

*Catholic District School Board Writing Partnership*

# Course Profile Transportation Technology

Grade 10

Open

- *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.

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Course Profiles are professional development materials designed to help teachers implement the new Grade 10 secondary school curriculum. These materials were created by writing partnerships of school boards and subject associations. The development of these resources was funded by the Ontario Ministry of Education. This document reflects the views of the developers and not necessarily those of the Ministry. Permission is given to reproduce these materials for any purpose except profit. Teachers are also encouraged to amend, revise, edit, cut, paste, and otherwise adapt this material for educational purposes.

Any references in this document to particular commercial resources, learning materials, equipment, or technology reflect only the opinions of the writers of this sample Course Profile, and do not reflect any official endorsement by the Ministry of Education or by the Partnership of School Boards that supported the production of the document.

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### **Acknowledgments**

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## Course Overview

### Transportation Technology, Grade 10, Open

#### Identifying Information

**Course Title:** Transportation Technology

**Grade:** 10

**Course Type:** Open

**Ministry Course Code:** TTJ2O

**Credit Value:** One

**Policy Document:** *The Ontario Curriculum, Grades 9 and 10, Technological Education, 1999.*

#### Description/Rationale

In this course students study a cross section of Transportation Technology topics, including the vehicles and support systems needed to move people and goods. Students will gain insight into these areas through research projects, industry visits, and practical, hands-on experience. Students learn measurement systems and methods; the analysis, design, and construction of a system to convert and make practical use of energy; the function of major vehicle system components; the impact of transportation systems on the environment; communication skills; and transportation-related career expectations.

Four units are identified, reflecting the Overall and Specific Expectations for Grade Ten Transportation. These units are selected because they offer an opportunity to include a wide range of learning opportunities, such as auto-mechanics, auto-body repair, and small engine repair. While many activities are written for automotive servicing to reflect the direction of the majority of schools in Ontario, most can be adapted to vehicles ranging from bicycles, boats, snowmobiles, or airplanes as local resources and needs dictate.

#### 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 units offer broad awareness of social conscience and personal choice. Professionalism in technical pursuits are presented as opportunities to serve God within the student's own community. 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 the students develop knowledge and skills that will be applicable in their lives now, and as preparation for further studies or careers. The opportunity to improve the lives of others will be integral to success. Moral and ethical business practices will be the foundation of the introduction of industry practices in the workplace.

#### Unit Titles (Time + Sequence)

Unit 1	Evolution of Transportation Technologies	10 hours
Unit 2	Applied Maintenance	30 hours
Unit 3	Power and Control Systems	25 hours
Unit 4	Future of Transportation Technology	45 hours

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## Unit Descriptions

### Unit 1: Evolution Of Transportation Technologies

**Time:** 10 hours

#### Unit Description

In this unit, students will demonstrate an understanding of the historical evolution of transportation technologies used on land, in the air, at sea, and/or space. Students will explore vehicles for moving people and goods and the support systems required to maintain their operations. The student's own community will be considered as well as the global perspective in respect to environmental impacts of transportation. Students will consider issues surrounding the quality of life for all members of community as an application of Gospel values.

### Unit 2: Applied Maintenance

**Time:** 30 hours

#### Unit Description

In this unit students perform a wide variety of commonly practised maintenance routines on vehicles. Students develop practical skills in vehicle maintenance and troubleshooting, and learn to observe safe work practices in a shop environment. Students also study the relationships between regular maintenance and inspection and vehicle performance and safety. These skills will provide an identifiable and marketable base for future co-op or employment opportunities and will serve as life skills to consumers of vehicles and services in the transportation industry. Through these activities, students will learn to work with a Christian perspective of honesty and integrity in the workplace.

### Unit 3: Power And Control Systems

**Time:** 25 hours

#### Unit Description

In this unit, students study means of propelling vehicles and controlling vehicle speed and direction. Upon completion of this unit students will identify components and describe the operation of power sources including two and four stroke/cycle engines and electric motors as well as the methods of transmitting power. Students will demonstrate understanding of the means for controlling vehicle direction and speed including braking, steering, and suspension systems by performing basic inspection and repair tasks. Creative, critical thinking in the form of troubleshooting, assembling, and disassembling vehicle systems will allow students to solve transportation-related problems in a manner reflecting their faith.

### Unit 4: Future Of Transportation Technology

**Time:** 45 hours

#### Unit Description

In this unit students identify and describe the responsibilities and duties of people currently offering services in the transportation industry and how those duties might be affected by changes in the industry over the next several years. Students will also identify and understand the role of technological developments in future career prospects. Students will have the opportunity to investigate future vehicle design through the design and fabrication of an alternative power vehicle. This unit will also further develop the student's understanding of God's call in their life and provide opportunities to serve and minister to the living and environmental needs of the community.

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## Course Notes

This program is open to students wishing to learn more about the Transportation industry. Expectations that relate to practical skills as well as theoretical knowledge of Transportation will be assessed throughout the course, which allows students to improve their skills on an ongoing basis. Awareness of careers in Transportation could be increased in a variety of ways, for example, job shadowing, computer research, field trips, and/or guest speakers.

While many of the activities involve automotive servicing, many activities may also be adapted to any vehicle from bicycles to airplanes. Teachers should ensure that all the expectations outlined in each activity are adaptable to the vehicle type at hand.

Teachers will address safety issues surrounding equipment and materials at appropriate times during the course. A general set of classroom policies should be developed during the course introduction to address expectations for both teacher and student. Included in this policy must be a statement requiring students to be checked out on all equipment before using it for the first time.

Teachers must ensure students are properly briefed on safe operation of equipment or handling of materials by addressing safety topics using a variety of teaching strategies. Safety issues must be included in theory lessons and subsequent tests or quizzes. Students must be assessed to ensure they are able to perform specific tasks safely, such as jacking or hoisting vehicles. Teachers must remain in the area to observe procedures are followed correctly. Teachers must be ever vigilant to ensure students are exercising due caution and following safety procedures while working in the shop. Students who do not adhere to safety precautions must be immediately corrected

Teachers must address safety/censorship on the Internet by implementing School Board policies on appropriate student use and access to Internet services.

Some activities described in this document involve work of a nature that requires supervision or inspection by a licensed Automotive Service Technician. Only qualified licensed teachers can supervise work on a vehicle if the vehicle will subsequently be returned to service. If the classroom teacher does not possess the qualifications, arrangements must be made for inspection prior to final assembly or this activity should be restricted to shop models only.

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## Teaching/Learning Strategies

A variety of teaching and learning strategies are used throughout this course including; classroom lessons; brainstorming; collaborative and co-operative learning; student teacher conferencing; design process; and independent study. Types of teaching/learning strategies include:

<b>Brainstorming</b>	group generation of initial ideas expressed without criticism or analysis
<b>Buddy system</b>	links students for peer/cross-age support
<b>Class discussion</b>	students actively participate by taking turns while discussing current issues
<b>Collaborative/co-operative learning</b>	small group learning providing high levels of student engagement and interdependence
<b>Computer-assisted learning</b>	learning of new material or review/reinforce material previously learned
<b>Conferencing/discussion</b>	student-to-student discussion and teacher-to-student discussion to encourage confidence and motivation to success in all learners
<b>The problem-solving process</b>	a problem solving approach using a prescribed process involving a number of steps, (e.g., design process or the process of troubleshooting)
<b>Independent study</b>	exploration and research of a topic interesting to students
<b>Journal writing</b>	the practice of expressing ideas, experiences, questions, reflections, personal understanding, or new learning in written form on regular basis
<b>Report/presentation</b>	oral, visual, and written presentation of researched topic to class or in community
<b>Research</b>	independent investigation
<b>Socratic lesson</b>	oral presentation of information by the teacher
<b>Just-on-time teaching</b>	theoretical material is presented to the student at the appropriate stage of his/her project
<b>Examples</b>	provide students with a model or a sample of student work to provide the standard toward which they are aiming

## Assessment and Evaluation

Assessment and evaluation techniques include the following:

- evaluation or assessment through journals and classroom presentations;
- student teacher conferencing;
- written tests, formal and informal observation;
- performance assessment rubrics;
- reflective learning including self assessment;
- peer assessment rubrics.

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## Accommodation

Various accommodations may be made throughout the program to assist students with physical and developmental needs. Possible program modification may include using wheelchair accessible equipment and tools, enlarged print, adapted handouts and pre-designed articles. Other accommodations may include teacher/student conferencing, teacher/student/parent conferencing, small group learning, peer tutoring and the use of a buddy system. Opportunities for enrichment may include increased complexity of the task (IEPs).

## Resources

Various resources will be used throughout the course, including textbooks, web sites, outside experts, technical manuals and instructional videos. Teacher-librarians may be asked to assist in searching for material related to the activity. Special tools may be required for several procedures, (for example, piston installation, brake spring removal, or coil spring replacement). Welding equipment may be required for the construction of the alternative energy vehicle. An electronic service manual system is a valuable asset for students to locate and print specifications and work procedures. 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 specific activities.

General resources may include:

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

Jellison, R. *Welding Fundamentals, 1/e*. Prentice Hall. 1996. ISBN 0-13-107178-5  
OEM Reference and Repair Manuals (various sources)

Religious Education, *Ontario Catholic Secondary Curriculum Policy Document, 1999*. Institute for Catholic Education, ISBN 0-9699178-7-2

Schwaller, Anthony E. *Transportation Energy and Power Technology*. Glencoe McGraw-Hill,  
ISBN 0-8273-3227-0

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

Almost all manufacturers have established web sites containing technical specifications and product lines. Local dealerships may also have web sites valuable for researching prices. General sites that are useful for transportation related developments include:

Popular Science, latest innovations in transportation and consumer products  
[www.popularscience.com](http://www.popularscience.com)

Popular Mechanics, latest information of innovations and inventions  
[www.popularmechanics.com](http://www.popularmechanics.com)

History of Technology, list of resources on the development of technology  
[www.englib.cornell.edu/ice/lists/historytechnology/historytechnology.html](http://www.englib.cornell.edu/ice/lists/historytechnology/historytechnology.html)

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

Society of Automotive Engineers  
<http://www.sae.org/index.com>

Transport Canada  
<http://www.tc.gc.ca>

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## OSS Policy Applications

The Grade 10 Transportation Technology Course is designated as a Technological Education program. All courses offered in technological education are open courses, which comprise a set of expectations that are appropriate for all students. (See *The Ontario Curriculum, Grades 9 and 10, Program Planning and Assessment, 1999* for a description of the different types of secondary school courses.) Students can use the course as a compulsory credit (1 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 Grades 11 and 12, and for productive participation in society.

Students are introduced to 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 accommodation to meet the needs of all students. Anti-discrimination education, equity/social justice issues, career goals/co-operative education, conflict resolution/violence prevention and community partnerships are addressed in the course. All of these support many of the Ontario Secondary School Policies.

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

## Course Evaluation

Teachers and students may evaluate a Transportation Technology course through a variety of methods. Teachers may network with colleagues from other schools, subject associations, and peers at the local school to determine what modifications or new ideas could be incorporated into the units. Since every teacher will approach the units in a unique way, there are ample opportunities for extensions, modifications, and applications. The community, local school and business community, may have input on various aspects of the Transportation Technology course.

The following areas should be assessed:

- Are expectations being met?
- Are the learning styles of all students being met through teaching strategies?
- Does assessment/evaluation measure student expectations in a reliable and accurate manner?
- Are parents/guardians informed of student performance on a regular basis?
- Are a variety of assessment/evaluation tools used?
- Are a variety of teaching/learning strategies used?
- Are the needs of students being met?

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## Coded Expectations, Transportation Technology, TTJ2O

### Theory and Foundation

#### Overall Expectations

**TFV.01T**

– describe the evolution of transportation technologies;

**TFV.02T**

– identify and describe different modes of transportation;

**TFV.03T**

– explain the importance of service and support systems to the transportation of people and products;

**TFV.04T**

– identify and describe different methods for converting, using, distributing, and storing energy;

**TFV.05T**

– describe the correlation between modes of transportation and the need for related support businesses.

#### Specific Expectations

**TF1.01T**

– identify current safety standards in transportation and secondary industries;

**TF1.02T**

– demonstrate knowledge of service procedures for different types of transportation vehicles;

**TF1.03T**

– describe various maintenance and support technologies related to the transportation of people and products;

**TF1.04T**

– describe the operation and application of major vehicle propulsion devices and the procedures used for servicing them;

**TF1.05T**

– identify and explain technologies for joining materials and describe their application;

**TF1.06T**

– describe the distribution network for fuel or energy required by transportation systems;

**TF1.07T**

– describe principles of design that apply in conserving energy in project work;

**TF1.08T**

– suggest improvements to a current transportation system to suit local conditions;

**TF1.09T**

– describe the importance of secondary industries for the transportation industry;

**TF1.10T**

– demonstrate knowledge of different propulsion systems.

### Skills and Processes

#### Overall Expectations

**SPV.01T**

– demonstrate accuracy in the use of measuring systems and methods;

**SPV.02T**

– design and construct systems to convert and make practical use of energy;

**SPV.03T**

– describe the function of major vehicle system components;

**SPV.04T**

– use a variety of fastening, fabrication, maintenance, and repair techniques correctly in projects.

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## **Specific Expectations**

### **SP1.01T**

– produce projects that demonstrate knowledge of a variety of transportation technologies;

### **SP1.02T**

– use measurement tools correctly to inspect and service vehicle systems;

### **SP1.03T**

– identify wear on vehicle system components on the basis of industry standards;

### **SP1.04T**

– design and construct propulsion systems capable of propelling vehicles for a variety of transportation modes under varying conditions;

### **SP1.05T**

– describe and maintain support systems related to vehicle operation;

### **SP1.06T**

– adapt a secondary system to control a propulsion system;

### **SP1.07T**

– use a variety of technologies for joining materials;

### **SP1.08T**

– repair or replace components to meet or exceed original equipment manufacturer (OEM) standards.

## **Impact and Consequences**

### **Overall Expectations**

#### **ICV.01T**

– describe the impact of transportation technology on society and the environment;

#### **ICV.02T**

– identify career opportunities in transportation-related fields and the education and training required for entry into those positions;

#### **ICV.03T**

– demonstrate understanding of methods for increasing the efficiency of energy use;

#### **ICV.04T**

– apply health and safety standards related to materials, processes, and equipment.

### **Specific Expectations**

#### **IC1.01T**

– identify methods for improving the efficiency of energy consumption in the transportation industry;

#### **IC1.02T**

– describe changes made to vehicle systems to enable them to use energy more efficiently;

#### **IC1.03T**

– explain the need to manufacture and dispose of vehicle system components in an environmentally friendly way;

#### **IC1.04T**

– describe the refinement and utilization of energy sources from their raw materials to their disposal;

#### **IC1.05T**

– identify local systems that deal with recycling in the transportation industry;

#### **IC1.06T**

– describe related career opportunities and the education and training required to gain entry to these positions;

#### **IC1.07T**

– describe health and safety regulations for the handling of tools, fuels, materials, and equipment.

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## 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.

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### **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;

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- 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

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## Unit 1: Evolution Of Transportation Technologies

**Time:** 10 hours

### Unit Description

In this unit, students will demonstrate an understanding of the historical evolution of transportation technologies used on land, in the air, at sea and/or in space. Students will explore vehicles for moving people and goods and the support systems required to maintain their operations. The student's own community will be considered, as well as the global perspective in respect to environmental impacts of transportation. Students will consider issues surrounding the quality of life for all members of community as an application of Gospel values.

### Strand(s) and Expectations

**Ontario Catholic School Graduate Expectations:** CGE 1d, 2b, 2c, 2e, 3f, 4c, 4f, 5a, 5b, 5d, 5e, 5f, 5g.

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

**Overall Expectations:** TFV.01T, TVF.02T, TFV.03T, TFV.05T, SPV.03T, SPV.04T, ICV.01T, ICV.02T, ICV.03T, ICV.04T.

**Specific Expectations:** TF1.01T, TF1.03T, TF1.09T, SP1.01T, SP1.07T, IC1.06T, IC1.07T.

### Activity Titles (Time + Sequence)

Activity 1	Research and Presentation Project	240 minutes
Activity 2	Transportation Display	240 minutes
Activity 3	Career Exploration: The Industry Visit	120 minutes

### Prior Knowledge Required

- Before working in a shop environment, students must be aware of general shop rules and safety requirements, as well as safety rules for specific tools and machines. Teachers must verify student's knowledge of safety through either a signed Safety Passport (Appendix A), and/or a test on safety knowledge (see Appendix B for General guidelines for safety).
- Students should also be aware of acceptable personal conduct standards as established by the teacher. Before contacting and working with businesses or community groups, students must be made aware of personal conduct and professional standards as established by the teacher. Before visiting a local business, students must also understand the safety rules specific to the business.
- Students should have a basic knowledge of Internet research and keyboarding techniques and procedures. Students should also be aware of acceptable use policies as established by the school board.

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## Planning Notes

- The activities described in this unit may be spread out over the duration of the course to allow students to research various topics and to integrate theory concepts with hands-on practical activities from other units. Access to the school Library/Resource Centre and computer labs must be arranged at key times throughout the unit.
- Students may integrate certain aspects of the activities with curriculum from other courses. For example: English may assist with report writing and library skills. Computers may assist with keyboarding and Internet skills while History may assist in contextualizing evolutionary timelines discussed in this project. Visual Arts may assist in background design, Design Technology and Construction Technology may be helpful for model building and design.
- The technical facility should have sufficient bench space for fabrication of projects. Students must be briefed on any safety-related aspects of equipment being used, (e.g., safe operation, guard placement, and the use of safety glasses). Depending on the medium selected, access to woodworking equipment (e.g., bandsaw) may be desirable. If the necessary equipment is located in another room, another teacher must monitor the students during the use of the equipment.
- Each activity will provide the opportunity for students to focus on specific career options and provide insights into the skills required for a variety of related professions. A number of teaching/learning strategies employed in the classroom will allow for career orientation, i.e., job shadowing, computer career and education research, field trips, and guest speakers.
- Before initiating unit activities, teachers should remind students of their responsibilities to promote social responsibility, human solidarity, and the common good throughout their work. Students should be aware that they are in this learning opportunity to develop their God-given potential, and that their goal in life should be to make a meaningful contribution to society.

## Teaching/Learning Strategies

- The first activity in this unit requires students to investigate, develop, and present reports about the evolution of selected areas of transportation, using the Internet and other resources. Activity 2 challenges pairs or teams of students to design and create a visual display of transportation technology for classroom demonstration. The final activity within this unit requires that students visit a local transportation facility and report on career-related information.
- This unit incorporates a variety of teaching and learning strategies, including; teacher-directed activities, individual learning activities, group work, and co-operative learning strategies. Provision should be made to provide the students with opportunities to work independently and in groups to perform the following tasks;
  - problem solving and trouble-shooting
  - brainstorming
  - using hand and power tools safely
  - following design processes
  - collecting information
  - writing technical research reports
  - managing time and resources
- Safe use of hand and power tools is addressed primarily through teacher demonstrations but may be reinforced with safety posters displayed in the room or safety notices placed near equipment. Evaluation on the safe operation of specific equipment may take written form or may take place in the technical facility through teacher evaluation of safe equipment operation. (See Appendices A and B.)
- Teachers can accommodate the variable learning rates of students by allowing increased time for activities, enhancing or compacting course content, assisting during evaluation processes, and/or facilitating peer-tutor assistance where possible.

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## Assessment and Evaluation

Assessment is an ongoing daily process that may include review of a daily/weekly log, (see Appendix C, Job Log sheet), observations of efforts in problem solving and critical thinking, participation in discussions and self and/or peer critiques. Students are evaluated on project deliverables such as reports, products, and presentations based on assessment charts presented in each activity.

## Resources

Crouse, W. *Automotive Mechanics*. Toronto: McGraw Hill, 1993. ISBN 0-028-009436

McCallagh, J. *Pedal Power*. USA: Rosedale Press, 1977. ISBN 0-87857-178-7

Schwaller, A. *Transportation Energy and Power Technology*. Toronto: Glencoe McGraw-Hill, 1992  
ISBN 0-8273-3227-0

Stephenson, G. *Power Technology*. Albany NY: Delmar Publishers, 1996.  
ISBN 0-8273-2446-4

Lets Find Out

<http://directory.netscape.com/reference/encyclopedia/>

How Things Work

<http://www.howthingswork.com/>

Industry Canada

[http://strategis.ic.gc.ca/sc\\_indps/sectors/engdoc/tran\\_hpg.html](http://strategis.ic.gc.ca/sc_indps/sectors/engdoc/tran_hpg.html)

Society of Automotive Engineers

<http://www.sae.org/index.htm>

Transport Canada

<http://www.tc.gc.ca>

Telephone Directories

Industrial Directories

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## **Activity 1: Research and Presentation Project**

**Time:** 240 minutes

### **Description**

Students will conduct research into the evolution of a system of transportation, (land, air, space, or marine). Research will reflect upon the history of the system, its mechanical origins, and its evolution into present day applications. Research will also include support systems or industries, employment opportunities and the effects of their changes upon our society and communities. Students identify social, technological, economic, and environmental implications of transportation issues. Consideration will be given to the reflection of Catholic values as they relate to the transportation industry.

### **Strand(s) and Expectations**

#### **Ontario Catholic School Graduate Expectations**

CGE1d - develops attitudes and values founded on Catholic social teaching and acts to promote social responsibility, human solidarity, and the common good;

CGE2b - reads, understands, and uses written materials effectively;

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;

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;

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;

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE5b - thinks critically about the meaning and purpose of work.

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

#### **Overall Expectations**

TFV.01 - explain the evolution of transportation technologies;

TFV.02T - identify and describe different modes of transportation;

TFV.03T - explain the importance of service and support systems to the transportation of people and products;

TFV.05T - describe the correlation between modes of transportation and the need for related support businesses;

ICV.01T - describe the impact of transportation technology on society and the environment;

ICV.02T - identify career opportunities in transportation-related fields and the education and training required for entry into those positions.

#### **Specific Expectations**

TF1.03T - describe various maintenance and support technologies related to the transportation of people and products;

TF1.09T - describe the importance of secondary industries for the transportation industry;

SP1.01T - produce projects that demonstrate knowledge of a variety of transportation technologies;

IC1.06T - describe related career opportunities and the education and training required to gain entry to these positions.

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## Planning Notes

- Access to school Library/Resource Centre and to the Internet should be arranged before conducting activity. Students may be able to integrate certain aspects of this activity with curriculum from other courses. For example, English may assist with report writing and library skills, Computers may assist with keyboarding and Internet skills, History may assist in contextualizing evolutionary timelines discussed in this project.
- Other resources necessary for this activity include:
  - a teacher-developed handout detailing assignment requirements;
  - an assortment of materials for construction of models – wood, plastics, cardboard, Styrofoam, other recycled materials;
  - a selection of hand tools (e.g., scissors, utility knives, etc.);
  - adhesives (e.g., glue, tape).

