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Electrotechnologies 11

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Electrotechnologies 11

Implementation Draft,

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Introduction

Background

The Department of Education has made a commitment to provide a broad-based, quality education in the public school system and to expand the range of programming to better meet the needs of all students. The Department is working in collaboration with school boards and other partners in education, business, industry, the community, and government to develop a variety of new courses.

Electrotechnologies 11 is one of a group of innovative multidisciplinary course options that share certain characteristics.

New course options draw from and contribute to students' knowledge and skills in more than one discipline. Students synthesize and apply knowledge and skills acquired in other courses, including courses in English language arts, social studies, science, arts, mathematics, and technology.

New course options provide increased opportunities for senior high school students to:

- earn the credits they require to attain a high school graduation diploma
- diversify their course options
- prepare for varied post-secondary destinations
- make connections among school, the community, and the workplace
- explore a range of career options

These courses offer students increased opportunities for hands-on experiences and for using technology within a variety of subject areas to expand and develop their learning and skills.

Electrotechnologies 11 focusses on helping students to gain an understanding of electro-mechanical systems. Students are motivated to learn by studying such systems in an activity-oriented environment.

Students enhance their problem-solving skills using observations, analysis, prediction, and verification. Electrotechnologies 11 provides opportunities for students to investigate and conceptualize real applications of technology and formulate conclusions as to how these applications affect their personal and work lives.

An approach to teaching and learning that emphasizes open-ended problem-solving will help to prepare students for the challenges they will meet in the world outside the school. In the workplace, projects
may not always be clearly defined, and standard methods and procedures may need to be modified and adapted to meet the unique requirements of a specific project. Experience with open-ended problem solving will give students practice in responding to challenges for which prescribed solutions do not already exist.

To enhance students' understanding of the foundation of the information-based society in which we live, Electrotechnologies 11 provides opportunities for students to reflect on scientific and technological investigations from a historical perspective. Such opportunities help students to make value judgments about the effects of technology in their personal and work lives.

Rationale

In our increasingly technological society, young people must be able to respond to rapidly changing social and economic conditions with confidence in their own abilities. They will be required to adapt to changes in their personal and professional lives more often and more quickly than past generations of graduates.

All students will have to make informed decisions about what they will do when they finish their secondary education. When they enter a highly competitive workforce, they must be able to face the challenges of an information-based society that is constantly changing.

To assist students in dealing with these issues, schools must consistently deliver high quality, cost-effective programs that students, parents, and the community find credible and relevant. It is becoming increasingly clear that the world of work places a strong emphasis on group endeavours in problem-solving situations, and the abilities of individuals will be combined in group efforts to solve increasingly complex problems.

Electrotechnologies 11 emphasizes a team approach to the solution of systems problems, preparing students for cooperative work environments.

Electrotechnologies 11 provides opportunities for students to investigate possible career paths into the technology industry and to develop knowledge and skills necessary to effective participation in the society of tomorrow. The course will help students to develop skills that can be applied in their personal and work-related lives now and in the future.

Electrotechnologies 11 also provides opportunities for students to strengthen and refine skills and knowledge learned in other areas of their high school program such as technology, physics, and mathematics.
Outcomes

Essential Graduation Learnings and Electrotechnologies 11

The Atlantic provinces worked together to identify the abilities and areas of knowledge that they considered essential for students graduating from high school. These are referred to as Essential Graduation Learnings. Details may be found in the document Public School Programs.

Some examples of learning in Electrotechnologies 11 that helps students move toward attainment of the essential graduation learnings are given below.

<table>
<thead>
<tr>
<th>Essential Graduation Learnings</th>
<th>Electrotechnologies 11 Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aesthetic Expression</strong></td>
<td>By the end of Electrotechnologies 11, students will be expected to</td>
</tr>
<tr>
<td>Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.</td>
<td>• use writing and other ways of representing to explore, extend, and reflect on their experiences, investigations, and insights into various areas of electrotechnology</td>
</tr>
<tr>
<td></td>
<td>• make effective choices of language and other ways of representing to express their interpretation of various technological problems</td>
</tr>
<tr>
<td><strong>Citizenship</strong></td>
<td>By the end of Electrotechnologies 11, students will be expected to</td>
</tr>
<tr>
<td>Graduates will be able to assess social, cultural, economic and environmental interdependence in a local and global context.</td>
<td>• display an understanding of the impact of technology on a global, national, and local scale</td>
</tr>
<tr>
<td></td>
<td>• work co-operatively in group environments</td>
</tr>
<tr>
<td></td>
<td>• display an understanding of the need for safety in work environments</td>
</tr>
<tr>
<td></td>
<td>• appreciate the historical significance of various developments in technology</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>By the end of Electrotechnologies 11, students will be expected to</td>
</tr>
<tr>
<td>Graduates will be able to use the listening, viewing, speaking, reading, and writing modes of language(s) as well as mathematical and scientific concepts and symbols to think, learn, and communicate effectively.</td>
<td>• demonstrate active listening and concern for the needs, rights, and feelings of others</td>
</tr>
<tr>
<td></td>
<td>• present ideas, insights, and information to others through a range of communication mediums</td>
</tr>
</tbody>
</table>
OUTCOMES

Essential Graduation Learnings

Personal Development
Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Problem Solving
Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, mathematical, and scientific concepts.

Technological Competence
Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

Electrotechnologies 11 Outcomes

By the end of Electrotechnologies 11, students will be expected to

- participate in career-related experiences that support their interest in technology and their development as lifelong learners
- use writing and other ways of representing to explore, extend, and reflect on the basis for their feelings, values, and attitudes relating to careers in technology
- ask discriminating questions to acquire, interpret, analyse, and evaluate ideas and information
- research, in systematic ways, specific information to meet personal learning needs

By the end of Electrotechnologies 11, students will be expected to

- use graphical techniques to solve problems
- use computer software to assist in problem solving
- evaluate, formulate, and present informed solutions to technological problems and scenarios
- use the Internet to assist in problem solving

By the end of Electrotechnologies 11, students will be expected to

- read and interpret electric schematic diagrams
- use computer software to simulate electric circuits
- use computer software to produce graphs of mathematical data
- use graphical techniques to solve problems
- use the Internet as an aid in research
- manipulate laboratory equipment
- assemble electronic circuits
- use electronic test equipment
Electrotechnologies
11 Outcomes

Module 1: Components and Concepts
Students will be expected to apply appropriate techniques, including component assembly procedures, to construct and analyse basic electronic circuits.

Module 2: Power Distribution and Conversion
Students will be expected to apply appropriate techniques, including component assembly procedures, to construct and test power distribution and conversion devices.

