# AUT 801B

Career and Technical Education

## Automotive Technology

### Brake Systems

# Curriculum Guide

Prince Edward Island
CANADA
Education, Early Learning and Culture

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# Acknowledgements

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| | |
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# Career and Technical Education

## Curriculum Renewal

Renewal of curriculum begins with the common understanding that K-12 students must engage in learning that enables them to participate in a world of rapid and complex change. This dynamically evolving environment requires that students develop multiple literacies, increase depth of knowledge, and acquire a range of skills, attitudes, and abilities that foster creativity, innovation, and problem-solving skills.

Students must also develop a desire for personal and collective achievement and a willingness to collaborate for the well-being of themselves and others. It is essential that educators and administrators have an in-depth understanding of curricular expectations as part of a broader learning continuum.

## Importance of Career and Technical Education

Career and Technical Education (CTE) provides relevance to learning and values the technical skills required to complete meaningful work as equally important to the academic skills required. This blend of thinking and doing is fundamental for CTE students to fully comprehend and demonstrate competency within CTE programming. The false dichotomy between hands-on and heads-on education is no longer relevant to modern education systems or modern economic systems. The current labour market demands that people have the ability to acquire skills, build proficiency, seek out critical knowledge, and adapt to an ever-changing landscape. To this end, students must be lifelong learners who commit to cultivating their knowledge and skills through a combination of experience and education.

High quality Career and Technical Education programs prepare students for success by incorporating rigorous academic and technical skills, essential workplace competencies, and a commitment to career education. Thinking and doing are not at odds; rather each is critical for the development of the other and the success of the learner.

Career and Technical Education curricula are designed to foster the development of all learners as technologically literate and capable citizens who possess the technical skills, strategic knowledge, and agility required in the development of innovative and responsible solutions to relevant technical problems and the career awareness required to transition to further education and work after secondary school.

## Goals for Career and Technical Education

Students will develop

- the technical skills, confidence, and employability skills needed to gain employment within their area of interest along with the critical thinking and problem-solving skills required to sustain employment.
- the academic skills required to further their education and to embrace the ever-changing reality of technical work as active learners and innovators with an entrepreneurial spirit.
- the knowledge, skills, and attitudes that will enable the agility required to be actively engaged in the development and implementation of their own career plans.

> "If, instead of keeping a child at his books, I keep him busy in a workshop, his hands labor to his mind's advantage: while he regards himself only as a workman he is growing into a philosopher."
>
> Jean Jacques Rousseau
> Emile; or, Concerning Education
> p. 140, 1889

## Course Descriptions

**AUT701A - Introduction to Auto Service** (prerequisite for all 800 level CTE-Automotive courses)

Introduction to Auto Service introduces students to tools, equipment, theories, and practices common to the trade with a constant emphasis on safe work habits. In this course, students will learn how to communicate effectively and present themselves professionally; assemble components using a variety of fasteners and adhesives; perform basic heating, cutting, and welding procedures; diagnose and service wheels and tires, and perform basic maintenance.

### AUT801A - Basic Powertrain

A basic working knowledge of the major systems of a vehicle is essential for any auto service technician. The basic powertrain course introduces students to engine operation, cooling systems, and vehicle drivelines. Students will learn about the operation of internal combustion engines and various fuel types and practice performing accurate measurements using a variety of common measuring tools. Students will conduct tests and service vehicle cooling systems and learn to diagnose and repair problems related to vehicle drivelines.

### AUT801B - Brake Systems

Brakes are one of the most fundamental safety systems on a vehicle. This course focuses on the components, types, service, and diagnosis of brake systems. Students will develop a clear knowledge of the fundamentals of friction and hydraulics related to brake component function. They will learn to service, repair, and diagnose drum brake systems, disc brake systems, and power brakes, and will be introduced to anti-lock brake systems.

### AUT801C - Electrical Systems

Today's automobiles use electricity to operate many different devices and systems. During this course, students will develop a basic understanding of electrical principles, fundamentals of magnetism, and scientific principles related to vehicle electrical systems. They will learn to service, test, and diagnose problems related to batteries. They will service and repair basic electrical circuits and use electrical meters and scan tools to test and diagnose vehicle electrical systems.

### AUT801D - Steering Systems

The steering gear mechanism is an integral component of any vehicle system. Students will learn how to diagnose and correct problems related to vehicle steering components. They will also learn about the service and repair of manual and power steering systems, steering columns, and basic frame construction.

### AUT801E - Suspension Systems

Suspension and steering components are second only to brakes among the most crucial safety systems in any vehicle. Students will learn about common steering angles and how each affects vehicle handling, and about basic alignment procedures. They will also learn to diagnose and correct problems related to vehicle suspension and steering components and perform a standard motor vehicle inspection.

Students wanting to challenge the Level 1 Apprenticeship Exam for Auto Service Technician will require a minimum of 5 CTE-Automotive courses. The student's average in all courses must be at or above 70% to qualify to challenge the Apprenticeship Exam.

# Essential Graduation Competencies (EGCs)

## EGC Overview

Curriculum is designed to articulate what students are expected to know and be able to do by the time they graduate from high school. The PEI Department of Education, Early Learning and Culture designs curriculum that is based on the Atlantic Canada Framework for Essential Graduation Competencies released by the Council of Atlantic Ministers of Education and Training (CAMET) in 2015.

Competencies articulate the interrelated sets of attitudes, skills, and knowledge—beyond foundational literacy and numeracy—that prepare learners to successfully participate in lifelong learning and life/work transitions. They are cross-curricular in nature and provide opportunities for interdisciplinary learning. Six competencies have been identified by CAMET: citizenship, communication, personal-career development, creativity and innovation, critical thinking, and technological fluency (Figure 1). Achievement of the essential graduation competencies (EGCs) will be addressed through the assessment and evaluation of curriculum outcomes developed for individual courses and programs.

## EGC Definitions

### Critical Thinking

Learners are expected to analyse and evaluate evidence, arguments, and ideas using various types of reasoning and systems thinking to inquire, make decisions, and solve problems. They reflect critically on thinking processes.

### Technological Fluency

Learners are expected to use and apply technology to collaborate, communicate, create, innovate, learn, and solve problems. They use technology in a legal, safe, and ethically responsible manner.

### Citizenship

Learners are expected to contribute to the quality and sustainability of their environment, communities, and society. They analyse cultural, economic, environmental, and social issues; make decisions and judgments; and solve problems and act as stewards in a local, national, and global context.

### Communication

Learners are expected to express themselves and interpret effectively through a variety of media. They participate in critical dialogue, listen, read, view, and create for information, enrichment, and enjoyment.

### Personal-Career Development

Learners are expected to become self-aware and self-directed individuals who set and pursue goals. They understand and appreciate how culture contributes to work and personal life roles. They make thoughtful decisions regarding health and wellness, and career pathways.

### Creativity and Innovation

Learners are expected to demonstrate openness to new experiences; to engage in creative processes; to make unexpected connections; and to generate new and dynamic ideas, techniques, and products. They value aesthetic expression and appreciate the creative and innovative work of others.

# Curriculum Design

## General Curriculum Outcomes (GCOs)

General curriculum outcome statements articulate what students are expected to know and be able to do upon completion of study in technology education. These statements provide a concise description of the student as a technologically literate and capable citizen.

### Technological Problem Solving

Students will be expected to design, develop, evaluate, and articulate technological solutions.

Technological problem solving incorporates a variety of strategies and processes, consumes resources, and results in products and services. Technological problem solving constitutes one of the most important ways in which students engage in technological activity.

### Technological Systems

Students will be expected to operate and manage technological systems.

Technological systems are the primary organizational structure for products and services. Understanding the nature of systems and understanding how to employ, moderate, and re-structure systems are important components of technological literacy and capability.

### History and Evolution of Technology

Students will be expected to demonstrate an understanding of the history and evolution of technology, and its social and cultural implications.

Technology, like many other areas of human endeavour, is often best understood in its historical context. Technology has had and continues to have profound effects on individuals, society, and the environment. Understanding the origins and effects of a particular technology provides a context for resolving today's problems and issues, and often leads to better solutions.

### Technology and Careers

Students will be expected to demonstrate an understanding of current and evolving careers and the influence of technology on the nature of work.

All jobs, occupations, careers, and professions exist in technological environments. An understanding of the range of technologies in the workplace and their effects on the nature of work is critical to planning career and education paths.

### Technological Responsibility

Students will be expected to demonstrate an understanding of the consequences of their technological choices.

The development of technology, and by extension its impact in the future, is entirely under human control. Individually and collectively, we share that responsibility. Accepting the responsibility and being empowered to take appropriate action require technological literacy and technological capability (knowledge, skills, and willingness).

## Specific Curriculum Outcomes (SCOs)

Specific curriculum outcomes state the intended outcomes of instruction, and identify what students are expected to know and be able to do for a particular unit or course. SCOs provide the goals or targets of the prescribed education program referenced in 71(a) of the PEI Education Act. They provide a focus for instruction in terms of measurable or observable student performance and are the basis for the assessment of student achievement across the province. PEI specific curriculum outcomes are developed with consideration of Bloom's Taxonomy of Learning and essential graduation competencies.

Specific curriculum outcomes will begin with the phrase, "Students are expected to …".

## Achievement Indicators (AIs)

Each specific curriculum outcome is described by a set of achievement indicators which help to support and define the depth and breadth of the corresponding SCO when taken as a set.

The set of achievement indicators provided for a specific curriculum outcome

- provides the intent (depth and breadth) of the outcome;
- tells the story, or creates a picture, of the outcome;
- defines the level and types of knowledge intended by the outcome;
- is not a mandatory checklist, prioritized list of instructional activities, or prescribed assessment items; and
- may include performance indicators.

The intent of AIs is for clarity and understanding, so that instructional design is aligned with the SCO. When teachers are planning for instruction, they must be aware of the set of indicators in order to fully understand the depth and breadth of the outcome. Teachers may substitute or add to the set of AIs as long as these additions maintain the integrity of the SCO. By constantly analysing and monitoring the needs of the students, teachers can determine which indicators are appropriate and relevant to prior knowledge, developmental stages, or the continuum of the scholastic year.

Lists of achievement indicators will begin with the phrase, "Students who have achieved this outcome should be able to …".

## Sample of Curriculum Page

Targeted Level for Assessment of SCO

***CTE***

**Brake Systems**
**AUT801B**

| Technical Skill Dimension | | | | | Worksite Safety | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization | Articulation | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | | | |
| | | | | | Procedural | Applying | | | | |
| | | | | | | Analysing | | 1.3 | 1.1 | |
| A.1 | | | | | Critical Thinking | Evaluating | | | 1.2, 1.4, 1.5 | |
| | | | | | | Creating | | | | |

SCO - Specific Curriculum Outcome

**Unit A: Safety**
***Worksite Safety***

**A.1**

Students are expected to …
**ensure work practices are followed to provide for personal safety, the safety of others, and to prevent accidents.**

**Achievement Indicators**

Students who have achieved this outcome should be able to

AIs - Set of Achievement Indicators for SCO

A.1.1 demonstrate the selection and use personal protective equipment (PPE);
A.1.2 evaluate workplace safety at all times;
A.1.3 demonstrate the ability to prevent fires and to prevent accidents;
A.1.4 perform the correct procedures when working with exhaust gases; and
A.1.5 perform the correct procedures when hoisting and jacking vehicles.

## Elaboration

An elaboration provides a fuller description of the SCO and the instructional intent behind it. It sets the parameters of the SCO, gives background information where possible, and offers a broader context to help teachers gain a deeper understanding of the scope of the SCO. This may also include suggestions and/or supporting resources that may be helpful in teaching the related outcome. Teachers should vet material for any inappropriate sidebars, questionable information, or redirected links.