## Prior Knowledge Required

- General library or Internet research skills
- Knowledge of how to work co-operatively in group settings
- Basic Internet/keyboarding skills

## Teaching/Learning Strategies

1. Teachers discuss the idea that in order to learn why transportation systems are the way they are, one must understand how they were developed historically. The automobile or the airplane are discussed as examples, reflecting on the issues of human safety and/or care for the environment. Students are asked to consider these values in their research, reporting, and presentation activity.
2. Students are given a list of possible research topics (including developments and advancements in vehicles, systems, and infrastructure), as well as presentation tools (e.g., posters, videos, performances, computer presentations, overheads, etc.). Students select and propose a particular transportation system (land, sea, air, space) for approval by the teacher.
3. Teachers describe the format of the required report (title page, acceptable length, illustrations, bibliography). Teachers also approve the method of presentation for each student.
4. Students are given the opportunity to visit the Library/Resource Centre and/or access the Internet in order to conduct their research. Students are asked to consider using a variety of types of reference media including texts, manuals, magazines, visits to local businesses, specialized software, and Internet search engines.
5. Students prepare a written report of their findings according to the predetermined criteria. Students hand in the report for assessment and evaluation.
6. Teachers may invite guests from the school or local community for the presentations. Students make their presentations to the class and invited guests. At the conclusion of the presentation, the audience is encouraged to ask questions to give the presenters an opportunity to demonstrate their learning.

## Assessment/Evaluation Techniques

Students will be assessed on several aspects of this project:

- Research: quality of research, bibliography and references, initiative
- Written report: content, accuracy of information, presentation, originality
- Verbal Presentation: depth of understanding of subject, quality and effort of presentation

### Sample Assessment Rubric for a Research Project

Expectations	Level 1	Level 2	Level 3	Level 4
Identify problems and use appropriate research strategies such as Internet or library to research possible solutions. TFV.02T	- displays limited initiative in problem solving and researching	- uses some researching techniques to attempt problem solving	- effectively identifies problems, uses appropriate research strategies such as Internet or library	- shows advanced knowledge of relevant information retrieval procedures
Apply research skills to accurately analyse and interpret information related to transportation technology. TFV.02T ICV.02T	- applies few of the research skills required in an inquiry/ analysis process	- retrieves some relevant information through research	- applies research skills to accurately analyse and interpret information related to transportation technology	- applies all of the skills required and applies with a high degree of effectiveness
Submit design report demonstrating thorough understanding of concepts and their relationships. TFV.03T TFV.05T IC1.06T TF1.03T TF1.09T	- offers limited documentation which displays some understanding of concepts	- provides documents with moderate clarity, and with some understanding of concepts	- submits report demonstrating thorough understanding of concepts and their relationships	- exhibits original design reports with an extensive command of concepts and transfers to new contexts with high effectiveness
Student presentation clearly communicates the ideas and issues and demonstrates insightful conclusions. TFV.01T ICV.01T ICV.02T	- communication demonstrates limited clarity, knowledge of facts or accurate conclusions	- presentation demonstrates some accurate facts and communicates with some sense of audience and purpose	- presentation clearly communicates the ideas and issues and demonstrates insightful conclusions	- communicates meaningful information with an exceptional degree of clarity and with a strong sense of audience and purpose

**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 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;
- flexibility in acceptable formats for presentations;
- additional homework assignments;
- consultation with parents;

- assistance with organization skills;
- modified work load;
- additional one-on-one time by 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 ed. departments when required to assist in creating an educational plan (IEP) for individual student.

### Resources

Crouse, W. *Automotive Mechanics*. Toronto: McGraw-Hill, 1993. ISBN 0-028-009436

McCallagh, J. *Pedal Power*. USA: Rosedale Press, 1977. ISBN 0-87857-178-7

Schwaller, A. *Transportation Energy and Power Technology*. Toronto: Glencoe McGraw-Hill, 1992. ISBN 0-8273-3227-0

Stephenson, G. *Power Technology*. Albany, NY: Delmar Publishers, 1996. ISBN 0-8273-2446-4

Lets Find Out

<http://directory.netscape.com/reference/encyclopedia/>

How Things Work

<http://www.howthingswork.com/>

Transport Canada

<http://www.tc.gc.ca>

## Activity 2: Transportation Display

**Time:** 240 minutes

### Description

Students create a display of a transportation system for use as a teaching aid in the classroom. The display should incorporate recycled parts and associated labels or display boards identifying components and features. Students will learn to identify parts and their function, co-operative work habits, as well as finishing techniques and safe use of hand tools. This activity provides a basis for co-operation and consideration of others.

### Strand(s) and Expectations

#### Ontario Catholic School Graduate Expectations

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;

CGE4c -takes initiative and demonstrates Christian leadership;

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE5a - works effectively as an interdependent team member;

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.

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

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## Overall Expectations

SPV.03T - describe the function of major vehicle system components;

SPV.04T - use a variety of fastening, fabrication, maintenance, and repair techniques correctly in projects;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

## Specific Expectations

SP1.01T - produce projects that demonstrate knowledge of a variety of transportation technologies;

SP1.07T - use a variety of technologies for joining materials;

IC1.07T - describe health and safety regulations for the handling of tools, fuels, materials, and equipment.

## Planning Notes

- Work area should have sufficient bench space for preparation of displays. Depending on medium selected, access to woodworking equipment (e.g., bandsaw) may be desirable.
- This activity may provide opportunities to integrate other curricular programs such as visual arts for display design, design technology and construction for fabrication techniques and safe use of tools, and computer technology for production of signage or graphics.
- Teachers should prepare the following materials before initiating activity:
  - parts for use in displays
  - assortment of materials for construction of display elements, e.g., wood, plastics, cardboard, Styrofoam, other recycled materials
  - selection of hand tools; scissors, saws, utility knives etc.
  - adhesives and finishing materials; glue, tape, cleaners, paints, sandpaper, etc.
- Before allowing students to access tools in the shop environment, safety rules must be established. Each student must demonstrate knowledge of safe practices. See Appendix A, Sample Safety Passport, and Appendix B, General guidelines for Safety in the Transportation Facility. Protective eyewear must be provided before students work in the shop environment.

## Prior Knowledge Required

Students must have awareness of general shop rules and safety requirements (see Appendices A and B) before working in the shop environment.

## Teaching/Learning Strategies

1. Teachers initiate the activity by describing the need for visual aids to help students in their understanding of vehicle components, and point out that by working co-operatively with a Christian view of helping others, everyone benefits. Students are then arranged in pairs to conduct the activity.
2. Teachers allocate components of vehicles (such as engine components, small engines, bicycles, etc., depending on local needs) to student pairs. Pairs prepare a display that will identify their component and its functions.
3. Students research their given components and the associated functions and design a method of display, (poster board, table top platform, etc.), preparing labels or identifying tags.
4. Students clean and prepare a sample of their component, including cutting for interior views, painting areas for highlighting, etc. Students also create their display boards, frames, or platforms using available materials, (use of recycled materials should be encouraged). Teachers should encourage artistic presentation and originality of display as well as quality of construction.
5. Students describe their displays to the class and what they have learned of that part's function within a vehicle system.

## Assessment/Evaluation Techniques

Students will be assessed on several aspects of this project:

- depth of research
- effort in preparation of display elements
- accuracy of information and knowledge demonstrated
- quality of construction, originality, aesthetics, informative value

### Assessment Chart for Transportation Display

Expectations	Level 1	Level 2	Level 3	Level 4
Student effectively demonstrates knowledge of components and functions SPV.03T SP1.01T	- displays limited initiative in researching component	- demonstrates some adequate initiative in researching component	- demonstrates considerable initiative in researching component	- exhibits exceptional initiative and depth in researching component
Student demonstrates co-operative work habits and Christian leadership CGE4c CGE5a CGE5f CGE5g	- requires some assistance in working co-operatively with partner and others; limited individual initiative in completing work	- demonstrates effective cooperation with partner and others; some individual initiative in completing work	- demonstrates effective cooperation with partner and others as well as individual initiative in completing work	- demonstrates leadership skills and superior individual initiative in completing work
Student transfers concepts and skills to create an accurate and representative project; demonstrating originality and artistic endeavor SP1.07T	- applies few of the skills required, implements construction requirements with limited effectiveness	- demonstrates some ability to transfer design concepts into project form; uses procedures and equipment to create moderately effective display	- transfers concepts and skills to create an accurate and representative project; demonstrating originality and artistic endeavor	- demonstrates and promotes the safe and correct use of procedures, equipment and technology to produce an aesthetically pleasing, informative, and technically precise project
Student demonstrates safe work habits SPV.04T ICV.04T IC1.07T	- requires constant supervision and reminders to work safely and cleanly	- works safely and cleanly with some required supervision	- works safely and cleanly with minimal supervision	- assists and supervises others to work safely and cleanly

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

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## Accommodations

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

- adapting the degree of difficulty of research and part identification needed;
- use of other school resources for assistance with graphic or fabrication activities;
- additional time allowance for completion of projects;
- flexibility in acceptable formats for final product;
- assistance with organizational work habits;
- additional one-on-one time by 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 ed. departments when required to assist in creating an educational plan (IEP) for individual student.

## Resources

Books, CDs, parts catalogs, instruction manuals or other materials provided by manufacturers of components will help the student identify materials.

Automotive textbooks may also be of use in identifying parts, such as:

Crouse, W. *Automotive Mechanics*. Toronto: McGraw Hill, 1993. ISBN 0-028-009436

How Things Work

<http://www.howthingswork.com/>

## Activity 3: Career Exploration: The Industry Visit

**Time:** 120 minutes

### Description

Students investigate career opportunities in the transportation field through a visit with local community transportation related businesses. Businesses may include municipal airports, flight schools, local train station, trucking hub, vehicle sales or rental centres, vehicle service facilities, courier services, taxi companies, or parts suppliers. Students prepare questionnaires to collect career information and complete a site visit report outlining knowledge gained. Students will be directed to examine careers in light of Christian values of work ethics and care of society and the environment.

### Strand(s) and Expectations

#### Ontario Catholic School Graduate Expectations

CGE1d - develops attitudes and values founded on Catholic social teaching and acts to promote social responsibility, human solidarity and the common good;

CGE2b - reads, understands, and uses written materials effectively;

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;

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;

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE5b - thinks critically about the meaning and purpose of work;

CGE5d - finds meaning, dignity, fulfillment, and vocation in work which contributes to the common good.

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

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## **Overall Expectations**

TFV.02T - identify and describe different modes of transportation;

TFV.03T - explain the importance of service and support systems to the transportation of people and products;

TFV.05T - describe the correlation between modes of transportation and the need for related support businesses;

ICV.02T - identify career opportunities in transportation-related fields and the education and training required for entry into those positions.

## **Specific Expectations**

TF1.01T - identify current safety standards in transportation and secondary industries;

TF1.09T - describe the importance of secondary industries for the transportation industry;

SP1.01T - produce projects that demonstrate knowledge of a variety of transportation technologies;

IC1.06T - describe related career opportunities and the education and training required to gain entry to these positions.

## **Planning Notes**

- Local businesses must be contacted beforehand to arrange class or group visits. Transportation to and from the site should be arranged, including costs, parent permission forms, and substitute teachers as outlined in school policies. Students should be made aware of school policies toward expected behaviour before conducting the site visit.
- An alternative to a site visit can take the form of phone interviews, where students conduct an interview of a pre-selected employer or employee of a transportation related business. In this case, teachers should contact selected businesses and pre-arrange for time for interviews.
- This activity provides opportunities for cross-curricular work in English for report writing and interviewing skills, Communications Technology and Business Studies for word processing.

## **Prior Knowledge Required**

Students must have awareness of acceptable personal conduct standards outlined in the school policy.

Students must also be made aware of safety rules at the business to be visited.

## **Teaching/Learning Strategies**

1. Teachers describe the purpose of the activity as an exploration of careers and business practices in a transportation industry. Teachers describe the agenda of developing questions to be asked, visiting the site, and preparing a report for evaluation.
2. Teachers direct students to examine careers in light of Christian values of work ethics and care of society and the environment. Questions to employers could reflect the business's ties with the community, benefits provided to employees, lifestyles of typical employees or corporate philosophies that guide their business practices.
3. Student prepare their individual questionnaires to ask company representatives. The questionnaire should include details such as educational requirements, daily tasks, salary ranges, types of employees required to operate the business, opportunities for advancement in the field, and/or employee job satisfaction.
4. Teachers arrange for the site visit after insuring that students have completed the necessary permission forms, and have prepared their questionnaires. While on site, students should be prepared to observe safety policies and rules and to have their questions answered.
5. Upon return, students prepare a short report detailing their knowledge gained through the site visit. The report should also include a short synopsis on the student's opinion of the possibilities of careers for themselves in this business. The report is handed in for assessment and evaluation.

## Assessment/Evaluation Techniques

### Assessment Chart for Site Visit Report

Expectations	Level 1	Level 2	Level 3	Level 4
Identify and explain relationships of local businesses to transportation TFV.02T TFV.03T TFV.05T ICV.02T TF1.09T	- demonstrates limited effort in understanding careers and business operations	- demonstrates moderate effort in understanding careers and business operations	- demonstrates considerable effort in understanding careers and business operations	- demonstrates exceptional effort in understanding careers and business operations
Identify job related safety risks TF1.01T	- limited descriptions of safety policies of business	- describes moderately safety policies of business	- describes effectively safety policies of business	- describes effectively safety policies of business and relates concepts to other businesses
Production of questionnaires and reports containing all required elements ICV.02T ICL.06T ICV.02T ICL.06T	- report and questionnaire have limited elements	- report and questionnaire have a moderate number of required elements	- report and questionnaire are complete and accurate	- report and questionnaire are complete, accurate, and comprehensive

**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 pre-printed questionnaires for students requiring extra assistance. Students may be assigned a partner as a peer helper to accompany them on the visit and assist in gathering information. Oral presentations can be substituted for written reports. Additional individual study topics or a multiple visits may be assigned for advanced students.

### Resources

Local phone directories or local chapters of the Chamber of Commerce can provide information on local businesses in transportation-related industries.

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## Unit 2: Applied Maintenance

**Time:** 30 hours

### Unit Description

In this unit students perform a wide variety of commonly practised maintenance routines on vehicles. Students develop practical skills in vehicle maintenance and troubleshooting and learn to observe safe work practices in a shop environment. Students also study the relationships between regular maintenance and inspection and vehicle performance and safety. These skills will provide an identifiable and marketable base for future co-op or employment opportunities and will serve as life skills to consumers of vehicles and services in the transportation industry. Through these activities, students will learn to work with a Christian perspective of honesty and integrity in the workplace.

### Strand(s) and Expectations

**Ontario Catholic School Graduate Expectations:** CGE 1l, 2b, 3c, 4a, 4f, 5a, 5d, 5h, 7a, 7b, 7i, 7j, 7l.

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

**Overall Expectations:** TFV.03T, TFV.05T, SPV.01T, SPV.03T, SPV.04T, ICV.01T, ICV.04T.

**Specific Expectations:** TF1.01T, TF1.02T, TF1.03T, TF1.04T, TF1.05T, TF1.09T, SP1.01T, SP1.02T, SP1.03T, SP1.05T, SP1.07T, SP1.08T, IC1.02T, IC1.03T, IC1.05T, TIC1.07T.

### Activity Titles (Time + Sequence)

Activity 1	Vehicle Inspections, Checklists, and Schedules	360 minutes
Activity 2	Maintaining Personal Transportation and Small Powered Equipment	360 minutes
Activity 3	Exhaust System Service	360 minutes
Activity 4	Servicing Wheels and Tires	360 minutes
Activity 5	Automotive Reconditioning and Care	360 minutes

### Prior Knowledge Required

The specific prior knowledge requirements for activities in this unit will depend on the sequence of delivery. The general knowledge required for the unit is as follows:

- understanding of basic shop operating procedures
- awareness of acceptable personal conduct standards
- awareness conduct as a responsible service provider
- understanding of safety rules
- technical reading skills
- Internet/research skills

In addition, the continued use of the Sample Safety Passport (Appendix A) introduced in Unit 1 is strongly encouraged.

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## Unit Planning Notes

- These activities require access to an equipped lab area with general mechanical hand tools as well as specific lifting devices, specialty tools for automotive, small engine and other applications, and their appropriate safety devices. Project examples and bench models are an aid in introducing the skills and knowledge. The reference materials for the activities may be in the form of general texts, but attention should be paid to the specific manuals and their instructions when they are required in servicing to the OEM standards.
- Some activity content is guided by Province of Ontario Standards. Current documentation should be available to support these standards as they are presented in specific projects.
- In keeping with industry standards, reports or task sheets should be in a document format, “template-style” work orders should be used to track student activities and facilitate real-world technical record keeping.
- Special note has been made of “customer care” and inspection of vehicles returning to service. An important aspect of providing actual (as opposed to simulated) services is the satisfaction, confidence, and safety of the people involved with the project. The customer (or community) and the learning service provider should be encouraged to use communication and problem solving in a co-operative manner to provide the best results.
- Adequate and timely opportunities can be found within the activity to reflect and act on the elements of faith that assist and encourage students in their endeavors. Acts of giving in the community, goals of excellence in their work, and the ideals of purposeful vocation can all be well reinforced on a day-to-day basis.

## Teaching/Learning Strategies

1. The activities in this unit may involve the servicing a variety of transportation examples. There is a great advantage in using projects that are appropriate to the student’s community. The work expectations are of an introductory service provider such as the initial work of a co-operative education placement or a student’s part-time employment. Teachers should ensure that Catholic ethical work practices are taught and reinforced throughout the unit’s activities.
2. Activity 1 is both a communications and technical activity that will allow students to identify and recognize deficiencies and potential problems in a vehicle. Common systems in transportation can be identified by using a checklist format. Students are expected to apply information and exercise judgment in their assessment of the system and component condition.
3. Activity 2 provides an opportunity, through the design and implementation of a “total service”, to be introduced to research methods using manuals, and project organization required in carrying out maintenance activities. A documented report is expected with the skills demonstration.
4. Activity 3 uses a specific system (the emissions control system), to reinforce repair skills and apply general industrial skills such as welding to a transportation project. Original Equipment Manufacturer (OEM) and provincial standards will be used to demonstrate the technical research expected in industry as well as creating an attitude of accountability in professional situations.
5. Activity 4 is an examination of a common starting point in industry - tire servicing. Through research, skills demonstration and knowledge acquisition by lessons, students will have the in-school opportunity to master a skills foundation applicable to a job situation in their community.
6. Activity 5 uses procedures in reconditioning of a vehicle adapted from the used car retail industry to introduce the skills necessary to improve the appearance, function, and value of any vehicle. An element of research is required to properly assess the project, and the report will be made in a professional style format.

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## Assessment and Evaluation

Assessment is an ongoing and daily process that involves student demonstration, observation of daily/weekly project work, maintenance of log or work orders, and practical and written examinations. Activity assessment rubrics and teacher/student or peer discussion may be used to determine progress in team or individual activity.

## Resources

Atkinson, H. *Mechanics of Small Engines*. Toronto: McGraw-Hill Ryerson, 1986.

ISBN 0-07-548870-1

Crouse, W. *Automotive Mechanics*. Toronto: McGraw-Hill, 1993. ISBN 0-028-009436

Deroche, A. *The Principals of Autobody Repairing and Repainting*. New Jersey: Prentice-Hall, 1992.

ISBN 0-13-678053-9

Fricker, W. *Welding Procedures and Practices*. Toronto: John Wiley and Sons, 1984.

ISBN 0-471-79783

Interdicasterial Commission. *Catechism of the Catholic Church*. New York: Doubleday, 1995.

ISBN 0-385-47967-0

Mitchell International. *Automechanics*. Toronto: Prentice-Hall, 1991. ISBN 0-13-583782-0

Mitchell International. *Automotive Fuel and Emissions Systems*. New Jersey: Prentice-Hall, 1991.

ISBN 0-13-584 103-8

Thiessen, F. and D. Dales. *Automotive Principles and Service*. Toronto: Prentice-Hall, 1994.

ISBN 0-13-336561-1

Ontario's Drive Clean Programme

<http://www.ene.gov.on.ca/>

Pollution Probe

<http://www.pollutionprobe.org>

Popular Mechanics Magazine

<http://www.popularmechanics.com/>

Inner.Auto

<http://www.innerauto.com>

How Things Work

<http://www.howthingswork.com/>

Computerized service manuals

OEM Service Manuals

Aftermarket Service Manuals

Ministry of Transportation Safety Inspection Standards

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## Activity 1: Vehicle Inspections, Checklists, and Schedules

**Time:** 360 minutes

### Description

In this activity students will be developing comprehensive inspection checklists and maintenance schedules, and perform thorough vehicle inspections. The students will develop skills that will enable them to identify various conditions, described on their checklists, that indicate problems or require maintenance. Students will identify the major systems and components inspected for daily use, pre-purchase of vehicles, seasonal inspection, and long trip or vacation inspections.

### Strand(s) and Expectations

#### Ontario Catholic School Graduate Expectations

CGE5a - works effectively as an interdependent team member;

CGE5d - finds meaning, dignity, fulfillment and vocation in work which contributes to the common good;

CGE5h - applies skills for employability, self-employment and entrepreneurship relative to Christian vocation.

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

#### Overall Expectations

TFV.03T - explain the importance of service and support systems to the transportation of people and products;

SPV.01T - demonstrate accuracy in the use of measuring systems and methods;

SPV.04T - use a variety of fastening, fabrication, maintenance, and repair techniques correctly in projects;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

#### Specific Expectations

TF1.02T - demonstrate knowledge of service procedures for different types of transportation vehicles;

TF1.04T - describe the operation and application of major vehicle propulsion devices and the procedures used for servicing them;

SP1.01T - produce projects that demonstrate knowledge of a variety of transportation technologies;

SP1.02T - use measurement tools correctly to inspect and service vehicle systems;

SP1.03T - identify wear on vehicle system components on the basis of industry standards;

SP1.05T - describe and maintain support systems related to vehicle operation;

SP1.08T - repair or replace components to meet or exceed original equipment manufacturer (OEM) standards.

### Planning Notes

Teachers should pre-select standard industry inspection and maintenance checklists. A complete vehicle service manual in print or software will include routine checklists. Vehicle owner's manuals will list recommended service schedules. Samples from mass transit, commercial carriers, retail service, automobile associations, and provincial guides should be presented to students.

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## Prior Knowledge Required

Students should have:

- general understanding of basic shop operating procedures
- awareness of acceptable personal conduct standards
- technical reading skills

Continued use of the Sample Safety Passport (Appendix A) as well as familiarity with general procedure as outlined in Appendix B is recommended.