Module 3: Digital Technology
Students will be expected to identify, select, and apply integrated circuits to solve practical problems.

Module 4: Control Systems
Students will be expected to formulate, apply, and test the principles governing the forms and functions of control systems.

Module 5: Electrotechnologies Project
Students will work alone or in groups to extend, apply, or explore in depth, ideas, issues, or skills introduced in modules 1, 2, 3, and/or 4.

Specific Curriculum Outcomes

Module 1: Concepts and Components (Compulsory)
Students will be expected to apply appropriate techniques, including component assembly procedures, to construct and analyse basic electronic circuits.

Students will be expected to:

- identify the variables involved in electronic circuits (current, voltage, and resistance)
- explain the relationship among variables involved in electronic circuits
- use a multimeter to measure the variables involved in electronic circuits
- arrange electronic components in series, parallel, and combination configurations
- predict the behaviour of electric circuits using their knowledge of the variables involved in electronic circuits
- solve problems involving series, parallel, and combination circuits
- demonstrate their ability to use industrially accepted fabrication techniques
- describe circuits using electronic symbols and conventions
- describe applications of series, parallel, and combination circuits
- identify appropriate construction methods to fabricate a circuit board
OUTCOMES

- lay out and construct a simple electronic circuit board using approved construction techniques
- use a PC board and accepted fabrication techniques to assemble a project

The following outcomes of Module 1 are addressed in all modules of Electrotechnologies 11.

- practise the appropriate health and safety procedures outlined in the Nova Scotia Occupational Health and Safety Act
- practise safety procedures applicable to chemical, electronic, and other equipment as appropriate
- use computer software to conduct investigations and solve problems
- use the Internet to search for and gather learning resource materials
- make connections among their learning, their own lives, and their communities

Module 2: Power Distribution and Conversion

Students will be expected to apply appropriate techniques, including component assembly procedures, to construct and test power distribution and conversion devices.

Students will be expected to:

- explain the relationship between electricity and magnetism
- construct electromagnetic devices that illustrate the relationship between electricity and magnetism
- describe a range of electromagnetic applications in a range of settings
- describe various types of AC and DC power supplies
- construct a simple power supply
- demonstrate an understanding of the environmental impact of a range of power generation systems
- explain electromotive principles as applied to direct current (DC) and single phase alternating current (AC) motors
- explain the operational characteristics of AC motors
- practise the appropriate health and safety procedures outlined in the Nova Scotia Occupational Health and Safety Act
- use computer software to conduct investigations and solve problems
- use the Internet to search for and gather learning resource materials
- make connections among their learning, their own lives, and their communities

Module 3: Control Systems

Students will be expected to identify, select, and apply integrated circuits to solve practical problems.
Students will be expected to

- describe the binary numbering system
- relate the binary number system to electronic concepts
- describe basic logic gates
- construct basic logic gates
- verify basic logic gates using multimeters
- construct a simple logic circuit and explain its functions
- distinguish between analog and digital systems
- identify and describe the major components of a logic system such as a microcomputer system
- identify the major integrated circuit (IC) families and describe their unique functions
- identify and interface components with small-scale integration IC families
- identify components and construct a prototype of typical small-scale and complex logic networks using integrated circuits
- practise the appropriate health and safety procedures outlined in the Nova Scotia Occupational Health and Safety Act
- use computer software to conduct investigations and solve problems
- use the Internet to search for and gather learning resource materials
- make connections among their learning, their own lives, and their communities

Module 4: Control Systems

Students will be expected to formulate, apply, and test the principles governing the forms and functions of control systems.

Students will be expected to

- describe a variety of everyday problems that are solved by control systems
- identify how control systems are used in residential and commercial applications
- explain how basic process control systems function
- describe the operation of devices used for process control using standard terms
- construct basic process control circuits using passive devices
- distinguish between digital and analog systems
- construct basic control systems to process input information in order to achieve a desired result
- practise the appropriate health and safety procedures outlined in the Nova Scotia Occupational Health and Safety Act
- use computer software to conduct investigations and solve problems
- use the Internet to search for and gather learning resource materials
- make connections among their learning, their own lives, and their communities
Module 5: Electrotechnologies Project

Students will work alone or in groups to extend, apply, or explore in depth ideas, issues, or skills introduced in Modules 1, 2, 3 and/or 4.

Students will be expected to

- develop and refine a proposal for an inquiry or the development of a product or electronic device
- identify information needs, and locate evaluate resources
- identify and extend, refine and/or acquire required skills
- share research and reflections made by themselves and their peers
- make project decisions which demonstrate creativity, innovation, and a willingness to take risks
- set deadlines and develop a work plan to manage time and resources
- develop a plan for monitoring their progress and judging success
- contribute to the criteria used for evaluation
- gather, organize, and synthesize information and ideas
- use their knowledge and skills to conduct an inquiry or create a product or electronic device
- present the results of their investigation or product
- reflect on and assess their own learning and the learning of others
- practise the appropriate health and safety procedures outlined in the Nova Scotia Occupational Health and Safety Act
- use computer software to conduct investigations and solve problems
- make connections among their learning, their own lives, and their communities
Course Design and Components

Features of Electrotechnologies 11

Electrotechnologies 11 is characterized by the following features:

- a strong applied focus with an emphasis on integrating, applying, and reinforcing the knowledge, skills, and attitudes developed in other courses
- a strong connection to the essential graduation learnings
- a strong focus on refining career-planning skills to explore a range of pathways from school
- a strong connection to labour market opportunities with a focus on enhancing students’ employability skills
- a strong connection to the community and workplace with a focus on using real-world community and workplace problems and situations as practical contexts for the application of knowledge and skills and for further learning
- a strong focus on hands-on learning experiences, including experiences with a range of technologies
- a flexible design framework based on learning modules

Key Concepts in Electrotechnologies

Structure

- the essential physical or conceptual parts of a product, process, or system, including the way in which the parts are constructed or organized

Material

- the substance or information from which the structure is made

Fabrication

- the act or process of forming and assembling materials and structures

Mechanism

- the parts of a structure that allow it to work or function

Power and Energy

- the resource that enables a mechanism to perform work

Controls

- the means by which a mechanism is activated and regulated

Systems

- combinations of interrelated parts (structures and/or mechanisms) that make up a whole and that may be connected with other systems

Function

- the use for which a product, process, or system is developed

Aesthetics

- the aspects of a product, process, or system that make it pleasing to the human senses
Ergonomics: The aspects of a product, process, or system that allow people to use it efficiently with minimal waste of time or energy.

Cross-Curricular Connections: Electrotechnologies 11 provides many connections to other technology education courses and to other subject areas in the high school curriculum.

