sufficient in-school research time.
- The teacher may predetermine the list of engines for students to choose from, to ensure that all possible power plants are covered.
- Students should be encouraged to choose a vehicle that interests them and investigate the power plant.
- A teacher-developed progress sheet may be used to record research developed to specific time lines.
- Before beginning the activity the teacher should remind the students of their Christian responsibility in developing effective communication, decision-making, problem-solving, time and resource management skills.

Teaching/Learning Strategies

1. Teachers discuss a base rationale for using the various types of engine design that should include gas/diesel, alternative fuels and high performance engines. Specific applications can be introduced at this point. Teachers also discuss environmental issues that need or are addressed by each type of engine design concept. Students are asked to list those issues for inclusion into their reports.
2. Students are given a list of power plants and their application, such as:
    - air-cooled, horizontally opposed engine – motorsports vehicle
    - diesel powered large displacement - ship
    - multiple or variable cam – high performance luxury car
3. A teacher-developed activity handout with research expectations and time constraints should be given to each student.
4. Students are given the opportunity to visit their Library/Resource Centre and/or access the Internet in order to conduct their research. Students should use a variety of types of reference media including texts, manuals, magazines, specialized software, and Internet search engines.
5. Students prepare a written report and present their findings to the class. Emphasis should be placed upon a strong visual presentation. The teacher may augment the presentation with essential theory on the given power plant.

Assessment & Evaluation of Student Achievement

Students will be assessed on several aspects of this project:

- research – the quality of the research demonstrated, use of a bibliography and reference list, and the initiative demonstrated
- written report – demonstrated knowledge of the content, accuracy of information, originality, and presentation
- verbal and visual presentation – the demonstrated depth of understanding of the subject, and the quality and effort given to the presentation

Sample Assessment Rubric for Technical Report and Presentation

Expectations	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Knowledge Application Demonstrates an understanding and application of ideas	- demonstrates a limited understanding and application of ideas	- demonstrates an adequate understanding and application of ideas	- consistently demonstrates an understanding and application of ideas	- demonstrates a thorough understanding and application of ideas in a variety of contexts
Thinking/Inquiry Organizes information	- may contain errors in formatting, needs remedial organizational skills	- may contain minor errors in formatting, demonstrates adequate organizational skills	- formatting clean and consistent, consistently demonstrates considerable organizational skills	- creative formatting, demonstrates considerable skill in organization of content
Communication Explains concepts in scientific and engineering terms	- limited demonstration of knowledge of scientific and engineering terminology	- adequately demonstrates knowledge of scientific and engineering terminology	- correctly demonstrates knowledge of scientific and engineering terminology	- always demonstrates knowledge of scientific and engineering terminology
Application Demonstrates knowledge of environmental issues	- limited demonstration of knowledge of environmental issues	- adequately demonstrates knowledge of environmental issues	- correctly demonstrates knowledge of environmental issues	- always demonstrates knowledge of environmental issues

Note: A student whose achievement is below level 1 (50%) has not met the expectations for this assignment or activity.

Accommodations

Strategies to accommodate a variety of learning styles in the classroom may include:

- additional handouts to summarize written and discussion material;
- use of other school resources for assistance with written assignments;
- additional time allowance for completion of practical projects;
- consultation with parents;
- assistance with organizational skills;
- additional one-on-one time by a teacher or peer tutors;
- alternative activities to meet student needs;
- providing enrichment opportunities such as requirements for more in-depth research.

If required, consultations should be held with students, parents, resource, guidance, and special education departments, to assist in developing or analysing the IEP for an individual student.

Resources

Print

Crouse, W., D. Anglin, and W. Course. *Automotive Mechanics*. Glencoe McGraw-Hill, 1993. ISBN 0028009436

Duffy, James E. *Auto Engines Technology*. The Goodheart-Wilcox Company, Inc., 1997. ISBN 1-56637-363-8

Lawlor, John. *Auto Math Handbook: Calculations, Formulas, Equations and Theory for Automotive Enthusiasts*. H.P. Books, 1991. ISBN 1557880204

Pulkrabek, Willard W. *Engineering Fundamentals of the Internal Combustion Engine*. Prentice Hall, 1997. ISBN 0135708540

Stockel, Martin W., Martin T. Stockel, and Chris Johnston. *Auto Fundamentals: How and Why of the Design, Construction, and Operation of Automobiles: Applicable to all Makes and Models*. Goodheart-Wilcox Co., 2000. ISBN 1566375770

Thiessen, F. and D. Dales. *Automotive Principles and Service*, 4th ed. Prentice Hall, 1994. ISBN 0-13-336561-1

Websites

Auto Technology - http://www.indiamart.com/autotechnology/auto-tech-engine.html.

Canadian Driver - http://www.canadiandriver.com

Engine Design - http://www.autoshop101.com

http://www.autopro.8k.com/engine.html

http:/www.gti.org

http://www.bartleby.com/65/in/intern.co.html

http://www.z28.com

http://monito.com

Engine Rebuilders Association - http://www.aera.org/main.htm

How Things Work - http://www.howthingswork.com/

Inner. Auto - www.innerauto.com

Popular Mechanics Magazine - http://www.popularmechanics.com/

Society of Automotive Engineers - http://www.sae.org/index.htm

Software

Mitchell. *On Demand Computerized Service Manuals*. San Diego, CA: 1999.

Motive Power Applied Work Practices, Various Titles. Produced by Algonquin College, Canadore College, and La Cite Collegiale in cooperation with the Ministry of Education and Training.

Email: cooke@algonquinc.on.ca

Other

OEM Reference and Repair Manuals and CD-ROMs

Ontario Occupational Health and Safety Act

Activity 2.5: Gaskets, Seals, and Sealants

Time: 300 minutes

Description

This activity introduces students to the theoretical and practical aspects of gaskets, seals, and sealants. Through teacher-led discussions and worksheets, students learn the theory behind gaskets, seals, and sealants. Using shop models, students apply this new knowledge to a variety of tasks: valve cover replacement, oil pan reseal, and camshaft seal replacement.
Students should be aware of the health and safety and environmental concerns throughout this activity.