## Teaching/Learning Strategies

1. The teacher presents the students with the challenge of developing inspection checklists and a maintenance schedule for a vehicle. The purpose of checklists, and the systems to be inspected will be reviewed. Sample checklists may be discussed or practised. Teachers should discuss the importance of issuing standard inspection and maintenance checklists or routines.
2. Students working independently or in small groups research, develop and perform inspections and maintenance schedules using criteria such as safety, mechanical fitness, efficiency and performance.
3. Theory Exercise
  - Each student researches and develops inspection checklists and maintenance schedules following manufacturer's specifications and practical manuals (the document should be computer generated). The rating system used in their inspection checklist such as pass/fail, requires service, service recommended in "x" km should match the purpose of the inspection. All students should submit the document for teacher's approval and assessment. Teachers should discuss with the class any questions that arise from reading of specs or manuals.
4. Practical Exercise
  - Students (independently or in groups assigned by teacher) perform the inspection on the vehicle using the checklists that they have designed, comparing results with manufacturers' specifications found in the technical manuals. Students will report their results to the teacher for confirmation and review of findings. As required, the teacher will inspect all vehicles leaving the facility.

## Assessment/Evaluation Techniques

- The students should be assessed on an ongoing basis as the inspection is designed and executed. The evaluation should be based on the results of the two parts of the activity. Teachers should evaluate the completed student inspection checklist, and observe and assess the student's performance in following and describing their individual checklist.
- A suggested set of techniques would be:
  - summative evaluation of the completed checklist
  - an evaluation of the practices demonstrated in executing the inspection

### Inspecting Checklists and Schedules Rubric

Criteria	Level 1	Level 2	Level 3	Level 4
Students will read and develop written technical materials as effective communication tools TFV.03T TF1.02T TF1.04T	- demonstrates limited understanding of inspection checklists and scheduled maintenance	- demonstrates adequate understanding of inspection checklists and scheduled maintenance	- demonstrates considerable understanding of inspection checklists and scheduled maintenance	- demonstrates thorough and insightful understanding of inspection checklists and scheduled maintenance
Student applies knowledge of industry standards to inspection checklist development SPV.01T SP1.01T SP1.03T SP1.05T	- written inspection checklist and maintenance schedule shows minimal adherence to industry-type format	- written inspection checklist and maintenance schedule shows adequate adherence to industry-type format	- written inspection checklist and maintenance schedule shows standard adherence to industry-type format	- written inspection checklist and maintenance schedule shows extensive knowledge and adherence to industry-type format
Student will perform designed inspection SPV.04T SP1.02T SP1.08T ICV.04T	- demonstrates limited capabilities to perform vehicle inspection	- demonstrates adequate capabilities to perform vehicle inspection	- demonstrates effective capabilities to perform vehicle inspection	- demonstrates thorough capabilities to perform vehicle inspection and assistance of others

**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 researching and developing a checklist depending on individual student or class needs. Students with strengths in one area of the activity should be encouraged to participate as team leaders there and as active group members in the other. 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.

#### Resources

Vehicle checklists and recommended maintenance schedules can be obtained from vehicle manuals or service station literature. General information can be obtained from:

Mitchell International. *Automechanics*. Toronto: Prentice-Hall, 1991. ISBN 0-13-583782-0

Thiessen, F. and D. Dales. *Automotive Principles and Service*. Toronto: Prentice-Hall, 1994.

ISBN 0-13-336561-1

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## **Activity 2: Maintaining Personal Transportation and Small Powered Equipment**

**Time:** 360 minutes

### **Description**

The students will plan and execute a complete service of a simple personal transportation vehicle or powered equipment. A good foundation of technical skills, basic knowledge of systems, and an awareness of industry methods will set the parameters for the service. The standard of this service is to maintain or restore the project to its original condition or functionality. Examples such as bicycles, skateboards, wheelchairs or small powered equipment may be accessible. Students will have ownership of the activity by servicing their own machines, or by acting as service providers for their community.

### **Strand(s) and Expectations**

#### **Ontario Catholic School Graduate Expectations**

CGE1i - integrates faith with life;

CGE2b - reads, understands, and uses written materials effectively;

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE7b - accepts accountability for one's own actions.

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

#### **Overall Expectations**

TFV.03T - explain the importance of service and support systems to the transportation of people and products;

SPV.04T - use a variety of fastening, fabrication, maintenance, and repair techniques correctly in projects;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

#### **Specific Expectations**

TF1.01T - identify current safety standards in transportation and secondary industries;

TF1.02T - demonstrate knowledge of service procedures for different types of transportation vehicles;

TF1.03T - describe various maintenance and support technologies related to the transportation of people and products;

SP1.02T - use measurement tools correctly to inspect and service vehicle systems;

SP1.03T - identify wear on vehicle system components on the basis of industry standards;

SP1.08T - repair or replace components to meet or exceed original equipment manufacturer (OEM) standards.

### **Planning Notes**

- The opportunity to work as service providers will demonstrate Catholic values in terms of the value of work, work ethics, and caring for others. Teachers should plan methods of illustrating these links as inherent in the professional conduct of those working in technology. The technology itself may be value neutral, but the integration of faith and life's activities will yield a richer experience for any student interacting with others.

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- Teachers should predetermine the scope of the activity based on local resources and needs. Special considerations should be given to instructing and assisting students in the handling of projects for clients. To ensure success, secure storage and adequate working space must be provided.
  - In addition:
    - specialty tools are required for some applications in order to achieve professional results
    - general and manufacturer specific procedure instructions may differ. Assist students in determining an applying the most appropriate procedures
    - testing of multiple projects in the same lab may not be possible at the same time. Design a schedule to ensure adequate supervision.

### **Prior Knowledge Required**

Students will need:

- understanding of basic shop operating procedures
- awareness of acceptable personal conduct standards
- awareness conduct as a responsible service provider
- understanding of safety rules
- technical reading skills
- Internet/research skills (preferred)

Teachers are encouraged to continue use of the Safety Passport (Appendix A), as well as adopt the general procedure rules as outlined in Appendix B.

### **Teaching/Learning Strategies**

1. Students will plan a schedule for the total service, and be provided with or create a resource sheet to track pertinent information contacts. Categories may include parts distributors, technical assistance call centres, web sites or local associations, clubs, and businesses. The timeline should provide a schedule for the inspection, research, and service components of the activity. This activity may also call for the design and creation of a promotional flyer or poster to highlight the activity in the school. This activity is an excellent opportunity to serve the school or community.
2. An initial class examination of a sample project, with teacher instruction and student participation will demonstrate how to isolate systems, identify mechanical wear, adjust components and ascertain specific manufacturer identification or model markings. Proper, safe, and ecologically sound procedures should be outlined.
3. Students will make the transition from casual user of the vehicle or equipment to dedicated service provider by objectively assessing the operation of their project example. This often results in an immediate raising of standards. “Client” input may be effective here. Teachers should emphasize that good communication between the service person and the client is a diagnostic tool and provides an objective benchmark for results. Clear descriptions of complaints and expectations will invariably result in a better service.
4. Planning for project and parts storage will simplify the shared facilities and resources. This mirrors the working situations in today’s industry. Students should be an integral part of this planning.
5. In designing the service procedure, students should assess working life of the components and the whole machine. Students will determine which parts should be serviced and which should be identified for future replacement. Students are to assess likely failures and recognize good design in systems and components. Teachers should assist the students in exploring the relationships between maintenance and performance, and maintenance and useful life of the equipment. Students prepare a service procedure outline based on their assessment.
6. Students who have completed the service procedure outline begin the service process. Modifications to the service procedure outline should be monitored by the teacher, to ensure that the students become aware of the accountability of providing specific services.

7. Students should demonstrate their results to others and compare procedures to emphasize foundational skills. A review of maintenance vs. repair or another subjective assessment of the process will emphasize to the students the value of their individual efforts.

**Assessment/Evaluation Techniques**

- a formative assessment spot check of the student’s service schedule
- an informal “customer satisfaction survey”, conducted by clients or other student’s role playing
- a summative evaluation based on the service outcome and student demonstration

**Sample Activity Assessment Rubric for a “Total Service”**

<b>Criteria</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Student can identify and relate the combined systems in a personal transportation vehicle or small powered equipment. TFV.03T	- limited understanding of the systems that exist in transportation	- moderate clarity in understanding the systems that exist in transportation	- considerable understanding of the systems that exist in transportation	- thorough understanding of the systems that exist in transportation
Student can formulate a system for comparing results of simple service and adjustment of mechanical systems. SPV.04T	- limited understanding of the processes involved in executing mechanical adjustments	- moderate understanding of the processes involved in executing mechanical adjustments	- considerable understanding of the processes involved in executing mechanical adjustments	- thorough understanding of the processes involved in executing mechanical adjustments
Student can function as a service provider in a technical setting and demonstrate employable or professional skills. SP1.03T	- limited ability to function in a working technical setting	- adequate ability to function in a working technical setting	- competent ability to function in a working technical setting	- exemplary ability to function in a working technical setting
Student can service a simple vehicle or piece of powered equipment. TF1.02T	- assists in service.	- performs service	- performs service with consistent results	- performs service with a high degree of complexity with consistent results
Students can recognize and/or apply similar procedures in separate projects. TF1.03T	- limited attempt made to extend applications of procedures	- some attempt made to extend applications of procedures	- considerable thought was used to extend applications of procedures	- insightful ideas were used to extend applications of procedures

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

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## Accommodations

Strategies to accommodate the 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;
- additional homework research assignments;
- consultation with parents;
- assistance with organization skills;
- additional one-on-one time by 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, when required, to assist in creating an educational plan (IEP) for individual student.

Accommodations for physical disabilities should be made as required to ensure the safety of individuals while participating in course activities.

## Resources

Atkinson, H. *Mechanics of Small Engines*. Toronto: McGraw-Hill Ryerson, 1986. ISBN 0-07-548870-1

McCallagh, J. *Pedal Power*. U.S.A.: Rosedale Press, 1977. ISBN 0-87857-178-7

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## Activity 3: Exhaust System Service

**Time:** 360 minutes

### Description

In this activity students inspect exhaust systems, diagnose problems and perform service operations. The students develop diagnostic and technical skills that enable them to inspect and replace exhaust components. Instruction is given on the use of tools that are commonly used in performing exhaust system repairs, such as the oxygen-acetylene torch for heating and cutting and the MIG (Metal Inert Gas) welder for welding. Students identify various emission system components and state their purpose. The importance of safety in a clean and harmonious workplace is reinforced throughout this activity.

### Strand(s) and Expectations

#### Ontario Catholic School Graduate Expectations

CGE5h - applies skills for employability, self-employment and entrepreneurship relative to Christian vocation;

CGE7I - respects the environment and uses resources wisely;

CGE7j - contributes to the common good.

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

#### Overall Expectations

TFV.03T - explain the importance of service and support systems to the transportation of people and products;

SPV.03T - describe the function of major vehicle system components;

SPV.04T - use a variety of fastening, fabrication, maintenance, and repair techniques correctly;

ICV.01T - describe the impact of transportation technology on society and the environment;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

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## Specific Expectations

TF1.01T - identify current safety standards in transportation and secondary industries;  
SP1.03T - identify wear on vehicle system components on the basis of industry standards;  
SP1.07T - use a variety of technologies for joining materials;  
SP1.08T - repair or replace components to meet or exceed original equipment manufacture (OEM);  
IC1.02T - describe changes made to vehicle systems to enable them to use energy more efficiently;  
IC1.07T - describe health and safety regulations for the handling of tools, fuels, materials, and equipment.

## Planning Notes

- Information on the gases produced by the internal combustion engine and their effects on the environment, including a general overview of some of the systems that have been developed to limit these emissions, should be prepared beforehand. Teachers should prepare for discussions on the criteria for inspecting the exhaust system and the consequences of operating a vehicle with a faulty exhaust system. Introduction to the Drive Clean Emissions Program (see Resources) may be included. For a particularly Catholic perspective of these issues, direction may be taken from the current Catechism which addresses Technology and the Environment.
- The teacher must demonstrate correct procedures and safety concerns when using the oxy-acetylene torch for cutting, heating and welding, and the electric welding equipment. Special caution must be taken to ensure all students observe appropriate protection during all demonstrations and subsequent practice sessions. Strict accordance with industry and site specific requirements for providing shielded and ventilated areas must be met. Students should be provided with scrap pieces of exhaust pipe and other materials, and ample time for practice welding.
- All work performed on vehicle exhaust systems must meet OEM specifications. No modifications may be made that will defeat any noise or emission control systems. The use of “test pipes” in place of catalytic converters is limited to in-shop testing as in industry. Teachers must foster in the students respect for environmental concerns.

## Prior Knowledge Required

Students should have:

- general understanding of basic shop operating procedures
- awareness of acceptable personal conduct standards
- understanding of general safety rules

The continued use of the Safety Passport (Appendix A) is strongly encouraged.

## Teaching/Learning Strategies

1. The teacher discusses the purpose of the exhaust system and various key components, including; exhaust manifold(s), expansion chambers, catalytic converters, and exhaust pipes. The teacher demonstrates inspection procedures for each component. The required safety procedures are discussed and demonstrated for each area of exhaust work. Students record all of the information in notes or refer to a teacher-developed information sheet.
2. Students inspect and diagnose the exhaust systems on different vehicles. The students record the required repairs and suggest appropriate service procedures. The teacher approves the repairs and supervises the component repair or replacement.

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3. The teacher demonstrates welding, heating, and cutting using the oxy-acetylene torch and the electric (arc, MIG, plasma cutter) welder. Students practise these skills using scrap pieces of material. During the demonstration the teacher reinforces correct operating procedures and reviews the following safety concerns:
    - the ground lead must be disconnected from the battery prior to electric welding;
    - a heat shield (i.e., metal sheet) must be placed between the exhaust pipe and the vehicle;
    - the area to be welded must be carefully inspect for the proximity of any gas lines or fuel tanks. (If any are present, the exhaust components must be removed from the vehicle prior to any welding operations.);
    - an observer must be able to view the inside of the vehicle to identify any smoke. (If the vehicle is on the hoist, a door must be open to permit an unobstructed view.);
    - an appropriate fire extinguisher must be readily available during the entire procedure.
  4. The teacher discusses the primary gasses produced by the internal combustion engine and briefly outlines their effects on the environment. (This discussion might be linked with a Science or Geography unit, consult those subject teachers).
  5. The teacher introduces the names and purposes of exhaust gas emission control components. Primary components to be identified are the catalytic converter, oxygen sensor, exhaust gas re-circulation valve, and evaporative canister. It should be understood that the systems are vehicle specific and a more comprehensive listing could be provided. As an enrichment to the activity, some students may be introduced to the complete gas flow (and vacuum) circuits and electronic sensor control circuits for these systems. Knowledge of environmental concerns may be appreciated in school/community groups or serve as a tie-in for using transportation as a study topic in another curriculum.
  6. The teacher must stress the importance of maintaining gas emission control devices to ensure minimum exhaust gas emissions from vehicles. This is an example of a professional pursuit being a response to God's calling to work. The environment should be a true concern to those working in transportation.

### **Assessment/Evaluation Techniques**

- Daily observation of the students' work and safety practices and organizational skills while performing required tasks are noted. Independent research, notebooks, and worksheets are checked for order and accuracy of information.
- Formal tests should be given on the safe operation of welding procedures. See Appendix 2.3 – Oxy-Acetylene Welding as an example

### Sample Assessment Rubric for Exhaust System Diagnosis and Repair

Expectations	Level 1	Level 2	Level 3	Level 4
Student can use the oxy-acetylene torch correctly and safely. SPV.04T SP1.07T ICV.04T IC1.07T	- uses the regulators and lights torch only with constant supervision	- heats and cuts pipes with regard to the safety with some required supervision	- heats, cuts and welds pipe using the correct procedures with minimal or no supervision	- heats, cuts, welds and brazes pipe to an air-tight seal consistently
Student can use the MIG welder safely. SPV.04T SP1.07T ICV.04T IC1.07T	- operates the welder safely only with constant supervision	- operates the welder safely to make beads on a flat surface with some assistance	- operates the welder safely to make beads around a suspended pipe with some assistance	- operates the welder safely to make beads. Adjusts settings to correct operating difficulties
Student can inspect the exhaust system. SP1.03T SP1.08T	- determines some of the major failures in the exhaust system	- determines most faults in the exhaust system	- identifies a complete list of components requiring service or replacement	- assesses the complete system and determines if emission-reducing components are present and functional
Student can state the importance of a properly functioning exhaust system. TFV.01T TF1.01T SPV.03T ICV.01T IC1.02T	- identifies some of the major exhaust system components and their purpose	- identifies most of the major exhaust system components and states the hazards of leaking exhaust systems	- identifies all major exhaust system components and states various effects of vehicle exhaust and emissions	- relates the components, their function and the hazards/ environmental effects they affect

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

#### Accommodations

- Students with special needs may rely more heavily on an automotive text to reference the components and their purposes. Teachers should allow for more inspection time for those who need more help to understand functions and components of systems.
- Teachers can also provide:
  - instructor and peer assistance in the identifying components and in making repairs;
  - instructional aid materials providing step-by-step instruction of exhaust systems inspection routines.
  - research into more specific details of component identification and manufacturer's specifications in exhaust gas flow circuits and electronic control circuits for enrichment;
  - research into the ecological effects of exhaust emissions and proposed emission legislation.

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## Resources

Fricker, W. *Welding Procedures and Practices*. Toronto: John Wiley and Sons, 1984.

ISBN 0-471-79783

Interdicasterial Commission. *Catechism of the Catholic Church*. New York: Doubleday, 1995.

ISBN 0-385-47967-0

Mitchell International. *Automotive Fuel and Emissions Systems*. New Jersey: Prentice-Hall, 1991.

ISBN 0-13-584 103-8

Ontario's Drive Clean Programme

<http://www.ene.gov.on.ca/>

Pollution Probe

<http://www.pollutionprobe.org/>

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Ministry of Transportation Safety Inspection Standards.

Ministry of Transportation Emission Laws

Ontario Health and Safety Act.

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## Appendix 2.3

### Sample Quiz

#### Oxy-Acetylene Welding

1. Oxygen fittings have \_\_\_\_\_ hand threads and acetylene fittings have \_\_\_\_\_ hand threads.
2. Regulator pressure should be adjusted to the:
  - a) thickness of the metal to be welded.
  - b) tip size.
  - c) welding position.
  - d) all of the above.
3. List three types of flames and circle the one which is most common for welding.
  - 1.
  - 2.
  - 3.
4. When adjusting acetylene pressure never exceed:
  - a) 25 psi
  - b) 10 psi
  - c) 30 psi
  - d) 15 psi
5. When oxygen regulators get hard to remove and install, the threads should be oiled.
  - a) TRUE
  - b) FALSE
6. At what angle and which direction should the torch be when welding?
7. What is the one substance that should not come in contact with oxygen in welding practice?
8. Circle the following statements as TRUE OR FALSE
  - a) Eye protection must be worn when using welding equipment. T F
  - b) Acetylene pressure should never be adjusted to exceed 15 psi. T F
  - c) When oxygen regulators become hard to remove and install, the threads should be oiled. T F
  - d) The oxygen tank valve should only be opened 1 ½ turns. T F
  - e) To ignite the torch, the acetylene valve is opened before the oxygen valve. T F
  - f) A backfire is generally caused by touching the torch tip against the work. T F

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## Appendix 2.3 (Continued)

### Sample Quiz

- g) Only ferrous metals can be cut with oxy-acetylene torches T F
- h) Moving the cutting torch too fast will lose the cut, while moving too slow will make a ragged edge or fused cut. T F
- i) When cutting metal, the torch tip should be held at a 45 degree angle. T F
- j) When cutting metal, the surface is heated by a gas flame and an oxygen jet does the cutting. T F
9. Choose information in Column II that corresponds to a topic in Column I. Each element in column II should be used only once.

#### Column I

- \_\_\_ 1. oxygen hoses
- \_\_\_ 2. acetylene tank valve
- \_\_\_ 3. leak test
- \_\_\_ 4. acetylene pressure
- \_\_\_ 5. backfire
- \_\_\_ 6. regulator
- \_\_\_ 7. flashback
- \_\_\_ 8. neutral flame

#### Column II

- A. soapy non-detergent water
- B. maximum 15 psi
- C. squealing sound
- D. left hand thread
- E. controlled pressure reduction
- F. cutting and welding
- G. 1 1/2 turns
- H. maximum 20 psi
- I. right hand thread
- J. welding only
- K. touching tip on work

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## **Activity 4: Servicing Wheels and Tires**

**Time:** 360 minutes

### **Description**

This activity introduces students to service procedures performed on tires and wheels. Students change, repair and balance tires, perform routine tire inspections for wear and inflation, perform tire rotations, and service non-sealed wheel bearings. The competencies relating to wheel and tire service are truly significant in terms of public safety. This activity provides an opportunity to reinforce moral and ethical responsibilities in daily work.

### **Strand(s) and Expectations**

#### **Ontario Catholic School Graduate Expectations**

CGE4a - demonstrates a confident and positive sense of self and respect for the dignity and welfare of others;

CGE5h - applies skills for employability, self-employment, and entrepreneurship relative to Christian vocation.

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

#### **Overall Expectations**

SPV.03T - describe the function of major vehicle system components;

SPV.04T - use a variety of fastening, fabrication, maintenance, and repair techniques correctly in projects

ICV.01T - describe the impact of transportation technology on society and the environment;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

#### **Specific Expectations**

TF1.02T - demonstrate knowledge of service procedures for different types of transportation vehicles;

TF1.05T - identify and explain technologies for joining materials and describe their application;

SP1.03T - repair or replace components to meet or exceed original equipment manufacturer (OEM) standards;

IC1.03T - explain the need to manufacture and dispose of vehicle system components in an environmentally friendly way;

IC1.05T - identify local systems that deal with recycling in the transportation industry.

### **Planning Notes**

- Several pieces of automotive equipment are required to complete these activities, including a tire changer and balancer, hoisting or lifting equipment and a compressed air source with tire valve chuck. The teacher must demonstrate safe and proper use of all special equipment. Damaged tires may have steel wire protruding from the tread, creating a safety hazard. Prior to servicing, tires should be inspected to determine if there are any such hazards. Use of the Safety Passport (Appendix A) is recommended for specialty equipment.
- A supply of tire plugs of different sizes and patches is required for tire repair. Students may practise repairs on donated wheels and tires that have been punctured. Students must demonstrate a high level of skill in servicing old tires before attempting to service customer wheels or tires.
- New tire weights must be used on wheels that will be returned to the road.

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## Prior Knowledge Required

Students should have:

- general understanding of basic shop operating procedures
- knowledge of safe use of specialty equipment (given just prior to use)
- awareness of acceptable personal conduct standards
- awareness conduct as a responsible service provider
- technical reading skills

Continued use of the Safety Passport (Appendix A) is strongly recommended, as well as general procedure outlines in a format similar to Appendix B.