English Language Arts: Students are expected to apply and refine language knowledge and skills in the preparation of reports, essays, summaries, discussions, and presentations. Teachers should encourage effective use of language and organization of ideas and information. Precise use of language in relation to the technical information is particularly important.

Mathematics: Mathematical skills, both algebraic and geometric, are basic tools in the analysis of data, as well as in the quantitative solution of problems in all modules of Electrotechnologies 11.

Sciences: Chemistry and physics are the primary connections to the sciences in Electrotechnologies 11. From their first experiments with wet cells through the design and construction of robotic systems, students discover and apply chemical and physical principles as they are needed. Throughout the course students investigate, analyse, predict, and test their own ideas.

Social Studies: A critical awareness of the development of science and technology concepts from a historical perspective is an important dimension of Electrotechnologies 11. An understanding of current trends in technology is difficult without awareness of the paths taken by our predecessors in reaching our present level of development. Students should have opportunities to examine the work done by notable contributors to technological theory.

Organization: Teachers and students may choose to organize the learning for Module 5 in any of the following ways:

- students may work alone
- students may work collaboratively with a partner or mentor
- students may work co-operatively in groups
- students may organize themselves into a design team, working collectively to explore an issue, solve a problem, or create a product in response to a need articulated by a school or community group
- students may undertake a shared or common project, working together in a class or group
Electrotechnologies 11 is designed to meet a range of learning needs. Students may earn one-half-credit by completing the compulsory module, Components and Concepts, and one other module, or they may earn a full credit by completing an additional three of the optional modules. Each module is twenty-five to thirty hours in length. The minimum time required for scheduling is 110 hours for a full credit and 55 hours for one-half credit.

**Sequence of Modules**

Modules may be organized in any of the following ways:

1. **Module 1**
   - Three of Modules 2, 3, 4, or 5

2. **Module 1**
   - **Module 2**
   - **Module 3**
   - **Module 4 or 5**

3. **Module 4**
   - **Module 1**
   - **Module 2**
   - **Module 3 or 5**
How to Use the Four-Column Curriculum Matrix

The curriculum for this course has been organized into four columns for several reasons:

- The organization illustrates how learning experiences flow from the outcomes.
- The relationship between outcomes and assessment strategies is immediately apparent.
- Related and interrelated outcomes can be grouped together.
- The range of strategies for teaching and learning associated with any specific outcome or outcomes can be scanned easily.
- The organization provides multiple ways of reading the document or of searching for specific information.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Suggestions for Teaching and Learning</th>
<th>Suggestions for Assessment</th>
<th>Resources and Notes</th>
</tr>
</thead>
</table>

This column offers a range of strategies from which teachers and students may choose. Suggested learning experiences can be used in various combinations to help students achieve an outcome or outcomes. It is not necessary to use all of these suggestions, nor is it necessary for all students to engage in the same learning experience.

This column contains a variety of information related to the items in the other columns, including suggested resources, elaborations on strategies, successes, cautions, and definitions.

This column describes what students are expected to know, be able to do, and value by the end of this course. While the outcomes may be clustered, they are not necessarily sequential.

These suggestions may be used to assess students' success in achieving the outcomes; they are linked to the Outcomes column, rather than the Suggestions for Teaching and Learning column. The suggestions are only samples; for more information, read the section Assessing and Evaluating Student Learning.
Contexts for Learning and Teaching

Principles of Learning

The public school program is based on principles of learning that teachers and administrators should use as the basis of the experiences they plan for their students. These principles include the following:

1. Learning is a process of actively constructing knowledge.

   Therefore, teachers and administrators have a responsibility to
   - create environments and plan experiences that foster inquiry, questioning, predicting, exploring, collecting, educational play, and communicating
   - engage learners in experiences that encourage their personal construction of knowledge, for example, hands-on, minds-on science and math; drama; creative movement; artistic representation; writing and talking to learn
   - provide learners with experiences that actively involve them and are personally meaningful

2. Students construct knowledge and make it meaningful in terms of their prior knowledge and experiences.

   Therefore, teachers and administrators have a responsibility to
   - find out what students already know and can do
   - create learning environments and plan experiences that build on learners’ prior knowledge
   - ensure that learners are able to see themselves reflected in the learning materials used in the school
   - recognize, value, and use the great diversity of experiences and information students bring to school
   - provide learning opportunities that respect and support students’ racial, cultural, and social identity
   - ensure that students are invited or challenged to build on prior knowledge, integrating new understandings with existing understandings

3. Learning is enhanced when it takes place in a social and collaborative environment.

   Therefore, teachers and administrators have a responsibility to
   - ensure that talk, group work, and collaborative ventures are central to class activities
• see that learners have frequent opportunities to learn from and with others
• structure opportunities for learners to engage in diverse social interactions with peers and adults
• help students to see themselves as members of a community of learners

4. Students need to continue to view learning as an integrated whole.

Therefore, teachers and administrators have a responsibility to
• plan opportunities to help students make connections across the curriculum and with the world outside and structure activities that require students to reflect on those connections
• invite students to apply strategies from across the curriculum to solve problems in real situations

5. Learners must see themselves as capable and successful.

Therefore, teachers and administrators have a responsibility to
• provide activities, resources, and challenges that are developmentally appropriate to the learner
• communicate high expectations for achievement to all students
• encourage risk-taking in learning
• ensure that all students experience genuine success on a regular basis
• value experimentation and treat approximation as signs of growth
• provide frequent opportunities for students to reflect on and describe what they know and can do
• provide learning experiences and resources that reflect the diversity of the local and global community
• provide learning opportunities that develop self-esteem

6. Learners have different ways of knowing and representing knowledge.

Therefore, teachers and administrators have a responsibility to
• recognize each learner’s preferred ways of constructing meaning and provide opportunities for exploring alternative ways
• plan a wide variety of open-ended experiences and assessment strategies
• recognize, acknowledge, and build on students’ diverse ways of knowing and representing their knowledge
• structure frequent opportunities for students to use various art forms—music, drama, visual arts, dance, movement, crafts—as a means of exploring, formulating, and expressing ideas

7. Reflection is an integral part of learning.

Therefore, teachers and administrators have a responsibility to

• challenge their beliefs and practices based on continuous reflection
• reflect on their own learning processes and experiences
• encourage students to reflect on their learning processes and experiences
• encourage students to acknowledge and articulate their learnings
• help students use their reflections to understand themselves as learners, make connections with other learnings, and proceed with learning

A Variety of Learning Styles and Needs

Learners have many ways of learning, knowing, understanding, and creating meaning. Research into links between learning styles and preferences and the physiology and function of the brain has provided educators with a number of helpful concepts of and models for learning. Howard Gardner, for example, identifies eight broad frames of mind or intelligences: linguistic, logical/mathematical, visual/spatial, body/kinesthetic, musical, interpersonal, intrapersonal, and naturalistic. Gardner believes that each learner has a unique combination of strengths and weaknesses in these eight areas, but that the intelligences can be more fully developed through diverse learning experiences. Other researchers and education psychologists use different models to describe and organize learning preferences.