Strand(s) & Learning Expectations

Strand(s): Skills and Processes, Impact and Consequences

Skills and Processes

Overall Expectations

SPV.01 - function effectively both as individuals and as members of a cooperative team to service and repair vehicles;
SPV.02 - apply the technological principles of input, process, and output in troubleshooting vehicle systems;
SPV.03 - use current technology (e.g., on-line information from manufacturers, CD-ROM manuals, computerized diagnostic tools) when servicing, repairing, and modifying vehicles.

Specific Expectations

SP1.02 - model and communicate product ideas, materials, and specifications;
SP1.04 - develop a plan of procedures that indicates the steps required when repairing or servicing a vehicle;
SP1.05 - complete a work order for a specific transportation technology task;
SP2.01 - use effectively, store safely, and maintain in good working order measurement, hand, power, machine, and pneumatic tools and equipment required for basic service tasks;
SP2.02 - operate a variety of heating, cutting, and welding equipment for basic service tasks;
SP2.03 - systematically troubleshoot basic service problems on vehicles by organizing the variables into the following categories: input, process, and output;
SP2.04 - access and apply information from manuals, software databases, on-line information, and computerized diagnostic tools when troubleshooting and repairing components;
SP3.01 - correctly interpret assembly drawings that depict the components of a vehicle's systems;
SP3.02 - conduct an accurate cost analysis of a repair or service and communicate the results of the analysis to a customer;
SP3.03 - produce oral, written, and word-processed reports of repairs or services;
SP4.02 - apply correctly, within the context of transportation technology, the scientific principles related to such areas as properties and states of matter, energy, force, Newton's laws of motion, simple machines, mechanical advantage, and basic electrical theory.

Impact and Consequences

Overall Expectations

ICV.01 - explain the environmental impact of materials and procedures used when servicing, repairing, and recycling vehicles;
ICV.02 - follow safe work practices in the transportation sector workplace, including safety procedures and practices and the use of protective clothing and gear.

Specific Expectations
IC1.01 - explain the importance of the proper disposal of waste products;
IC1.02 - explain the benefits of using environmentally friendly products in the repair and service of vehicles;
IC2.01 - work safely when performing tasks in the transportation sector;
IC2.02 - use all required protective clothing and safety equipment (e.g., to protect the eyes, ears, hands, head, feet, and respiratory system) when working in the transportation sector;
IC2.03 - identify which aspects of the Occupational Health and Safety Act (OHSA), the Workplace Hazardous Materials Information System (WHMIS), and the Motor Vehicle Repair Act relate specifically to a transportation technology program;
IC2.04 - use material safety data sheets (MSDS) from the WHMIS when handling materials;
IC3.02 - explain the importance of employability skills in achieving success in the workplace.

Ontario Catholic School Graduate Expectations
CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;
CGE2b - reads, understands and uses written materials effectively;
CGE4b - demonstrates flexibility and adaptability.

Prior Knowledge & Skills

- Before working in a shop environment, students must be aware of general shop rules, health and safety requirements, and the safety rules for specific tools and machines.
- Basic 4-stroke cycle engine theory and practice
- Vehicle jacking/hoisting procedures and proper placement of jack stands
- Awareness of acceptable personal conduct standards
- Basic shop hand tool knowledge

Planning Notes

- Students are advised to wear proper work attire (shop coat or coveralls). Safety boots are highly recommended.
- Safety eyewear is mandatory.
- Recommended materials for this activity include:
  - Service manuals or other means of researching procedures and specifications;
  - Hand tools, torque wrench, seal removal and installation tools, model engine on stand, and donated or "customer" owned vehicle.
- To facilitate effective learning there should be no more than two students per group or task.
- Teachers may produce a task analysis sheet for students to record crucial steps and necessary data.
- This activity can be linked to science (chemistry and physics)

Teaching/Learning Strategies

1. The teacher discusses with students the environmental consequence and impact oil leaks have on the earth, and our responsibilities as Christian stewards of the earth.
2. The teacher presents a short theoretical lesson on the function, purpose, and location of seals, gaskets, and sealants.
3. Student review a shop manual to follow correct servicing procedures.

   Valve Cover Reseal
   - Remove cover using correct hand tools.
   - Remove gasket from cover and check for wear due to heat and being compressed.
   - Clean head surface and install new gasket paying attention to correct torquing procedures.

Oil Pan Reseal

- The teacher outlines the maintenance concerns with different types of oil pans.
- This activity requires students to hoist the vehicle. The teacher must ensure competency for such a procedure.
- Student drain oil if using a live vehicle or proceed to a model engine.
- Remove pan bolts according to manufacturer procedure.
- If sealed with silicone, the teacher demonstrates the correct removal procedure pointing out the risk and implication of bending the oil pan lip.
- If sealed with a gasket students may proceed on their own.
- Removal on a live vehicle may require students to remove exhaust components. Please take note, as this will increase the task time.
- The teacher provides an example of the correct amount of silicone required to reseal the pan and the implications and consequence of using too much.
- Students replace the oil pan and follow correct manufacturer torquing procedures.
- If a live vehicle is used, refill with oil.

4. Students hand in the completed task analysis sheet. (see Appendix…)

Assessment & Evaluation of Student Achievement

Teachers are to observe students performing tasks during class time as part of the assessment strategy. A teacher-developed tracking sheet may be used to organize this process. (See Appendix 2A and 2B.) Student task sheets may be reviewed as an indication of communication skills and comprehension of the topic. Summative evaluation of the activity can be accomplished by having students complete a written or practical test.