## Performance Indicators

Performance indicators are located in the Elaboration section of the guide. They are intended to provide the teacher with a wide range of activities, ideas, and/or tasks that students may be engaged with as they progress towards mastery of an outcome. Performance indicators are not prescriptive and are not a checklist. The list of performance indicators is by no means an exhaustive list of possible tasks a student may engage in as they are working towards the outcome. Performance indicators help teachers to connect the work the students are engaged in to particular outcomes within a course.

## Formative Assessment Guide

The formative assessment guide provides teachers with a general description of what the students are able to do within the context of each unit at each level of technical skill development. Teachers can use this tool as a foundation when developing customized rubrics, checklists, or observation methods. Teachers can also use the language in the formative assessment guide when providing descriptive feedback to students on how well they are progressing towards the learning outcome.

## National Occupational Analysis

Each elaboration will also contain a reference to the National Occupational Analysis (NOA), for the trade. This is provided to highlight which Tasks, Required Knowledge, and Sub-tasks are aligned to a particular set of outcomes. Teachers are encouraged to familiarize themselves with the NOA for their trade. The NOA is designed to facilitate understanding of the occupation and the work performed by tradespersons.

## Bloom's Taxonomy

In 1956, Bloom, et.al., published a framework for the purpose of classifying expectations for student learning as indicated by educational outcomes. This unidimensional framework of cognitive processes became known as Bloom's Taxonomy. David Krathwohl's 2002 revision of this taxonomy introduced a second dimension, the knowledge dimension, that classified the type of knowledge described by an outcome. To fully understand a specific curriculum outcome, it is important to understand how the learning is representative of both the cognitive process and knowledge dimensions.

## Knowledge Process Dimension

The knowledge process dimension classifies four types of knowledge, ranging from concrete to abstract, learners may be expected to acquire or construct. The noun included in a specific curriculum outcome represents the knowledge process dimension.

| | Explanation of Knowledge Level |
|---|---|
| **Factual**<br>The basic elements students must know to be acquainted with a discipline or solve problems in it<br><br>**KNOWING THAT** | • knowledge of terminology (e.g., technical vocabulary, name of equipment)<br>• knowledge of specific details and elements (e.g., general shop safety procedures, operating procedures) |
| **Conceptual**<br>The interrelationship among the basic elements within a larger structure that enables them to function together<br><br>**KNOWING WHAT and WHY** | • knowledge of classifications and categories (e.g., types of tools, equipment, and materials)<br>• knowledge of theories, models, and structures (e.g., electrical theory, hydraulics) |
| **Procedural**<br>How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods<br><br>**KNOWING HOW** | • knowledge of subject-specific-skills and algorithms (e.g., technical skills with tools, repair procedures)<br>• knowledge of subject-specific techniques and methods (e.g., safe operating procedures on stationary equipment)<br>• knowledge of criteria for determining when to use appropriate procedures (e.g., work orders, AllData) |
| **Metacognitive**<br>Knowledge of cognition in general as well as awareness and knowledge of one's own cognition<br><br>**KNOWING HOW TO KNOW** | • strategic knowledge (i.e., knowledge of where to locate required information)<br>• knowledge about cognitive tasks, including appropriate contextual and conditional knowledge (i.e., knowledge of the skills required to complete a task)<br>• Self-knowledge (i.e., awareness of one's own knowledge and ability level) |

## Cognitive Process Dimension

The cognitive process dimension represents a continuum of increasing cognitive complexity, from lower order thinking skills to higher order thinking skills. The verb that begins a specific curriculum outcome represents the cognitive process dimension. The verbs listed under each cognitive process dimension represent the specific verbs used for SCOs or AIs within all six automotive curricula. There is also a subject-specific definition of each cognitive process dimension that relates directly to automotive technology.

| Explanation of Cognitive Process Dimension | |
|---|---|
| Remembering | Retrieve, recall, and/or recognize specific information or knowledge from memory |
| define, identify, locate | Students define terminology and locate equipment, tools, and safety requirements. Students follow protocols and procedures established within the automotive facility. Students locate parts and/or components of an automotive system. |
| Understanding | Construct meaning from different sources and types of information, and explain ideas and concepts |
| choose, describe, explain | Students can describe and/or explain the function and operation of automotive systems by reading, writing, and speaking. Students choose the correct procedure, tool, or resource to support their understanding of the knowledge and skill required to meet the outcome. |
| Applying | Implement or apply information to complete a task, carry out a procedure through executing or implementing knowledge |
| apply, communicate, complete, maintain, practise, read, service, use | Students execute a given task or work order when the repair procedure is provided. Students deepen their understanding of concepts by engaging their hands and practising their skills. Students communicate both orally and in writing, and are able to access information related to the automotive tasks they are engaged in. |
| Analysing | Break information into component parts and determine how the parts relate or interrelate to one another or to an overall structure or purpose |
| analyse, compare, demonstrate, inspect | Students make the connection between the theory and the practice. Students begin to put together their understanding of automotive concepts with their ability to complete tasks. Students will start to make connections between tasks and begin to transfer their knowledge to new situations. For example, when a student is demonstrating a repair or service they should be able to clearly demonstrate an understanding of both the theory and skills required to successfully complete the task. |
| Evaluating | Justify a decision or course of action, problem solve, or select materials and/or methods based on criteria and standards through checking and critiquing |
| enhance, ensure, evaluate, interpret, perform, reflect, select, troubleshoot | Students make decisions and select and adjust the working parameters independently to complete automotive tasks. Students begin to respond to challenges and perform tasks with a combination of both skill and precision. For example, when a student is performing a task will interpret information and troubleshoot problems as they arise. Students will reflect on jobs and critique their own, and others performance. |
| Creating | Form a coherent functional whole by skillfully combining elements together and generating new knowledge to guide the execution of the work |
| create, develop, diagnose and repair | Students develop an approach to diagnosing vehicle problems and perform the repair safely, efficiently, and precisely. Students begin to take responsibility for their own knowledge and skill as a mechanic, approach their work in an independent manner, and with a proficiency of skill. |

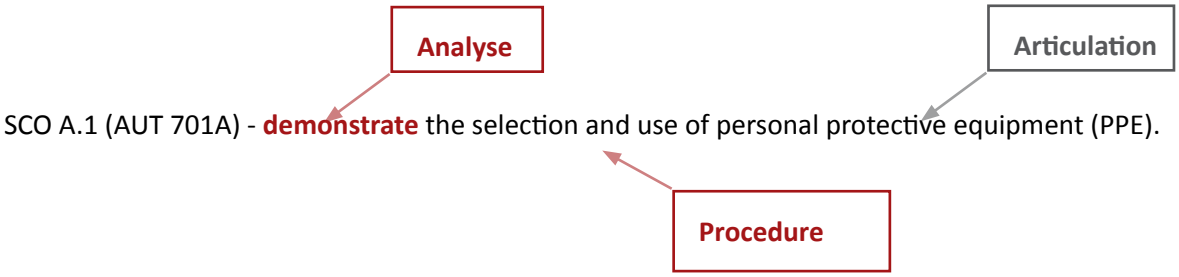
## Technical Skill Dimension

The technical skill dimension, as defined by Dave's psychomotor taxonomy (1975), classifies five types of ways learners may be expected to demonstrate or carry out skilled tasks, procedures, or movements. This ranges from imitation, (where students mimic what they see modelled), through to naturalization, (where students perform tasks automatically and with high level of skill).

| Explanation of Technical Skill Dimension | |
|---|---|
| **Imitation** | ability to copy or replicate the actions of others following observations |
| **Manipulation** | ability to repeat or reproduce actions to prescribed standard from memory or instructions |
| **Precision** | ability to perform actions with expertise and without interventions and the ability to demonstrate and explain actions to others |
| **Articulation** | ability to adapt existing psychomotor skills in a non-standard way, in different contexts, using alternative tools and instruments to satisfy need |
| **Naturalization** | ability to perform actions in an automatic, intuitive, or unconscious way appropriate to the context |

## SCO Structure

Examining the structure of a specific curriculum outcome is necessary to fully understand its intent prior to planning instruction and assessment. The Bloom's verb in the outcome relates to the expected level and type of thinking (cognitive process). A noun or phrase communicates the type of knowledge (i.e., factual, conceptual, procedural, or metacognitive) that is the focus of the outcome. The degree of technical skill is communicated through the remainder of the outcome and indicated on the Taxonomy Table.




## Taxonomy Tables

Combining the three dimensions, (cognitive process dimension, knowledge process dimension, and technical skill dimension), into one taxonomy table helps teachers to visualize the overall expectations of a course. As teachers reflect deeply and collaborate with each other to identify the types of knowledge required by each outcome, they will be better able to plan what student achievement will look, sound, and feel like in the learning environment. This clear visualization of the desired results (i.e., evidence of achievement of outcomes) assists teachers in planning learning experiences that will lead to student achievement of the outcome at the targeted level.

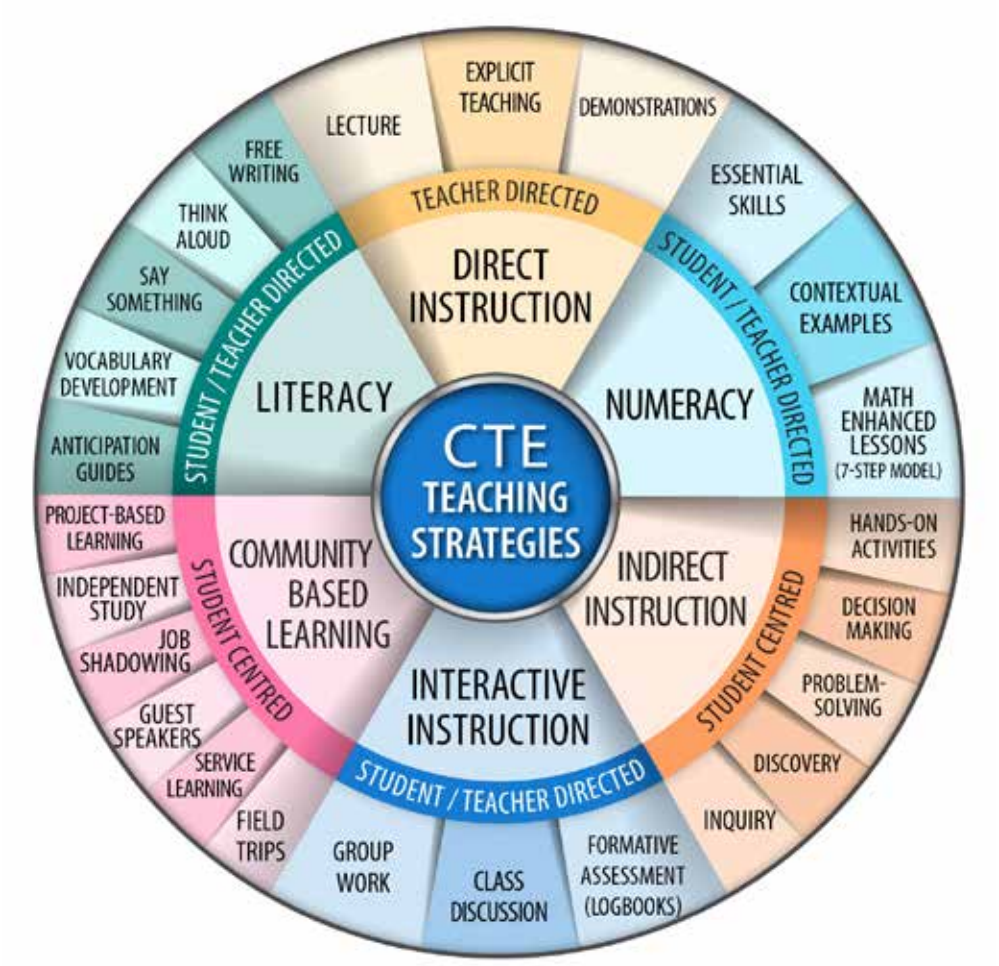
The taxonomy table for AUT 801B appears on page 25. Each outcome also has a taxonomy table that is specific to that outcome and the given achievement indicators. The table is located on the upper right-hand corner.