Students' ability to learn is also influenced by individual preferences and needs within a range of environmental factors, including light, temperature, sound levels, nutrition, proximity to others, opportunities to move around, and time of day.

How students receive and process information and the ways they interact with peers and their environment, in specific contexts, are both indicators and shapers of their preferred learning styles. Most learners have a preferred learning style, depending on the situation and the type and form of information the student is dealing with, just as most teachers have a preferred teaching style, depending on the context. By reflecting on their own styles and preferences as learners and as teachers in various contexts, teachers can

• build on their own teaching-style strengths
develop awareness of and expertise in a number of learning and teaching styles and preferences
identify differences in student learning styles and preferences
organize learning experiences to accommodate the range of ways in which students learn, especially for whom the range of ways of learning is limited

Learning experiences and resources that engage students’ multiple ways of understanding allow them to become aware of and reflect on their learning processes and preferences. To enhance their opportunities for success, students need

- a variety of learning experiences to accommodate their diverse learning styles and preferences
- opportunities to reflect on their preferences and the preferences of others to understand how they learn best and that others may learn differently
- opportunities to explore, apply, and experiment with learning styles other than those they prefer, in learning contexts that encourage risk taking
- opportunities to return to preferred learning styles at critical stages in their learning
- opportunities to reflect on other factors that affect their learning, for example, environmental, emotional, sociological, cultural, and physical factors
- a timeline appropriate for their individual learning needs within which to complete their work

The Senior High School Learning Environment

Creating Community

To establish the supportive environment which characterizes a community of learners, teachers need to demonstrate a valuing of all learners, illustrating how diversity enhances the learning experiences of all students, for example, by emphasizing courtesy in the classroom through greeting students by name, thanking them for answers, and inviting, rather than demanding participation. Students could also be encouraged to share interests, experiences, and expertise with one another.

Students must know one another in order to take learning risks, make good decisions about their learning, and build peer partnerships for tutoring, sharing, cooperative learning, and other collaborative learning experiences. Through mini-lessons, workshops, and small-group dynamic activities during initial classes, knowledge is shared about individual learning styles, interpersonal skills, and team building.
The teacher should act as a facilitator, attending to both active and passive students during group activities, modelling ways of drawing everyone into the activity as well as ways of respecting and valuing each person’s contribution, and identifying learners’ strengths and needs for future conferences on an individual basis.

Having established community within the classroom, the teacher and students together can make decisions about learning activities. Whether students are working as a whole class, in small groups, in triads, in pairs, or individually, teachers should:

- encourage comments from all students during whole class discussion, demonstrating confidence in and respect for their ideas
- guide students to direct questions evenly to members of the group
- encourage students to discover and work from the prior knowledge in their own social, racial or cultural experiences
- encourage questions, probing but never assuming prior knowledge
- select partners or encourage students to select different partners for specific purposes
- help students establish a comfort zone in small groups where they will be willing to contribute to the learning experience
- observe students during group work, identifying strengths and needs, and conference with individuals to help them develop new roles and strategies
- include options for students to work alone for specific and clearly defined purposes

Engaging All Students

A supportive environment is important for all learners and is especially important in encouraging disengaged or underachieving learners.

Electrotechnologies 11 provides new opportunities to engage students who lack confidence in themselves as learners, who have a potential that has not been realized, or whose learning has been interrupted, for example refugees. These students may need substantial support in gaining essential knowledge and skills and in interacting with others.

Students need to engage fully in learning experiences that:

- are perceived as authentic and worthwhile
- build on their prior knowledge
- allow them to construct meaning in their own way, at their own pace
- link learning to understanding and affirming their own experiences
- encourage them to experience ownership and control of their learning
- feature frequent feedback and encouragement
• include opportunities for teachers and others to request and receive clarification and elaboration
• are not threatening or intimidating
• focus on successes rather than failures
• are organized into clear, structured segments

It is important that teachers design learning experiences that provide a balance between challenge and success, and between support and autonomy.

All students benefit from a variety of grouping arrangements that allow optimum opportunities for meaningful teacher-student and student-student interaction. An effective instructional design provides a balance of the following grouping strategies:

• large-group or whole-class learning
• teacher-directed small-group learning
• small-group-directed learning
• co-operative learning groups
• one-to-one teacher-student learning
• independent learning
• partnered learning
• peer or cross-age tutoring
• mentoring

Health and Safety

Activities in shop, laboratory, or workplace settings should include an element of safety education. Teachers should plan learning experiences with a specific safety focus, and also embed safe practices in classroom procedures and routines in order that students may acquire

• a strong orientation toward both personal and group safety
• an awareness of potential safety hazards at school and in the workplace
• a knowledge of safety procedures and safe work habits
• a knowledge of emergency procedures
• the ability to design and maintain safe work areas

Learning Beyond the Classroom

Electrotechnologies 11 offers many opportunities for students to extend learning beyond the classroom. Alternative settings provide students with opportunities to connect their learning to tangible, practical purposes, their future education and career plans, and the world beyond the high school setting.

Teachers may choose to organize learning experiences which include workplace settings for some or all students. Learning experiences may include
- practices and procedures to encourage students to use technology properly and with care
- activities with mentors
- classroom visits from workplace experts
- field trips to local business, industry, and community sites
- a focus on career exploration through job shadowing
- work placements which extend and reinforce learning
- entrepreneurship-related projects
- community and service learning projects
- use of Internet listservs, newsgroup, bulletin board, and on-line conversations

It is important that administrators and teachers work to establish mutually beneficial relationships with businesses, organizations, and industries in the community. Class or group field trips are an effective way to initiate the contact. In organizing field trips teachers should

- visit the facility beforehand to identify potential safety issues, establish a relationship with personnel, and clarify the purposes of the trip
- work with students to articulate clear expectations for learning during the field trip experience
- schedule field trips to complement preceding and subsequent classroom learning experiences
- ensure that the field trip complies with their Board’s guidelines and policies
- establish class practices and procedures that promote positive and ongoing community relationships

Meeting the Needs of All Students

Learners require inclusive classrooms, where a wide variety of learning experiences ensure that all students have equitable opportunities to reach their potential.