## Teaching/Learning Strategies

1. The teacher introduces the activity by discussing the importance of tires in vehicle handling and braking in all weather conditions. The responsibilities of people of the Catholic faith to work ethically and responsibility especially when people's lives are concerned is to be reinforced throughout the activity. Teachers describe the dangerous consequences when attention to safety is not considered daily. Teachers ask students to consider how they would feel at the end of each day when the welfare of others is or is not recognized to be of prime importance.
2. The teacher demonstrates to the class the correct procedures for:
  - inspecting a tire for tread wear and air leaks;
  - tire changing and balancing;
  - installing and tightening wheels.
3. Students are called upon to assist the teacher in all aspects of the procedure. In small groups, students practice these service procedures on donated vehicles and/or wheels. (See Appendix 2.4 – Tires and Wheels Instructional Aid Sheet.)
4. The teacher discusses tire construction and tire types as well as service and inspection procedures, including correct tire inflation methods and tire sizing information. Recycling methods and the impact of carelessly discarded tires is also discussed. As an enrichment activity some students may research current and future uses for discarded tires. The importance of correct torquing procedures is reviewed. All wheel nuts must be torqued to specifications prior to returning to service.
5. Students remove a tire from a vehicle and place it in the water tank to determine the existence and location of leaks. If leaks are detected, students mark their location on the tire with a tire crayon (or equivalent). Special attention is paid to bead sealing areas and tire valve (seals) stems. The tire is removed from the wheel if it is to be patched or resealed. Tires that lose air but show no evidence of leaks are resealed. Tires with small punctures in the tread area are repaired using tire plugs.
6. Students remove the tire from the wheel using the tire changer. The beads of the tire and flanges of the wheel are inspected for good sealing characteristics. Rust or corrosion is removed using scrapers and wire brushes. Tire bead sealing compounds (recommended for use on aluminum alloy wheels) may be used to help seal the bead.
7. Students affix patches on the tire using correct tire puncture repair procedures. These procedures are determined by the tire type and the repair material. The tire is reinstalled on the wheel. Students then inflate the tire to vehicle manufacturer's specification.
8. Students mount the tire in the tire balancer. If the wheel is to be returned to the road, new tire weights must be used to ensure a secure attachment to the wheel. Tires that require excessive weight in order to balance should be inspected for further problems. One suggested strategy to reduce the amount of required weights is to reinstall and rotate the tires 90 degrees on the rim before re-testing. Tire weights must be installed in one location only, on each side of the wheel. The need for weight placement at a second location indicates faulty placement of the original weight.

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9. To improve tread life, students may rotate the tires to alternate positions on the vehicle. Tires with the greatest tread depth should be placed on the driving wheels. Tires must be rotated according to manufacturer specifications, usually found in the owner's manual. All tires on a vehicle must match the recommended tire type, size and inflation pressure stated on the vehicle identification sticker located on the end of the driver's door or door post (or in the owners manual).
  10. All wheel nuts must be torqued to OEM specification. The teacher must monitor students to ensure this step has been followed. Failure to torque wheels correctly may result in over- or under-tightened wheels. Over-tightened wheels can cause warping and imbalance or may be difficult to remove. Under-torqued wheels will result in wheels coming loose on the vehicle. Proper observance of torquing procedures will eliminate these concerns.
  11. Wheels mounted with adjustable, tapered roller bearings should be inspected for looseness and free-rolling characteristics. Free rolling characteristics include the tightness of the wheel and the sound of the spinning bearing as the wheel is spun. Excessively tight, loose, or noisy bearings must be disassembled and inspected. Students may check radial free play in the bearing with a dial indicator.
  12. Some vehicles require that certain brake components, such as calipers or brake drums, be removed when servicing wheel bearings. The teacher must ensure that these components are properly removed and replaced.
  13. Students perform the following procedures in servicing tapered roller bearings. (See Appendix 2.4 – Servicing Wheel Bearings Instructional Aid Sheet at the end of this activity.)
    - Remove the wheels and the bearing dust caps. The cotter pin, retaining nut, and washer are removed and placed in the dust cap for safe, clean storage. The bearing hub is removed from the vehicle, with the bearing inside, and moved to a clean bench space.
    - The outer bearing is removed by inverting the hub. The grease seal retains the inner bearing. A wooden punch may be used to drive the bearing out, pushing the grease seal ahead of it.
    - Clean all parts in an approved parts cleaner. The grease seal is usually replaced, but if it is to be reused, it should be wiped clean, and not placed in the parts cleaner.
    - Inspect bearings and cones (in the hub) for signs of wear. All contact areas should appear uniform and shiny. A flat, gray finish or black spots indicate a worn bearing which must be replaced. Any visible damage to the grease seal indicates the need for replacement.
    - Repack wheel bearing with appropriately rated wheel bearing grease. Bearings must be pre-greased using a wheel bearing grease packer, if available. If this tool is not available bearings may be "hand-packed" by repeatedly forcing the grease into the bearing using the palm of the hand.
    - Install the inner bearing and grease the seal in the hub, ensuring that the seal is pressed squarely into the hub to the correct depth in order to prevent damage to the seal. A small amount of grease may be placed in between the inner and outer bearing. Do not fill this area with grease.
    - Install the hub on the spindle with care to ensure that the inner seal is not damaged.
    - Install the bearing retaining washer and nut.
    - Adjust the torque on the wheel bearing nut following manufactures specifications and lock it in place using a new cotter pin. Install the dust cap.

### **Assessment/Evaluation Techniques**

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. Formative evaluation of task sheets by teachers after students have completed the assigned element may be used in evaluation. Summative evaluation of the activity can be accomplished by having students complete a written or practical test.

**Sample Assessment Rubric for Tire and Wheel Inspection and Service**

<b>Expectations</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
remove and install wheel on vehicle TF1.02 TSPV.04 TICV.04T	- safely supports vehicle and removes wheel only with constant supervision	- safely supports vehicle and removes wheel with only minor supervision	- safely supports vehicle, removes wheel, and describes variations in procedures with little/no supervision	- safely supports vehicle, removes wheel, and assists other students in correct variations of procedures.
inspect wheel and tire, determine service required TF1.02T SPV.04T SP1.03T	- demonstrates some knowledge of safe testing procedures with constant reminders or supervision required	- demonstrates correct and safe testing procedures with some supervision and reminders required	- demonstrates correct and safe testing procedures without supervision or reminders required	- demonstrates correct and safe testing procedures, can recommend correct serviceability schedules
service wheel using tire changer and balancer TF1.02T SPV.04T SP1.08T ICV.04T	- demonstrates some knowledge of safe servicing procedures with constant reminders or supervision required	- demonstrates correct and safe servicing procedures with some supervision and reminders required	- demonstrates correct and safe servicing procedures without supervision or reminders required	- demonstrates correct and safe servicing procedures, can recommend correct serviceability schedules
repair tire using tire plugs and tire patches TF1.05T SPV.04T SP1.08T	- requires constant supervision to make repairs safely and correctly	- repairs tire with some supervision	- repairs tire safely and correctly without assistance	- repairs tire without assistance and is able to effectively assist others
discuss tire construction, disposal, and sizing methods TFV.01T SPV.03T ICV.01T IC1.03T IC1.05T	- requires significant help to identify tire nomenclature and serviceable life of tire	- identifies some tire nomenclature and suggests serviceable life of tire	- defines and interprets tire by reading tire stamping and suggests life-cycle of tire and materials	- formulates suggestions of equivalent tire specifications and discusses the problem of tire disposal
service wheel bearings. TF1.02T SPV.04T SP1.03T SP1.08T	- requires constant supervision to remove wheel bearing assembly	- removes and re-packs wheel bearings only with assistance	- lubricates and reinstalls wheel bearings and adjusts bearings pre-load to specification	- services wheel bearing and correctly determines condition through interpretation

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

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## Accommodations

Some students may require additional help in the form of individual attention to accomplish complicated procedures. Some students may also need extra time to practice procedures to reinforce understanding. Additionally, instructor and peer assistance may be required in identifying components and in making repairs. For enrichment, research into more specific details of tire wear indicators or non-automotive tire parameters may be specified. For an additional enrichment activity, teachers may direct students to research the ecological effects of prohibited tire disposal methods.

## Resources

Specific tire information can be obtained from tire manufacturer web sites or sales literature. General information can be obtained from:

Mitchell International. *Automechanics*. Toronto: Prentice-Hall, 1991. ISBN 0-13-583782-0

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

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## Appendix 2.4

### Tires and Wheels Instructional Aid Sheet

#### Tires

- Tires have two main functions: to absorb road shocks and to provide traction for steering, accelerating and braking.
- The tire bead is a high tensile steel wire covered with rubber. Its function is to prevent the tire from being thrown off the rim by spinning action of the wheel. The bead forms an airtight seal against the wheel flange.
- The cord body supports the load on the tire. It is composed of strips of material that have been bonded into one unit. Commonly used materials are rayon, nylon, polyester and kevlar.
- Radial ply tires provide the least amount of tread flexing or squirming as the tire rotates against the road. This causes less resistance to rolling, resulting in longer tire life and better fuel economy.
- Radial tires have a flexible construction resulting in greater traction to the road during cornering.
- Tire treads are the part of the tire that are in contact with the road. The tread is laid over the cord body and bonded to it. Tread type can affect mileage, handling, ride, road noise, and traction.
- Many tires have tread wear indicators, which are portions of the tread groove that have been filled with rubber. When the non-filled tread wears down to the level of the filled sections the tire must be replaced.
- Treads may be smooth and shallow for good mileage and low road noise, but must be deep enough to channel water out from under the tire to prevent hydroplaning.
- Treads may be very coarse and deep to provide better traction in soft conditions such as mud or snow
- Most information about a tire can be found on its sidewall. The designation “P195/75R14” provides the following information about the tire:
  - P: Application (passenger);
  - 195: Tread Width (in mm);
  - 75: Aspect Ratio (sidewall height expressed as a percentage of tread width, e.g., 75% of 195 mm);
  - R: Tire construction (radial);
  - 14: Rim Size (14 in.).
- A tire marked “T” is for temporary use (i.e., as a spare only). It will not withstand prolonged use.
- The inflation information written on the side of the tire represents the maximum pressure for the tire at its maximum-rated load. This is not the recommended pressure for everyday use. The manufacturer’s recommended tire pressure, which is usually found on the owner’s manual or on the vehicle’s doorpost, is a better guide for inflation for everyday use.
- Check the tire pressure when the tire is cold (i.e., has not been operated for more than one mile for at least three hours). Tire pressure can increase nearly 10 psi when the tire is hot.
- Over-inflated tires can result in a rough ride and in reduced traction. It can also cause increased wear in the centre of the tread.
- Under-inflated tires can result in poor handling, high heat, belt damage, increased fuel consumption, and increased wear on the edge of the tread.
- Tires must be rotated to different positions on the vehicle periodically to maximize the tread life. On most rear wheel-drive vehicles the right, rear tire wears twice as fast as the right, front tire. This is because most roads are crowned to provide drainage, causing the vehicle to lean out slightly. This in turn causes most of the driving force to be applied to the right.

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## Appendix 2.4 (Continued)

### Tires and Wheels Instructional Aid Sheet

#### Wheels

- The wheels are the part of the vehicle to which the tires are mounted. Wheels are usually made by welding the following two components together:
  - disk, the centre section of the wheel, which contains the mounting holes for the wheel and centres the wheel on the vehicle;
  - rim, the outer ring around the disc, which is shaped to include a drop well to allow the installation and removal of tires and a flange to prevent the tire from coming off the rim. Modern tires do not use tubes to contain air, therefore the rim must be air tight to prevent leakage.
- Safety rims have humps between the tire bead flanges and the drop well at the centre of the wheel. Should the tire lose pressure during operation, the humps help to prevent the tire from moving into the drop well and coming off the rim.
- Wheel nuts and bolts have shoulders or conical seats to align with the taper of the mounting hole, permitting the wheel to be accurately centred on the spindle.
- Wheel nuts must be torqued to correct specifications. A wheel nut that is too loose can result in movement that will wear out the mounting hole, or more seriously, can cause the loss of the wheel. A nut that is over-tightened can fracture the wheel stud or warp the brake disc, causing vibration while braking.
- Three causes of wheel failure are:
  - road impacts, causing the wheel to be bent, wobble or fail to seal the tire;
  - corroded flanges which fail to seal the tire;
  - damaged mounting holes that are usually caused by improperly tightened or installed wheel nuts.

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## Appendix 2.4 b

### Servicing Wheel Bearings Instructional Aid Sheet

- Remove the hub from the vehicle.
- Remove the outer bearing and attaching parts and place on the bench or in a container. Bearings must be returned to the original hub location.
- Remove the inner bearing. This usually requires the removal of the grease seal in the back of the hub. Often, the grease seal may be driven out by using a wooden dowel to remove the inner bearing. If the seal is damaged or shows signs of deterioration, replace it. Do not wash grease seals in solvent.
- Clean the bearings, attaching parts, spindles and the hubs in the solvent tank. If compressed air is used for drying, be sure to wear safety glasses. Do not spin the bearings with air. Inspect the bearings to determine if they may be reused.
- Repack the bearings with approved grease. Place about three tablespoons of grease in the palm of your hand and press the bearing into the edge of it. After a few motions the grease will begin to come out the opposite edge of the bearing. Turn the bearing in your hand and continue packing until grease has come through on the entire opposite edge. Alternatively, use a wheel bearing-grease packer, if available.
- Place a light coating of grease inside the hub. Do not apply more than 3 mm thickness as this may cause the hub to overheat.
- Place the inner bearing back in its cone and install the grease seal.
- Place the hub on the spindle and install the outer bearing. Install the washer and attaching nut. Do not tighten at this time.

### Adjusting the Wheel Bearings

- Wheel bearing adjustment is necessary to ensure the bearings do not run too loose or too tight.
- Always spin the wheel while tightening the wheel bearings to assist in the alignment and to prevent any damage to the bearings. Tighten the adjusting nut according to the manufacturers recommended procedures. This will pre-load the bearings and allow the wheel to spin freely. A slight amount of side play may be felt if the wheel is rocked in and out at the top.
- Install the cotterpin and dust cap. If it is necessary to adjust the nut to install the cotterpin always loosen the nut. Never tighten the nut to align the holes for the cotterpin. Do not put grease in the dust cap.

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## **Activity 5: Automotive Reconditioning and Care**

**Time:** 360 minutes

### **Description**

This activity will provide opportunities for students to apply industry techniques designed to enhance a vehicle's appearance or prolong its useful life. Students perform service in exterior and interior finishes, and engine shampooing. Professional methods for car cleaning and detailing, reconditioning and accessory installations are the focus for the activity. The self worth of the individual within the context of the operation of transportation systems is reinforced in this activity.

### **Strand(s) and Expectations**

#### **Catholic School Graduate Expectations**

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

CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;

CGE7a - acts morally and legally as a person formed in Catholic traditions;

CGE7i - respects the environment and uses resources wisely.

#### **Overall Expectations**

TFV.05T - describe the correlation between modes of transportation and the need for related support businesses;

SPV.04T - use a variety of fastening, fabrication, maintenance, and repair techniques correctly in projects;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

#### **Specific Expectations**

TF1.02T - demonstrate knowledge of service procedures for different types of transportation vehicles;

TF1.09T - describe the importance of secondary industries for the transportation industry;

SP1.08T - repair or replace components to meet or exceed original equipment manufacturer (OEM) standards;

ICS.07T - describe health and safety regulations for the handling of tools, fuels, materials, and equipment.

### **Planning Notes**

- Teachers should determine an effective method of demonstrating to students the value of work and the benefit of securing skills to provide a basis for a possible employment, self-employment, or entrepreneurship relative to Christian vocation. A possible avenue of discussion on this matter is the examination of the demand in the transportation industry for a variety of skill-sets, one of which is the detailer position. This position may be entry level to more technical positions within a service facility, or it may be a challenging and rewarding dedicated posting or business opportunity.
- Teachers should locate and prepare job descriptions of positions involving detailing and reconditioning prior to initiating the activity. Manufacturers' and aftermarket manuals generally provide some guidelines on the trade.
- The activity may be sequenced in a rotating small group schedule or a dedicated team project. Teachers may prepare recording equipment (photography or video) so that students can prepare before and after comparison visuals.

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- At this level, reinforcement of even rudimentary skills is beneficial. Most students will have had the experience somewhere of simply washing a car, but the professional carwash is performed efficiently and consistently. Ecological awareness of chemicals used in detailing should be covered and may require manufacturers material sheets or WHMIS material data sheets.
  - Teachers may convey that these and other skills have applications in student's lives and also indicate they are a sound platform for co-operative education or employment opportunities.

### **Prior Knowledge Required**

Knowledge of safe and co-operative work habits is required before initiating this activity. Students should know how to work with others and to take initiative in organizing and clean up.

### **Teaching/Learning Strategies**

1. Teachers should introduce the activity by discussion and examination of a sample vehicle. Consider the age, condition and value of the vehicle in the preliminary plan of appropriate procedures. Students are told that this activity should be executed to a high or professional level, and quality of results will be assessed. A reconditioning protocol may be designed or adapted from a commercial model. It is suggested that students work from work-orders or task sheets.
2. Cleaning
  - Students will organize and perform a retail industry-calibre cleaning. The products used and management of materials are to be stressed here and the level of results explicit. The responsibilities of being a service provider should be emphasized, along with the self-monitoring that becomes part of a professional working day.
  - Under-hood detailing may involve engine shampooing, fluid checks, and top-ups, etc. so common course concepts may be reinforced. Interior reconditioning will involve cleaning and detailing to a standard outlined by the teacher.
3. Systems Check
  - All lights and lenses should be checked. Repair and replace as necessary. Locks and latches should be lubricated and adjusted as required. Glass and seals should be inspected for fit and function. Wipers and wash system should be serviced.
  - The customer expectations should be incorporated, (radios left on settings, floor mats considered, etc.) creating awareness of the standards in industry. The vehicle's owners manual should be considered as a reference with ready and accurate information.
4. Body Systems
  - Maintenance of paint and trim, and its affect on value and longevity of vehicle should be discussed as well as reasonable and practised methods of small rust repairs (spot repairs) and paint restoration. Simple repairs may be demonstrated or executed by prepared students. Estimating practices for larger repairs may be approached as a consumer awareness issue or as a communications exercise.
5. Accessories or Value Added Components
  - Striping and decal application or removal may be pertinent. Proper handling of solvents and automotive adhesives and knowledge of WHMIS and workplace safety documentation should be outlined. Other accessories should be discussed with sufficient background in the systems they affect so informed choices may be made and safe and proper installations may be possible. Electrical accessories such as lighting, for example, should be discussed with an automotive electronics perspective. The concept of value-added can provide a link between business and technical studies.

6. Appraisal and Disclosure

- Students should, through research and investigation, determine a set of market values for the vehicle. The teacher may invite an automotive insurance appraiser to explain to the students how vehicles are appraised using insurance industry practices. An objective determination of its relative condition should be formulated and a set of parameters for a professional endorsement of the vehicle should be discussed. Students should prepare a brief or appraisal document outlining the inspection findings and servicing required. Business ethics should be discussed at this time.

**Assessment/Evaluation Techniques**

Students may be assessed on the following elements of the activity:

- a formative assessment using teacher observation of a teacher developed task sheet exercise
- an informal assessment of individual/group discussion and decision making in determining required repairs
- a summative evaluation of the student’s vehicle appraisal document

**Sample Assessment Rubric for Automotive Reconditioning Activity**

<b>Expectations</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
discuss the benefits of vehicle detailing and identify local businesses performing similar procedures TFV.03T ICV.02T IC1.06T	- lists some detailing procedures which would increase vehicle value	- lists several detailing procedures which would increase vehicle value	- discusses the benefits of the procedure in terms of value and longevity of the vehicle	- identifies local businesses performing detailing and discusses job requirements
perform detailing procedures SPV.04T ICV.04T TFI.02T SP1.01T SP1.08T IC1.07T	- completes some procedures with care and workmanship under supervision	- completes several procedures with care and workmanship under some supervision	- completes several procedures with care and workmanship	- completes several procedures with excellent care and workmanship
determine vehicle value SP1.03T	- determines a value of a vehicle with some accuracy	- determines the value of a vehicle with most assessments accurate	- determines the value of a vehicle based on generally accepted practices	- determines the value of a vehicle and can prove the accuracy of the estimate

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

**Accommodations**

Teachers should allocate more individual attention to assist students that need help in the hands-on aspects of this activity. The level of detail required by students can be adjusted to meet local or individual needs. Research into new technologies for detailing can be given to select students as an enrichment activity.

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## **Resources**

Local automotive supply dealers, detailers, and retail outlets should be contacted. Other general resources include:

Deroche, A. *The Principals of Autobody Repairing and Repainting*. New Jersey: Prentice-Hall, 1992.  
ISBN 0-13-678053-9

National Detail System

<http://www.nationaldetail.com>

Detailers Choice

<http://www.detailerschoice.cm/>

## **Other**

Computerized service manuals

OEM service manuals

Aftermarket service manuals

Ministry of Transportation Safety Inspection Standards

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## Unit 3: Power and Control Systems

**Time:** 25 hours

### Unit Description

In this unit, students study means of propelling vehicles and controlling vehicle speed and direction. Upon completion of this unit students will identify components and describe the operation of power sources including two and four stroke/cycle engines and electric motors as well as the methods of transmitting power. Students will demonstrate understanding of the means for controlling vehicle direction and speed including braking, steering and suspension systems by performing basic inspection and repair tasks. Creative, critical thinking in the form of troubleshooting, assembling, and disassembling vehicle systems will allow students to solve transportation-related problems in a manner reflecting their faith.

### Strand(s) and Expectations

**Ontario Catholic School Graduate Expectations:** CGE 1d, 2b, 3c, 4b, 4f, 5a, 5h, 7i.

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

**Overall Expectations:** TFV.03T, TFV.04T, SPV.01T, SPV.03T, ICV.04T.

**Specific Expectations:** TF1.01T, TF1.02T, TF1.04T, SP1.02T, SP1.03T, SP1.08T, IC1.07T.

### Activity Titles (Time + Sequence)

Activity 1	Four Stroke/Cycle Engine Teardown	420 minutes
Activity 2	Brake Service	360 minutes
Activity 3	Servicing Steering Systems	360 minutes
Activity 4	Inspecting the Suspension System	360 minutes

### Prior Knowledge Required

- Before working in a shop environment, students must be aware of general shop rules and safety requirements, as well as safety rules for specific tools and machines. Teachers must verify student's knowledge of safety through either a signed Safety Passport (Appendix A), and/or a test on safety knowledge (Appendix B). Vehicle jacking/hoisting procedures and proper placement of axle stands are to be reviewed prior to inspection/troubleshooting activities, (see Appendix C).
- Students should also be aware of acceptable personal conduct standards as established by the teacher. Co-operative teamwork, maintaining the shop cleanliness, care for equipment, confident and positive sense of self, and respect for the dignity and welfare of others are Christian values that must be understood before working in the shop environment.