# Curriculum Delivery

## Instructional Strategies

Teaching is both a science and an art. There is a wealth of instructional strategies and methodologies described in the literature related to career and technical education that teachers have at their disposal when creating a learning environment that best suits the needs of their students.

Below is an instructional strategies wheel that is designed to identify a range of strategies that are effective when preparing lessons, assignments, and experiences for the career and technical education classroom. The list is not intended to be exhaustive, and CTE teachers are encouraged to continually read and engage in current research, pedagogy, and practice related to their field.



## Literacy

Employing cross-curricular reading and writing strategies in the delivery of the curriculum will provide students with tools that will help them build knowledge and develop strategies to become more proficient in both their technical skills and their literacy skills. Integrating literacy into the CTE classroom is essential for students to develop strong connections between the practical skills and technical knowledge required.

### Pre-Reading Strategies

Pre-reading strategies are used prior to assigning a reading and are designed to activate the students' prior knowledge on a subject, promote inquiry and discussion, provide clarity, and give the students reason to engage in the text. Examples include the following:

- FREE WRITING - This strategy provides students with a short amount of time to record what they already know or believe about the topic. Free writes should never be collected or evaluated. The only rule of the free write is that students write for the entire time allotted even if they run out of things to say.
- ANTICIPATION GUIDES - These guides consist of four or five statements about a topic that students are asked to either agree or disagree with prior to reading. The statements should be carefully crafted to raise the students' interest in the subject (so that all students do not respond in the same way), and be supported by the assigned reading. After reading, students should revisit and discuss their responses.

### During-Reading Strategies

During-reading strategies are designed to promote active reading of the material. They provide students with specific tasks to complete or things to discover while reading the document. During-reading strategies can be used in small groups or as individual tasks.

- *THINK ALOUD* - Think Aloud is a very effective strategy to use when reading aloud to students. During the Think Aloud, it is important to model and reflect on how you yourself make meaning when reading challenging trade-related text, and how you relate the topic back to prior topics covered.
- *SAY SOMETHING* - Before assigning the Say Something, take time to model the strategy with a student or colleague and review the rules that will make for a successful Say Something. It is a good idea to post these rules so everyone can see them and be reminded of them during the activity.
    - *With your partner, decide who will say something first.*
    - *When you say something, make a prediction, ask a question, clarify something you had misunderstood, and/or make a connection.*
    - *If you cannot do one or more of the above things, then you need to re-read.*
- *RE-READING* - "Re-reading is probably the number one strategy independent readers use when something stumps them in a text. It's probably the last strategy dependent readers use" (Beers 2003, p.105). Before asking students to re-read a section of text, you must first set the activity up for success.
    - *Prove to students that re-reading is valuable to their learning. You can model this while doing a Think Aloud where you model your thinking as you interpret the text.*
    - *Provide the students with specific tasks to complete while they re-read a section.*
    - *Review the text as a group after everyone has re-read it.*

## Post-Reading Strategies

Post-reading strategies are designed to provide students with opportunities to reflect on what they have read and make links to their learning.

- *LEARNING JOURNALS* - These journals provide a forum through which students can record and document their learning.
- *SUMMARIZING* - Summarizing is an effective strategy to use prior to having students complete an assigned task in the shop. This provides students with an opportunity to describe what they are going to do and how they plan to accomplish it. This may be done in written form or orally, depending on the given task.

## Math in CTE

The National Council of Teachers of Mathematics states that wanting all students to learn math does not mean that all students can or should learn math in the same way.

The National Research Center for Career and Technical Education (NRCCTE) has developed the Math in CTE model that addresses and makes explicit the math concepts as they arise naturally from the CTE curriculum. Math is an essential component of CTE curriculum and is an essential tool required to perform the tasks of given occupations (NRCCTE 2006).

One of the challenges in teaching contextual math in CTE is that students are unable to transfer the math skills and knowledge to a new situation, as it is too embedded in the original context (NRCCTE 2006). The Math in CTE model addresses this challenge by bringing the math skill out of context and into the abstract, so that students may develop the understanding behind what they are learning, and then the model continues to provide opportunities for students to apply the knowledge in context.

By making explicit the math that is incorporated into the CTE context, students are able to make connections to their math classes and develop their transferable math skills.

## Math in CTE 7-Step Model

Below is the 7-step Math in CTE model that will enable CTE teachers to identify the math skills covered in their lessons, develop a math-enhanced lesson, and assess the students' math abilities.

**Introduce technical lesson.**

- Explain the technical lesson.
- Identify the math embedded in the lesson.

**Assess students' math awareness.**

- Use a formative assessment.
- Assess whether students use the correct mathematical terms when discussing the lesson topic.
- Use a variety of questioning/discussion techniques to determine students' math awareness.

**Work through math problems related to the technical lesson.**

- Connect the technical vocabulary to the math vocabulary and gradually integrate the two, being sure to not abandon either set.

**Work through related contextual examples.**

- Use examples with varying levels of difficulty.
- Continue to bridge the gap between the technical concept and the math skills.
- Check for understanding.

**Work through traditional math examples.**

- Provide students with an opportunity to practise using a worksheet of basic math problems as they would appear on a test.
- Move from basic to advanced examples.
- Check for understanding.

**Have students demonstrate understanding.**

- Provide students with the opportunity to relate the math concept back to CTE context.
- Conclude the math lesson back in the context of the technical lesson.

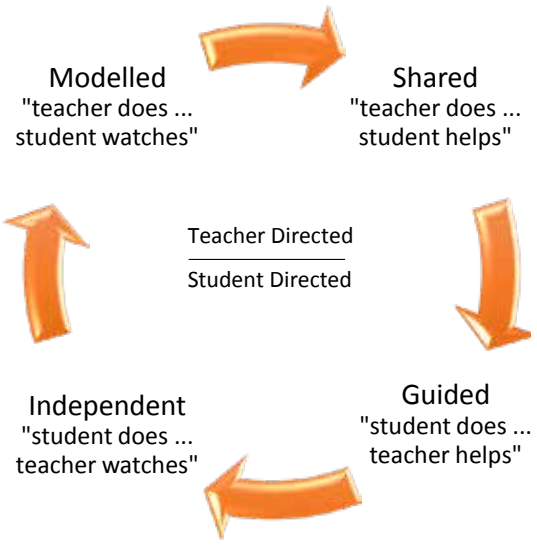
**Assign a formal assessment.**

- Include math problems in formal assessments of the technical lesson.

## Gradual Release of Responsibility

Teachers must determine when students can work independently and when they require assistance. In the *gradual release of responsibility* approach, students move from a high level of teacher support to independent practice. The teacher models a concept or strategy and makes explicit the thinking he/she engages in when choosing and applying the strategy in a specific context. The teacher gradually releases the responsibility through a phase of shared and guided practice that leads the student to independence. If necessary, the teacher increases the level of support when students need further assistance. Gradual release is a useful strategy to employ. The graphic below provides a visual representation of this process.

Teachers may wish to begin the process at any point in the cycle. For example, teachers may provide a diagnostic assessment (independent stage) to establish what students know prior to teaching in order to determine which practices need to be modelled and which ones the students are able to perform independently.



## Curricular Planning Using Understanding by Design

Understanding by Design (UbD) is often referred to as backward design. UbD is a curricular planning model developed by American educators Grant Wiggins and Jay McTighe. The main premise is that learning, and hence understanding, must be demonstrated through *transference*—the ability to apply what has been learned to a new situation or problem. In order to assess the level of learning, it is necessary to plan instruction as a backward experience of three stages beginning with the *end-in-mind* or the desired results, moving to the second stage of *evidence-of-learning* or assessment, and ending with the *learning plan* or the activities that will engage students and scaffold them toward the end result or *performance task*.

### Basics of UbD

- helps transform specific curriculum outcomes (SCOs) into meaningful learning elements and assessments
- encourages teachers to become coaches and facilitators of meaningful learning rather than purveyors of superficial content
- reveals learning when students make sense of, and are able to transfer, learning to new and authentic situations
- requires ongoing review of instructional design to ensure effective practice and continuous improvement for achievement
- promotes a way of thinking about curricular planning in a broader sense, not a rigid program or prescriptive plan
- ensures deeper student understanding by making meaning from big ideas
- overcomes instructional errors associated with simplified textbook coverage and activity-oriented teaching (activity without a clear purpose)

| Stage 1<br>Desired Results | Stage 2<br>Evidence | Stage 3<br>Learning Plan |
|---|---|---|
| The knowledge, skills, and attitudes that are articulated in specific curriculum outcomes (SCOs) are identified. | Performance tasks and criteria are determined. *Performance tasks* should be authentic tasks that are designed to simulate or replicate real-world performances and establish a realistic context with a genuine purpose, audience, and constraints. *Performance criteria* will provide the evidence of learning that is needed to assess the learning. Criteria can be weighted and include the following:<br>• **Content** - aptness, adequacy, or accuracy of knowledge and skills used<br>• **Process** - the means, processes, attitude, or approaches taken in the performance or in the preparation for performance<br>• **Quality** - attention to detail, polish, and craftsmanship<br>• **Impact** - Did the performance work? What was its effect, its result, its outcome - irrespective of effort, attitude, and approach? | In the final stage, the sequence of learning activities that will scaffold students toward the performance task and understanding are planned. |

## The Evaluative Process

Assessment and evaluation are integral components of the teaching and learning processes.

Effectively planned evaluation promotes learning, builds confidence, and develops students' understanding of themselves as learners. Effectively planned assessment and evaluation also improves and guides future instruction and learning.

Through the entire evaluative process, the teacher reflects on the appropriateness of the assessment techniques used to evaluate student achievement of the SCOs. Such reflection assists the teacher in making decisions concerning adjustments to subsequent instruction, assessment, and evaluation.

Effective and authentic assessment involves

- designing performance tasks that align with specific curriculum outcomes;
- including students in determining how their learning will be demonstrated; and
- planning for the three phases of assessment (*for*, *as*, and *of* learning).

Assessments need to be reflective of the cognitive process(es) and level(s) of knowledge and skill indicated by the outcome. An authentic assessment will collect data at the level for which it is designed.

Whether conducting assessment for learning or assessment of learning, a teacher must have sufficient proof of a student's learning. By using a process known as triangulation, teachers can obtain data of student learning from three different sources, (i.e., observations, conversations, and products), thereby ensuring sufficient data is collected in order to evaluate student learning. Observations and conservations are more informal forms of evidence that may be, for example, recorded as anecdotal notes. Products include tests, projects, or other tasks that enable students to demonstrate what they know and can do at the end of the learning process. By collecting data from multiple sources, teachers are able to verify the data they collect against each other, thus allowing them to gain an accurate portrayal of student progress.

Effective evaluation involves considering the totality of the assessment data and interpreting it to make informed judgments about student learning.

## Assessment

**Assessment is the act of gathering information on an ongoing basis in order to understand students' individual learning and needs. It is the journey of their learning.**

Effective assessment improves the quality of learning and teaching. It helps students to become self-reflective and to feel in control of their own learning, and enables teachers to reflect on and adjust their instructional practices. When students are given opportunities to demonstrate what they know and what they can do with that knowledge, optimal performance can be realized.

Assessment has three interrelated purposes:

- assessment *for* learning to guide and inform instruction
- assessment *as* learning to involve students in self-assessment and setting goals for their own learning
- assessment *of* learning to determine student progress relative to curriculum outcomes

Even though each of the three purposes of assessment requires a different role and planning for teachers, the information gathered through any one purpose is beneficial and contributes to an overall picture of an individual student's achievement.