In designing learning experiences, teachers must accommodate the learning needs of individuals, and consider the abilities, experiences, interests, and values which they bring to the classroom.

In recognizing and valuing the diversity of students, teachers should consider ways to

- create a climate and design learning experiences to affirm the dignity and worth of all learners in the classroom community
- give consideration to the social and economic situations of all learners
- model the use of inclusive language, attitudes, and actions supportive of all learners
- acknowledge racial and cultural uniqueness
- adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address learners' needs and build on their strengths
- provide opportunities for learners to work in a variety of contexts, including mixed-ability groupings
- identify and utilize strategies and resources that respond to the range of students' learning styles and preferences
- build on students' individual levels of knowledge, skills, and attitudes
- design learning and assessment tasks that draw on learners' strengths
- use students' strengths and abilities to motivate and support their learning
- provide opportunities for students to make choices that will broaden their access to a range of learning experiences
- acknowledge the accomplishment of learning tasks, especially those that learners believed were too challenging for them

In a supportive learning environment, all students receive equitable access to resources, including the teacher's time and attention, technology, learning assistance, a range of roles in group activities, and choices of learning experiences when options are available.

All students are disadvantaged when oral, written, and visual language creates, reflects, and reinforces stereotyping. Teachers promote social, cultural, racial, and gender equity when they provide opportunities for students to critically examine the texts, contexts, and environments associated with Electrotechnologies 11 in the classroom, in the community, and in the media. Teachers should look for opportunities to

- promote critical thinking
- recognize knowledge as socially constructed
- model gender-fair language and respectful listening in all their interactions with students
- articulate high expectations for all students
- provide equal opportunity for input and response from all students
- encourage all students to assume leadership roles
- ensure that all students have a broad range of choice in learning and assessment tasks
- encourage students to avoid making decisions about roles and language choices based on stereotyping
- include the experiences and perceptions of all students in all aspects of their learning
- recognize the contributions of men and women of all social, cultural, linguistic, and racial backgrounds to all disciplines throughout history
Social and cultural diversity in student populations expands and enriches the learning experiences of all students. Students can learn much from the backgrounds, experiences, and perspectives of their classmates. In a community of learners, participants explore the diversity of their own and others' customs, histories, values, beliefs, languages, and ways of seeing and making sense of the world.

When learning experiences are structured to allow for a range of perspectives, students from varied social and cultural backgrounds realize that their ways of seeing and knowing are not the only ones possible. They can come to examine more carefully the complexity of ideas and issues arising from the differences in their perspectives and understand how cultural and social diversity enrich their lives and their culture.

The curriculum outcomes designed for Electrotechnologies 11 provide a framework for a range of learning experiences for all students.

Teachers must adapt learning contexts, including environment, strategies for learning and strategies for assessment, to provide support and challenge for all students, using curriculum outcomes to plan learning experiences appropriate to students' individual learning needs. When these changes are not sufficient for a student to meet designated outcomes, an individual program plan is required. For more detailed information, see Special Education Policy Manual (1996), Policy 2.6.

A range of learning experiences, teaching and learning strategies, resources, and environments provide expanded opportunities for all learners to experience success as they work toward the achievement of designated outcomes. Many of the learning experiences suggested in this guide provide access for a wide range of learners, simultaneously emphasizing both group support and individual activity. Similarly, the suggestions for a variety of assessment practices provide multiple ways for students to demonstrate their achievements.

In order to provide a range of learning experiences to challenge all students, teachers may adapt learning contexts to stimulate and extend learning. Teachers should consider ways that students can extend their knowledge base, thinking processes, learning strategies, self-awareness, and insights. Some learners can benefit from opportunities to negotiate their own challenges, design their own learning experiences, set their own schedules, and work individually or with learning partners.

Some students' learning needs may be met by opportunities for them to focus on learning contexts which emphasize experimentation, inquiry, and critical and personal perspectives; in these contexts, teachers should work with students to identify and obtain access to appropriate resources.
The Nova Scotia Department of Education has articulated five components to the learning outcomes framework for the integration of IT within curriculum programs:

1. Basic Operations and Concepts
   concepts and skills associated with the safe, efficient operation of a range of information technologies

2. Productivity Tools and Software
   the efficient selection and use of IT to perform tasks such as
   - the exploration of ideas
   - data collection
   - data manipulation, including the discovery of patterns and relationships
   - problem solving
   - the representation of learning

3. Communications Technology
   the use of specific, interactive technologies which support collaboration and sharing through communication

4. Research, Problem Solving, and Decision Making
   the organization, reasoning, and evaluation by which students rationalize their use of IT

5. Social, Ethical, and Human Issues
   that understanding associated with the use of IT which encourages in students a commitment to pursue personal and social good, particularly to build and improve their learning environments and to foster stronger relationships with their peers and others who support their learning

As information technologies shift the ways in which society accesses, communicates, and transfers information and ideas, they inevitably change the ways in which students learn.

Students must be prepared to deal with an information and communications environment characterized by continuous, rapid change, an exponential growth of information, and expanding opportunities to interact and interconnect with others in a global context.
Because technologies are constantly and rapidly evolving, it is important that teachers make careful decisions about applications, always in relation to the extent to which technology applications help students to achieve the curriculum outcomes.

Technology can support learning for the following specific purposes.

**Inquiry**

**Theory Building:** Students can develop ideas, plan projects; track the results of growth in their understanding, develop dynamic, detailed outlines; and develop models to test their understanding using software and hardware for modelling, simulation, representation, integration, and planning.

**Data Access:** Students can search for and access documents, multimedia events, simulations, and conversations through hypertext/hypermedia software; digital, CD-ROM, and Internet libraries, and databases.

**Data Collection:** Students can create, obtain, and organize information in a range of forms, using sensing, scanning, image and sound recording and editing technology, databases, spreadsheets, survey software, and Internet search software.

**Communication**

**Media Communication:** Students can create, edit, and publish, present, or post documents, presentations, multimedia events, Web pages, simulations, models, and interactive learning programs, using word processing, publishing, presentation, Web page development, and hypertext software.

**Interaction/Collaboration:** Students can share information, ideas, interests, concerns, and questions with others through e-mail; Internet audio, video, and print conferences; information servers; Internet news groups and listservs; and student-created hypertext environments.

**Teaching and Learning:** Students can acquire, refine and communicate ideas, information, and skills using tutoring systems and software, instructional simulations, drill and practice software, and telementoring systems.