Sample Assessment Rubric for Oil Pan Reseal

Expectations	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Knowledge Thinking/Inquiry Communication State purpose and rationale for oil pan reseal	- identify oil pan leaks	- identify oil pan leaks and two methods of resealing	- describe different methods of resealing an oil pan	- describe method and purpose for oil pan reseal and describe environmental impact
Application Oil pan removal	- seldom removes oil pan correctly	- sometimes removes oil pan correctly	- usually removes oil pan correctly	- removes oil pan independently and correctly with proper technique
Application Uses tools and equipment correctly	- selects and uses some hand tools and cares for them appropriately	- selects and uses most hand tools correctly and cares for them appropriately	- selects and uses all tools correctly and cares for them appropriately	- selects and uses all tools correctly and cares for them appropriately and advises group members on correct tool usage

Application Oil pan replacement	- seldom replaces oil pan correctly	- occasionally correct with oil pan reseal and replacement	- reseals and replaces oil pan correctly and uses proper torquing procedure	- reseals and replaces oil pan independently using correct procedures and advises group members
Communication Task Sheet Report	- records some information on task sheet	- records most information on task sheet	- fully completes task sheet	- fully completes task sheet with all key information noted

Note: A student whose achievement is below level 1 (50%) has not met the expectations for this assignment or activity.

Accommodations

Strategies to accommodate the various learning styles in the classroom may include:

- additional handouts to summarize written and discussion material;
- use of other school resources for assistance with written assignments;
- additional time allowance for completion of practical projects;
- additional homework research assignments;
- consultation with parents;
- assistance with organizational skills;
- additional one-on-one time by teacher or peer tutors;
- alternative activities to meet student needs;
- assistance in moving heavy components.

If required, consultations should be held with students, parents, resource, guidance, and special education departments, to assist in understanding and developing an IEP for individual students.

Resources

Print

Crouse, W., D. Anglin, and W. Crouse. *Automotive Mechanics*. Glencoe McGraw-Hill, 1993. ISBN 0028009436

Duffy, James E. *Auto Engines Technology*. The Goodheart-Wilcox Company, Inc., 1997. ISBN 1-56637-363-8

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Websites

Auto Technology - http://www.indiamart.com/autotechnology/auto-tech-engine.html.

Canadian Driver - http://www.canadiandriver.com

Engine Design - http://www.autoshop101.com

Engine Rebuilders Association - http://www.aera.org/main.htm

How Things Work - http://www.howthingswork.com/

Inner. Auto - www.innerauto.com

Society of Automotive Engineers - http://www.sae.org/index.htm

Software

Mitchell. On Demand Computerized Service Manuals. San Diego, CA: 1999.

Motive Power Applied Work Practices, Various Titles, Produced by Algonquin College, Canadore College, and La Cite Collegiale in cooperation with the Ministry of Education and Training.

Email: cooke@algonquinc.on.ca

Other

OEM Reference and Repair Manuals

Ontario Health and Safety Act

Appendix 2A

Sample Activity Tracking Sheet for Unit 2 Activities

Task Sheet

Task: _____ Name_____
Date: Start _____ Group_____
Completion _____

Vehicle Information Make Model Engine Displacement **Tools Required:** **Materials Required:** **Health/Safety Precautions:** **Specifications:** **Resources Used:** **Procedures (point form):** **Special Notes:**	
Teacher Comment:	

Appendix 2B

Sample Assessment Tracking Form For Use in Unit 2 Activities

Review these points with students to reinforce good work habits.

Managed work area before commencing job	Y__ N__
Worked with group throughout activity	Y__ N__
Communicated and confirmed points of safety in activity while in progress	Y__ N__
Accessed and referred to appropriate manuals and supporting texts as required for activity	Y__ N__
Managed work area and time to individual and group members advantage during activity	Y__ N__
Noted condition and functioning of related systems during repair or task	Y__ N__
Related activities to prior knowledge or to further study for own and group benefit	Y__ N__
Used tools effectively and investigated special techniques as required in individual tasks	Y__ N__
Made suggestions and inquiries as required in diagnosis discussions	Y__ N__
Used task notes to assist in diagnosis consultations and accurate assessment	Y__ N__
Noted health, ethical, and environmental concerns as they applied to task	Y__ N__
Exhibited safe and courteous conduct wherever possible in activity	Y__ N__
Attempted to act as a strong team member in individual portions of tasks	Y__ N__
Demonstrated a mature and professional-type manner with visitors or “customers”	Y__ N__
Attempted to relate the task or activity to his or her skill set or subject knowledge	Y__ N__
Demonstrated ability to reject poor suggestions or improper procedures	Y__ N__
Shared success with group without demanding individual attention	Y__ N__
Attempted to improve work area, if time remained after task completed	Y__ N__
Attempted to assist others as required, if time remained after task completed	Y__ N__
Other	Y__ N__

Unit 4: Vehicle Electrical Systems

Time: 30 hours

Unit Description

Students acquire fundamental knowledge and skills for use in diagnosing and repairing the electrical systems found on most vehicles. Students begin by studying basic electrical principles and troubleshooting techniques. Students complete tasks at electrical workstations, develop skills in reading wiring diagrams, and perform system diagnosis and service. The final activity requires students to utilise knowledge and skills developed in the previous activities when describing, diagnosing, and servicing the starting and charging system. Cross-curricular opportunities exist in the areas of science and math. The advantages of becoming a reflective and creative thinker in this challenging subject area are stressed.

Unit Synopsis Chart

Activity	Time	Expectations	Assessment	Tasks
4.1 Electrical Fundamentals	600 min	TFV.02, TF2.01, SPV.01, SPV.02, SPV.03, SPV.05, SP1.04, SP2.01, SP2.03, SP2.04, SP3.01, ICV.02, ICV.05, IC2.01, IC2.02, IC3.02	Knowledge/ Understanding Thinking/ Inquiry Application	Students: - demonstrate knowledge and understanding of basic electrical theory; - construct, analyse, and repair automotive electrical circuits; - interpret wiring diagrams.
4.2 Starting System Diagnosis and Service	600 min	TFV.02, TF2.01, SPV.01, SPV.02, SPV.03, SP2.01, SP2.03, SP2.04, SP3.01, SP4.02 ICV.02, IC2.01, IC2.02	Knowledge/ Understanding Thinking/ Inquiry Application	Students: - demonstrate knowledge and understanding of starting system theory of operation; - locate testing procedures; - diagnose starting system problems.
4.3 Charging System Diagnosis and Service	600 min	TFV.02, TFV.03, TF2.01, SPV.01, SPV.02, SPV.03, SP1.04, SP1.05, SP2.01, SP2.03, SP2.04, SP3.01, SP4.02, SP4.03, ICV.02, IC2.01, IC2.02	Knowledge/ Understanding Thinking/ Inquiry Application	Students: - demonstrate knowledge and understanding of charging system theory of operation; - locate testing procedures; - diagnose starting system problems.