All assessment practices should respect the needs of diverse learners and should respect and appreciate learners' cultural diversity. Teachers should provide students with a variety of ways to demonstrate on an ongoing basis what they know and are able to do with many different types of assessment over time. Valuable information about students can be gained through intentional conversations, observations, processes, performance, and products. A balance among these sources ensures reliable and valid assessment of student learning.

Effective assessment strategies

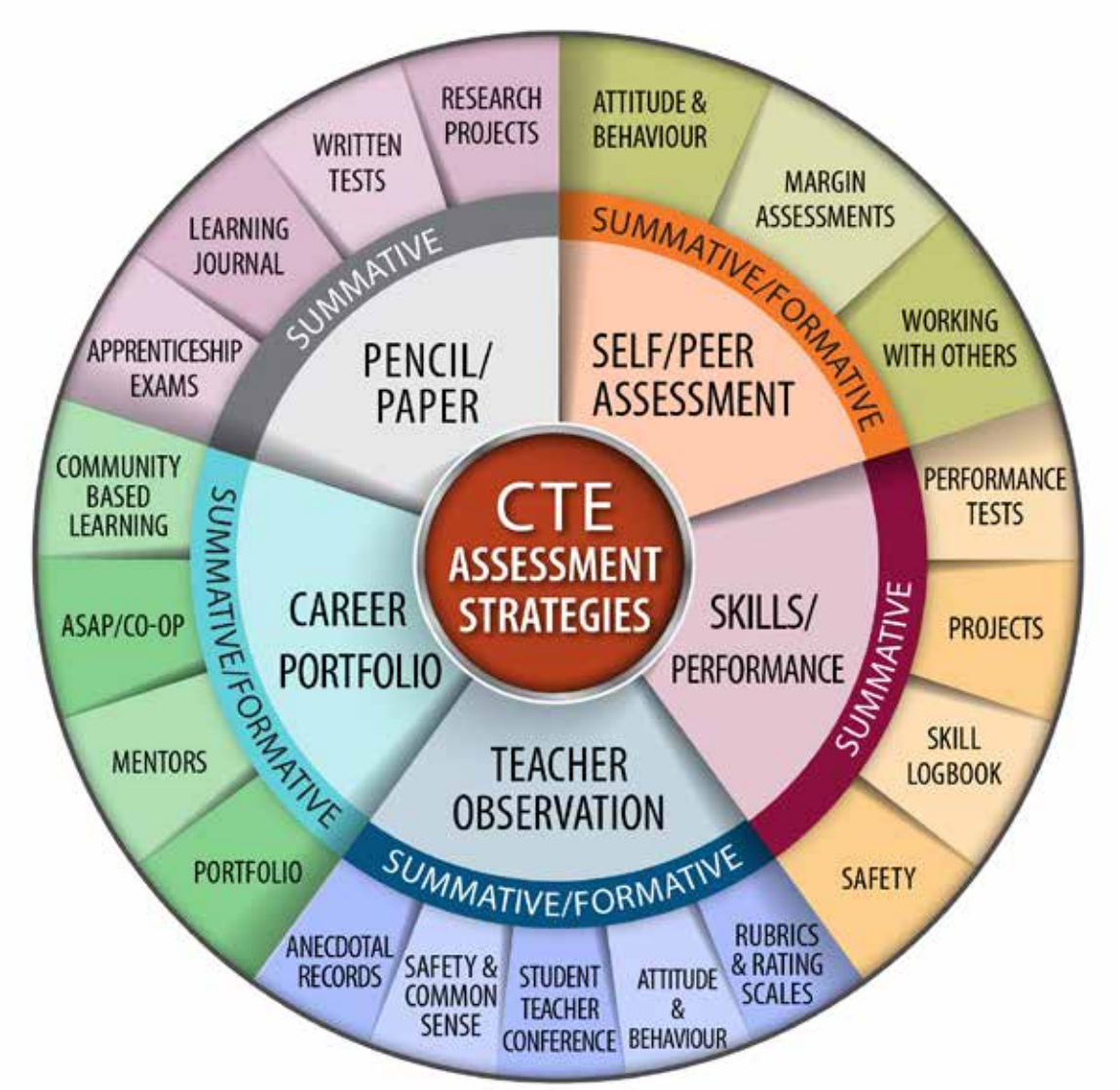
- are appropriate for the purposes of instruction, the needs and experiences of the students, and learning strategies used;
- assist teachers in selecting appropriate instruction and intervention strategies to promote the gradual release of responsibility;
- reflect where the students are in terms of learning and help to determine the levels and types of support or instruction that will follow;
- allow for relevant, descriptive, and supportive feedback that gives students clear directions for improvement, and engages students in metacognitive self-assessment and goal setting that can increase their success as learners;
- are explicit and communicated to students and parents so students know expectations and criteria to be used to determine the level of achievement;
- must be valid in that they measure what they intend to measure and reliable in that they consistently achieve the same results when used again, or similar results with a similar group of students;
- involve students in the co-construction, interpretation, and reporting of assessments by incorporating their interests, multiple intelligences, and learning styles;
- accommodate for the diverse learning needs of students; and
- are comprehensive and enable all students to have diverse and multiple opportunities to demonstrate their learning consistently and independently.

Students should know what they are expected to learn as designated by SCOs and the criteria that will be used to determine the quality of their achievement.

This information allows students to make informed choices about the most effective ways to demonstrate what they know and are able to do. It is important that students participate actively in assessment by co-creating criteria that can be used to make judgments about their own learning. Assessment must provide opportunities for students to reflect on their progress, evaluate their learning, and set goals for future learning. Students may benefit from examining various scoring criteria, rubrics, and student exemplars.

Student involvement in the assessment process can be achieved by

- incorporating students' interests into assessment tasks (e.g., allowing students to select and read texts that relate to their interests);
- providing opportunities for students to self-assess their learning; and
- co-creating assessment criteria with the student, working to describe how a specific skill or product is judged to be successful; and using student exemplars to illustrate a range of skill development (i.e., practise using the assessment criteria to guide their own work).




## Evaluation

Evaluation is the culminating act of interpreting the balanced information gathered through relevant and authentic assessments for the purpose of making judgments.

Inherent in the idea of evaluating is "value." **Evaluation is based on the cumulative assessments of the SCOs. The SCOs should be clearly understood by learners before instruction, assessment, and evaluation takes place.** Evaluation is informed by a quality, authentic formative and summative assessment process.

During evaluation, the teacher:

- interprets all assessment information and makes judgments about student progress;
- reports on student progress; and
- makes informed decisions about student learning programs based on the judgments or evaluations.

## STEAM Pedagogy

The acronym STEAM represents Science, Technology, Engineering, Art, and Math. STEAM education is a pedagogical approach which provides students the opportunity to integrate learning associated with these five disciplines while solving meaningful problems.

The original acronym, STEM was introduced in the 1990s by the National Science Foundation. The 'A' was added to STEM in recognition that creative thinking normally associated with art is as necessary as analytical thinking when solving problems in science, engineering, and technology. The ability to think mathematically is also an integral aspect of these three fields.

Problem-solving is an iterative, multi-layered and multi-stepped process that requires flexible thinking patterns (Figure 12). The analytical thinking component involves selecting, gathering, sorting, comparing, and contrasting information. Analytical thinking is convergent thinking which helps to identify and narrow possible solutions. Creative thinking is required to solve broad, open-ended problems that do not have a readily apparent solution and are not single-outcome specific. Creative processes involves divergent thinking or out-of-the-box thinking. A creative thinker may consider solutions that are based on intuition and emotion rather than logic. Creative solutions can also arise from observation, inspiration, and serendipity. STEAM activities are designed to encourage the flexibility to move back and forth between these two cognitive processes. They also support the development of other habits of mind necessary for STEAM such as persistence and resilience.

Selected Habits of Mind and Skills Encouraged by STEAM

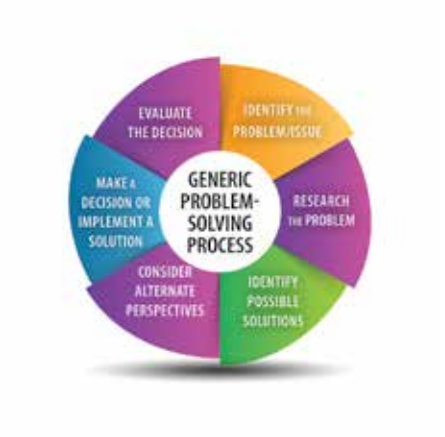
- creativity
- innovation
- persistence
- resilience
- flexibility
- collaboration
- communication
- critical thinking
- analytical thinking
- manipulative skills
- digital fluency

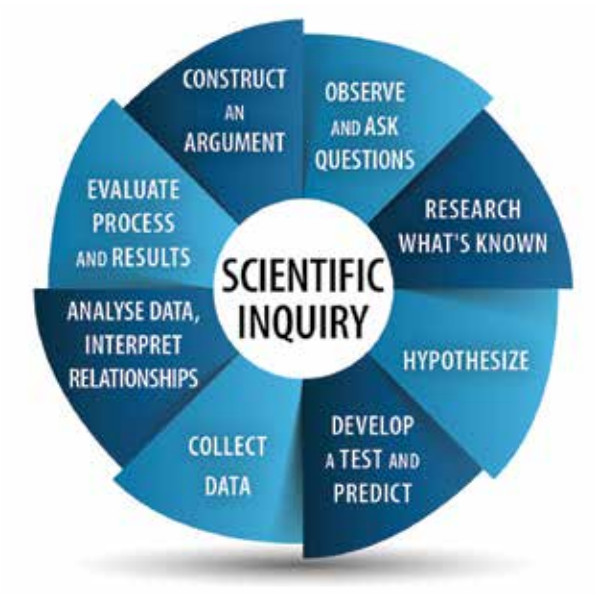
All five disciplines do not have to be targeted at the same time during a STEAM activity. To obtain the benefit of STEAM-based instruction, the problem presented should not have a readily apparent solution or be single outcome specific. The problem should be open-ended and designed in a way that the learner has more than one possible path to the solution. Productive struggle and reflection should be encouraged.

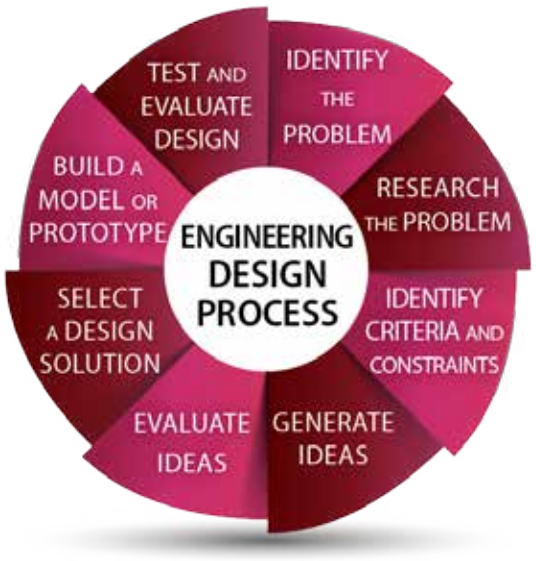
| Problem-Solving Component | S | T | E | A | M |
|---|---|---|---|---|---|
| | Science | Technology | Engineering | Art | Mathematics |
| **Nature of Problem** | Extending our understanding of the natural world | Developing ways to extend human capacity | Addressing a human need or concern | Expressing and interpreting human perception | Discovering mathematical relationships |
| **Name of Process** | Scientific Inquiry | Technology Design | Engineering Design | Creative Process | Mathematical Analysis |
| **Initial Question** | What causes...? | How can I...? | How can I make...? | Imagine if... | What is the relationship...? |
| **Solutions and Products** | Communications of new knowledge | Digital products, digital processes | Structures, equipment, machines, processes | Aesthetic expression, products, processes | Numerical solutions, equations |

## Steam Processes

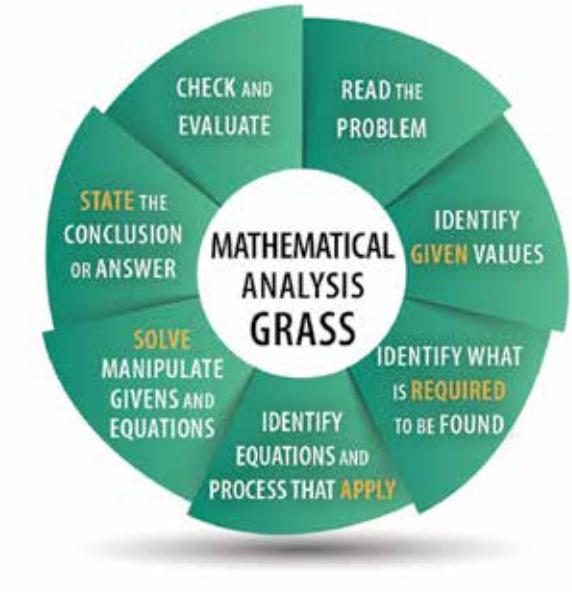
STEAM problem-solving processes (i.e., scientific inquiry, technology and engineering design, the creative process, and mathematical analysis) differ in the nature of the question and the solution or product. However, all are based on the generic problem-solving process. All are iterative processes that involve reflection, evaluation, and feedback throughout. All require analytical thinking and creative thinking. The figures below compare the problem-solving processes for science, engineering, art, and math.