**Expression**

Students can shape the creative expression of their ideas, feelings, insights, and understandings using graphic software, music making, composing, editing and synthesizing technology; interactive video and hypermedia, animation software; multimedia composing technology; sound and light control systems and software; and video and audio recording and editing technology.
The Role of Technology in Electrotechnologies 11

Electrotechnologies 11 uses technology to illustrate how the world around us may be adapted to human needs by

- creating electronic and electro-mechanical devices for our use
- managing and assisting human production processes
- using or controlling aspects of our natural environment

Students need to understand the connections among these areas and how they interact with one another and with society as a whole.

The study of electronic and electro-mechanical devices requires students to design and build a variety of devices using different types of tools and equipment and a wide range of materials. They also study the uses made of various devices and their effects on society and the environment.

Students analyse and learn about a range of human production processes and undertake projects that require them to design, develop, and use examples of such processes. In doing so, they take account of the impact of the processes on individuals, the environment, and society as a whole.

Students analyse and learn about different environmental systems and the technologies that enable us to use or modify those systems to suit our own purposes. They also examine the impact of technology on the natural environment. They learn about both the beneficial and the harmful effects and the short-term and long-term consequences of various types of technological intervention.
Assessing and Evaluating Student Learning

Assessment is the systematic process of gathering information on student learning.

Evaluation is the process of analysing, reflecting upon, and summarizing assessment information, and making judgements or decisions based upon the information gathered.

The Principles of Assessment and Evaluation articulated in the document Public School Programs should be used as the basis of assessment and evaluation, policies, procedures, and practices.

Using a Variety of Assessment Strategies

When teachers make decisions about what learning to assess and evaluate, how to assess and evaluate, and how to communicate the results, they send clear messages to students and others about what learning they value; for example, teachers can communicate that they value risk taking or lateral thinking by including these elements in determining marks.

Assessment involves the use of a variety of methods to gather information about a wide range of student learning and to develop a valid and reliable snapshot of what students know and are able to do that is clear, comprehensive, and balanced. The assessment process provides information about each student's progress toward achievement of learning outcomes that teachers can use to assign marks, to initiate conversations with students, or to make decisions in planning subsequent learning experiences.

Teachers align assessment and evaluation practices with student-centred learning practices when they

- design assessment and evaluation tasks that help students make judgements about their own learning and performance
- provide assessment and evaluation tasks that allow for a variety of learning styles and preferences
- individualize assessment and evaluation tasks to accommodate specific learning needs
- work with students to describe and clarify what will be assessed and evaluated and how it will be assessed and evaluated
- provide students with regular, specific, frequent, and consistent feedback on their learning
Assessment activities, tasks, and strategies include, for example,

- anecdotal records
- artifacts
- audiotapes
- certifications
- checklists
- conferences
- demonstrations
- dramatizations
- exhibitions
- interviews (structured or informal)
- inventories
- investigations
- learning logs or journals
- media products
- observations (structured or informal)
- peer assessments
- performance tasks
- portfolios
- presentations
- projects
- questioning
- questionnaires
- quizzes, tests, examinations
- rating scales
- reports
- reviews of performance
- self-assessments
- sorting scales (rubrics)
- surveys
- videotapes
- work samples
- written assignments

Involving Students in the Assessment Process

When students are aware of the outcomes they are responsible for and the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate what they know, are able to do, and value.

It is important that students participate actively in the assessment and evaluation of their learning, developing their own criteria and learning to judge a range of qualities in their work. Students should have access to models in the form of scoring criteria, rubrics, and work samples.
As lifelong learners, students assess their own progress, rather than relying on external measures, for example marks, to tell them how well they are doing. Students who are empowered to assess their own progress are more likely to perceive their learning as its own reward. Rather than asking What does the teacher want? students need to ask questions such as What have I learned? What can I do now that I couldn't do before? What do I need to learn next?

Effective assessment practices provide opportunities for students to

- reflect on their progress toward achievement of learning outcomes
- assess and evaluate their learning
- set goals for future learning

Diverse Learning Styles and Needs

Teachers should develop assessment practices which affirm and accommodate students' cultural and linguistic diversity. Teachers should consider patterns of social interaction, diverse learning styles, and the multiple ways oral, written, and visual language are used in different cultures for a range of purposes. Student performance takes place not only in a learning context, but in a social and cultural context as well.

Assessment practices must be fair, equitable, and without bias, providing a range of opportunities for students to demonstrate their learning.

Teachers should be flexible in evaluating the learning success of students, and seek diverse ways for students to demonstrate their personal best. In inclusive classrooms, students with special needs have opportunities to demonstrate their learning in their own way, using media which accommodate their needs, and at their own pace.

Portfolios

A major feature of assessment and evaluation in Electrotechnologies 11 is the use of portfolios. A portfolio is a purposeful selection of a student's work that tells the story of the student's efforts, progress, and achievement.

Portfolios engage students in the assessment process and allow them to participate in the evaluation of their learning. Portfolios are most effective when they provide opportunities for students to reflect on and make decisions about their learning. The students and teacher should collaborate to make decisions about the contents of the portfolio and to develop the criteria for evaluating the portfolio. Portfolios should include

- the guidelines for selection
- the criteria for judging merit
- evidence of student reflection
Portfolio assessment is especially helpful for the student who needs significant support. Teachers should place notes and work samples from informal assessment in the portfolio and use the portfolio to collaborate with the student in identifying strengths and needs, selecting learning experiences, and selecting work that best reflects the student’s progress toward achievement of learning outcomes.

It is important that students share their portfolios with other students so that all students may see exemplars that represent a range of strategies for expression and levels of complexity in ideas and understanding.

Outlines and other evidence of planning, along with multiple revisions, allow students to examine their progress and demonstrate achievement to teachers, parents, and others.

Students should be encouraged to develop a portfolio which demonstrates their achievements in a context beyond a particular course, including letters, certificates, and photographs, for example, as well as written documents. A career portfolio can be very helpful when students need to demonstrate their achievements to potential employers or admission offices of post-secondary institutions.

**Tests and Examinations**

Traditional tests and examinations are not, by themselves, adequate to assess student learning. The format of tests and examinations can be revised and adapted to reflect key aspects of the curriculum. Some teachers, for example, have designed tests and examinations based on collaborative or small-group learning, projects, or portfolio learning. Creating opportunities for students to collaborate on a test or examination is an effective practice in the interactive classroom, when assessing learning of a higher order than recall of information, for example, learning that requires synthesis, analysis, or evaluation.

In learning activities that involve responding to a text or solving a problem, for example, students might work collaboratively to clarify and define the task, and then work either collaboratively or individually to develop an answer. Students might be given a range of questions, issues, or problems, and work collaboratively to clarify their understanding of the assignments and plan responses in preparation for the examination for which only one of the questions, issues, or problems will be assigned. The initial list of questions, issues, or problems can be developed by the teacher, negotiated by the teacher with students, or developed by students and screened by the teacher.
Process-based tests and examinations allow students to demonstrate knowledge and skills and apply strategies at multiple stages in learning processes, for example, in creating texts; responding to texts or issues; solving problems; or gathering, evaluating, and synthesizing information.