Activity 4.1: Electrical Fundamentals

Time: 600 minutes

Description

This activity involves the construction, diagnosis, and repair of a 12-volt electrical lighting circuit. Students design and construct a functional vehicle lighting system using a teacher-supplied wiring schematic, soldering tools, crimp-type connectors, shrink tube, pigtail sockets, and other items associated with any basic, functioning, electrical circuit. Discussions on battery design, function and safety, as well as the theory of electricity and current flow are important outcomes in this activity. Students read and utilize wiring diagrams in designing series, parallel, and series-parallel circuits to complete their project. All topics are covered in class with teacher-directed lessons and demonstrations, as well as in the lab with student-centred practise and performance tasks.

Strand(s) & Learning Expectations

Strand(s): Theory and Foundation, Skills and Processes, Impact and Consequences

Overall Expectations

TFV.02 - explain the use of each component of a vehicle system;
SPV.01 - function effectively both as individuals and as members of a cooperative team to service and repair vehicles;
SPV.02 - apply the technological principles of input, process, and output in troubleshooting vehicle systems;
SPV.03 - use current technology (e.g., on-line information from manufacturers, CD-ROM manuals, computerized diagnostic tools) when servicing, repairing, and modifying vehicles;
SPV.05 - use mathematical and language skills effectively and apply scientific principles to help solve transportation technology challenges;
ICV.02 - follow safe work practices in the transportation sector workplace, including safety procedures and practices and the use of protective clothing and gear;
ICV.05 - describe and evaluate the employability skills required to be successful in the workplace.

Specific Expectations

TF2.01 - analyse and describe the use of each of the following components of a vehicle: the chassis, frame, and body; the engine system; the fuel system; the electrical/electronics system; the gear and power train system; the steering system; the brake system; and the suspension system;
SP1.04 - develop a plan of procedures that indicates the steps required when repairing or servicing a vehicle;
SP2.01 - use effectively, store safely, and maintain in good working order measurement, hand, power, machine, and pneumatic tools and equipment required for basic service tasks;
SP2.03 - systematically troubleshoot basic service problems on vehicles by organizing the variables into the following categories: input, process, and output;
SP2.04 - access and apply information from manuals, software databases, on-line information, and computerized diagnostic tools when troubleshooting and repairing components;
SP3.01 - correctly interpret assembly drawings that depict the components of a vehicle's systems;
IC2.01 - work safely when performing tasks in the transportation sector;
IC2.02 - use all required protective clothing and gear (to protect the eyes, ears, hands, head, feet and respiratory system) when working in the transportation sector;
IC3.02 - explain the importance of employability skills in achieving success in the workplace.

Prior Knowledge & Skills

- Familiarity with basic electrical circuits from the Grade 9 Science Curriculum
- Awareness of basic hand tool safety

Planning Notes

- Prepare lesson notes, textbook assignments, demonstrations, lab assignments.
- Develop a test in which the students:
  - describe how chemical energy is converted into electrical energy inside of a battery, and in turn how electrical energy is converted to produce light, run motors, or operate on-board electronics;
  - describe the precautions necessary in working around wet-cell batteries and live electrical circuits, e.g., the need for fusible links;
  - read electrical schematics to set up and diagnose electrical circuits;
  - use the correct tools to construct an electrical circuit, e.g., soldering tools, wire strippers, diagonal-cutters and crimping tools;
  - use the correct tools required to diagnose, test, and repair electrical circuits, e.g., Digital Volt Ohm Meter (D.V.O.M.) to correctly measure the current, voltage, and resistance.
- Invite a guest speaker to speak with the class about the career opportunities in automotive electrical/electronics.
- Arrange for a supply of common automotive insulated wire (assorted gauges), pigtail sockets and accompanying bulbs, various switches, alligator clips, flashers, and a flat, non-conductive piece of material of a suitable size to complete the activity. Access to a 12-volt, wet cell battery is also essential.
- Obtain sample wiring diagrams of a simple lighting system. These wiring diagrams can easily be located in any automotive repair manual/textbook or electronic automotive shop package, or can be created by the teacher.
- Create test harnesses for use when practising with the DVOM. A test harness is made by placing three or four different coloured wires in a sleeve. The harness can simulate specific characteristics which can be identified with a DVOM by installing diodes or resistors on selected wires, or by creating open or short circuits within the tubing. Several test harnesses can be made and labelled. The characteristics of each harness are noted on a master list.
- Cross-curricular opportunities may exist in math and science.

Teaching/Learning Strategies

1. The teacher and students discuss the ever-increasing need to effectively repair wiring systems in modern transportation technology vehicles. Aspects such as career opportunities and post-secondary training required are discussed. If possible, a guest speaker may speak with the class on career opportunities in automotive electrical/electronics.
2. In pairs, students brainstorm and record the maximum number of electrical devices and systems in a modern vehicle. Students check their list against the actual number of systems by referring to a textbook, website (see resources), or an automotive repair manual (or software). The teacher and students then discuss the challenge to the vehicle designer and repair technician of making all components work reliably.
3. The teacher and students discuss and review electrical principles and how electrical circuits work. The key concepts to be reviewed are:
   - electrons and electron flow;
   - components: power source, a conductor, and a load, fuse;
   - characteristics of electron flow (voltage, current, resistance);
   - circuit types (parallel, series, series/parallel).

   Students take notes on this review.