# Career & Technical Education

## Automotive Technology

## Brake Systems

### Course Description

Brakes are one of the most fundamental safety systems on a vehicle. This course focuses on the components, types, service, and diagnosis of brake systems. Students will develop a clear knowledge of the fundamentals of friction and hydraulics related to brake component function. They will learn to service, repair, and diagnose drum brake systems, disc brake systems, and power brakes, and will be introduced to anti-lock brake systems.

### Taxonomy Table

| Technical Skill Dimension | | | | | AUT 801B | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization | Articulation | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | | | |
| B.2, B.3 | | C.2, C.3, D.1, D.5 | | | Procedural | Applying | | D.1 | D.3, D.5 | |
| | | | | | | Analysing | | B.2 | B.3, C.2 | |
| A.1, D.6 | | B.1, B.4, C.1, D.2, D.3, D.4 | | | Critical Thinking | Evaluating | | | A.1, C.1 | B.1 |
| | | | | | | Creating | | | D.2, D.3, D.4, D.6 | B.4 |

| Technical Skill Dimension | | | | | Worksite Safety | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization / Articulation | | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | | | |
| | | | | | Procedural | Applying | | | | |
| | | | | | | Analysing | | 1.3 | 1.1 | |
| A.1 | | | | | Critical Thinking | Evaluating | | | 1.2, 1.4, 1.5 | |
| | | | | | | Creating | | | | |

## Unit A: Safety
***Worksite Safety***

| | |
|---|---|
| **A.1** | Students are expected to…<br>**ensure work practices are followed to provide for personal safety, the safety of others, and to prevent accidents.** |

### Achievement Indicators

Students who have achieved this outcome should be able to…

A.1.1 demonstrate the selection and use of personal protective equipment (PPE);

A.1.2 evaluate workplace safety at all times;

A.1.3 demonstrate the ability to prevent fires and to prevent accidents;

A.1.4 perform the correct procedures when working with exhaust gases; and

A.1.5 perform the correct procedures when hoisting and jacking vehicles.

## Elaboration

The safety outcome is considered as an integrated outcome and therefore cannot be taught or learned in isolation from the ongoing work within the automotive facility. Students should be assessed on an ongoing basis and should be given timely formative feedback to enable them to deepen their knowledge and develop their skills related to working safely in the CTE-Automotive classroom.

Assessment of safety should focus on the following key areas.

- student's use of personal protective equipment
- student's active participation in the evaluation of their own, and others' safe work practices
- student's critical thinking in regards to their personal safety skills, others' safety skills, and the emergency action plans within the facility
- student's ability to hoist and lift vehicles in a safe and appropriate manner consistent with the safety procedures in the automotive facility

While the factual knowledge required for these outcomes will be directly instructed at the beginning of the course, the assessment of these outcomes is ongoing throughout the course.

Students who are expressing an interest in continuing their learning in CTE should begin to consider purchasing their own PPE (safety glasses, hearing protection); however, the CTE facility must have a set of PPE equipment available for students.

Health and safety laws can be broken down into three categories:

- Acts - Establish legal authority (general principles, responsibilities, rights)
- Regulations - Outlines the legal rules (safety requirements, exposure limits, WHMIS)
- Guidelines and Codes - Outlines details (testing procedures, record keeping)

Student should be familiar with the responsibilities of government, employers, and employees as it relates to OH&S and be accountable for their rights as workers/students (the Right to Know, the Right to Participate, and the Right to Refuse).

Developing a safe attitude contributes significantly to an accident-free environment. Safe working procedures and conditions will support accident prevention and promote a healthy work environment. Safety in CTE is of primary importance at all times.

It is critical that students are aware of the application and capacity of the hoisting and lifting equipment in the automotive shop and that each piece of lifting equipment is only used for the purpose, and within the limits, for which it is designed. Some of the many different types of hoisting and lifting equipment within an automotive shop include floor jacks, jack stands, engine hoists, and vehicle hoists. Each piece of equipment is designed for a particular purpose within the trade and engineered to particular standards and specifications. Students need to be aware of the procedures and inspection schedule as required by the CTE facility.

## Performance Indicators

- Describing the PPE required for particular applications within the trade.
- Explaining the proper use of PPE required for particular tasks and/or applications.
- Demonstrating the proper use and selection of PPE at all times when working in the CTE facility.
- Identifing defects in PPE and report accordingly.
- Explaining key areas of responsibility a student has in regards to safety.
- Explaining the roles and responsibilities of Occupational Health and Safety within a workplace.
- Applying the rights of employees within the CTE worksite (the Right to Know, the Right to Participate, and the Right to Refuse).
- Explaining the three components of the Workplace Hazardous Materials Information System (WHMIS).
- Interpreting WHMIS labels to understand the procedure to follow to avoid associated hazards.
- Evaluating an emergency action plan in the event of an emergency within the CTE facility.
- Explaining the basic composition and dangers of exhaust gases.
- Demonstrating the proper procedures for ventilating the work area.
- Demonstrating the proper installation and operation of exhaust ventilation equipment required to remove exhaust gases from the work area.
- Locating fire exits.
- Explaining the classes of fires and the appropriate fire extinguishers to fight each class of fire.
- Identifying procedures and fire-safety equipment related to the prevention, detection, and warning of fires.
- Locating electrical shut-off switches.
- Locating eyewash station.
- Locating first aid stations.
- Defining terminology associated with hoisting and lifting.
- Identifying types of hoisting and lifting equipment and accessories.
- Identifying hazards and describing safe work practices pertaining to hoisting and lifting.
- Explaining information pertaining to hoisting and lifting found on drawings and specifications.
- Locating the lift points on vehicles.
- Practising operating the vehicle hoist safely and efficiently.
- Practising the correct procedures required for the safe and efficient operation of a range of hoisting and lifting equipment.
- Practising procedures used to visually inspect and properly store hoisting and lifting equipment.

## Red Seal Occupational Standard 2016 Reference

| **Task A-1 - Performs safety-related functions** | |
|---|---|
| A-1.01 - Maintains safe work environment | |
| Code | Performance Criteria |
| A-1.01.01P | recognize potential worksite hazards and hazardous materials |
| A-1.01.02P | apply jurisdictional safety regulations |
| A-1.01.03P | handle, remove, and dispose of hazardous materials |
| A-1.01.04P | perform sensory inspection of vehicles |
| A-1.01.05P | maintain clean and clutter-free work area |
| A-1.01.06P | adhere to manufacturers' safety guidelines |
| A-1.01.07P | remove, repair, or replace defective equipment |
| A-1.01.08P | report hazards and safety concerns to supervisor |
| A-1.02 - Uses personal protective equipment (PPE) and safety equipment | |
| A-1.02.01P | select PPE and safety equipment required for specific tasks |
| A-1.02.02P | recognize workplace hazards that require the use of PPE and safety equipment |
| A-1.02.03P | inspect and maintain PPE and safety equipment |
| A-1.02.04P | operate safety equipment |
| A-1.02.05P | recognize, remove, and replace defective PPE |
| A-1.02.06P | recognize, remove, service, or replace defective safety equipment |
| A-1.02.07P | report defective PPE and safety equipment to supervisor |
| **Task A-2 - Uses tools, equipment, and documentation** | |
| A-2.03 - Uses hoisting and lifting equipment | |
| A-2.03.01P | determine vehicle or item lifting points and required adapters and extensions |
| A-2.03.02P | determine type and capacity of hoisting and lifting equipment required for vehicle or item to be lifted |
| A-2.03.03P | operate vehicle hoists and lifting equipment |
| A-2.03.04P | operate shop lifting equipment |

## Internet Search

For more details on information related to these outcomes, use the following key word searches for current sites.

- Canadian Centre for Occupational Health and Safety-Young Workers
- WHMIS (webpage and/or image search)
- Young Workers Canada (webpage, image, and/or video search)
- Classes of fires (webpage and/or image search)
- Fire Equipment Manufacturers Association (search site for portable fire extinguishers)

| Technical Skill Dimension | | | | | Employability Skills | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization | Articulation | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | | | |
| | | | | | Procedural | Applying | | | | |
| | | | | | | Analysing | | | 1.4 | |
| | | B.1 | | | Critical Thinking | Evaluating | | | 1.3 | 1.1, 1.2 |
| | | | | | | Creating | | | | |

## Unit B: Career Development
***Employability Skills***

**B.1**

Students are expected to…
**exhibit personal and essential workplace employability skills.**

### Achievement Indicators
Students who have achieved this outcome should be able to…

B.1.1 exhibit a positive attitude towards themselves, their work, instructors, and classmates;

B.1.2 reflect on their personal work ethic skills taking necessary steps to grow and improve;

B.1.3 perform tasks using effective time management skills; and

B.1.4 demonstrate project management skills to allow for projects to progress on schedule.

| Technical Skill Dimension | | | | | Numeracy | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization | Articulation | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | | | |
| B.2 | | | | | Procedural | Applying | | | | |
| | | | | | | Analysing | | 2.1, 2.2, 2.3, 2.4, 2.5 | | |
| | | | | | Critical Thinking | Evaluating | | | | |
| | | | | | | Creating | | | | |

## Unit B: Career Development
***Numeracy***

**B.2**

Students are expected to…
**demonstrate essential numeracy skills to solve automotive service problems.**

### Achievement Indicators

Students who have achieved this outcome should be able to…

B.2.1 demonstrate mathematical skills involving fractions to trade related problems;

B.2.2 demonstrate mathematical skills involving decimals to trade related problems;

B.2.3 demonstrate mathematical skills involving percent to trade related problems;

B.2.4 demonstrate mathematical skills involving rate and ratio to trade related problems; and

B.2.5 demonstrate mathematical skills involving geometry to trade related problems.

| Technical Skill Dimension | | | | | Literacy | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization / Articulation | | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | 3.8, 3.9 | | |
| B.3 | | | | | Procedural | Applying | | 3.1, 3.2, 3.7 | | |
| | | | | | | Analysing | | | 3.5, 3.6 | |
| | | | | | Critical Thinking | Evaluating | | 3.4 | 3.3 | |
| | | | | | | Creating | | | | |

## Unit B: Career Development
***Literacy***

**B.3**

Students are expected to…
**perform essential literacy skills to work effectively within the trade.**

### Achievement Indicators

Students who have achieved this outcome should be able to…

B.3.1 use standard terms and units of measure for components and operations within a given course;

B.3.2 communicate trade-related information with customers and other tradespeople effectively;

B.3.3 interpret electronic service information to diagnose, service, or repair vehicles;

B.3.4 interpret vehicle repair forums for diagnostic purposes;

B.3.5 reference work orders and other trade-related documents accurately and effectively;

B.3.6 reference equipment and safety manuals describing safe operating procedures;

B.3.7 maintain a logbook or portfolio of technical work;

B.3.8 discuss class assignments with peers and teachers to understand expectations; and

B.3.9 discuss ideas about tasks and safety issues within the CTE facility.

| Technical Skill Dimension | | | | | Career Portfolio | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization | Articulation | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | | | |
| | | | | | Procedural | Applying | | | | |
| | | | | | | Analysing | | 4.2, 4.3, 4.4 | | |
| | | B.4 | | | Critical Thinking | Evaluating | | | | 4.1 |
| | | | | | | Creating | | | | 4.5 |

## Unit B: Career Development
***Career Portfolio***

| | |
|---|---|
| **B.4** | Students are expected to…<br>**create a personal CTE Portfolio to document and record employability and technical skills.** |

### Achievement Indicators

Students who have achieved this outcome should be able to…

B.4.1 reflect on individual progress related to specific technical skills and knowledge as well as transferable skills acquired within the CTE-Automotive course;

B.4.2 research opportunities available and related careers connected to the automotive service technician trade using relevant trade documents (NOA, NOC, Red Seal website, IPG);

B.4.3 research secondary and post-secondary opportunities to further engage in trade-related occupations;

B.4.4 research the components of the apprenticeship training model; and

B.4.5 create a portfolio to document specific technical skills, knowledge, and transferable skills and support their career development and personal goals.