### Planning Notes

- A facility for the disassembly and re-assembly of vehicles needs to be prepared beforehand. The classroom must have sturdy benches (suitable for laying out large and heavy engine components), low shelves for short term storage of removed components, a ventilation system, etc. A class set of safety eyewear is also required. Lab coats or coveralls should be available to protect student clothing.
- A variety of posters illustrating safe working procedures may be displayed around the room. (See the resources section below for a further listing of required resources.) The students are to be instructed and assessed on the safe use of all new equipment listed in this unit using either the Safety Passport model of tracking student learning (Appendix A), or safety tests based on specific tooling safety requirements.

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- Work that is performed on brake systems and steering and suspension systems of a vehicle that will be returning to service must be inspected by a licensed Automotive Service Technician before assembly is completed. If the classroom teacher does not possess these qualifications, these activities should be restricted to table top models and/or shop vehicles that will not be returning to service.
  - Students are to complete teacher-developed worksheets of procedures and observations at predetermined points in the activities. Teachers may elect to require students to log time on worksheets based on industry models.
  - This unit can be linked with Mathematics units on ratios (calculation of gear ratios), physical parameters such as volume, displacement, speed, budget and business calculations and geometry. Science units on heat, pressure, friction and/or energy, specifically heat energy and kinetic energy can be demonstrated and reinforced through the activities in this unit.
  - A summary of the equipment and resources required for this follows:
    - engines, preferably simple four-cylinder models, mounted on approved engine stands
    - service manuals or other means of locating procedures and specifications
    - containers such as cans for storage of small parts or components
    - basic shop tools including brake spring tools, micrometers, vehicle hoist or floor jack, axle stands and dial indicators
    - a variety of typical suspension system components and models
    - one drum and disk brake assembly per group (may be table top models salvaged from wrecking yards or donated vehicles, or actual customer vehicles)
    - brake service vacuum or catch pans with brake-parts cleaning solutions
    - strut assemblies
    - an approved parts cleaner

### **Teaching/Learning Strategies**

- Teachers regularly reinforce key Christian values as they conduct daily class activities. Students are reminded of their responsibilities to work with others, respect fellow students' needs and safety, and maintaining a positive attitude and environment. The care for the personal safety of customers of transportation services, and care for the environment are to be reinforced through class discussions and question/answer sessions while conducting activities.
- At the beginning of this unit the teacher provides theoretical sessions on engine and system operations. Theories of operations are conducted regularly during each activity as individual systems are inspected.
- In the inspection activities (Activities 1 through 5), students disassemble, inspect, and reassemble components under teacher supervision. Students research required procedures and specifications using service manuals, (computer and/or printed publications). Based on information gained from theoretical sessions and service manuals (and teacher assistance if required) students develop a procedural worksheet. Safety precautions regarding specific operations such as handling brake dust are addressed before conducting the activity and reinforced on an ongoing basis.
- This unit incorporates a variety of teaching and learning strategies, including; teacher-directed activities, individual learning activities, group work and co-operative learning strategies. Teachers provide students with opportunities to work independently and in groups to perform the tasks of problem solving and troubleshooting, using hand and power tools safely, following shop procedures, collecting technical information, maintaining facilities and equipment, and peer assessing work.

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- Safe use of hand and power tools is addressed primarily through teacher demonstrations but may be reinforced with safety posters displayed in the room or safety notices placed near equipment. Evaluation on the safe operation of specific equipment may take written form or may take place in the technical facility through teacher evaluation of safe equipment operation. (See Appendices A and B.)
  - Teachers can accommodate the variable learning rates of students by allowing increased time for activities, enhancing or compacting course content, assisting during evaluation processes, and/or facilitating peer-tutor assistance where possible.
  - Each activity provides opportunities for students to focus on specific career options and provides insights into the skills required for a variety of related professions. A number of teaching/learning strategies employed in the classroom allow for career orientation (e.g., job shadowing, computer career and education research, field trips, and guest speakers).

### **Assessment and Evaluation**

Assessment is a daily process that may include:

- the use of daily log book entries to determine individual participation and achievement and contributions to the group effort;
- regular practical and theory tests and/or quizzes;
- project evaluation and critiques by self, peers, and teacher;
- participation in discussions and conferences;
- activity rubrics.

Each activity will provide the opportunity for students to focus on specific career options and provide insights into the skills required for a variety of related professions. A number of teaching/learning strategies employed in the classroom will allow for career orientation, e.g., job shadowing, computer career and education research, field trips, and guest speakers.

### **Resources**

General resources include the following. Specific resources are listed in each activity.

#### Print Based

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

Jellison, R. *Welding Fundamentals. 1/e*. Prentice Hall, 1996. ISBN 0-13-107178-5

Schwaller, Anthony E. *Transportation Energy and Power Technology*. Glencoe McGraw-Hill.  
ISBN 0-8273-3227-0

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

#### Web Sites

Air Quality Program

<http://www.pollutionprobe.org/air/index.htm>

Inner.Auto

<http://www.innerauto.com>

Ontario's Drive Clean Programme

<http://www.ene.gov.on.ca/>

Ontario's Drive Clean

<http://www.driveclean.com/>

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Pollution Probe

<http://www.pollutionprobe.org/>

Society of Automotive Engineers

<http://www.sae.org/index.htm>

Service Manuals/Software or Specification books

These are available at most facilities specializing in services such as brake service

## **Activity 1: Four Stroke/Cycle Engine Teardown**

**Time:** 420 minutes

### **Description**

This activity provides students with the opportunity to discover the inner workings of an internal combustion engine through theoretical lessons and hands-on engine experience. Using shop models and diagrams, students learn the names and purposes of major engine components as well as the four-stroke/cycle theory. Students develop skill in using simple and specialized automotive tools and measuring instruments. The importance of being responsible to the needs of individuals, particularly in regards to the safety of self and others will be central to the activity.

### **Strand(s) and Expectations**

#### **Ontario Catholic School Graduate Expectations**

CGE2b - reads, understands, and uses written materials effectively;

CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;

CGE4b - demonstrates flexibility and adaptability;

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE5a - works effectively as an interdependent team member;

CGE7i - respects the environment and uses resources wisely.

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

#### **Overall Expectations**

TFV.04T - identify and describe different methods for converting, using, distributing, and storing energy;

SPV.03T - describe the function of major vehicle system components;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

#### **Specific Expectations**

TF1.04T - describe the operation and application of major vehicle propulsion devices and the procedures used for servicing them;

SP1.02T - use measurement tools correctly to inspect and service vehicle systems;

SP1.03T - identify wear on vehicle system components on the basis of industry standards;

IC1.07T - describe health and safety regulations for the handling of tools, fuels, materials, and equipment.

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## Planning Notes

- The classroom requires sturdy benches suitable for laying out large and heavy engine components, shelves for short term storage of removed components and variety of posters displaying safe working procedures. A class set of safety glasses must be provided.
- Students are instructed to bring proper work clothing (preferably coveralls) prior to commencing this activity. Safety shoes are also recommended.
- Recommended materials for this activity include:
  - one engine (preferably a simple 4-cylinder model) per group, mounted on approved engine stands;
  - service manuals or other means of researching procedures and specifications;
  - valve spring and piston ring compressors, micrometers and dial indicators
  - containers such as cans for storage of small parts or components;
  - teacher-developed checklist of procedures and observations to be completed by students at predetermined points in the activity.

This activity can be linked with units in Mathematics (calculations of volume and displacement), and Science (heat, energy and pressure).

## Prior Knowledge Required

- understanding of basic shop operating procedures
- awareness of acceptable personal conduct standards
- understanding of safety rules (see Appendices A and B)

## Teaching/Learning Strategies

1. Teachers begin by describing the operation of the shop, particularly in regards to the Christian values of helping and caring for others. Teachers remind students that they are responsible to work safely, assist each other in maintaining the shop and tooling, and to ensure all equipment used is put away and all areas are clean before leaving class.
2. The teacher acquaints students with a basic set of hand tools and briefs them on their correct usage, care, and safety concerns. The need for other safety equipment such as safety glasses and their proper usage is also discussed.
3. The teacher assists students in locating the correct service information for the engine on which they will work. Students work with the teacher to develop a sequential procedural sheet, including a checklist to be completed at various stages of work. Precautions and special points of interest can be noted on this worksheet. The procedures are reviewed before commencing the activity. The teacher assists students with all aspects of the procedures and checklist, as required.
4. Students work in small groups of two or three, to reduce the number of engines required and to provide partners to help with heavier components. Groups may be selected by either the teacher or by the students. The teacher may alter the group arrangements as necessary during the activity to assist students who are experiencing difficulties in completing the activity.
5. The teacher conducts short theoretical sessions at predetermined points in the activity to address the purposes of the major engine components, and four-stroke/cycle engine terms and operating theory. These points can be reinforced with individual students as they work on their engines.
6. Students research engine specifications using technical manuals (printed or computerized) and note them on their procedural worksheets. They then remove cylinder heads and oil pans. The heads are set aside and are not disassembled until the short block is completed.

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7. The teacher conducts a brief classroom session demonstrating the use of measurement tools such as the dial gauge, micrometer and thickness gauge. The students measure engine bore and strokes using micrometers and dial indicators and compare them to the specifications noted on their procedural worksheets. Piston and connecting rod assemblies are removed and labelled. The students remove the crankshaft and check bearing diameters with a micrometer.
  8. Students begin to reassemble the block by checking crankshaft bearing clearance using a thickness gauge (e.g., Plastigauge). All components are torqued to specification upon re-assembly.
  9. Students locate the correct timing chain or belt alignment procedures and note them on their procedural worksheet prior to installation. A classroom session describing the valve train components and operation reinforces the need for this alignment procedure.
  10. Students disassemble the cylinder head once the short block is completely assembled and the crankshaft turns correctly. The teacher performs a demonstration of correct procedures (including safety precautions) for using valve spring compressors before students perform this task. Valves are removed and all components are placed in a fixture to maintain correct order for re-assembly. The students measure valve guide clearance and compare this information to specifications. The cylinder head is checked for flatness. Students install the reassembled cylinder head and torque it to the block using correct procedures and specifications.
  11. All components are reassembled on the engine and inspected by the teacher. Students complete their procedural checklist and hand in for evaluation. Students enter their activities and times in their daily log. (See Appendix C – Job Log Sheet). Teachers quiz the students on terminology and/or procedures.

### **Assessment/Evaluation Techniques**

Daily observation of student progress is noted. Daily student entries in a logbook provide information used to assist the teacher in evaluating individual accomplishment as well as contributions to group work. Notebooks and worksheets are checked for accuracy and organization. All written work is to be complete, in chronological order and neatly written. All worksheets must be completed as the activity progresses. Quizzes on terminology and/or procedures is given to assess student's learning.

**Sample Assessment Rubric for Engine Teardown Activity**

<b>Expectations</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
explain engine theory of operation TFV.04T TF1.04T	- describes most of the features of the four strokes	- describes the terminology and features of the four strokes	- describes fully piston direction and valve position during each stroke	- defines and uses correct terminology such as TDC, stroke and cycle, and describes the pressures which occur within the cylinder during each stroke
disassemble engine TF1.04T	- engine is disassembled with limited parts' organization	- engine is disassembled with some organization of parts displayed	- engine is disassembled with a organization of parts displayed	- engine is disassembled with high degree of parts' organization
use tools and equipment correctly SP1.02T IC1.07T	- selects and uses hand tools but requires constant supervision	- selects and uses hand tools with some supervision	- uses all hand tools with minimal supervision, including some special tools such as piston ring compressor	- demonstrates leadership in helping others use hand tools including special tools such as micrometers and dial indicators
identify and state purpose of engine components SPV.03T	- identifies some major components	- identifies most major components	- identifies and explains operation of most major components	- identifies all components and explains their operation
reassemble engine ICV.04T	- engine is reassembled but requires more attention to complete	- engine is reassembled in working order with only minor problems	- engine is reassembled with precision and in working order	- engine is reassembled with all parts installed correctly, torqued to proper specifications, and engine turns over
report findings SP1.03T	- demonstrates limited ability in preparing report	- demonstrates adequate ability in preparing report	- demonstrates considerable ability in preparing report	- demonstrates professional level ability in preparing report

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

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## Accommodations

The teacher may provide pre-printed notes for those who require assistance. Students may be assigned as a peer helper to assist others. Testing method (oral or written), may be adapted to student's needs. Certain procedures requiring greater accuracy and skill level may be omitted from the procedural worksheet. Individual study topics may be assigned for extra credit. Some students may perform more specialized tasks, such as working on more complex engines, or grinding valves.

## Resources

Automotive Textbooks such as:

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

Jellison, R. *Welding Fundamentals, 1/e*. Prentice-Hall, 1996. ISBN 0-13-107178-5

Schwaller, Anthony E. *Transportation Energy and Power Technology*. Glencoe McGraw-Hill. ISBN 0-8273-3227-0

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

*Mitchell's On Demand Computerized Service Manuals* 9889 Willow Creek Road, San Diego, CA 92131  
USA Phone: +1 (619) 578 6550 Fax: +1 (619) 530 8911

Service manuals or specification books available at most automobile dealerships or after-market parts depots such as Canadian Tire

## Web Sites

Engine Rebuilders Association

<http://www.aera.org/main.htm>

## Videos

Several video tapes are available from The Learning Tree

<http://www.autovideo2000.com>

Several video titles are available from ICS Learning

<http://www.icslearning.com>

## Activity 2: Brake Service

**Time:** 360 minutes

## Description

Students disassemble, inspect and re-assemble drum and/or disc brake components of a selected vehicle. Students research specifications using technical manuals then measure and compare brake components to the specifications. Identification of brake components, their operation, inspection procedures and comparison between drum and disc brakes is the focus of the activity. Students are reminded as Catholics of the importance of this work in ensuring the well being and safety of others.

## Strand(s) and Expectations

### Ontario Catholic School Graduate Expectations

CGE1d - develops attitudes and values founded on Catholic social teaching and acts to promote social responsibility, human solidarity and the common good;

CGE2b - reads, understands, and uses written materials effectively;

CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;

CGE4b - demonstrates flexibility and adaptability;

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CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE5a - works effectively as an interdependent team member;

CGE5h - applies skills for employability, self-employment and entrepreneurship relative to Christian vocation;

CGE7i - respects the environment and uses resources wisely.

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

### **Overall Expectations**

TFV.04T - identify and describe different methods for converting, using, distributing, and storing energy;

SPV.01T - demonstrate accuracy in the use of measuring systems and methods;

SPV.03T - describe the function of major vehicle system components;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

### **Specific Expectations**

TF1.01T - identify current safety standards in transportation and secondary industries;

TF1.02T - demonstrate knowledge of service procedures for different types of transportation vehicles;

SP1.02T - use measurement tools correctly to inspect and service vehicle systems;

SP1.03T - identify wear on vehicle system components on the basis of industry standards;

IC1.07T - describe health and safety regulations for the handling of tools, fuels, materials, and equipment.

### **Planning Notes**

- Teachers are to plan specific times to remind students of the importance of professionalism and thorough standards of practice that ensure the safety of people whose lives depend on proper brake operation.
- Brake system work which is performed on a vehicle that will be returning to service must be inspected by a licensed Automotive Service Technician before assembly is complete. If the classroom teacher does not possess these qualifications this activity should be restricted to models or vehicles that will not be returned to service.
- Brake dust may contain asbestos, a known health hazard. Special care must be taken to minimize exposure. A brake vacuum is a required tool for dealing with brake dust, but may be substituted with special cleaners. Inexpensive dust masks may be worn during this process. Do not use conventional shop vacuums or air hoses. A class set of safety glasses must be provided. It is recommended that students wear coveralls or lab coats while working in the shop environment.
- Required basic tools include brake spring tools, micrometers, and dial indicators. Other materials required for this activity include:
  - drum and disc brake assemblies (may be tabletop models salvaged from wrecking yards or donated vehicles, or from actual customer vehicles). A key exercise of this activity is to compare the operations of both drum and disc type brake systems, both systems should be present;
  - service manuals or other means of researching procedures and specifications (Note: Most brake shops will donate used specification books provided by brake manufacturers);
  - brake service vacuum or catch pans with brake-parts cleaning solutions;
  - teacher-developed worksheet of procedures and observations to be completed by students at predetermined points in the activity.
- This activity can be linked with Science units on friction or energy (specifically heat energy and kinetic energy).

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## Prior Knowledge Required

- understanding of basic shop operating procedures
- awareness of acceptable personal conduct standards
- understanding of safety rules (Appendices A and B)
- vehicle jacking/hoisting procedures and proper placement of axle stands

## Teaching/Learning Strategies

Teachers remind students that as stewards of the earth and society (as outlined in the social teachings of the Church) they are to work diligently and professionally at all times when working on brake systems. Lives and safety of human beings are dependent on the work of the brake inspector, and this fact should always be on their mind.

Teachers discuss with students the sequence of procedures they must follow (see Appendix 3.2a – Handout on Drum Brake Service Procedures and Appendix 3.2b – Handout on Disc Brake Service Procedures for examples). Precautions and special points of interest can be noted on this worksheet. Special emphasis is placed on reviewing hoisting and jacking procedures and the correct placement of axle stands. The teacher must ensure that students observe safety precautions regarding brake dust.

1. Students work with partners to reduce the number of brake assemblies required. Partners are selected either by the teacher or by students. The teacher may alter the group arrangements as necessary during the activity to assist students who are experiencing difficulties in completing the activity. Teachers may decide to rotate teams onto the two types of brake systems.
2. The teacher conducts short sessions at predetermined points in the activity to address the purpose of the brake system components and operating theory. Simple hydraulic concepts are introduced. These points can be reinforced with individual students as they work on the activity.
3. Students research brake specifications using technical manuals (printed or computerized) and note them on their procedural worksheets.
4. Brake inspection procedures are outlined on the student worksheet, and are reinforced by the teacher through a demonstration of a typical brake inspection.

## Drum Brakes

1. Students remove wheels and brake drums. The teacher may be required to assist with drum removal. Some assemblies may require the self-adjuster to be backed off while others may require the drums to be heated in order to remove them. Caution when working with brake dust is required. Brake dust may contain varying amounts of asbestos, a known health hazard if inhaled. An approved brake vacuum is an essential tool but may be replaced with approved cleaning solutions. Do not substitute with a conventional shop vacuum; the filter is inadequate. Keep the airborne material to a minimum by first soaking the drum with a water or a WHMIS-approved brake cleaner.
2. Students measure the drum diameter using micrometers and dial indicators and compare them to specifications. The teacher assists students who encounter difficulties using these tools.
3. Drum brakes are inspected for wheel cylinder or axle seal leaks, broken or corroded brake springs, brake lining condition, parking brake cable operation, self-adjusting mechanism operation and backing plate condition. The students note all observations on the worksheet.
4. Prior to component removal, students sketch a diagram of the brake assembly on the worksheet to facilitate re-assembly.
5. The students clean the backing plates with a wire brush and a brake vacuum or cleaning solution. When dry, a lubricant such as Lubriplate or anti-seize compound is applied by the students to the backing plate and brake shoe contact points.
6. The teacher inspects the assembled brakes before and after the students install the brake drum and adjust the lining clearance.

## Disc Brakes

1. Disc brakes are inspected for the condition of calipers, brake pads, brake discs and flex hoses. All observations are noted on the worksheet
2. Calipers are inspected for any signs of fluid leaks, that the piston moves freely in the caliper and that floating calipers are free moving on their mounts
3. Brake pads are inspected for wear, glazing or heat checks
4. Students inspect brake discs for visible scoring, heat spots, glazing and measure disc thickness and runout using micrometers and dial indicators and compare them to specifications. Some models may require that a few wheel nuts be reinstalled to secure the disc to the hub while checking runout. Other models may require wheel bearing adjustment prior to this check. The teacher assists students who encounter difficulties completing these checks.
5. Flex hoses are inspected for any signs of cracking or checking or any visible signs of damage
6. Components are reassembled, with wheel bearings adjusted and calipers torqued to specification
7. Teacher inspects assembled brakes before tires are installed and ensures brake pedal has been pumped several times to bring brake pads in contact with disc.

For both systems, students install the tires and torque them to specification.

## Assessment/Evaluation Techniques

Daily observation of student progress is noted. Daily student entries in a logbook provide information used to assist the teacher in evaluating individual accomplishment as well as contributions to group work. Notebooks and worksheets are checked for accuracy and organization. All written work is to be completed in chronological order and neatly written. All worksheets must be completed as the activity progresses. Written or oral quizzes may be given at appropriate points in the activity.

Expectation	Level 1	Level 2	Level 3	Level 4
explain the effects of friction in the braking system TFV.04T SPV.03T	- explain most brake component operations and identify at least half of all components	- explain adequately brake operations and identify most components	- explain brake operations and identify all components	- explain brake operations in terms of physical principles and identify all components
disassemble brake components TF1.02T	- demonstrates limited organization and cleanliness with constant supervision required	- demonstrates adequate organization and cleanliness with some supervision required	- demonstrates proper organization and thorough cleanliness with little or no supervision	- demonstrates professional organizational skills and thorough cleanliness with little or no supervision
takes all necessary precautions in handling brake dust ICV.04T TF1.01T TF1.02T IC1.07T	- applies safety procedures with constant supervision	- applies safety procedures with some supervision	- applies safety procedures with little or no supervision	- demonstrates initiative and leadership in applying safety procedures and assists others

<b>Expectation</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
reassemble brake components TF1.02T	- demonstrates need for reinforcement when attempting procedures in re-assembly	- demonstrates most of the proper procedures in re-assembly with some assistance from teacher	- demonstrates proper procedures in re-assembly with minimal assistance from teacher	- demonstrates initiative and leadership in re-assembly procedures and assists others
report findings SPV.01T TF1.02T SP1.02T SP1.03T	- demonstrates limited ability in preparing report	- demonstrates adequate ability in preparing report	- demonstrates considerable ability in preparing report	- demonstrates professional level ability in preparing report

**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 pre-printed notes to students who are unable to keep pace with classroom sessions. Students may be assigned peer helpers. Certain procedures requiring greater accuracy and skill level may be omitted from the procedural worksheet. Testing methods can be adapted to suit individual student needs. Individual study topics may be assigned for extra credit. Students may be assigned as peer helpers to assist others. Some students may perform specialized tasks such as machining brake drums/discs or working on customer vehicles rather than on donated vehicles or models.

### **Resources**

Automotive Textbooks such as:

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

Schwaller, Anthony E. *Transportation Energy and Power Technology*. Glencoe McGraw-Hill, ISBN 0-8273-3227-0

Service Manuals/Software or Specification books available at most facilities specializing in brake service, for example:

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

### **Web Sites**

ABS Brakes Education

<http://www.abs-education.org/index.html>

### **Videos**

Several video tapes are available from The Learning Tree

<http://www.autovideo2000.com>

Several video titles are available from ICS Learning

<http://www.icslearning.com>

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## Appendix 3.2a

### Handout on Drum Brake Service Procedures

**Safety Note:** Asbestos has been used in brake linings for many years. Asbestos dust is a health hazard if inhaled. **Do not clean brake parts with compressed air.** Avoid breathing the dust off of brake parts.