Traditional tests and examinations may present a number of problems in scheduling and resource allocation. Process-based tests and examinations may be undertaken in steps during several class periods over a number of days. Students have opportunities to revise, reflect on, and extend their knowledge and understanding. Teachers have opportunities to develop comprehensive assessments, to monitor and evaluate learning at multiple points in a process, and to use time flexibly.

Certification and Credentialling

In Electrotechnologies 11, students will need to prepare to demonstrate their learning through entrance tests and examinations, or to obtain or upgrade a certification. Replicating this type of assessment in the classroom can help students prepare for the conditions and assessment formats they may encounter in workplace and post-secondary situations.

To make this kind of assessment an effective learning experience, teachers should define a specific context and purpose, for example, the operation of a device, the identification of materials labels, or the demonstration of a technique or procedure.

Effective Assessment and Evaluation Practices

Effective assessment improves the quality of learning and teaching. It can help students to become more reflective and to have control of their own learning, and it can help teachers to monitor and focus their instructional programs.

Assessment and evaluation of student learning should accommodate the complexity of learning and reflect the complexity of the curriculum. Evaluation should be based on the full range of learning outcomes towards which students have been working during the reporting period, be proportionate to the learning experiences related to each outcome, and focus on patterns of achievement as well as specific achievement.

In reflecting on the effectiveness of their assessment program, teachers should consider the extent to which their practices

- are fair in terms of the student’s background or circumstances
- are integrated with learning
- provide opportunities for authentic learning
- focus on what students can do rather than on what they cannot do
- provide students with relevant, supportive feedback that helps them to shape their learning
• describe students’ progress toward learning outcomes
• help them to make decisions about revising, supporting, or extending learning experiences
• support learning risk taking
• provide specific information about the processes and strategies students are using
• provide students with diverse and multiple opportunities to demonstrate their achievement
• provide evidence of achievement in which students can take pride
• acknowledge attitudes and values as significant learning outcomes
• encourage students to reflect on their learning and to articulate personal learning plans
• help them to make decisions about teaching strategies, learning experiences and environments, student grouping, and resources
• accommodate multiple responses and a range of tasks and resources
• include students in developing, interpreting and reporting on assessment
APPENDICES
Appendix A: Using Electronic Workbench

Electronic Workbench is a very sophisticated but versatile program. It can be used in educational situations ranging from elementary school through the research level.

There are many facets to Electronic Workbench. Teachers of Electrotechnologies 11 should become familiar with its operation before allowing students to work with it. While there is some useful documentation with the program, most of it goes far beyond the needs of grade 11 students. With that in mind, the program is an excellent source of material for enrichment work.

The EWB main screen is a bit formidable at first. To construct simple circuits one must use the items in the lower toolbar.

Each of the buttons brings up another toolbar containing various electronic components which may be dragged into the drawing area in the main window, in this case, the window labeled “Untitled”.

In Electrotechnologies 11 most students will be able to complete compulsory tasks using very few of the tool palettes. In most cases they will not be required to use all tools within specific palettes. The User’s Guide does not illustrate all the Parts Bin components. It is assumed that users will have the program at hand to try things out. Therefore the following are the parts bin palettes which will be of most use to Grade 11 students:
Sources

Basic Components

Diodes
Transistors

Logic Gates

Indicators
Miscellaneous Components

One of the palettes can be opened at a time. The circuit is drawn by dragging a selected component or components into the drawing area. When the mouse cursor is placed on a free end of a component, a black dot appears. You may drag this dot to any other component on the drawing area. EWB then completes the connection by drawing in wires automatically in a geometric fashion. EWB is not a CAD program. Most of the work of creating actual diagrams is carried out behind the scenes. EWB itself arranges wires in a neat rectangular fashion so the user need not be concerned about creating neat diagrams.

Very few sample circuits are contained with the EWB software. Those that are provided are rather too advanced for grade 11 students, at least at first. It is best if teachers provide some simple examples themselves to get students started. It is estimated that from a cold start, a teacher should be able to produce a working diagram of a DC power source, a resistance, and a multimeter in about an hour.

Circuits may be turned on and off with the power switch at the top right hand corner of the EWB screen.
A Sample Lab with Electronic Workbench

This example describes the steps used to create a very simple circuit using EWB.

Purpose to emulate measurement of voltage and current in a simple circuit using Electronics Workbench

Tools Electronics Workbench running on a PC.

Method
- Start Electronics Workbench.
- Click on the sources palette to open it.
- Drag a battery onto the work surface by holding the left mouse button and pulling the battery onto the work surface. Drop it there by releasing the left mouse button.
- Close the sources palette by clicking the “X” in the top right corner of it.

Your screen should look like this:

![Image of Electronics Workbench](image)

To proceed:
• Click on the Basic Palette to open it.
• Drag and drop a resistor onto the work surface. It will be horizontally displayed. Right click on the resistor to open its context menu.
• Select “Rotate” to align the resistor vertically.
• Close the Basic Palette.

Your screen should now look like this:
To proceed:

- Click on the Indicators Palette to open it.
- Drag and Drop a Voltmeter ([V]) to the right of the resistor.
- Drag and Drop an Ammeter above and between the battery and the resistor.
- Close the Indicators Palette.

Your screen should now look like this:
To proceed:

- Move the mouse pointer to the top lead of the battery. A small black dot should appear.
- Holding down the left mouse button, drag that dot to the left lead of the ammeter.
- Drop the line when a black dot appears at the end of the ammeter lead.
- Do the same for the voltmeter.
- Join the right-hand lead of the ammeter to the wire on the top of the resistor.
- Join the bottom voltmeter lead to the bottom lead of the resistor.

Your screen should now look something like this:

The lead positions may be adjusted by dragging them until the diagram is the way you want it.
To proceed:

- Turn on the circuit by pressing the toggle switch at the top right of the screen down using a mouse click
- Allow time for EWB to perform necessary calculations before displaying the readings in the Ammeter and Voltmeter.

Your screen should now look like this:

Notice that the currents and voltages will be rounded off. EWB uses floating point mathematics which is very much like using logarithms to do calculations.
To proceed:

- Click on the resistor with the RIGHT mouse button to open a context menu.
- Select “Component Properties” from that menu by clicking on it with the left mouse button.
- In the box showing the properties, change the resistance to 5
- Turn the circuit back on with the toggle switch. You will have to do this every time you make a change to a component property.