## Elaboration

The outcomes in Unit B - Career Development are integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the career and technical education facility. These outcomes require the students to actively participate in all projects, tasks, and learning opportunities related to the course.

Students should be assessed on these outcomes on an ongoing basis and should be given timely formative feedback to enable them to deepen their knowledge and develop their skills related to employability skills, numeracy skills, literacy skills, and career development.

The factual knowledge required in Unit B should be presented to the students using relevant, trade related examples and supported by the Employability Skills 2000+ (Conference Board of Canada), the Essential Skills (HRSDC), and the Red Seal Occupational Standard for Automotive Service Technician.

**Essential Skills in CTE**
Personal Management and Teamwork Skills as defined by the Conference Board of Canada 2000+ Employability Skills.

### Demonstrate Positive Attitudes and Behaviours

- feel good about yourself and be confident
- deal with people, problems, and situations with honesty, integrity, and personal ethics
- recognize your own and other people's good efforts
- take care of your personal health
- show interest, initiative, and effort

### Be Responsible

- set goals and priorities, balancing work and personal life
- plan and manage time, money, and other resources to achieve goals
- assess, weigh, and manage risk
- be accountable for your actions and the actions of your group
- be socially responsible and contribute to your community

### Be Adaptable

- work independently or as part of a team
- carry out multiple tasks or projects
- be innovative and resourceful; identify and suggest alternative ways to achieve goals and get the job done
- be open and respond constructively to change
- learn from your mistakes and accept feedback
- cope with uncertainty

### Learn Continuously

- be willing to continuously learn and grow
- assess personal strengths and areas for development
- set your own learning goals
- identify and access learning sources and opportunities
- plan for and achieve your learning goals

### Work with Others

- understand and work within the dynamics of a group
- ensure that a team's purpose and objectives are clear
- be flexible; respect, and be open to and supportive of the thoughts, opinions, and contributions of others in a group
- recognize and respect people's diversity, individual differences, and perspectives
- accept and provide feedback in a constructive and considerate manner
- contribute to a team by sharing information and expertise
- lead or support when appropriate, motivating a group for high performance
- understand the role of conflict in a group to reach solutions
- manage and resolve conflict when appropriate

### Participate in Projects and Tasks

- plan, design, or carry out a project or task from start to finish with well-defined objectives and outcomes
- develop a plan, seek feedback, test, revise, and implement
- work to agreed-upon quality standards and specifications
- select and use appropriate tools and technology for a task or project
- adapt to changing requirements and information continuously to monitor the success of a project or task and identify ways to improve

### Numeracy in CTE

Success in any trade or technology requires that students develop strong number sense and proficiency when performing automotive tasks requiring mathematical skills. Number sense develops when students connect numbers to real-life experiences, thereby allowing them to apply mathematical operations in a concrete manner to solve real contextual problems.

The intention of Numeracy in CTE is not to directly teach the math skills defined by the achievement indicators; rather it is to intentionally challenge the students with real-world technical problems that will require them to use/develop their math skills.

To support teachers in the instruction and assessment of contextual mathematics, there is a 7-step lesson planning progress call Math-in-CTE that was developed by the National Research Centre for Career and Technical Education.

## Literacy in CTE

Success in any trade or technical field requires that students develop strong literacy and communication skills. Students need to be able to communicate effectively and appropriately within all aspects of the automotive service technician trade in verbal, non-verbal, electronic, and written forms.

Literacy skills as defined by the Conference Board of Canada 2000+ Employability Skills.

### Communicate

- read and understand information presented in a variety of forms (e.g., words, graphs, charts, diagrams)
- write and speak so others pay attention and understand
- listen and ask questions to understand and appreciate the points of view of others
- share information using a range of information and communication technologies (e.g., voice mail, e-mail, computers)
- use relevant scientific, technological, and mathematical knowledge and skills to explain or clarify ideas

### Manage Information

- locate, gather, and organize information using appropriate technology and information systems
- access, analyse, and apply knowledge and skills from various disciplines (e.g., the arts, languages, science, technology, mathematics, social sciences, and the humanities)

### CTE Career Portfolio

The purpose of the CTE Career Portfolio is for students to begin to discover the purpose and relevance of their learning in the CTE environment and how it connects to their current and future goals. CTE programs offer students the opportunity to gain valuable experience working on real and relevant projects all the while building technical skills within the discipline. These experience and technical skills can open a wide range of doors for students as they progress through high school, enter the labour market, and consider their post-secondary options. It is critical that CTE teachers engage students in meaningful conversations related to the CTE-Portfolio so students are able to articulate their experience and value their learning with the CTE program.

## Formative Assessment Guide

| Naturalization/Articulation | Precision | Manipulation | Imitation | |
|---|---|---|---|---|
| **Innovative (end of 6th course)** | **Complex (end of 3rd course)** | | **Simple (end of 1st course)** | |
| Students communicate and discuss solutions to automotive problems using both existing and emerging terminology within trade; strategically apply mathematical reasoning and number sense to solve technical problems. | Students use automotive terminology to help solve problems; use common automotive tools to solve basic complete basic tasks. | | Students can communicate with others using common trade language and perform basic mathematical calculations. | **Recall** |
| Students demonstrate a work ethic that is expected of an entry level Auto Service Technician Apprentice; adjust work schedules to ensure work is completed. | Students demonstrate a work ethic that shows a commitment to both the task and the others within the group; determine work schedules and timelines to ensure work is completed. | | Students can follow workplace protocols such as arriving on time, remaining on-task to complete assigned work, and working effectively as member of a group. | **Procedural** |
| Students have a clear understanding of their next steps and leverage the CTE-Portfolio to help them activate their plan for either a transition to the labour market or to post-secondary training (Apprenticeship, College, University). | Students use the evidence in their CTE Portfolio to determine their next steps; they continue to collect evidence and deepen their understanding of career and post-secondary options available through the automotive program. | | Students can collect and record relevant information to begin to build their CTE Portfolio. | **Critical Thinking** |

## Essential Skills for Automotive Service Technicians

| | |
|---|---|
| **Reading**<br>Automotive service technicians must read and comprehend a variety of materials including repair manuals, manufacturers' bulletins, and safety documents. They refer to government regulations,vehicle inspection procedures, hazardous material handling and disposal, and safety requirements of vehicles. | **Numeracy**<br>Automotive service technicians take a variety of measurements using digital and analog equipment. They estimate the amount of time required to complete repairs. Automotive service technicians compare measurements of energy, dimension, speed, horsepower, temperature, and torque to specifications. They analyse pressure, power, torque, compression, and electrical readings to assess vehicle performance and troubleshoot faults. |
| **Document Use**<br>Automotive service technicians interpret technical drawings and flowcharts. They locate data such as classifications, product and material specifications, identification numbers, quantities, and costs. Automotive service technicians often use specification tables. They scan a variety of manufacturers' labels for part numbers, serial numbers, sizes, colours, and other information and adhere to hazard and safety icons. | **Writing**<br>Automotive service technicians complete workplace documents such as written explanations to the client, work orders, inspection reports, and incident reports. |
| **Working with Others**<br>Most automotive service technicians work independently on jobs outlined in work orders. They may assist others with jobs that require two people or are within their specific area of expertise. They collaborate effectively with colleagues including salespersons, parts persons, and management to resolve concerns, situations, and problems. | **Digital Technology**<br>Automotive service technicians use computerized scanning equipment, onboard vehicle diagnostics, and hand-held diagnostic tools to gain operational information about vehicles. They access the Internet and databases to retrieve repair information. Automotive service technicians use digital technology to exchange information with other technicians, service managers, colleagues in other locations, and manufacturer support specialists. Keyboarding and basic computer skills are an asset. |
| **Thinking**<br>Automotive service technicians use thinking skills and visual analysis to diagnose and repair problems. They evaluate the severity of vehicle defects and deficiencies and the quality of repairs. Automotive service technicians decide the most efficient course of action to complete a job. | **Oral Communication**<br>Automotive service technicians gather information from different sources about vehicle faults and needed repairs, explain the results of inspections and repairs, and discuss maintenance procedures. They exchange technical repair and troubleshooting information with others such as service managers, apprentices, co-workers, colleagues, and suppliers. |
| **Continuous Learning**<br>Constant change in the industry makes it vital for automotive service technicians to stay current with the latest technology. They learn on the job, in organized information activities, and in work discussion groups. Their training is provided by vehicle manufacturers, parts suppliers, employers, and associations. They also advance skills by reading work-related magazines, periodicals, and automotive websites. | |

## Red Seal Occupational Standard 2016 Reference

| | |
|---|---|
| **Task A-2 - Uses tools, equipment, and documentation** | |
| A-2.04 - Uses technical information | |
| A-2.04.01P | access technical diagnostic and repair information |
| A-2.04.02P | interpret and apply technical information |
| A-2.04.03P | create parts and labour lists and work orders |
| **Task A-3 - Uses communication and mentoring techniques** | |
| A-3.01 - Uses communication techniques | |
| A.3.01.01P | demonstrates two-way communication practices one-on-one and in a group |
| A.3.01.02P | listens using active listening practices |
| A.3.01.03P | receives and responds to feedback on work |
| A.3.01.04P | explains and provides feedback |
| A.3.01.05P | uses questioning to improve communication |
| A.3.01.06P | participates in discussions |
| A-3.02 - Uses mentoring techniques | |
| A.3.02.01P | identify and communicate learning objective and point of lesson |
| A.3.02.02P | link lesson to other lessons and the job |
| A.3.02.03P | demonstrates performance of a skill to learner |
| A.3.02.04P | set up conditions required for learner to practice a skill |
| A.3.02.05P | assess ability to perform tasks with increasing independence |
| A.3.02.06P | give supportive and corrective feedback |
| A.3.02.07P | support learner in pursuing technical training opportunities |
| A.3.02.08P | support equity groups; workplace is harassment and discrimination-free |

| Technical Skill Dimension | | | | | Tool Use | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization | Articulation | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | | | |
| | | | | | Procedural | Applying | | | 1.4 | |
| | | | | | | Analysing | | | 1.2, 1.3 | |
| | | C.1 | | | Critical Thinking | Evaluating | | 1.5 | 1.1, 1.7 | 1.6 |
| | | | | | | Creating | | | | |

## Unit C: Tools and Equipment
***Tool Use***

| | |
|---|---|
| **C.1** | Students are expected to…<br>**enhance their tactile skills involving the use and selection of tools and equipment to solve technical problems related to automotive technology.** |

### Achievement Indicators
Students who have achieved this outcome should be able to…

C.1.1 perform automotive tasks safely and effectively using hand tools;

C.1.2 demonstrate standard operations using portable power tools safely and effectively;

C.1.3 demonstrate standard operations using stationary power tools safely and effectively;

C.1.4 complete assembly tasks using component fasteners, adhesives, and sealers safety and effectively;

C.1.5 select the correct tool to perform a given task;

C.1.6 reflect on their use of tools and equipment; and

C.1.7 enhance their tactile skills in the proficient use of tools and equipment.

| Technical Skill Dimension | | | | | Measurement | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization | Articulation | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | | | |
| | | C.2 | | | Procedural | Applying | | | | |
| | | | | | | Analysing | | 2.1, 2.2 | 2.3, 2.4 | |
| | | | | | Critical Thinking | Evaluating | | | | |
| | | | | | | Creating | | | | |

## Unit C: Tools and Equipment
***Measurement***

| | |
|---|---|
| **C.2** | Students are expected to…<br>**demonstrate accurate measurements of automotive components using measuring tools that are common to the trade.** |

### Achievement Indicators

Students who have achieved this outcome should be able to…

C.2.1 demonstrate the ability to convert numbers from decimals to fractions;

C.2.2 demonstrate linear measurements in imperial and SI units;

C.2.3 demonstrate the correct care and use of measuring tools; and

C.2.4 demonstrate proper torque measurements and procedures using imperial and SI units.