#### Disassemble and Inspect

- Remove the rear wheels. **Note:** Before beginning this procedure, ensure that the vehicle is properly supported on axle stands.
- Remove the brake drums. **Note:** Do not step on the brake pedal while the brake drums are removed. This will cause the pistons to pop out of the wheel cylinders.
- Inspect the brake drums for "hot spots" or excessive wear. The drums may be measured to determine if they can be reused.
- Inspect the brake linings for wear, cracks, or oil-soaking. If the brake linings are oil-soaked, the source of the oil leak must be repaired at this time.
- Check that both pistons in each wheel cylinder are moving freely by prying the brake shoes forward and backward against the wheel cylinder. Inspect the wheel cylinders for leaks by gently peeling back the boots and checking for brake fluid. Check that the bleed screw can be loosened. Use a six-point wrench or socket to avoid damaging the screw.
- Operate the park brake lever inside the car and observe that the park brake cables are releasing fully at the rear brakes.
- Remove brake linings from one side of the vehicle only. This will allow you to check the other side for correct reassembly.
- Clean the backing plates. Use a solvent and a parts brush. Do not create dust. Inspect the backing plates for damage or wear.
- Based on your inspection thus far, create a parts list.

*Your work must be inspected by your Instructor before proceeding to the next procedure.*

#### Service and Reassemble

- Repair or replace parts, as discussed with instructor.
- Lubricate the contact points on the backing plates with an anti-seize compound.
- Install the brake shoes on the backing plate. Install the primary shoe (long lining) on the rear of the backing plate. Clean and lubricate the self-adjuster screw. An anti-seize compound may be used on the threads.
- If the drums require machining, mount the drums on the brake drum lathe and wrap the anti-vibration strap around the drum. Set up the cutter. *Have the Instructor inspect your machine set-up before starting the machine.* Remove only enough material to true the drums. **Note:** Safety glasses are required for this procedure.
- Install the drums and adjust the shoes to fit. The drums should turn but have a slight drag. Be sure the park brake cables are loose when fitting the drums.
- Fill the master cylinder brake fluid reservoir. **Note:** Avoid contacting skin with the brake fluid.
- Check the brake lines for air. Have an assistant hold firm pressure on the brake pedal. Open the bleed screw and check for air bubbles. Close the bleed screw before the assistant releases the brake pedal. Check the brake fluid level in the master cylinder.
- Install the wheel and hubcap.

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## Appendix 3.2b

### Handout on Disc Brake Service Procedures

**Safety Note:** Asbestos has been used in brake linings for many years. Asbestos dust is a health hazard if inhaled. **Do not clean brake parts with compressed air.** Avoid breathing the dust off of brake parts.

#### Disassemble and Inspect

- Remove the front wheels. **Note:** Before beginning this procedure, ensure that the vehicle is properly supported on axle stands.
- Inspect the hydraulic hoses attached to the brake calipers for bulges or cracks.
- Determine if the bleed screws can be loosened. Use a six-point socket or wrench to avoid damaging the screw.
- Remove the brake caliper. The procedure for removing the brake caliper varies from one vehicle to another. Use the service manual to determine the correct procedure for the vehicle being worked on.

**Note:** Do not allow the caliper to hang by the hydraulic hose. Use a piece of mechanics wire to suspend the caliper after its removal.

- Remove the brake pads from the caliper. Press the caliper piston back into the bore using a block of wood or equivalent and secure the piston with a c-clamp. The piston should move with moderate pressure on the clamp.
- Inspect the caliper for signs of brake fluid leakage or damaged rubber boots.
- Remove the brake rotors. On rear-wheel drive vehicles this usually requires the removal and disassembly of the wheel bearings. On many front-wheel drive vehicles the rotor is held in place by the wheel and will come off easily once the caliper is removed. Clean and inspect the wheel bearings.
- Inspect the brake rotor for cracks, hot spots, or excessive wear. Measure the rotor with a micrometer to determine if it is thick enough to be reused.
- Based on your inspection, create a list of recommended service and required parts.

*Your work must be inspected by the Instructor before proceeding to the next procedure.*

- Repair or replace parts as discussed with instructor.
- If the rotors require machining, mount the rotors in the brake rotor lathe. Set up the cutter. *Have the Instructor inspect your machine set-up before starting the machine.* Remove only enough material to true the rotors. **Note:** Safety glasses are required for this procedure.
- Repack the wheel bearings with grease. Thoroughly clean any filings from the rotors before installing the bearings.
- Clean and lubricate the pins or slides that allow the calipers to "float" on the rotors.
- Install the rotors on the vehicle and adjust the wheel bearings. Lock the adjusting nut with the cotter pin and install the dust cap.
- Install the brake pads in the caliper, ensuring that any anti-rattle springs or anti-vibration compounds are in place.
- Install the brake calipers on the rotors. Use a thread-lock agent if required on the mounting bolts.
- Fill the master cylinder brake fluid reservoir. **Note:** Avoid contacting skin with the brake fluid.
- Check the brake lines for air. Have an assistant pump the brake pedal until the caliper piston moves out to firmly hold the disc pads against the rotor. While holding firm pressure on the brake pedal, open the bleed screw and check for air bubbles. Close the bleed screw before the assistant releases the brake pedal. **Note:** A commercially-available brake bleeding system may also be used for this procedure.
- Check the brake fluid level in the master cylinder.
- Install and torque the wheel nuts and reinstall the hubcap.

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## Activity 3: Servicing Steering Systems

**Time:** 360 minutes

### Description

Students disassemble, inspect, and reassemble typical steering systems used on modern vehicles. Students inspect steering component wear using specialized measuring instruments and technical manuals to compare with manufacturer's specifications. Students learn the names and purposes of steering system components and related steering system geometry through theoretical lessons and worksheet exercises using shop vehicles. Students will apply creative thinking techniques and learn to appreciate their talents as God-given gifts and their potential as productive citizens.

### Strand(s) and Expectations

#### Ontario Catholic School Graduate Expectations

CGE2b - reads, understands and uses written materials effectively;  
CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;  
CGE4b - demonstrates flexibility and adaptability;  
CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;  
CGE5a - works effectively as an interdependent team member;  
CGE5c - develops one's God-given potential and makes a meaningful contribution to society;  
CGE5h - applies skills for employability, self-employment and entrepreneurship relative to Christian vocation;  
CGE7i - respects the environment and uses resources wisely.

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

#### Overall Expectations

TFV.03T - explain the importance of service and support systems to the transportation of people and products;  
SPV.01T - demonstrate accuracy in the use of measuring systems and methods;  
SPV.03T - describe the function of major vehicle systems components;  
ICV.04T - apply health and safety standards related to materials, processes, and equipment.

#### Specific Expectations

TF1.02T - demonstrate knowledge of service procedures for different types of transportation vehicles;  
SP1.02T - use measurement tools correctly to inspect and service vehicle systems;  
SP1.03T - identify wear on vehicle system components on the basis of industry standards;  
SP1.08T - repair or replace components to meet or exceed original equipment manufacturer (OEM) standards;  
IC1.07T - describe health and safety regulations for the handling of tools, fuels, materials, and equipment.

### Planning Notes

- A licensed Automotive Service Technician must inspect steering system work performed on a vehicle that be returning to service before assembly is complete. If the teacher does not possess these qualifications, this activity should be restricted to models or vehicles that will not be returned to service.
- The classroom requires sturdy benches (large enough to hold disassembled components) with vises, lower shelves for short-term storage of removed components and variety of posters displaying safe working procedures. A class set of safety glasses must be provided.

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- Required basic tools include brake spring tools, micrometers and dial indicators. Other materials required for this activity include:
    - steering assemblies using a variety of typical steering system components used on modern vehicles (parts should be cleaned, ready for disassembly). Steering inspections may be performed on donated or customer vehicles;
    - service manuals or other means of researching procedures and specifications;
    - an approved parts-cleaning solution.
  - This activity can be linked with units in Mathematics (calculations), and Science (physics, mechanics).

### **Prior Knowledge Required**

- understanding of basics shop operating procedures
- awareness of acceptable personal conduct standards
- understanding of safety rules
- vehicle jacking/ hoisting procedures and proper placement of axle stands

### **Teaching/Learning Strategies**

1. Teachers relate that the students are going to embark on an interesting facet of control technology, and that as trained service personnel they will be applying principles of mechanical physics to solve real world problems. Students are also reminded that it is their Christian responsibility to ensure the safety of others and be diligent in their work ethics.
2. This activity requires that students jack or hoist vehicles to inspect or service them. The teacher must ensure that each student is properly briefed in the correct procedures for this as well as in proper axle stand placement. Proper and safe use of special tools must be addressed prior to student utilizing them.
3. In order to accommodate class participation, the class can be divided in half; one half of the class disassembling steering system components and the other half performing front-end inspections.
4. Students work with the teacher to develop a sequential procedural sheet to follow, including a checklist to be completed at various stages of work. Precautions and special points of interest can be noted on this worksheet. The procedures are reviewed before commencing the activity.
5. Students work with partners selected either by the teacher or by the students. The teacher may alter the group arrangements as necessary during the activity to assist students who are experiencing difficulties in completing the activity.
6. The teacher presents short theoretical sessions at predetermined points in the activity to address the purposes of the steering system components and operating theory. These points are reinforced to each group as they work on the activity.

#### *Steering Gears*

1. Students research disassembly procedures and specifications for the type of steering gear they are working on (rack and pinion or re-circulating ball) using technical manuals and note them on the procedural worksheets. Students disassemble the steering gear using procedures related by the teacher. The teacher may be required to assist with some parts of the procedure when additional specialized tools are required.
2. When disassembly is complete, students clean all parts (using approved parts cleaner) to prepare them for inspection. Students inspect all parts as per the technical manual and record all data on their procedural worksheet. The steering gear is reassembled and any adjustment required is made using the correct tools. The teacher verifies that all adjustments are correct and the steering gear is ready for the next group.

*Steering Linkages*

1. The students research inspection procedures and specifications for the components (e.g., tie rod ends and idler arm) using technical manuals and note them on their procedural worksheet. The teacher assists in the setup of specialized tools (e.g., ball joint indicator) as needed. Students inspect all parts as per the technical manual and record all data on their procedural worksheet.
2. Students replace defective components with parts that meet OEM standards, following the manufactures procedures. The teacher inspects all steering components for proper installation before tires are installed. Special note is made of cotterpin installations.

**Assessment/Evaluation Techniques**

Daily observation of student progress is noted. Daily student entries in a logbook provide information used to assist the teacher in evaluating individual accomplishment as well as contributions to group work. Notebooks and worksheets are checked for accuracy and organization. All written work is to be completed in chronological order and neatly written. All worksheets must be completed as the activity progresses. Students are also quizzed orally throughout the activity to assess their level of understanding.

**Sample Assessment Rubric for Inspecting Steering System Activity**

<b>Expectations</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Explain the importance of service and support systems TFV.03T CGE5c	- demonstrates acceptable work ethic in performing tasks but requires constant reminders	- demonstrates acceptable work ethic and diligence in performing tasks	- demonstrates professional attitude and diligence in performing tasks	- demonstrates professional attitude and diligence in performing tasks, assists teachers and others without prompting
Explain the effects that caster, camber, toe-in toe-out and the Ackerman principle have on the vehicle SPV.03T	- demonstrates a limited explanation of most of the steering geometry principles	- adequately explains steering geometry principles	- accurately explains steering geometry principles	- accurately explains steering geometry principles in terms of mechanics and physics
Locate required information on wear characteristics and compares with work at hand SP1.03T	- locates required information with significant teacher prompting	- locates required information with minimal teacher prompting	- locates required information on own initiative	- assists others in finding required information

<b>Expectations</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Student disassembles and reassembles rack and pinion or recirculating ball and nut steering gear SPV.01T TF1.02T ICV.04T	- requires significant assistance to demonstrate safe and proper way of disassembly and re-assembly	- requires some assistance to demonstrate safe and proper way of disassembly and re-assembly	- demonstrates safe and proper way of disassembly and re-assembly	- completes all procedures as outlined and assists others who are experiencing difficulty
Identify and state purpose of tie rod ends, centre link, pitman arm, idler arm, drag link and ball joints SPV.03T	- demonstrates a limited knowledge of most of the steering components	- adequately identifies steering components	- accurately identifies steering components	- accurately identifies steering components and system operation in terms of mechanics and physics
Inspect tie rod ends, centre link, pitman arm, idler arm, drag link and ball joints and accurately report findings SP1.02T SP1.03T SP1.08T IC1.07T	- demonstrates limited knowledge of inspection procedures and requires assistance with reporting skills	- demonstrates moderate knowledge of inspection procedures and adequately reports findings	- demonstrates complete knowledge of inspection procedures and accurately reports findings	- demonstrates professional level knowledge of inspection procedures and accurately reports findings
	- demonstrates limited knowledge of safety procedures and regulations	- demonstrates knowledge of safety procedures and regulations with prompting	- demonstrates knowledge of safety procedures and regulations	- trains others with respect to safety procedures and regulations

**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 pre-printed notes to students who are unable to keep pace with classroom sessions. Certain procedures requiring greater accuracy and skill level may be omitted from the procedural handout. Individual study topics may be assigned for extra credit. Some students may perform specialized tasks such as replacing defective steering components on customer vehicles rather than shop vehicles or models.

### **Resources**

Automotive Textbooks such as:

Schwaller, Anthony E. *Transportation Energy and Power Technology*. Glencoe McGraw-Hill. ISBN 0-8273-3227-0

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

Service Manuals/Software or Specification books available from most parts, e.g., Software: Mitchell. *On Demand Computerized Service Manuals*. San Diego, CA: 1999.

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## Activity 4: Inspecting the Suspension System

Time: 360 minutes

### Description

In this activity students inspect and compare typical suspension systems used on modern vehicles. Safety precautions regarding the handling of shocks and the use of spring compressors are included. Students use specialized measuring instruments and technical manuals to diagnosis suspension related problems. Students learn the names, types, and purpose of suspension components through theoretical lessons and worksheet exercises using shop vehicles. The application of safety rules and procedures to protect the well being of teammates and society at large is stressed in this activity.

### Strand(s) and Expectations

#### Ontario Catholic School Graduate Expectations

CGE2b - reads, understands and uses written materials effectively;

CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;

CGE4b - demonstrates flexibility and adaptability;

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE5a - works effectively as an interdependent team member;

CGE5h - applies skills for employability, self-employment and entrepreneurship relative to Christian vocation;

CGE7i - respects the environment and uses resources wisely.

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

#### Overall Expectations

TFV.03T - explain the importance of service and support systems to the transportation of people and products;

SPV.01T - demonstrate accuracy in the use of measuring systems and methods;

SPV.03T - describe the function of major vehicle systems components;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

#### Specific Expectations

TF1.02T - demonstrate knowledge of service procedures for different types of transportation vehicles;

SP1.02T - use measurement tools correctly to inspect and service vehicle systems;

SP1.03T - identify wear on vehicle system components on the basis of industry standards;

SP1.08T - repair or replace components to meet or exceed original equipment manufacturer (OEM) standards.

### Planning Notes

- A licensed Automotive Service Technician must inspect suspension system work performed on a vehicle that is to be returned to service before assembly is completed. If the teacher does not possess these qualifications, this activity should be restricted to models and shop vehicles that will not be returning to service.
- A class set of safety glasses must be provided before initiating the activity.
- This activity requires space for disassembling components and for temporary storage. Required basic tools include a vehicle hoist or floor jack, axle stands and dial indicators. Materials required for this activity include:
  - a variety of typical suspension system components and models (suspension system inspections may be performed on donated or customer vehicles);
  - strut assemblies, which can be located at local auto salvage yards;

- 
- service manuals or other means of researching procedures and specifications;
  - WHMIS-approved parts-cleaning solutions.
- Teachers should insure all students keep a logbook to record their daily activities. This log book will be used by the teacher to assess student knowledge gained through conducting the activity.

### **Prior Knowledge Required**

- understanding of basics shop operating procedures
- awareness of acceptable personal conduct standards
- understanding of general safety rules
- vehicle jacking/hoisting procedures and proper placement of axle stands

### **Teaching/Learning Strategies**

1. Teachers direct students in a discussion of the purpose and components of any suspension system. Teachers then direct students to consider the performance of a vehicle without each component. Teachers conclude the discussion by asking students to keep in mind their responsibilities as Catholics that safety of their customers is the prime consideration of what they are about to do.
2. This activity requires that students jack or hoist vehicles to inspect or service them. The teacher must ensure that each student is properly briefed in the correct procedures for this and in proper axle stand placement. Several procedures require work around suspension springs. Students must be made aware of the safety concerns of compressed springs. Proper and safe use of special tools must be addressed prior to student utilizing them. (See Appendix A: Safety Passport for sample safety signing sheet.) Teachers also tell students to keep a daily log of their activities.
3. Students work with the teacher to develop a sequential procedural sheet to follow, including a checklist to be completed at various stages of work. Precautions and special points of interest can be noted on the worksheet. The procedures are reviewed before commencing the activity.
4. Students work in small groups of two or more to reduce the required number of strut assemblies and vehicles required. Groups may be selected by either the teacher or by the students. The teacher may alter the group arrangements as necessary during the activity to assist students who are experiencing difficulties in completing the activity.
5. The teacher conducts short theoretical sessions at predetermined points in the activity to reinforce the purposes of the suspension system components and operating theory as discussed at the beginning of the activity. These points should be reinforced to each group as they work on the activity.

#### *Part 1*

- The students research disassembly procedures and safety precautions for a suspension strut using technical manuals (printed or computerized), and note the information on their procedural handouts.
- Students inspect struts for signs of wear or leakage. At this point the teacher may (if qualified) demonstrate the safe procedures for the disassembly of the strut using all the required specialized equipment. Students inspect all parts for leaks, damage or corrosion. Students inspect strut bearings, springs seats, springs, mounting plate and strut. (The inspection can be much more thorough if the strut assembly has been disassembled).
- The students inspect all parts as per technical manual and record all data on their procedural worksheet. The strut is reassembled by the teacher (see above cautionary notes).

#### *Part 2*

- Students research inspection procedures for suspension components (e.g., sway bars, shock absorbers and bushings) using technical manuals and note the information on their procedural worksheet. Students replace defective components with parts that meet OEM standards, following the manufacturer's procedures.
- The teacher inspects all components for proper installation before the tires are installed.

## Assessment/Evaluation Techniques

Daily observation of student progress is noted. Daily student entries in a logbook provide information used to assist the teacher in evaluating individual accomplishment as well as contributions to group work. Notebooks and worksheets are checked for accuracy and organization. All written work is to be complete, in chronological order and neatly written. All worksheets must be completed as the activity progresses. Oral quizzes should be given at appropriate points in the activity.

### Sample Assessment Rubric for Inspecting Suspension System Activity

Expectation	Level 1	Level 2	Level 3	Level 4
explain the features of different types of suspension systems TFV.03T SPV.03T	- demonstrates limited knowledge of system types and features	- demonstrates moderate knowledge of most of the features of system types	- demonstrates accurate and comprehensive knowledge of system types	- demonstrates comprehensive knowledge of system types and can explain in scientific terms
locate required information on wear characteristics and measures current component wear accurately SPV.01T SP1.03T	- locates required information with significant teacher prompting; requires supervision in measuring	- locates required information with minimal teacher prompting and supervision	- locates required information on own initiative and conducts inspection with little or no supervision	- assists others to find required information; accurately conducts inspection, assists others
installs shock absorbers or other components safely ICV.04T SP1.08T	- installs shock absorbers or other components with constant reminders to observe safety requirements	- installs shock absorbers or other components following all safety requirements with some reminders	- installs shock absorbers or other components following all safety requirements	- assists others in installation of shock absorbers or other components ensuring all are following all safety requirements
inspect suspension system components SPV.01T SP1.02T SP1.03T	- completes suspension system inspection safely with constant supervision; procedural checklist requires further work	- completes suspension system inspection safely and adequately with minimal supervision required; prepares adequate procedural checklist	- completes suspension system inspection safely and accurately with little or no supervision; prepares comprehensive procedural checklist	- completes suspension system inspection safely and accurately while assisting others; prepares comprehensive procedural checklist and notes

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

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## **Accommodations**

The teacher may provide pre-printed notes to students who are unable to keep pace with classroom sessions. Students may be assigned peer helpers. Certain procedures requiring greater accuracy and skill level may be omitted from the procedural worksheet. Oral testing can be substituted for written testing. Individual study topics may be assigned for extra credit. Students may be assigned as peer helpers to assist others. Some students may perform specialized tasks such as working on customer vehicles instead of shop vehicles or models, or replacing defective suspension components.

## **Resources**

Automotive Textbooks

Schwaller, Anthony E. *Transportation Energy and Power Technology*. Glencoe McGraw-Hill.

ISBN 0-8273-3227-0

Thiessen, F. and D. Dales. *Automotive Principles and Service, 4/e*. Prentice Hall, 1994.

ISBN 0-13-336561-1

Service manuals/software or specification books available from most parts suppliers, e.g., Software: Mitchell. *On Demand Computerized Service Manuals*. San Diego, CA: 1999.

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## Unit 4: Future Of Transportation Technology

**Time:** 45 hours

### Unit Description

In this unit students identify and describe the responsibilities and duties of people currently offering services in the transportation industry and how those duties might be affected by changes in the industry over the next several years. Students will also identify and understand the role of technological developments in future career prospects. Students will have the opportunity to investigate future vehicle design through the design and fabrication of an alternative power. This unit will also further develop the student's understanding of God's call in their life and provide opportunities to serve and minister to the living and environmental needs of the community.

### Strand(s) and Expectations

**Ontario Catholic School Graduate Expectations:** CGE 1d, f, i, 2b, c, 3c, 4e, f, g, 5a, c, e, g, h, 7l.

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

**Overall Expectations:** TFV.03T, TFV.04T, TFV.05T, SPV.01T, SPV.02T, SPV.03T, SPV.04T, ICV.01T, ICV.02T, ICV.03T, ICV.04T.

**Specific Expectations:** TF1.01T, TF1.02T, TF1.03T, TF1.05T, TF1.06T, TF1.07T, TF1.08T, TF1.09T, TF1.10T, SP1.01T, SP1.05T, SP1.04T, SP1.06T, SP1.07T, IC1.01T, IC1.02T, IC1.04T, IC1.06T, IC1.07T.

### Activity Titles (Time +Sequence)

Activity 1	Introduction To Emissions Testing	360 minutes
Activity 2	Service Facility Design	600 minutes
Activity 3	Design and Fabrication of an Alternative Power Vehicle	1500 minutes
Activity 4	Creating a Skills Profile	240 minutes

### Prior Knowledge Required

The general knowledge required for the unit is as follows:

- understanding of basic shop operating procedures
- awareness of acceptable personal conduct standards
- awareness conduct as a responsible service provider
- understanding of safety rules
- technical reading skills
- Internet/research skills

In addition, the continued use of the Safety Passport (Appendix A) introduced in Unit 1 is expected. It may be referenced in Activity 3 as part of the skills profile.