4. The teacher discusses safety concerns related to the handling of wet-cell batteries. The teacher emphasizes the risk of explosion, the dangers due to exposure to battery acid, and the risks caused by a direct battery short.
5. The teacher explains the operation, service procedures, and rating systems used with automotive batteries. Students participate in a class discussion on the merits of lead/acid batteries and disposal considerations.
6. The teacher discusses the importance of safety when working on any electrical system. Danger such as electrical fires caused by improperly repaired circuits and vehicle damage due to electrostatic discharge must be addressed.
7. In small groups, students are given a power source, i.e., a 12-V automotive type battery or a 12-V DC regulated power supply, several pieces of wire, four identical 12-V light bulbs, and alligator leads. (**Note:** students must wear safety glasses when working with batteries). The groups are instructed to build two different types of circuits, each capable of lighting two bulbs. They draw simple diagrams to represent their circuits and make qualitative comparison regarding the brightness of the light bulbs. They share their constructed circuits with the class. Students then make notes, record definitions, and give examples of the following: source, load, series circuit, parallel circuit, current, characteristics of schematic drawings, and the meaning of a variety of common schematic symbols.
8. Students locate a simple wiring diagram using shop manuals or computer databases. The basic structure of a wiring diagram and methods of interpreting them are discussed. Students practise reading wiring diagrams by tracing specific circuits on printed copies, using a highlighter or pencil.
9. The teacher and students discuss the proper handling techniques of DVOMs. Through teacher demonstration, students learn how to correctly connect a DVOM (ammeter, voltmeter, and resistance functions) into a circuit and to perform a test to ensure the safety of the equipment prior to taking a measurement.
10. Students use the ammeter to take readings at specific locations in the series and parallel circuits constructed. Students take part in a teacher-led discussion of electrical current and are challenged to explain what it is they have been measuring. They record their readings, the location of their measurements (using schematic drawings and the symbol for ammeter), and their own working definition of electrical current.
11. Students use the voltmeter to take readings across the light bulbs in the series and parallel circuits constructed in Activity 2.1. They record their readings and the location of their measurements (using schematic drawings and the symbol for voltmeter) in their notebooks.
12. Students practise using the DVOM on teacher-prepared sections of wiring harnesses with hidden resistors, diodes, opens, and shorts. Students determine the characteristics of each harness and compare their findings with the master list previously created by the teacher.
13. Each student group creates a circuit with a single resistor (not a light bulb) and a variable voltage supply. Groups use different resistors, e.g., 15, 20, and 30 ohms, and for five different voltages across the resistor, they measure and record the current passing through the resistor. They graph their own results and the results of two other groups that have used different resistors.
14. The teacher demonstrates proper techniques and safety precautions to be followed when making wiring connections including soldering and mechanical connections. (Note: students wear must safety glasses when soldering, and adequate ventilation must be provided.) Students are instructed to avoid breathing fumes and to exercise caution when handling hot soldering irons.
15. Using a wiring diagram, students make a working model of an automobile lighting circuit. The teacher supplies students with common automotive insulated wire, pigtail sockets and accompanying bulbs, a switch, alligator clips, flasher, and a flat, non-conductive piece of material of a suitable size to complete the activity.
16. Students use the DVOM to determine voltage drop, current draw, and resistance across selected sections of the circuit.

Assessment & Evaluation of Student Achievement

- Written quizzes and tests are given at appropriate points of the activity.
- Student-teacher conferencing occurs regularly throughout the activity to check for student understanding (see Appendix A – Student's Weekly Log Sheet).
- A logbook, completed daily by each student, provides information used to assist the teacher in evaluating individual accomplishments as well as development of learning skills (see Appendix B – Daily Checklist of Student Activities).
- A checklist, completed daily by the teacher, tracks student performance in the shop.
- Notes are checked for completeness and accuracy.

Accommodations

Some program modifications and strategies may include:

- providing pre-printed handouts to summarize board and discussion material, and wiring diagrams;
- providing additional one-on-one time with the teacher or peer tutors;
- providing teacher and peer assistance where appropriate;
- allowing student-to-student discussion and teacher-to-student conferencing throughout the activity;
- providing more complex circuits or complete electrical kit projects for students to work on, for an enrichment activity.

Resources

Print

Chapman, Norm. *Principles of Electricity and Electronics for the Automotive Technician*. South Puget Sound Community College: Delmar, 2000. ISBN 0-8273-8479-3

Duffy, James E. *Auto Electricity and Electronics Technology*. Illinois: Goodheart-Wilcox, 1995. ISBN 1-56637-053-1

Hollembeak, Barry. *Automotive Electricity, Electronics and Computer Controls*. Technical Training, Inc., Delmar, 1999. ISBN 0-8273-6566-7

Kabala, Thomas. *Electricity 1: Devices, Circuits and Materials*. Delmar, 2001. ISBN 0-7668-1917-5

Schwaller, Anthony, E. *Motor Automotive Technology*. Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

Thiessen, Frank J. and Davis N. Dales. *Automotive Principles and Service*, 4th ed. New Jersey: Prentice Hall, 1994. ISBN 0-13-336561-1

OEM Reference and Repair Manuals Available from local Dealerships

Video

Understanding Auto Technology and Repair Video Series – Tape 3: Understanding Automotive Electricity. Delmar, 2000. ISBN 0-7668-0794-0

Understanding Auto Technology and Repair Video Series – Tape 4: How to Diagnose Automotive Electrical Problems. Delmar, 2000. ISBN 0-7668-0795-9

Understanding Auto Technology and Repair Video Series – Tape 5: Understanding Automotive Electronics. Delmar, 2000. ISBN 0-7668-0796-7

Understanding Auto Technology and Repair Video Series – Tape 6: How to Diagnose Automotive Electronics Problems. Delmar, 2000. ISBN 0-7668-0797-5

Websites

How Things Work - http://www.howthingswork.com/

Inner. Auto - http://www.innerauto.com/

Software

Mitchell. *On Demand Computerized Service Manuals*. San Diego, CA: 1999.

Activity 4.2: Starting System Diagnosis and Service

Time: 600 minutes

Description

Students develop knowledge and skills required for the diagnosis and repair of the starting system electrical circuit and components. Topics covered include starter motor theory of operation, starting circuit components and operation, and system diagnosis and repair procedures. All topics are covered in-class with teacher-directed lessons and demonstrations, and in the lab with student-centred practice and performance tasks.

Students develop thinking and problem-solving skills through the practise of trouble shooting starting system problems using acquired knowledge and skills, and the use of prescribed diagnostic routines and testing procedures.