## Elaboration

The outcomes in Unit C - Tools and Equipment are integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the career and technical education facility. These outcomes require the students to actively participate in all projects, tasks, and learning opportunities related to the course.

Developing students' skill and proficiency in working with their hands is critical to the success of anyone interested in pursuing a career in the skilled trades. Students need to be provided time to practise their skills using hand tools, power tools, and stationary power equipment on a variety of projects and applications.

The outcomes is this unit are integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the automotive facility. This outcome requires the students to use hand tools, portable tools, and stationary power tools in a safe and appropriate manner consistent with the safety procedures in the CTE facility.

While the factual knowledge and use of hand tools, power tools, and stationary equipment required in these outcomes will be directly instructed and demonstrated, these outcomes should be assessed on an ongoing basis and students should be given timely, formative feedback to enable them to deepen their knowledge and develop their skills related to the use of these tools.

Teachers should consider developing an instructional plan that provides students with a broad overview of all the hand tools, power tools, and stationary equipment they will need during the course. This should be followed up with specific instruction, direction, and demonstration of the skill when the task is required.

Vehicles are assembled with a great variety of fasteners, adhesives, and sealants. The student should be able to correctly identify, select, remove, and replace fasteners common to the automotive trade. Proper knowledge and use of fasteners is required to maintain vehicle integrity, operation, and safety.

## Performance Indicators

- Demonstrating converting fractions to decimals, rounding off to three decimal places.
- Converting decimals to fractions, rounding off to the nearest 1/64, and expressing them in the simplest form.
- Demonstrating reading a ruler and measuring tape to the smallest graduation on the scale, (normally to 1/64" or 0.5 mm), developing proficiency in both imperial and SI measuring.
- Demonstrating using feeler gauges to measure clearances between components.
- Demonstrating using vernier calipers to measure inside, outside, and depth dimensions.
- Demonstrating obtaining precise measurements, and demonstrating the proper use and care of micrometers.
- Demonstrating the setup, use, and reading of dial indicators.
- Interpreting the results of their measurements with tolerances obtained from industry charts and tables.
- Demonstrating the use and limitations of the common transfer-type measuring tools.
- Demonstrating the use of inside and outside calipers.
- Demonstrating the use of small hole gauges and telescoping gauges.
- Demonstrating how a bearing clearance measurement can be obtained using a Plastigage.
- Explaining the most common cause of damage to precision measuring tools.
- Demonstrating basic care of precision measuring tools.

- Inspecting precision tools for damage and basic calibration.
- Defining torque and explaining why it is important for automotive components.
- Explaining the common units of torque in imperial and SI units.
- Determining the value of torque using the formula torque = lever length x force.
- Identifying various types of torque wrenches.
- Explaining how to check a torque wrench for calibration.
- Demonstrating using and caring for torque wrenches.

## Red Seal Occupational Standard 2016 Reference

| **Task A-2 - Uses tools, equipment, and documentation** | |
|---|---|
| A-2.01 - Uses tools and equipment | |
| A-2.01.01P | organize and store personal tools and equipment |
| A-2.01.02P | organize and store shop tools and equipment |
| A-2.01.03P | inspect tools and equipment regularly to recognize wear, damage, defects, or expiry |
| A-2.01.04P | clean, lubricate, and maintain tools and equipment |
| A-2.01.05P | identify, remove, repair, or replace defective equipment |
| A-2.01.06P | calibrate measuring tools |
| A-2.01.07P | operate shop tools and equipment |
| A-2.01.01L | demonstrate knowledge of hand and power tools, their applications, maintenance, and procedures for use |
| A-2.01.02L | demonstrate knowledge of measuring and testing devices, their applications, maintenance, and procedures for use |
| A-2.01.03L | demonstrate knowledge of shop tools and equipment, their applications, maintenance, and procedures for use |
| A-2.01.04L | demonstrate knowledge of welding, cutting, and heating equipment and their applications |

| Technical Skill Dimension | | | | | Brake System Operation | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization / Articulation | | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | 1.2 | | |
| | | | | | | Understanding | | 1.1 | | |
| | | D.1 | | | Procedural | Applying | | 1.3 | | |
| | | | | | | Analysing | | | | |
| | | | | | Critical Thinking | Evaluating | | | | |
| | | | | | | Creating | | | | |

## Unit D: Automotive Service
***Brake System Operation***

**D.1**

Students are expected to…
**apply scientific principles to explain brake system operations.**

### Achievement Indicators

Students who have achieved this outcome should be able to…

D.1.1 explain the principles of operation of brake systems;

D.1.2 define Pascal's law and its implications for brake systems; and

D.1.3 use the correct brake fluid for a given application, based on purpose, function, and characteristics of brake fluids.

## Performance Indicators

An apprentice must develop a thorough knowledge of the scientific fundamentals of friction and hydraulics, and how they apply to brake system operation. A clear understanding of brake components and their function is essential for the safe diagnosis and service of the automotive brake system.

- Explaining the Canadian government brake system requirements for new vehicles and the responsibilities of the automotive service technician.
- Explaining the purpose of a brake system.
- Describing the forms of energy conversion involved in stopping a vehicle.
- Defining the terms work, energy, torque, and power as they apply to the braking system.
- Calculating work, torque, and power using the appropriate units.
- Explaining the law of conservation of energy.
- Defining and calculating kinetic energy.
- Explaining thermal energy and the three methods of heat transfer as they relate to braking systems.
- Describing friction and how it is used in the brake system.
- Explaining coefficient of friction, static friction, and kinetic friction as they relate to braking systems.
- Stating the two basic principles of liquids in a system: liquids are non-compressible, pressure is equal everywhere in the system.
- Explaining Pascal's law and the relationship between pressure, force, and area.
- Describing two methods for increasing force output in a hydraulic system.
- Demonstrating the difference between hydrostatic and hydrodynamic systems.
- Explaining common terms related to brake fluids.
- Identifying the three ratings used to classify the composition and properties of brake fluids (DOT).
- Describing the compatibility of the various classifications of brake fluids.
- Identifying DOT 5 brake fluid by colour recognition.
- Describing the effects of water contamination in brake systems.
- Demonstrating proper handling and disposal practices when working with brake fluids.

| Technical Skill Dimension | | | | | Hydraulic Systems | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization | Articulation | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | 2.1, 2.2, 2.3, 2.4 | 2.5 | |
| | | | | | Procedural | Applying | | | | |
| | | | | | | Analysing | | | | |
| | | D.2 | | | Critical Thinking | Evaluating | | | | |
| | | | | | | Creating | | | 2.6 | |

## Unit D: Automotive Service
***Hydraulic Systems***

**D.2**

Students are expected to…
**diagnose and repair brake system hydraulic components.**

### Achievement Indicators

Students who have achieved this outcome should be able to…

D.2.1 explain the operation, construction, and design features of common types of brake master cylinders;

D.2.2 explain the operation, construction, and design features of wheel cylinders and calipers used in brake systems;

D.2.3 explain the construction and design features of brake hoses and lines;

D.2.4 describe the purpose and operation of the metering, proportioning, and pressure differential valves;

D.2.5 describe the operation of the hydraulic components when used as a system; and

D.2.6 diagnose and repair brake system hydraulic components.

## Performance Indicators

The vehicle brake system is the most critical of all of the vehicle safety systems. The braking system is in constant use and must function in a safe and reliable fashion at all times. Brake performance depends largely on the hydraulic components within the system. An apprentice must gain a thorough knowledge of the brake system's hydraulic components, their operation, and their service.

- Explaining the purpose and function of the master cylinder.
- Identifying the major parts of a single piston and tandem master cylinder.
- Explaining the design and purpose of a quick take-up master cylinder.
- Explaining the purpose and function of the wheel cylinder.
- Identifying the major components of the wheel cylinder.
- Explaining the design and operation of the wheel cylinder.
- Explaining the design and operation of disc brake calipers.
- Identifying the major components of disc brake calipers.
- Demonstrating the function of floating, fixed, and low-drag calipers.
- Explaining the function of fluid lines in the brake system.
- Demonstrating the design of steel lines used in brake systems.
- Identifying the two types of flares (ISO, SAE) for brake fittings.
- Explaining the design and application of flex lines.
- Describing the purpose, location, and operation of the pressure differential valve.
- Describing the purpose and operation of the metering valve in a disc/drum brake system.
- Describing the purpose and operation of the proportioning valve.
- Identifying the various functions of a combination valve in the braking system.
- Identifying the brake components on a schematic diagram.
- Demonstrating a visual inspection of the master cylinder.
- Listing problems that would indicate that service of the master cylinder is required.
- Demonstrating a visual inspection of the disc calipers and wheel cylinders.
- Listing problems that would indicate that a disc caliper or wheel cylinder would require service.
- Demonstrating overhauling a wheel cylinder and a disc caliper.
- Demonstrating a visual inspection of the brake fluid lines (both rigid and flex hoses).
- Demonstrating proper procedures for cutting, bending, and flaring steel lines.
- Demonstrating proper procedures for fabricating and replacing steel lines, and replacing flex hoses.
- Demonstrating the proper procedure for bleeding the brake system.
- Demonstrating proper handling and disposal practices when working with brake fluids.

| Technical Skill Dimension | | | | | Drum Brakes | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization / Articulation | | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | 3.1, 3.3 | | |
| | | | | | Procedural | Applying | | | | |
| | | | | | | Analysing | | | | |
| | | D.3 | | | Critical Thinking | Evaluating | | | | |
| | | | | | | Creating | | | 3.2, 3.4 | |

## Unit D: Automotive Service
***Drum Brakes***

**D.3**

Students are expected to…
**diagnose and repair drum brake systems.**

### Achievement Indicators

Students who have achieved this outcome should be able to…

D.3.1 explain the construction, design features, and operation of a drum brake system;

D.3.2 diagnose and repair drum brake systems;

D.3.3 explain the construction and design features of drum-type parking brake systems; and

D.3.4 diagnose and repair drum-type parking brake systems.

## Performance Indicators

Drum brake systems are utilized on most vehicles on the road today. The apprentice must be familiar with the design and operation of drum brakes so as to diagnose, service, and repair these safety systems. It is critical that the brake system be maintained to the original specifications of the manufacturer.