### Planning Notes

- Ensure that tools and equipment are in safe working order before proceeding. Make suitable substitutions for emissions testing equipment if it is not possible to access these items. (Fuel and ignition system testing devices may be used to demonstrate advanced tests which have results and data directly applicable to the study of emissions.)
- Teachers may prepare teaching aids such as posters, handouts, videos overheads, etc. Teachers should consider using a guest speaker to emphasize the "shop floor" perspective.

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- Teachers should plan the use of the technique of teachable moments to reinforce the values lessons contained in the activities. Foster the awareness of vocation and wise use of the earth's resources as these concepts are encountered in the tasks. Teachers should always emphasize the role of the Catholic church in helping to foster personal growth and leadership in ensuring moral and ethical practices are followed in the workplace.

### **Teaching/Learning Strategies**

- As a set of activities representing the whole course, engaged students should draw from the various skills and information learned in order to complete these tasks. Areas of particular interest, as well as those found challenging, may be revisited.
- Activity 1 will require investigation and exercise as individual students and small group members. Activity 2 emphasizes a team approach in organizing and operating a simulated work environment. Activity 3 gives students the opportunity to explore new skills in design and fabrication through group and individual effort. Activity 4 is an individual review of the specific skills required in related technical employment and a listing of the areas of competence acknowledged by the student.

### **Assessment and Evaluation**

Formal and informal teacher observation, as well as teacher conferencing with individual students and groups, will be used to monitor student development. Other assessment and evaluation strategies may include participation in class discussion, tests and quizzes and written reports. Activity 3 may represent a culminating performance assessment task while Activity 4 may represent the formative and summative evaluation of the unit or course. The skills profile at the end of this unit will help gauge the students skills acquired throughout this course and can be used to form a diagnostic assessment of required skills to enter the workplace.

### **Resources**

General resources include:

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

Jellison R. *Welding Fundamentals, 1/e*. Prentice Hall, 1996. ISBN 0-13-107178-5

Mitchell International. *Automechanics*. Toronto: Prentice-Hall, 1991. ISBN 0-13-583782-0

Mitchell International. *Automotive Fuel and Emissions Systems*. New Jersey: Prentice-Hall, 1991. ISBN 0-13-584 103-8

Service Manuals or Specification books available at most automobile dealerships or after-market parts depots such as Canadian Tire.

Ontario's Drive Clean Programme

<http://www.ene.gov.on.ca/>

Pollution Probe

<http://www.pollutionprobe.org>

Popular Mechanics Magazine

<http://www.popularmechanics.com/>

Ministry of Transportation Emission Laws

Ontario Health and Safety Act

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## Activity 1: Introduction To Emissions Testing

**Time:** 360 minutes

### Description

In this unit students will learn the properties of combustion and evaporative emissions of fossil fuels in light of future environmental issues. The students will research and identify the five gases to be tested, and their recommended acceptable levels. The students will perform emissions testing procedures or fuel and ignition system testing that indicates emission status, and compare these results with those outlined by the Ontario Drive Clean Program and manufacturer specifications. Using information collected in connection with this activity, students will suggest ten methods to reduce emissions in individual or industry-wide situations and provide a rationale as to how that goal is a reflection of his/her faith.

### Strand(s) and Expectations

#### Ontario Catholic School Graduate Expectations

CGE1i - integrates faith with life;

CGE2b - reads, understands and uses written materials effectively;

CGE3c - think reflectively and creatively to evaluate situation and solve problems and opportunities;

CGE7i - respects the environment and uses resources wisely.

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

#### Overall Expectations

TFV.03T - explain the importance of service and support systems to the transportation of people and products;

SPV.03T - describe the function of major vehicle system components;

ICV.01T - describe the impact of transportation technology on society and the environment;

ICV.03T - demonstrate understanding of methods for increasing the efficiency of energy use;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

#### Specific Expectations

TF1.02T - demonstrate knowledge of service procedures for different types of transportation vehicles;

IC1.01T - identify methods for improving the efficiency of energy consumption in the transportation industry;

IC1.02T - describe changes made to vehicle systems to enable them to use energy more efficiently;

IC1.04T - describe the refinement and utilization of energy sources from their raw materials to their disposal;

IC1.07T - describe health and safety regulations for the handling of tools, fuels, materials, and equipment.

### Planning Notes

- The teacher will create student groups prior to this activity. The teacher may wish to rotate groups onto computers while demonstrating emissions testing to other small groups.
- Teachers should prepare task sheets providing names and abbreviations of the five gases for research on the Internet or in other media as well as a list of several web sites or contact organizations.
- The testing equipment or analyzer should be set and calibrated to give accurate and comprehensible results. Prepare test station or vehicle for testing. Determine manufacturers emission levels for comparison purposes prior to testing. Organize a sequence a testing procedure for group participation. Determine criteria for workable or acceptable emissions solutions suggestions.

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### **Prior Knowledge Required**

This activity requires a general understanding of combustion and the resulting emissions. The testing procedures will require the general shop conduct and technical literacy expected in the preceding units. The use of the Safety Passport (Appendix A) is also recommended.

### **Teaching/Learning Strategies**

The teacher initiates the activity by describing the environmental issues about fossil fuel pollution and resource depletion. The importance of maintaining proper engine performance is stressed.

The teacher also:

- demonstrates gas analyser with a shop car, testing emissions and fuel vapours from the fuel supply;
- identifies the gasses being read and calibration procedures for the gas analyser;
- suggests possible solutions reduce emissions.

The students will:

- research the five gas properties and their appropriate levels on the Internet or in textbooks;
- perform emissions tests in small groups and compare their results to the standards of the Drive Clean Program and the manufacturer's specifications;
- perform a variety of tests examining or simulating major/minor tune up problems, and compare those readings with the properly functioning testing;
- list a variety of solutions for emissions reduction.

### **Assessment/Evaluation Techniques**

The teacher will observe group participation and evaluate a knowledge component through testing or submitted brief. This will allow:

- Formative assessment of each student's contribution to group and class discussion.
- Summative evaluation of proper testing procedures and the understanding of the relationship between proper maintenance and emissions levels
- Summative evaluation of student understanding of the five gases and their appropriate levels in relation to the environment and the global impact of transportation industry.
- Summative evaluation of student suggestions to reduce emissions.

### Emissions Rubric for Unit 4, Activity 1

Criteria	Level 1	Level 2	Level 3	Level 4
Student can identify the environmental impact of hydrocarbons, carbon monoxide, carbon dioxide, oxides of nitrogen and oxygen and the need for emissions testing SPV.03T ICV.01T IC1.04T	- limited understanding of the environmental impact of Transportation emissions	- some clarity in understanding the environmental impact of Transportation emissions	- acceptable understanding of the environmental impact of Transportation emissions	- exceptional understanding of the environmental impact of Transportation emissions
Student can identify relationship between emissions testing and maintenance TFV.03T ICV.03T IC1.01T, IC1.02T	- limited understanding of the five gases and their direct relevance to maintenance	- adequate understanding of the five gases and their direct relevance to maintenance	- competent understanding of the five gases and their direct relevance to maintenance	- exemplary understanding of the five gases and their direct relevance to maintenance
Student can perform emissions testing TF1.02T ICV.04T	- performs emissions testing and calibration only with supervision	- performs emissions testing and calibration with adequate results	- performs emissions testing and calibration with successful results	- performs emissions testing and calibration with a high degree of accuracy
Students can identify and find ways to reduce emissions ICV.01T ICV.03T CGE3c	- limited identification of ideas to reduce emissions	- adequate identification of ideas to reduce emissions	- considerable to identification of new ideas to reduce emissions	- insightful ideas were used to develop new or revise ideas to reduce emissions

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

### Accommodations

- Some students may require more assistance to understand the physics of gas emissions. Teachers may provide:
  - additional handouts to summarize written and discussion material;
  - additional time allowance for completion of practical projects;
  - additional homework assignments;
  - additional one-on-one time by teacher or peer tutors.
- For an enrichment activity, teachers may give students the opportunities for more in-depth research into gas emissions or global pollution issues.
- If required, consultations should be held with students, parents, resource, guidance and special education departments when required to assist in creating an educational plan (IEP) for individual student.
- Accommodations for physical disabilities should be made as required to ensure the safety of individuals while participating in these course activities.

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## Resources

The teacher-librarian should be consulted for material on the physics and chemistry of fossil fuel emissions and pollution. Other resources are:

Mitchell International. *Automotive Fuel and Emissions*. New Jersey: Prentice-Hall, 1991.  
ISBN 0-13-584 103-8

1-800 ALT-FUEL (alternate fuel available from dealers in pamphlet form)

## Web Sites

Ford Motor Company

[http://www.fleet.ford.com/get\\_started/alternative\\_fuel\\_vehicles/default.asp](http://www.fleet.ford.com/get_started/alternative_fuel_vehicles/default.asp)

Pollution Probe

<http://www.pollutionprobe.org/>

Ontario's Drive Clean Programme

<http://www.ene.gov.on.ca/>

Ontario's Drive Clean

<http://www.driveclean.com/>

Air Quality Program

<http://www.pollutionprobe.org/air/index.htm>

## Activity 2: Service Facility Design

**Time:** 600 minutes

### Description

Students will plan a future service facility to test, maintain or repair a targeted mode of transportation or offer a specialized repair service. Students will identify the target service and clientele, evaluate the criteria for the facility's location, design and draw a shop floor plan, and estimate the number of vehicles to be serviced per day. Student will explore the effectiveness of their plan with a presentation and demonstration of their work. The inclusion of an explicit element of living in faith within their facility design will allow students to project their beliefs into future careers and life experiences.

### Strand(s) and Expectations

#### Ontario Catholic School Graduate Expectations

CGE1i - integrates faith with life;

CGE3c - think reflectively and creatively to evaluate situation and solve problems;

CGE4f - applies effective communication, decision-making, problem-solving, time, and resource management skills;

CGE5a - works effectively as an interdependent team member;

CGE5c - develops one's God-given potential and makes a meaningful contribution to society;

CGE5h - applies skills for employability, self-employment and entrepreneurship relative to Christian vocation.

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

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## Overall Expectations

TFV.03T - explain the importance of service and support systems to the transportation of people and products;

TFV.05T - describe the correlation between modes of transportation and the need for related support businesses;

ICV.01T - describe the impact of transportation technology on society and the environment;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

## Specific Expectations

TF1.03T - describe various maintenance and support technologies related to the transportation of people and products;

TF1.06T - describe the distribution network for fuel or energy required by transportation systems;

TF1.07T - describe principles of design that apply in conserving energy in project work;

TF1.08T - suggest improvements to a current transportation system to suit local conditions;

TF1.09T - describe the importance of secondary industries for the transportation industry;

SP1.05T - describe and maintain support systems related to vehicle operation;

IC1.01T - identify methods for improving the efficiency of energy consumption in the transportation industry.

## Planning Notes

- Teachers should prepare a list of possible specialty service facilities in regards to previous lessons and available resources for demonstrations. Teachers may consult teachers of business or local related businesses for advice on business plans or other operational material. See Appendix 4.2 for directions and sequence of conducting this activity.
- The teacher may want to rotate group members in order to pair advanced students to assist in the Mathematics portion of this activity with a basic or general student who requires additional help in this area. Teachers should prepare a presentation content and procedure checklist. Drawing or modelling materials and tools such as paper, rulers, markers, construction paper, cardboard, paints, etc., are to be obtained beforehand.

## Prior Knowledge Required

Considering the open-ended challenge of the activity, students should possess the following knowledge and skills:

- understanding of basic shop operating procedures;
- awareness of personal conduct;
- Internet research skills;
- working co-operatively in a group environment;
- jacking/hoisting procedures;
- general maintenance inspections;
- basic business math skills.

Students should also have an awareness of transportation servicing derived from the previous activities in this course. Use of the Safety Passport (Appendix A) is recommended for student demonstrations on shop machinery and tooling.

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## Teaching/Learning Strategies

The teacher will:

- review the timelines for the project presentation, including demonstration of the project;
- instruct students to review related skills and processes through practice demonstrations;
- instruct students to begin brainstorming based on group consensus;
- show by example the types of services required in distributing fuel, for an example the students can base their work;
- provide instruction on a group-by-group basis depending on the complexity of the project;
- distribute the presentation checklist and review procedure and content requirements;
- observe demonstrations of professionalism, safety practices and evidence to support students decisions;
- encourage the students to incorporate a faith statement into their facility design or operation. This may be done by prayer, mission statement, employee policy, company logo, or any number of workplace employee regulations or business practices.

The students will:

- begin brainstorming in small groups on the various modes of transportation and area of specialization;
- conduct Internet or classroom research on facility, timeline of service and estimate number of vehicles to be serviced. Research should include how fuel is distributed throughout the transportation system. (This may be a side issue to the student's own facility design, but will help them understand the structure of transportation networks.);
- develop a business premise, site outline; and floor plan and run this simulated service facility to experience first hand any concerns or problems. Plans should include how conservation of resources will be addressed;
- exercise an element of faith reflection in the facility;
- prepare a presentation or lead a discussion highlighting their operation.

## Assessment/Evaluation Techniques

The teacher will conduct a:

- formative assessment of student's contribution to group and class discussion;
- summative evaluation of proper facility procedures;
- formative assessment of safe working skills through observation;
- summative evaluation of presentation, supporting material and cost feasibility.

### Presentation/Demonstration Rubric for Service Facility Design

Expectations	Level 1	Level 2	Level 3	Level 4
develop a project design that displays knowledge and understanding of important design considerations TFV.03T TFV.05T TF1.03T TF1.06T TF1.07T TF1.09T ICV.01T IC1.01T	- design demonstrates a limited comprehension of the importance of key considerations, such as location and building design	- design demonstrates good comprehension of the importance of some of the key considerations such as either location or building design	- design demonstrates good comprehension of most design considerations.	- design demonstrates excellent comprehension of most design considerations
draw or construct a service facility model SPV.01T SP1.05T ICV.04T	- drawing or models are limited in illustrating required features	- drawing or models are adequate to illustrate required features	- drawings or model displays careful workmanship with good attention to detail	- drawings or model displays professional level research, careful workmanship with fine attention to detail
present and demonstrate service TVF.03T TF1.08T IC1.01T	- demonstrates limited safety considerations and proper procedures	- demonstrates adequately safety considerations and procedures	- demonstrates safety considerations and well researched procedures	- demonstrates exceptionally well safety considerations, researched procedures and consideration for future applications

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

#### Accommodations

- Some students may require more guidance to decide on strategies and criteria for design. Teachers should allocate individual or group attention to assist in design decisions as required.
- Specific areas of enrichment might be the incorporation of more specific business plan principles, or the inclusion of promoting the facility project to the community through the media or sponsoring industry.

#### Resources

Information on business practices or considerations can be obtained from local businesses, local Chamber of Commerce, local chapter of the Canadian Automobile Association (CAA), or business teachers within the school. Presentations by local community leaders in the area of transportation may be instrumental in assisting the students on design decisions.

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## **Appendix 4.2**

### **Transportation Technology**

#### **Service Facility Project Situation**

After determining your “leading edge” transportation specialty, your group will have to design and implement a business plan and location strategy for your project. Your group has just learned of this excellent opportunity and have a limited time to prepare the detailed business plan with a shop layout, equipment lists, and hone all the basic procedures involved in the area of specialization. Your target area should be displayed with a detailed map and an approximate figure of how many vehicles you will be testing in an average day. Internet access will be available. Make sure your group has spent some time coming up with key search words to speed up the search process.

#### **Service Facility Project**

*Business Plan:* Be sure to answer all these questions and investigate the pertinent facts

Can we predict at least five years of testing and repairs?

How can we insure that we remain current:

- with the changing technologies?
- estimating the cost of servicing shop equipment?
- with capable skilled staff?

What are the economic factors of the targeted area? (age, population, local industry, etc.)

Is there a need for our service?

#### **Investigation/Ideas**

Have we considered:

- floor plan and lot layout (office, storage, restrooms, waiting area, hoists, flow of service)
- tools and equipment list with a break down of prices and totals
- support staff required
- operating budget including items such as snow removal, taxes, lot fees
- maintenance, advertising, and insurance, heat, electricity, telephone, water, recycling
- ensuring a clean and appealing facility
- age of the transportation mode you are targeting.
- service rates within your area
- the types of transportation vehicles in your area
- population of targeted service area
- is work seasonal, if so how will you compensate
- will you be able to meet your customers demands

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**Appendix 4.2 continued**  
**Transportation Technology**

Service Facility Project Situation

Name of Company:

Specialization area:

Group Members        1-  
                                 2-  
                                 3-

*Statement of Revenues and Expenses*  
*For the Projected for 1999-2000*

Monthly  
Annually

**REVENUES**

Projected Labour Sales Repair:  
Projected Labour Sales Maintenance:  
Projected Specialty:

Total Projected Revenue:

**EXPENSES**

Employee salaries:  
Insurance:  
Rent:  
Utilities:  
Materials:  
Office supplies:  
Advertising:  
Travel and entertainment:  
Professional services:  
Taxes:  
Meetings and conferences:  
Communications:

Total Expenses:

    Total Revenue:

    Minus Total Expenses:

    Net Profit after Expenses:

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## **Activity 3: Design and Fabrication of an Alternative Power Vehicle**

**Time:** 1500 minutes

### **Description**

In this culminating activity, students design and construct an alternative power vehicle by incorporating knowledge and skills gained throughout this course. Through practical application, students learn the concepts of design prototyping, mechanics, and fabrication, as well as concepts of alternative energy sources for motive power. Students are encouraged to create a vehicle that will be eligible to compete in some form of organized competition aimed specifically at this age/ability group. Through this activity, students will also learn to appreciate self worth as a productive member of a project team, the use of prayer in focussing energy and seeking communion with God, and social responsibility in promoting the common good.

### **Strand(s) and Expectations**

#### **Ontario Catholic School Graduate Expectations**

CGE1d - develops attitudes and values founded on Catholic social teaching and acts to promote social responsibility, human solidarity, and the common good;

CGE1f - seeks intimacy with God and celebrates communion with God, others and creation through prayer and worship;

CGE1i - integrates faith with life;

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;

CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;

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;

CGE5a - works effectively as an interdependent team member;

CGE5e - respects the rights, responsibilities, and contributions of self and others;

CGE5g - achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others.

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

#### **Overall Expectations**

TFV.04T - identify and describe different methods for converting, using, distributing and storing energy;

SPV.01T - demonstrate accuracy in the use of measuring systems and methods;

SPV.02T - design and construct systems to convert and make practical use of energy;

SPV.04T - use a variety of fastening, fabrication, maintenance, and repair techniques correctly in projects;

ICV.04T - apply health and safety standards related to materials, processes, and equipment.

#### **Specific Expectations**

TF1.05T - identify and explain technologies for joining materials and describe their application;

TF1.10T - demonstrate knowledge of different propulsion systems;

TF1.07T - describe principals of design that apply in conserving energy in project work;

SP1.01T - produce projects that demonstrate knowledge of a variety of transportation technologies;

SP1.04T - design and construct propulsion systems capable of propelling vehicles for a variety of transportation modes under varying conditions;

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SP1.06T - adapt a secondary system to control a propulsion system;  
SP1.07T - use a variety of technologies for joining materials;  
IC1.07T - describe health and safety regulations for the handling of tools, fuels, materials and equipment.

### **Planning Notes**

- This activity involves the design prototyping of a vehicle using alternative power in competition. Teachers should consult other transportation teachers in their respective boards for organization of inter-school or inter-board competitions and associated rules and/or design criteria. Teachers may prepare learning materials such as video recordings of races, posters of racing vehicles, magazines or lists of web sites to give students ideas of what they are about to accomplish.
- This activity can be adapted to local or seasonal needs. Financial requirements may determine material and design options. Project budget should be established in advance when possible. Suggested vehicles may be:
  - Electrical powered three- or four-wheeled vehicles (possibly starter motor/battery power trains)
  - Human powered vehicles using used bicycles for land or water
  - Combustion engine vehicles using alternative fuels
  - Wind powered vehicles for land or water
  - Humorous vehicles such as beds on wheels (charity competitions)
- A neat, well-organized technical facility is required for this project. Fabrication requires space for jiggling and layout of components prior to assembly. Depending on materials selected, access to various types of welding equipment will be required. Teachers must ensure all students wear eye protection at all times in the shop environment. Teachers must also be aware of safety regulations if conducting testing both on or off school property as required.
- This project allows students to utilize knowledge gained in other courses. For example, cross-curricular applications may include:
  - Physics - forces, friction, aerodynamics, electricity
  - Business - fund raising, promotion, sponsorships, budget or competition spreadsheets
  - Mathematics - gear ratios, budget, measurement calculations
  - Computers - research, CAD, graphics, business letters
- Material required for this activity may include:
  - handouts describing project requirements or criteria, timelines, etc.
  - welding supplies (if fabricating from metals)
  - fabrication materials and tools: plastics, wood, metals as required
  - used bicycles, assorted components as required
- Teachers must ensure that each student has been properly briefed on correct and safe use of all equipment. At this point in the course all students should have been “documented” on their ability to correctly use tools using either the Safety Passport model or safety tests. Teachers should have documented proof of safety knowledge before allowing students to use any equipment such as metal fabrication tools.