Strand(s) & Learning Expectations

Strand(s): Theory and Foundation, Skills and Processes, Impact and Consequences

Overall Expectations

TFV.02 - explain the use of each component of a vehicle system;
SPV.01 - function effectively both as individuals and as members of a cooperative team to service and repair vehicles;
SPV.02 - apply the technological principles of input, process, and output in troubleshooting vehicle systems;
SPV.03 - use current technology (e.g. on-line information from manufacturers, CD-ROM manuals, computerized diagnostic tools) when servicing, repairing, and modifying vehicles;
ICV.02 - follow safe work practices in the transportation sector workplace, including safety procedures and practices and the use of protective clothing and gear.

Specific Expectations

TF2.01 - analyse and describe the use of each of the following components of a vehicle: the chassis, frame, and body; the engine system; the fuel system; the electrical/ electronics system; the gear and power train system; the steering system; the brake system; and the suspension system;
SP2.01 - use effectively, store safely, and maintain in good working order measurement, hand, power, machine, and pneumatic tools and equipment required for basic service tasks;
SP2.03 - systematically troubleshoot basic service problems on vehicles by organizing the variables into the following categories: input, process, and output;
SP2.04 - access and apply information from manuals, software databases, on-line information and computerized diagnostic tools when troubleshooting and repairing components;
SP3.01 - correctly interpret assembly drawings that depict the components of a vehicle's systems;
SP4.02 - apply correctly, within the context of transportation technology, the scientific principles related to such areas as properties and states of matter, energy, force, Newton's laws of motion, simple machines, mechanical advantage, and basic electrical theory;
IC2.01 - work safely when performing tasks in the transportation sector;
IC2.02 - use all required protective clothing and gear (to protect the eyes, ears, hands, head, feet, and respiratory system) when working in the transportation sector.

Prior Knowledge & Skills

- Fundamental understanding of electricity and electromagnetism
- Knowledge of the correct use of test lights and Multi-meters
- Ability to interpret wiring diagrams
- Knowledge of safe work practices when working with electricity

Planning Notes

- Prepare lesson notes, demonstrations, and opportunities to apply learning.
- Develop a test in which students:
  - describe electrical energy and explain its conversion to the mechanical operation of solenoids, relays, and motors;
  - understand and/or create component and wiring sketches or schematic drawings;
  - use current information, technologies, and equipment to diagnose and repair the system;
  - describe and demonstrate safe and appropriate work practices.
- Obtain several loose components, e.g., various starter motor and starter drive designs, a ring gear, safety switches, solenoids, and relays to be used as models for students to inspect and handle when discussing theory of operation. (Note: cutaway or disassembled components are helpful in explaining operation.)
- Create an aid for demonstrating the electrical principles of a direct current (DC) motor by winding several metres of light gauge wire around a steel core. The resulting coil can be connected to a variable DC power supply to create an electromagnet. A short loop of wire, connected to the power supply with a small load in series, is held above the coil. The loop moves towards or away from the coil, depending on the polarity of the coil or the loop of wire. Ensure the power supply has overload protection and all circuits have a fusible link.
- Obtain defective components (that have been saved from previous repairs or donated by local repair shops) to be used as examples of malfunctioning circuits on which students can observe the symptoms and testing routines for common faults.
- Create a template for a diagnostic chart and an example of a starting system diagnostic chart from a service manual. A blank template for student use may be made by blocking out some or all of the contents of a printed sample template.
- Provide shop vehicles or actual test/repair work. Shop vehicles may have defective parts installed.

Teaching/Learning Strategies

System Theory and Demonstrations

1. The teacher introduces the activity by discussing the role of the starting system, its parts, and their purpose. The use of display models that students can handle and inspect is desirable.
2. The teacher demonstrates the electrical principle which states, “a current-carrying conductor will move when placed in a magnetic field” by holding a light gauge wire connected to a battery through a small load (test light) over a coil of wire wound around a steel bar. The wire is made to draw towards or lift away from the coil by reversing the polarity of the wire. The teacher reviews the following key concepts:
   - construction of starter motors and the electrical theory of operation for automotive DC motors;
   - construction and operation of inertia drives and over-running clutch drives, including the concept of gear ratio;
   - construction and operation of relays and solenoids;
   - schematic layout of circuit including ignition switch and park/neutral or clutch switch.
3. The teacher demonstrates, working components by mounting the starter motor, relay, or solenoid securely in a bench vice and connecting it to a shop battery with booster cables or other heavy gauge conductors. The use of a remote starter switch demonstrates the use of this device as well as provides a safe way to operate the starter or other components. A test light or ohm meter is used to demonstrate the results of the relay operation. (Note: the teacher and students must wear safety glasses when handling batteries and operating components in this manner.)

System Testing and Diagnosis

4. The teacher reviews electrical safety with students, with a special emphasis on fusing circuits and the hazards of wet cell automotive style batteries.
5. Students are supplied with a typical wiring diagram for a starting system in a common vehicle. Students trace the system circuit using a pen for high current conductors and a pencil for low current conductors. The teacher completes the same activity using an overhead slide and projector, and coloured markers. Students check their work against the overhead.
6. The teacher notes possible system faults on the diagram, such as a discharged battery or open circuit in the solenoid. Students suggest effects on the system in terms of what they expect, hear, or see with test light or volt meter. As each fault is discussed, a system model with defective components or connections is used to verify the findings of students. The teacher uses this opportunity to demonstrate any alternative or better way of testing for each fault, including performing starter draw and voltage drop tests. Students record their observations.
7. Students create a diagnostic chart from their recorded observations. A template may be made by "deleting" some or all of the contents of a diagnostic chart provided by the teacher. Once complete, the chart is compared to a similar chart taken from a service manual. Students update their charts with any necessary changes.

System Service

8. Working with a partner, students assess the condition of a sample starting circuit. Starter draw tests are performed with teacher assistance and compared to specifications, as is engine cranking speed.
9. If starting system problems are observed, students locate and use the appropriate trouble chart and determine the course of action.
10. After the correct repair procedures have been located and the teacher has been consulted, the students perform the required repair work.