- Identifying the major components of a drum brake system.
- Demonstrating design and operation of a drum brake system.
- Defining terminology related to the brake shoe.
- Identifying the components of a dual-servo brake shoe arrangement.
- Demonstrating operation of a dual-servo brake shoe design.
- Identifying the components of a leading-trailing drum brake assembly.
- Demonstrating operation of leading-trailing brakes.
- Identifying other combinations of brake shoe configurations.
- Explaining the design and function of the backing plate.
- Explaining the design and function of the brake shoes.
- Explaining the design and composition of brake linings.
- Explaining the design and function of the wheel cylinder.
- Explaining the design and function of the various springs in a drum brake assembly.
- Explaining the design and function of brake adjusters.
- Demonstrating purpose, design, and composition of brake drums.
- Demonstrating safety precautions that must be practised while servicing and repairing brake systems.
- Demonstrating proper procedure for marking and removing brake drums.
- Demonstrating proper procedure for cleaning, inspecting, and measuring brake drums.
- Explaining procedure used to machine a brake drum.
- Demonstrating proper procedure for disassembling the brake shoes and hardware.
- Demonstrating procedure for servicing or replacing wheel cylinders.
- Demonstrating procedures for cleaning, inspecting, and replacing the backing plate.
- Demonstrating procedures for inspecting and evaluating brake shoe condition.
- Demonstrating proper procedures for replacing brake shoes, and for servicing and installing brake hardware.
- Demonstrating proper procedure for installing brake drums.
- Identifying the parking brake assembly components.
- Demonstrating design and function of the parking brake assembly.
- Demonstrating proper procedures for removing and replacing parking brake cables.
- Demonstrating proper procedures for adjusting brake cables.

| Technical Skill Dimension | | | | | Disc Brakes | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization / Articulation | | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | 4.1, 4.3 | | |
| | | | | | Procedural | Applying | | | | |
| | | | | | | Analysing | | | | |
| | | D.4 | | | Critical Thinking | Evaluating | | | | |
| | | | | | | Creating | | | 4.2, 4.4 | |

## Unit D: Automotive Service
***Disc Brakes***

**D.4** Students are expected to…
**diagnose and repair disc brake systems.**

### Achievement Indicators
Students who have achieved this outcome should be able to…

D.4.1 explain the construction, operation, and design features of disc brake systems;

D.4.2 diagnose and repair disc brake systems;

D.4.3 explain the construction and operation of disc-type parking brake systems; and

D.4.4 diagnose and repair disc-type parking brake systems.

## Performance Indicators

Disc brakes are used on almost every vehicle on the road today. The apprentice must be able to service, diagnose, and repair these systems, maintaining them to the manufacturer's specifications. Careful attention to detail is essential to ensure effective functioning of the disc brake system.

- Explaining the advantages of disc brakes over drum brakes.
- Demonstrating basic design, construction, and operation of disc brakes.
- Identifying the components of a disc brake system.
- Explaining the design and construction of calipers.
- Demonstrating basic operation of the disc calipers in applied and released modes.
- Comparing and contrasting the difference between fixed and floating calipers.
- Describing how a caliper is mounted.
- Identifying the components of the caliper and brake pad.
- Identifying and analysing brake pad wear problems.
- Demonstrating inspecting brake pads and diagnosing any problems.
- Listing six reasons to replace brake pads.
- Demonstrating inspecting brake calipers and diagnosing any problems.
- Demonstrating proper procedure used to bleed and remove brake calipers.
- Demonstrating servicing, repairing, or rebuilding a caliper.
- Demonstrating examining the brake disc condition to ensure that it meets the manufacturer's specifications.
- Listing reasons to resurface or replace a brake disc.
- Testing a brake disc for runout and measuring thickness.
- Listing things to consider in machining or replacing a disc.
- Demonstrating procedure used to machine a brake disc.
- Describing the two types of parking brakes employed on disc brake systems.
- Identifying the components of a drum-in-hat parking brake system.
- Explaining the design and operation of a drum-in-hat parking brake system.
- Describing the two common types of integral parking brakes (lead-screw, ball-and-ramp).
- Identifying the components of an integral parking brake.
- Explaining the design and operation of an integral parking brake system.
- Explaining the procedure required to adjust a drum-in-hat parking brake system.
- Demonstrating the procedure to replace the brake shoes in a drum-in-hat parking brake system.
- Demonstrating the procedure for removing a mechanical caliper parking brake.
- Listing the special considerations in the removal of mechanical calipers.
- Demonstrating the installation of brake pads and calipers in an integral caliper parking brake system.

| Technical Skill Dimension | | | | | Power Brakes | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization / Articulation | | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | 5.1, 5.2, 5.5 | | |
| | | D.5 | | | Procedural | Applying | | | 5.3, 5.4 | |
| | | | | | | Analysing | | | | |
| | | | | | Critical Thinking | Evaluating | | | | |
| | | | | | | Creating | | | | |

## Unit D: Automotive Service
***Power Brakes***

**D.5**

Students are expected to…
**service power brakes.**

### Achievement Indicators

Students who have achieved this outcome should be able to…

D.5.1 describe the operation of vacuum-operated power brake units;

D.5.2 describe the operation of hydraulically-operated power brake units;

D.5.3 apply a procedure for testing a power brake unit;

D.5.4 service problems related to a power brake; and

D.5.5 describe safety precautions needed when working on hybrid vehicle braking systems.

## Performance Indicators

Most vehicles use some form of power-assist to aid the effort applied by the driver on the brake pedal. The apprentice must understand the design and operating characteristics of power brake systems, and appreciate the safety precautions required in their service and repair.

- Demonstrating the principle of operation of a vacuum brake booster.
- Listing the principal applications of a vacuum booster.
- Identifying the components in a vacuum-suspended brake booster system.
- Explaining the operation of the vacuum suspended booster in the released, applied, and holding positions.
- Demonstrating the principle of operation of a hydraulic brake booster.
- Listing the principal applications of a hydraulic brake booster.
- Identifying the components of a hydraulic booster system.
- Explaining the stages of operation of the hydraulic brake booster in the unapplied, applied, holding, and released positions.
- Describing the role of the accumulator.
- Listing the two common causes of vacuum-assist power brake problems.
- Listing the items to check prior to testing the booster unit.
- Demonstrating the procedure used to perform a booster function test.
- Demonstrating the procedure used to perform an unapplied leakage test.
- Demonstrating the procedure used to perform an applied leakage test.
- Listing the items to check prior to testing the hydraulic-assist power brake unit.
- Demonstrating the procedure used to perform a pedal drop test.
- Describing the procedure used to perform an accumulator test.
- Listing four indications of a defective booster.
- Describing the steps required to remove a vacuum-assist booster.
- Describing the procedure used to adjust the pushrod length in a new booster.
- Describing the steps required to install a new brake booster.
- Listing five possible problems exterior to the hydraulic booster that may affect booster performance.
- Demonstrating the procedure used to test the power steering pump.
- Identifying seal leaks and diagnosing the required repair.
- Listing problems that would cause a hard pedal or lack of power-assist.
- Listing possible causes of slow pedal return.
- Listing three likely causes of chatter or vibration in the pedal or booster.
- Listing two causes of “grabby” brakes.
- Comparing regenerative versus friction braking.
- Describing safety precautions and special training required to service hybrid vehicle braking systems.
- Describing special considerations for bleeding the braking system on hybrid vehicles.

| Technical Skill Dimension | | | | | Brake System Diagnosis | | Knowledge Dimension | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Naturalization / Articulation | | Precision | Manipulation | Imitation | | | Factual | Conceptual | Procedural | Metacognitive |
| Innovative | | Complex | | Simple | Cognitive Dimension | | | | | |
| | | | | | Recall | Remembering | | | | |
| | | | | | | Understanding | | | | |
| | | | | | Procedural | Applying | | | | |
| | | | | | | Analysing | | | 6.1, 6.2 | |
| D.6 | | | | | Critical Thinking | Evaluating | | | | |
| | | | | | | Creating | | | 6.3 | |

## Unit D: Automotive Service
***Brake System Diagnosis***

**D.6**

Students are expected to…
**diagnose and repair problems related to brake systems.**

### Achievement Indicators

Students who have achieved this outcome should be able to…

D.6.1 demonstrate brake flushing and bleeding procedures on brake systems;

D.6.2 demonstrate a bleeding procedure for an ABS brake system; and

D.6.3 diagnose and repair problems related to brake systems.

## Performance Indicators

Brakes are one of the most fundamental safety systems on a vehicle. The apprentice must be able to diagnose problems accurately and efficiently, maintaining the braking system to the original manufacturer's specifications.

- Demonstrating the procedure to check the brake fluid level.
- Inspecting brake fluid for contamination.
- Listing reasons for flushing a brake system.
- Explaining the need to bleed brake systems.
- Listing four methods of bleeding or flushing the brake system.
- Demonstrating use of appropriate safety equipment and proper preparation of the vehicle.
- Demonstrating the freeing, removal, and cleaning of the bleed screws.
- Interpreting manufacturer's specifications to select the proper brake fluid.
- Demonstrating following the procedure for bleeding and collecting the used brake fluid.
- Disposing of the fluid in a proper manner.
- Demonstrating following the proper sequence for bleeding the system.
- Demonstrating the gravity bleed technique and listing the advantages and limitations of this method.
- Demonstrating the manual bleed technique and listing the advantages and limitations of this method.
- Describing the procedure for pressure bleeding and listing the advantages and limitations.
- Practising special considerations when dealing with anti-lock brake systems (ABS), and consulting with manufacturer's specifications.
- Describing the procedure for vacuum bleeding and listing the advantages and limitations.
- Describing the general procedure for performing an ABS automated bleed.
- Describing how to prepare for a road test.
- Listing problems you may diagnose by testing the pedal feel.
- Identifying things to check during a road test.
- Listing possible diagnoses that could be made by listening to brake noises.
- Demonstrating the process used to check for vibration/pulsation problems.
- Demonstrating the process used to diagnose brake-pull problems.
- Evaluating vehicle braking efficiency and ABS operation.
- Analysing observed symptoms to create a diagnostic plan.
- Consulting manufacturer's information bulletins, service manuals, and on-line technical support.
- Demonstrating procedures used to disassemble and inspect brake components.
- Demonstrating the proper procedures used to repair or replace faulty components, using approved parts and methods.
- Verifying proper operation of the braking system.
- Demonstrating safety precautions required in the service and repair of brake systems, and the legal implications of not taking safety precautions.

## Red Seal Occupational Standard 2016 Reference

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|---|---|
| **Task F-18 - Diagnoses steering and suspension, braking, control systems, tires, wheels, hubs, and wheel bearings** | |
| F-18.02 - Diagnoses braking and control systems | |
| F-18.02.01P | verify concern to determine diagnostic strategy |
| F-18.02.02P | perform road test(when safe to do so)to identify braking concerns *(high school students will not perform the road test)* |
| F-18.02.03P | select and use diagnostic tools and equipment |
| F-18.02.04P | determine type of braking system |
| F-18.02.05P | inspect braking system components and fluids |
| F-18.02.06P | identify ABS/TCS and stability control system components |
| F-18.02.07P | perform tests |
| F-18.02.08P | interpret and analyse results of tests and inspections |
| F-18.02.01L | demonstrate knowledge of braking systems, their components, and operation |
| F-18.02.03L | demonstrate knowledge of the procedures used to diagnose braking systems |
| F-18.02.03L | demonstrate knowledge of the procedures used to diagnose control systems |
| **Task F-19 - Repairs steering and suspension, braking, control systems, tires, wheels, hubs, and wheel bearings** | |
| F-19.02 - Repairs braking and control systems | |
| F-19.02.01P | select and use repair tools and equipment |
| F-19.02.02P | select repair materials |
| F-19.02.03P | remove, replace, or service components |
| F-19.02.04P | verify repair by system re-test and road test *(high school students will not perform the road test)* |