### **Prior Knowledge Required**

- Independent research skills
- Safe operation of hand and power tools in a transportation facility
- Knowledge of how to work effectively in group settings
- General knowledge of safe operation of oxy-acetylene and/or MIG welding techniques as required
- Basic knowledge of systems such as steering, brakes, power transmission as acquired throughout this course
- General shop and specific workshop equipment safety rules and procedures, verified by teacher

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## Teaching/Learning Strategies

1. Teachers describe to students that engineers use the venue of car racing to develop and test new technologies or improve existing ones. The history of technological development in transportation is full of examples of competitions that pushed the boundaries of power, speed, and control. Examples include car, motorcycle, bicycle, boat, etc. racing; and prize competitions such as the ones that resulted in Lindbergh's crossing of the Atlantic, the recent round-the-world crossing by balloon, the present race of private enterprise's ventures in space vehicles. For this activity, students will be developing an alternative energy vehicle for a competition that will push the envelope in future transportation design.
2. The teacher acquaints students with general design parameters of this project. The students and teacher discuss the implications of alternative energy (human power, electric, hydrogen, alternative fuel, etc.) as a replacement for hydrocarbon based fuels. Environmental considerations are discussed by prompting students to list the environmental problems of continued use of oil and gasoline.
3. If the project is to be an entry in some form of competition students must receive a copy of event rules, especially those pertaining to vehicle design. Students are also directed to maintain logbooks to record their progress and individual participation.
4. Teachers direct discussions on possible designs using the criteria developed for the competition. Teachers briefly mention key points of vehicle engineering, such as frame rigidity, trusses and gussets, principles of brake, suspension, steering and power train systems that students need to consider. Teachers assist the class in deciding on overall dimensions that would fit within the criteria. Students are directed to create hand sketches with general dimensions before attempting fabrication. Teachers may also require students to create structural models using welding rod or wood strips.
5. Teachers describe the process of design prototyping, that of designing a product by modelling with minimal drawing and calculations. (**Note:** In this type of design, students will have little or no experience or training in drawing or calculating parameters of frames and power trains. For complex structures, it is sometimes best to use materials at hand (wood, scrap steel, cardboard, etc.) and experiment to get a "feel" for the design. In the process of prototyping, designers will try and test ideas to decide on what is the best design).
6. Teachers outline the duties to be completed throughout the activity. Teachers assign duties to students and assemble teams as required. Depending on space, availability of materials and the abilities of the students, the teacher may require that each team complete an entire vehicle, or alternatively, the teacher may require that each team takes responsibility for developing one aspect of the project. Specialized teams or individuals could be created for brakes, frame, electrical, body, business contacts, resource material sources, documentation, etc.
7. Teachers gather the class to have a quiet reflection on the task at hand. Teachers mention how major sport stars and/or teams enter into competition by first spending a few moments in prayer. Teachers describe how this time can be used to focus one's energies, to remind oneself of their responsibilities as Christians in fair play and in teamwork, and to bring the team together and ask for help from God in their quest for excellence. Teachers may conduct each prayer session, or alternatively, ask students to take turns in conducting the service. This may be conducted before entering the shop area each day, and/or before testing the vehicle, and before the competition start.
8. Teachers must instruct and demonstrate the proper use of unfamiliar equipment and allow students to practice using this equipment under direct supervision. Teachers should work with individuals and allow students to try procedures by testing fabrication techniques with scrap materials.
9. Students locate all major materials required for the vehicle construction. Old bicycle frames and other salvaged components may be used. Teachers may elect to include the local community by inviting them to become sponsors of the competition. Teachers may select individual students to contact possible sponsors for financial support.

10. Students begin construction of vehicle components. The vehicle frame is laid out, dimensions for lengths of frame components are calculated, prepared and assembled. Students fabricate elements for drive mounts, steering, suspension components then assembled and tested.
11. Students who may be working on specialized tasks may occasionally make presentations to the class in order to share information and co-ordinate fabrication schedules.
12. The students test the assembled vehicle to identify potential design or construction flaws prior to any extensive operation of the vehicle. The teacher must determine that the vehicle is safe to operate, and is being operated safely. A helmet must be worn by the operator. It is recommended that the vehicle be tested on axle stands, without a driver, to determine that the drive and braking systems are operating properly before track-testing occurs.
13. Vehicles that are designed for formal competition must be carefully inspected to identify and correct any problems or rule violations. Teachers should leave enough time to correct problems and retest. Before taking the vehicle out for testing, students are asked to gather together and spend a moment in prayer.

### Assessment/Evaluation Techniques

Students will be assessed based on a combination of the following:

- teacher observation of effort and attention to detail by each student
- analysis of daily journal entries
- presentation or oral quizzes on student's knowledge of key concepts
- performance and quality of finished vehicle (quality and effort)

### Sample Assessment Rubric for Alternative Vehicle Activity

Expectations	Level 1	Level 2	Level 3	Level 4
Demonstrates knowledge of safety issues, and/or fabrication techniques TF1.05T IC1.07T	- demonstrates safe work habits; requires direct supervision - explains only a few methods of material fabrication used in production of their vehicles	- demonstrates safe work habits; requires some direct supervision explains most of the methods of material fabrication used in production of their vehicles	- demonstrates safe work habits; requires very little direct supervision - explains methods of material fabrication used in production of their vehicles	- demonstrates safe work habits; assists others by explaining methods of material fabrication used in production of their vehicles
Demonstrates ability to research and identify different methods of power transmission, control, and frame principles TFV.04T TF1.10T SP1.04T IC1.07T	- demonstrates limited ability in investigation of alternative ideas, (sketches, calculations, log books, oral quizzes)	- demonstrates adequate investigation of alternative ideas, (sketches, calculations, log books, oral quizzes)	- demonstrates thorough investigation of alternative ideas, (sketches, calculations, log books, oral quizzes)	- demonstrates thorough, methodical, and insightful investigation of alternative ideas, (sketches, calculations, log books, oral quizzes)

<b>Expectations</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Construct project or components in a manner that reflects quality, precision, and accuracy TFI.05T SPV.04T SPV.01T SP1.07T ICV.04T	- uses procedures, equipment and materials only with extensive supervision	- constructs a functional project with some supervision required	- constructs project or components in a manner that reflects quality, precision, and accuracy	- constructs project that reflects exemplary standards of quality and finish at a near professional level
Document all procedures in a thorough manner TF1.05T SP1.01T IC1.07T	- offers documentation which displays limited understanding of concepts	- demonstrates and documents with moderate clarity and some understanding of concepts	- documents all procedures in a thorough manner reflecting a considerable understanding of design and fabrication process	- exhibits thorough comprehension of design and construction process and offers clear and concise analysis of project procedure

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

### **Accommodations**

In this activity, some students may have difficulties with the design and/or fabrication aspects. Teachers may provide:

- additional handouts to summarize discussion material;
- additional time allowance for completion of practical projects;
- assistance with organization skills;
- additional one-on-one time by teacher or peer tutors.

Teachers may provide enrichment opportunities such as project management, competition organization, body/graphics work for those students who have experience in this type of work.

### **Resources**

Teachers should consult with teachers from other schools on project possibilities and for arranging local competitions. The Internet has many examples of competitions that can be used to determine strategy.

Other resources include:

Bamsey, I. *The Anatomy and Development of the Sports Prototype Racing Car*. England: Haynes Publishing, 1991. ISBN 0-87938-586-3

Competitions

EVCO Electrathon

<http://www.igs.net/~darrylmcmahon/otthon99.html>

Queen's University Electric Car Race

<http://educ.queensu.ca/~techstd/gecr1999.htm>

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## Activity 4: Creating a Skills Profile

Time: 240 minutes

### Description

Students will research and describe the skills necessary for entry into transportation related careers. Students will create a personal skills profile indicating their level of ability in performing specific skills. The student will then compare the necessary skills required in the workplace and their personal skills profile. The students will reference the profile to develop or modify a cover letter and resume that would enhance their opportunities for employment or co-op placements. This identification of abilities will be an opportunity for students to define their personal goals, life choices, and future directions for growth in light of Christian vocational values.

### Strand(s) and Expectations

#### Ontario Catholic School Graduate Expectations

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;

CGE4e - sets appropriate goals and priorities in school, work, and personal life;

CGE4g - examines and reflects on one's personal values, abilities, and aspirations influencing life's choices and opportunities;

CGE5h - applies skills for employability, self-employment, and entrepreneurship relative to Christian vocation.

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

#### Overall Expectations

ICV.02T - identify career opportunities in transportation-related fields and the education and training required for entry into those positions.

#### Specific Expectations

TF1.01T - identify current safety standards in transportation and secondary industries;

IC1.06T - describe related career opportunities and the education and training required to gain entry to these positions.

### Planning Notes

- Teachers should consult with the Guidance or Student Services department of their school for career information and to tie this activity to their career education directions. The cover letter and resume should be based on co-operative education, business, or English department formats.
- The content of the workplace skills menu used to develop the student's own profile should reflect the activities and included skills of the specific projects used in this course. It may be developed over time or be specific to the single course. The Skills Profile data can be changed easily to meet local workplace requirements.

### Prior Knowledge Required

This activity requires that the student review his/her competencies and all prior knowledge associated with the course.

The specific prior knowledge that will assist in this task includes:

- technical literacy;
- written communications skills appropriate to writing business documents.

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## Teaching/Learning Strategies

The teacher will:

- present local skills requirements for employability in local business;
- define four levels of proficiency in performing basic skills (as per Skills sheet);
- introduce the skills profile format (Appendix 4.4);
- review the industry visit and report (Unit 1, Activity 3);
- introduce the format required for a cover letter and resume;
- create a local workplace skills rubric for reference.

The students will:

- assess and identify their own level in performing the basics skills they have identified;
- complete individual skills profile;
- create or modify an appropriate cover letter and resume.

## Assessment/Evaluation Techniques

Teachers may assess the completeness of skills profile sheet. Evaluation of effort and quality of research apparent in completed resume and cover letter provides the basis of marks for this activity.

### Presentation Rubric for Unit 4, Activity 4

Criteria	Level 1	Level 2	Level 3	Level 4
Identify career opportunities in transportation related fields and the education and training required for entry into those positions (workplace/self profile comparison) TF1.01T ICS.06T CGE4g	- limited understanding of the skills required at entry level positions in transportation related fields	- moderate understanding of the skills required at entry level positions in transportation related fields	- substantial grasp of the skills required at entry level positions in transportation related fields	- thorough understanding of the skills required at entry level positions in transportation related fields
Describe related career opportunities and the education and training required to gain entry to these positions (cover letter/ resume) ICV.02T	- cover and resume contains flaws such as grammar, spelling, format that requires more effort on the part of the student	- cover and resume contains minor flaws such as grammar, spelling, or format that requires more attention on the part of the student	- demonstrates quality effort in preparing resume and cover letter	- demonstrates exceptional and professional effort in preparing resume and cover letter

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

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## **Resources**

Guidance or student services departments have an array of information in publications and CDs geared to career paths in Transportation industries. Teachers should consult those teachers for materials or guest appearances.

Many job banks exist on the Internet, mainly for high tech careers. Teachers should instruct students to begin search at:

Industry Canada

[http://strategis.ic.gc.ca/sc\\_indps/sectors/engdoc/tran\\_hpg.html](http://strategis.ic.gc.ca/sc_indps/sectors/engdoc/tran_hpg.html)

### Appendix 4.3 Sample Transportation Skills Profile

	Level of Achievement			
	Level 1	Level 2	Level 3	Level 4
<b>Air Pollution Control Systems</b>				
Identifies/repairs/replaces crankcase control systems				
Identifies/repairs/replaces evaporation control systems (ECS)				
Identifies/repairs/replaces exhaust gas recirculation system (EGR)				
Identifies/repairs/replaces air injection reaction system (AIR)				
Identifies/repairs/replaces closed loop emission control system				
<b>Aviation</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Researches and is aware of various flying opportunities such as ultra light, recreational, private and commercial aviation				
Identifies various types of aircraft (fixed wing, rotary wing, lighter than air)				
Identifies various aircraft configurations (undercarriage, wing, engine, seating)				
Understands the factors that determine flight safety (weather, instrumentation, training, airworthiness, light planning, communication)				
Understands general aviation terms (airfoil, propulsion, forces on an aircraft, vortices)				
Identifies various wing configurations and their application (straight wing, tapered wing, elliptical wing, swept back wing)				
Identifies flight instrumentation and usage of compass, outside air temperature gauge, pilot tube, altimeter, vertical airspeed indicator, gyro				
Identifies the following support services provided by an airport: weather reports, fuel and maintenance, passenger transportation, freight movement				
Identifies wing designs and terms such as aspect ratios and chord line				
Identifies the purpose and function of ailerons, stabilizer, elevators, rudder, power plants, landing gear and fuselage				
Identifies propulsion systems (free flight, reaction engines, piston engines)				

<b>Small Engines</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Services a small engine				
Sharpens and balances a blade				
Cleans and tunes up and adjusts valves				
Services the cooling system				
Changes a water pump and impeller				
Changes lower end lubricant				
Changes a propeller and shear pin				
Winterizes an engine				
Reseals an engine				
Adjusts and sharpens chains				
Adjusts, services and replaces cables				
Prepares for service				
Repairs and replaces tires and rims				
Services mechanical and hydraulic brakes				
Services mechanical and hydraulic clutch				
Repairs and replaces tires and rims				
<b>Charging Systems</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Identifies, diagnoses and services alternator/regulator/harness				
Uses a shop manual for trouble-shooting				
Understands and applies electrical theory				

<b>Drive train</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Locates, identifies, diagnoses, repairs/replaces to the manufacturer's specifications, the clutch assembly/related component/procedures				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the manual transmissions				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the synchronizing units/gears/shafts				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the automatic transmissions				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the torque converters				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the drive shafts/universal joints				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the differential/related components				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the axles and bearings				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the manual and automatic transaxles				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, front/rear wheel bearings				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, coil springs front/rear suspension				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, torsion bar front/rear suspension				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, McPherson strut suspensions				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, shock absorbers – gas/hydraulic				
<b>Brakes</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the hydraulic brake system components				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the drum/disc brakes				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, the vacuum assisted power brake units				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, brake system bleeding procedures				

<b>Alignment and Tires</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, power and manual steering systems				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, recirculating ball manual steering gear				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, integral power steering systems				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, non-integral power steering gear				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, power/manual rack and pinion steering				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, wheel alignment factors				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, pre-alignment checks				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, checking front-end components for wear				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, wheel and tire construction				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, tire sidewall information /ratings				
Identifies, diagnoses, repairs/replaces to manufacturer's specifications, tire wear diagnosis				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, methods of tire rotation				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, methods of tire rotation				
Locates, identifies, diagnoses, repairs/replaces to manufacturer's specifications, methods of tire rotation				

<b>Principles of Engine Operation</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Locates, identifies, diagnoses, repairs, replaces, and services the internal combustion system				
Locates, identifies, diagnoses, repairs, replaces, and services two and four stroke engines				
Locates, identifies, diagnoses, repairs, replaces, and services various types of engines				
Locates, identifies, diagnoses, repairs, replaces, and services the cylinder head and block construction/materials				
Locates, identifies, diagnoses, repairs, replaces, and services the crankshafts and bearings				
Locates, identifies, diagnoses, repairs, replaces, and services the connecting rods and bearings				
Locates, identifies, diagnoses, repairs, replaces, and services the pistons and piston rings				
Locates, identifies, diagnoses, repairs, replaces, and services the camshafts and camshaft drives				
Locates, identifies, diagnoses, repairs, replaces, and services the valves and valve trains				
Locates, identifies, diagnoses, repairs, replaces, and services the hydraulic/solid valve lifters				
Locates, identifies, diagnoses, repairs, replaces, and services the manifolds and their designs				
<b>Cooling System</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Locates, identifies, diagnoses, repairs, replaces, services, and records the cooling system operation and the components				
Locates, identifies, diagnoses, repairs, replaces, services, and records the ratio of ethylene-glycol antifreeze				
Locates, identifies, diagnoses, repairs, replaces, services, and records the mechanical/electrical cooling fans				
Locates, identifies, diagnoses, repairs, replaces, services, and records the flushing equipment and procedures				
Locates, identifies, diagnoses, repairs, replaces, services, and records the draining and winterizing procedures				
Locates, identifies, diagnoses, repairs, replaces, services, and records the heating systems/connectors/hoses				

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

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## Appendix A

### Sample Safety Passport

This is a sample of a generic Safety Passport that may be adapted for use in a number of technology classrooms. The purpose of the safety passport is to ensure that students are fully aware of all safety features on each piece of equipment in the technical facility prior to using them independently. This process may be adapted to suit the individual teacher and students' needs.

The general process is as follows:

1. When the teacher introduces a new piece of equipment (e.g., lathe). The student records the date of the safety demonstration on their safety passport and this is initialed by the teacher (see sample below). During this lesson in which the teacher demonstrates techniques for the safe operation of the machine and personal protective equipment (e.g., proper eye protection, secure loose hair, remove jewelry, protective clothing, etc.) the students prepare a note in their notebooks. This safety note carefully recorded in each student's notebook along with the signed passport slip. The teacher also carefully notes on the attendance for that day that if any students are absent for the safety lesson then a makeup opportunity must be provided.
2. Secondly, each student must complete a written (or oral) test on the safe operation of the machine tool, outlining all safety features that must be observed. The written tests must also be kept by the students in their notebooks. These individual machine tests are designed to compliment any general facility safety rules. Upon satisfactory completion of the test the student dates the "tested" column and teacher initials this as complete.
3. Next, students must demonstrate to the teacher that they have a thorough knowledge of the safety rules for the equipment and are able to demonstrate their competency on the equipment. Once the teacher has observed the required safe setup and operation of the equipment by a student they the teacher signs off that portion of their passport.
4. Once the student has completed 1, 2, and 3, the teacher signs the final column of student's safety passport that they are able to use that equipment. Students must be able to provide the teacher with their signed off passport for that equipment each time they wish to use that equipment. A summary document of all the various permissions may be created by the student and signed by the teacher (as permissions are earned); these summary safety passports may be protected with page protectors or laminated for protection. See the sample summary passport below.

### Sample Equipment Safety Passport

Student Name: _____							
Equipment: _____							
See notebook for the note on safe setup and operation of the equipment.							
Attended Teacher Safety Instruction and Demonstration (and note recorded)		Passed Written or Oral Testing		Demonstrated Safe Setup and Operation of Equipment to Teacher		Granted Permission to Use Equipment by Teacher	
Date of Lesson	Teacher Initial	Date Tested	Teacher Initial	Date of Demo	Teacher Initial	Date	Teacher Initial

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## Appendix B

### General Guidelines for Safety in the Transportation Facility.

Follow these simple rules to help prevent accidents.

1. Work quietly and give your job your full attention. Avoid unnecessary noise or shouting which may distract another student from his work. **ABSOLUTELY NO INAPPROPRIATE CONDUCT PERMITTED!**
2. Keep your work area clear. Keep jack handles out of the way. Stand creepers against the wall or under the vehicle being worked on when not in use. Keep tools under control. Do not allow tools to be scattered around your work area.
3. Do not carry screwdrivers or other sharp tools in your pockets. You may injure yourself or another student or damage a vehicle.
4. Dress correctly. Work clothes are required. Wear coveralls and shoes. Shorts and sandals are not permitted in the shop.
5. Keep your hands and tools clean. Grease or oil may cause your grip to slip and you may injure yourself.
6. Clean up all oil or grease spills immediately. Clean it up so no one will slip and fall.
7. Do not use compressed air to clean clothes. Do not direct the air in the direction of another student. Particles blown around can injure others.
8. Always wear safety glasses when there is risk of flying or falling debris. (e.g., under a vehicle or when using the grinder or drill)
9. When handling a battery, always wear safety glasses and avoid contact with the acid inside the battery.
10. Cars can fall off jacks! Always be sure the jack is correctly centred. Always place safety stands under the vehicle. Never touch a jack when someone is under a vehicle.
11. Use the right tool for the job. Incorrect use of tools can result in tool breakage, damage to the job, or personal injury.

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## Appendix B2

### Jacking and Hoisting Vehicles

#### JACKING

Jacking refers to lifting a vehicle by means of a floor jack. Axle stands must be used whenever a vehicle is raised with a jack, even if the vehicle will not be worked under. Before jacking any vehicle the axle stands must be ready. Place one stand at each corner of the car to be lifted. Place the jack under a rigid piece of the chassis, as described in the vehicle owner's manual (under jacking procedures). The teacher must inspect the positioning of the jack to ensure the placement is correct prior to any lifting of the vehicle. On some vehicles the design of the body or rust damage can make the correct placement of the jack difficult. Extensive damage can occur through incorrect jack placement. Most rear-wheel drive vehicles can be lifted at the rear by placing the jack under the center of the rear axle, at the differential housing. Some front-wheel drive vehicles can be lifted by placing the jack under the frame crossing under the engine. Wherever you place the jack, check the owner's manual or the maintenance reference materials available for the vehicle being lifted. If in doubt, do not attempt to jack the vehicle. Front-wheel drive vehicles can often be lifted at the rear by placing the jack under the rear axle or at the pivot points for the rear control arms, in the center of the car. The front often has a solid steel frame around the engine. Be sure the point you have selected is strong enough. Some sections of steel may look strong but are actually light gauge steel.

Once the jack has been correctly placed under the vehicle, operate the jack to a height that will allow easy access to the parts to be work on. If working under the vehicle, allow enough room to move around under the vehicle. Raise one end of the vehicle at a time but avoid lifting one corner at a time. Once raised, place the axle stands under the vehicle. Place the stands by reaching under the vehicle, as the vehicle is not yet secure. Do not go under the vehicle to place the stands. This is dangerous! Raise the stands and locate them in areas that are strong enough to support the weight of the vehicle when the jack is removed. Refer to the owner's manual for the appropriate "lifting points", when placing the stands. Axle stands should be placed in a location where they will not be in the way for performing the required service. Once the axle stands are in place, slowly lower the jack until the weight of the vehicle is on the axle stands. Remove the jack from under the vehicle. Repeat this process to raise the other end of the vehicle, if required. Never attempt to lift both ends of a vehicle at the same time, as this will cause the vehicle to be unstable. To lower the vehicle, place the jack under the vehicle in an appropriate spot and operate the jack until the vehicle weight is off the axle stands. Remove the stands and slowly lower the vehicle. Repeat for the other end if needed.

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## Appendix B2 (Continued)

### Jacking and Hoisting Vehicles

#### HOISTING

Hoisting refers to lifting a vehicle by means of the shop hoist. The vehicle should be located on the hoist, precisely as per the hoist's operating instructions. If possible allow for the opening of the driver's door when the vehicle is on the hoist. The vehicle is shut off and left in neutral to allow slight movement forward or backward when lining up the lifting arms. The lifting arms are equipped with safety locks to prevent them from moving unless released by the release lever. Swing the arms under the vehicle and locate them at a point strong enough to support the weight of the vehicle, as outlined in the vehicle's owners manual. There are often lifting points along the side of the car intended for use with the jack or hoist. These points are strong enough for hoisting, providing the body is not badly rusted. If uncertain as to the condition of the body for hoisting, do not attempt to lift!. If possible, place the arms under the frame. Check that the raised pads on the end of the hoist arms are fully on the arms. Never lift a vehicle if the raised pads are not *completely* on the hoist arms.

Operate the hoist until the vehicle begins to rise. Stop and re-check the positioning of the hoist arms. Make sure that the points selected for lifting not collapsing. If unsure, stop and ask! When ready, continue raising the vehicle to the required height. The hoist is equipped with safety features that make it safe for working underneath the vehicle without extra support. If work to be performed might upset the balance of the vehicle (e.g., removing rear axles or transmissions), or if the vehicle appears at all unstable, use the special axle stands provided for use on the hoist. Place the stands under areas able to support the weight of the vehicle and lower the hoist until only some of the vehicle weight rests on them. Do not lower the hoist excessively. Leaving some weight on the hoist arms prevents the hoist lifting arms from moving out of position before the hoist is raised again. If the weight of the vehicle has been removed from the hoist arms, the positioning of the arms must be rechecked before re-lifting.

**Appendix C  
Job Log Sheet**

STUDENT:	COURSE:
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Date	Hours	Project	Activity Performed	Teacher Signature
<b>Total Hours</b>		Student Signature/date: Instructor Signature/date:		