Assessment & Evaluation of Student Achievement

- Log books are completed daily by students, providing students an opportunity to demonstrate knowledge acquired and note daily participation and achievements (see Appendix A – Student's Weekly Log Sheet).
- Text and teacher-developed assignments, notes, and diagnostic charts are collected and evaluated for neatness and correctness.
- A test is given to determine student learning.
- A daily checklist of student activities is completed by the teacher, and tracks student performance in the shop (see Appendix B – Daily Checklist of Student Activities).

Accommodations

Some program modifications and strategies may include:

- reviewing students' IEPs and making the necessary accommodations;
- providing enlarged wiring diagrams or a magnifying glass to accurately trace circuits;
- providing teacher and peer assistance where appropriate;
- allowing for adjusted timelines for the completion of the circuit activities;
- providing additional one-on-one time with the teacher or peer tutors;
- allowing student-to-student discussion and teacher-to-student conferencing throughout the activity;
- having peer tutors assist in the handling of equipment;
- encouraging students to research why some starting motors/systems draw much more electrical energy (current) than others when starting, for an enrichment activity.

Resources

Print

Chapman, Norm. *Principles of Electricity and Electronics for the Automotive Technician*. South Puget Sound Community College: Delmar, 2000. ISBN 0-8273-8479-3

Duffy, James E. *Auto Electricity and Electronics Technology*. Illinois: Goodheart-Wilcox, 1995. ISBN 1-56637-053-1

Hollembeak, Barry. *Automotive Electricity, Electronics and Computer Controls*. Technical Training, Inc., Delmar, 1999. ISBN 0-8273-6566-7

Schwaller, Anthony, E. *Motor Automotive Technology*. Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

Thiessen, Frank J. and Davis N. Dales. *Automotive Principles and Service*, 4th ed. New Jersey: Prentice Hall, 1994. ISBN 0-13-336561-1

Video

Understanding Auto Technology and Repair Video Series – Tape 3: Understanding Automotive Electricity. Delmar, 2000. ISBN 0-7668-0794-0

Understanding Auto Technology and Repair Video Series – Tape 4: How to Diagnose Automotive Electrical Problems. Delmar, 2000. ISBN 0-7668-0795-9

Understanding Auto Technology and Repair Video Series – Tape 5: Understanding Automotive Electronics. Delmar, 2000. ISBN 0-7668-0796-7

Understanding Auto Technology and Repair Video Series – Tape 6: How to Diagnose Automotive Electronics Problems. Delmar, 2000. ISBN 0-7668-0797-5

Activity 4.3: Charging System Diagnosis and Service

Time: 600 minutes

Description

This activity builds upon the previous two activities by requiring students to use skills and knowledge acquired in those activities to understand charging system theory of operation and perform diagnostics and repairs. Students develop knowledge and skills required to diagnose and repair the charging system electrical circuits and components. All topics are covered in-class with teacher-directed lessons and demonstrations, and in the lab with student-centred practise and performance tasks.
Students develop thinking and problem-solving skills through the practise of trouble-shooting charging system problems using acquired knowledge and skills, as well as using prescribed diagnostic routines and testing procedures.

Strand(s) & Learning Expectations

Stand(s): Theory and Foundation, Skills and Processes, Impact and Consequences

Overall Expectations

TFV.02 - explain the use of each component of a vehicle system;
TFV.03 - analyse and describe the interrelationships of vehicle systems;
SPV.01 - function effectively both as individuals and as members of a cooperative team to service and repair vehicles;
SPV.02 - apply the technological principles of input, process, and output in troubleshooting vehicle systems;

SPV.03 - use current technology (e.g., on-line information from manufacturers, CD-ROM manuals, computerized diagnostic tools) when servicing, repairing, and modifying vehicles;
ICV.02 - follow safe work practices in the transportation sector workplace, including safety procedures and practices and the use of protective clothing and gear.

Specific Expectations

TF2.01 - analyse and describe the use of each of the following components of a vehicle: the chassis, frame, and body; the engine system; the fuel system; the electrical/electronics system; the gear and power train system; the steering system; the brake system; and the suspension system;
SP1.04 - develop a plan of procedures that indicates the steps required when repairing or servicing a vehicle;
SP1.05 - complete a work order for a specific transportation technology task;
SP2.01 - use effectively, store safely, and maintain in good working order measurement, hand, power, machine, and pneumatic tools and equipment required for basic service tasks;
SP2.03 - systematically troubleshoot basic service problems on vehicles by organizing the variables into the following categories: input, process, and output;
SP2.04 - access and apply information from manuals, software databases, on-line information, and computerized diagnostic tools when troubleshooting and repairing components;
SP3.01 - correctly interpret assembly drawings that depict the components of a vehicle's systems;
SP4.02 - apply correctly, within the context of transportation technology, the scientific principles related to such areas as properties and states of matter, energy, force, Newton's laws of motion, simple machines, mechanical advantage, and basic electrical theory;
SP4.03 - use appropriate technical language in technical reports and presentations;
IC2.01 - work safely when performing tasks in the transportation sector;
IC2.02 - use all required protective clothing and gear (e.g., to protect the eyes, ears, hands, head, feet, and respiratory system) when working in the transportation sector.

Prior Knowledge & Skills

- Fundamental understanding of electricity and electrical circuits
- Ability to use test lights and multi-meters correctly
- Ability to interpret wiring diagrams properly
- Awareness of some of the concerns regarding electrical safety

Planning Notes

- Prepare lesson notes, demonstrations, and opportunities to apply learning.
- Develop a test in which students:
  - describe how an alternator converts mechanical energy into electrical energy;
  - describe the basic types of alternators and how they are constructed;
  - read electrical schematics consisting of alternator control devices, charging indicator, and a battery;
  - diagnose and repair alternators and regulators (external and internal) using proper test equipment;
  - describe the advantages of an alternator over a generator;
  - describe and practise safe and appropriate work habits.
- Obtain several styles of alternators and regulators (including cutaway and disassembled components) for students to inspect during discussions to help them to understand the theory and principles of operation.
- Set up shop vehicles with defective parts installed, ready for diagnosing.
- Set up defective parts for bench tests, including internal circuitry checks.

- Obtain charging system diagnostic charts from class shop manuals or from area dealerships.
- Create a simple demonstration aid by winding a length of small gauge wire and attaching each end to a sensitive DVOM. As a magnetic field is passed over this winding, an induced voltage and current can be read on the meter.

Teaching/Learning Strategies

System Theory and Demonstrations

1. The teacher introduces the activity by discussing the role of the charging system, its parts, and their purpose. Students inspect display models to increase understanding.
2. The teacher discusses how charging systems work on the principles of magnetism to change mechanical energy into electrical energy using induction. The key points to include are:
    - fundamentals such as electromagnetic induction principles, speed and voltage induction,
    - factors affecting voltage and amperage output, construction of alternators (external and internal regulators), and theory of operation;
    - schematic layout, including different styles of charging indicators and lights;
    - advantages of an alternator over a DC generator (e.g. limited current output and poor low speed characteristics).
3. The teacher performs demonstrations on a vehicle using an inductive pickup and a multi-meter to show amperage and voltage output with varying loads.

System Testing and Diagnosis

4. The teacher starts the activity by having students reflect upon previous experiences with charging system failures.
5. The teacher supplies the students with a typical charging system schematic and (using an overhead slide) follows through circuit operation and relates it to actual on-car set-up and design.
6. The teacher adds open or shorted circuits to the schematic and students respond with the effects that they would have on operation. Students must indicate where power and ground is found in the circuit. On the schematic diagram, the teacher indicates simple test points for input and output voltage checks.
7. Students use service manuals to locate correct test procedures and diagnose shop vehicles with inoperative charging systems.

System Service

8. Students test operational charging systems for proper voltage and current output with varying loads. (**Note:** students must use proper tools and equipment, and all safety precautions must be followed.)
9. Students disassemble alternators at the bench and check slip rings, brushes, and bearings for wear. Internal parts such as the stator, rotor, rectifier assembly, and regulator (where applicable) are tested. Any defective components are discussed with the teacher.

Assessment & Evaluation of Student Achievement

- Log books are completed daily by students providing students an opportunity to demonstrate knowledge acquired and note daily participation and achievements (see Appendix A – Student's Weekly Log Sheet).
- Assignments, notes, and diagnostic charts are collected and assessed for neatness and correctness.
- A test is given to determine student learning.
- A daily checklist of student activities is completed by the teacher, and tracks student performance in the shop (see Appendix B – Daily Checklist of Student Activities).

Accommodations

Some program modifications and strategies may include:

- reviewing students' IEPs and making the necessary accommodations;
- providing enlarged wiring diagrams or a magnifying glass to accurately trace circuits;
- providing teacher and peer assistance where appropriate;
- providing additional one-on-one time with the teacher or peer tutors;
- having peer tutors assist in the handling of equipment;
- allowing for adjusted timelines for the completion of the this activity;
- allowing for additional time after class to continue the study of the operation of the charging system.

Resources

Print

Chapman, Norm. *Principles of Electricity and Electronics for the Automotive Technician*. South Puget Sound Community College: Delmar, 2000. ISBN 0-8273-8479-3

Derato, Frank C. *Automotive Electrical and Electronics Systems* 2nd ed. United States: Glencoe Division Macmillian/McGraw-Hill, 1994. ISBN 0-02-800412-4

Erjavec, Jack. *Automotive Technology: A Systems Approach*, 3rd ed. United States: Delmar Thomas Learning, 2000. ISBN 0-7668-0673-1

Hollembeak, Barry. *Automotive Electricity, Electronics and Computer Controls*. Technical Training, Inc., Delmar, 1999. ISBN 0-8273-6566-7

Schwaller, Anthony, E. *Motor Automotive Technology.* Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

Thiessen, Frank J. and Davis N. Dales. *Automotive Principles and Service*, 4th ed. New Jersey: Prentice Hall, 1994. ISBN 0-13-336561-1

Video

Understanding Auto Technology and Repair Video Series – Tape 3: Understanding Automotive Electricity. Delmar, 2000. ISBN 0-7668-0794-0

Understanding Auto Technology and Repair Video Series – Tape 4: How to Diagnose Automotive Electrical Problems. Delmar, 2000. ISBN 0-7668-0795-9

Understanding Auto Technology and Repair Video Series – Tape 5: Understanding Automotive Electronics. Delmar, 2000. ISBN 0-7668-0796-7

Understanding Auto Technology and Repair Video Series – Tape 6: How to Diagnose Automotive Electronics Problems. Delmar, 2000. ISBN 0-7668-0797-5

Websites

Learn How Everything Works – http://www.howthingswork.com/

Appendix A

Student's Weekly Log Sheet

This page is to be completed daily, detailing the activities with which you have been involved. Your entries are used as an aid in determining a Practical Performance mark. Include any information you would like your teacher to know when calculating this mark. This page must be handed in each week.

Name: _____ Class: _____ (Monday) Date: _____

On-Time? ❑ Prepared? (book, etc,) ❑ Participation (1-10) ❑

Description of Activities:

_____

_____

_____

_____

(Tuesday) Date: _____

On-Time? ❑ Prepared? (book, etc,) ❑ Participation (1-10) ❑

Description of Activities:

_____

_____

_____

_____

(Wednesday) Date: _____

On-Time? ❑ Prepared? (book, etc,) ❑ Participation (1-10) ❑

Description of Activities:

_____

_____

_____

_____

(Thursday) Date: _____

On-Time? ❑ Prepared? (book, etc,) ❑ Participation (1-10) ❑

Description of Activities:

_____

_____

_____

_____

(Friday) Date: _____

On-Time? ❑ Prepared? (book, etc,) ❑ Participation (1-10) ❑

Description of Activities:

_____

_____

_____

_____

Appendix B

Daily Checklist of Student Activities (Learning Skills)

Class: _____ Date: _____

Student	Present	On-time	Prepared	On-task	Use of Resources	Safe Work Practices	Evidence of Problem Solving	Correct Procedures	Correct Use of Equipment			Comments

Additional Comments:

_____

_____

_____

_____

_____

_____

_____

_____

_____