Your screen should now look like this:

Notice that the current changes.
Change the resistance several times keeping a written record for the current and voltage.
To proceed:

Right click on the battery and change its voltage to 24.
Turn on the circuit.

Your screen should now look something like this:

Now record several values of current and resistance, leaving the resistance the same and changing the voltage.

Analysis

- Draw graphs of current against voltage for a varying resistance and constant voltage.
- Draw graphs of current against voltage for a varying voltage and a constant resistance.
- What are the shapes of your graphs?
- Draw graphs of voltage against resistance for a varying resistance and a constant voltage.
- How does the shape of your graph differ from the previous ones?
- Calculate the slope of your graphs.
- Write down your conclusions about how voltage, current and resistance are related.
- Suggest ways you could use to verify your conclusions and test them with Electronics Workbench.
Appendix B: Using the Internet

The Internet can be a valuable resource for information searches on topics not readily available in the classroom. It is most valuable used to extend concepts learned in the classroom. It is important that teachers ensure that all students have equal access to Internet resources.

The links listed here may not all be operational due to the fluid nature of the Internet. An on-line site for Electrotechnologies 11 containing support for this course and current links to technology related sites may be found at http://www.ednet.ns.ca/educ/currwebs/electro

Teachers can approach the Electrotechnologies 11 webmaster for aid in creating dedicated forums in which discussions can be carried on among classes in other schools. An example might be the case where students in schools from different parts of the province want to share information gathered during field trips to businesses in their local areas with other schools.

General Links for All Modules

<table>
<thead>
<tr>
<th>Website</th>
<th>Comment</th>
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<tbody>
<tr>
<td>Math Studyworks Collaboratory</td>
<td>Internet extensions for Math Studyworks. Using an external browser is faster than using the Web connection in the Math Studyworks program.</td>
</tr>
<tr>
<td>San Francisco Exploratorium</td>
<td>Very useful general scientific site</td>
</tr>
<tr>
<td>Ontario Science Centre</td>
<td>Very useful general scientific site</td>
</tr>
<tr>
<td>The Discovery Channel</td>
<td>Features some on-line versions of technology programs</td>
</tr>
<tr>
<td>Critical Velocity</td>
<td>Independently maintained science site. Contains archives of articles useful in the ET course and also the beginnings of a list of schematic symbols with images describing the actual components.</td>
</tr>
<tr>
<td>Carnegie Science Academy</td>
<td>Society that encourages high school students to take an interest in science.</td>
</tr>
<tr>
<td>Edison</td>
<td>Digital magazine about Science &amp; Technology. Scientists and experts answer Kids' questions</td>
</tr>
<tr>
<td>The Evidence Database at Berkeley</td>
<td>Famous database of archived articles covering all branches of scientific thought.</td>
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Module 1: Components and Concepts

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<th>Website</th>
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<tr>
<td>Lawrence Livermore National Laboratory</td>
<td>High energy electrostatic devices</td>
</tr>
<tr>
<td>van de Graaf Linear Accelerator Facility</td>
<td>Advanced site showing uses of electrostatic devices. A research site.</td>
</tr>
<tr>
<td>Electrostatic Applications</td>
<td>Contains a section for Projects and Teaching</td>
</tr>
<tr>
<td>Electrostatics articles</td>
<td>Devoted to popular articles dealing with electrostatics such as the Hindenberg disaster.</td>
</tr>
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### Module 2: Power Distribution and Conversion

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<th>Website</th>
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<tbody>
<tr>
<td>Auburn University Oersted Page</td>
<td>Demonstration of apparatus used in the Oersted Effect</td>
</tr>
<tr>
<td>Oersted</td>
<td>Part of a comprehensive site dealing with the development of electrical technology</td>
</tr>
<tr>
<td>AAPT page devoted to recipients of the Oersted medal for science teaching</td>
<td>Teachers' page</td>
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### Module 3: Digital Technology

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<th>Website</th>
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<tbody>
<tr>
<td>The Programmable ASIC company</td>
<td>A list of paper on control circuit chips</td>
</tr>
<tr>
<td>Siemens</td>
<td>A large manufacturer of electronic components and circuit boards</td>
</tr>
<tr>
<td>IEEE</td>
<td>History of computing</td>
</tr>
<tr>
<td>IEEE</td>
<td>Design and test of computers</td>
</tr>
<tr>
<td>ASCII</td>
<td>An ASCII chart in various number systems</td>
</tr>
<tr>
<td>Another ASCII site</td>
<td>Very useful site for educators. Winner of several awards</td>
</tr>
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### Module 4: Robotics

<table>
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<th>Website</th>
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<tbody>
<tr>
<td>Automation Tooling Systems</td>
<td>One of the largest Canadian robotics companies</td>
</tr>
<tr>
<td><a href="http://www.androidworld.com/Android">http://www.androidworld.com/Android</a> World</td>
<td>A site devoted to anthropomorphic robots</td>
</tr>
<tr>
<td>Cool Robot of the Week</td>
<td>A NASA site that features robotics sites</td>
</tr>
<tr>
<td>Robot Science and Technology On-Line magazine</td>
<td>Magazine for educators, students, hobbyists, and enthusiasts</td>
</tr>
<tr>
<td>White Noise BEAM Robotics</td>
<td>A very interesting private site that specializes in the construction of robots using simple materials</td>
</tr>
</tbody>
</table>
Appendix C: Using Common Materials to Construct and Use Electric Wet Cells for Testing Circuits

Rationale

Common fruits and vegetables may be used to derive most of the circuit concepts detailed in Module 1 as well as showing the nature of wet cells. However, since this is a technology course, students should be exposed to real industrial quality devices as well.

The Nature of Wet Cells

Wet cells are nothing more than a container filled with an electrolyte into which are immersed electrodes of differing metals. Since fruits are acidic in nature we assume that they can be used as the container filled with the electrolyte.

Naturally, the best fruits and vegetables to use are the most acidic, but the investigation should not be limited to them. It is just as important to get so called “bad” results as it is to get good ones. Therefore, one might want to consider using lemons, oranges, apples, melons, or potatoes. Citrus fruits will give the best results, but others will also give valuable results.

Any small strips of metal such as pieces cut from cans, nails, screws, and so on can be used as electrodes.

Getting Organized

As is the case with any small-group learning experience, organization is of the utmost importance. The teacher should lead the groups in developing strategies that will result in worthwhile results. It is probably best to limit group size to four or five students.

Have the students accept responsibilities to build wet cells from predetermined fruits and electrodes in order to provide a range of results.

Developing Testing Strategies

Most students will readily accept the fact that the way to test a wet cell is to see if it produces “electrical power”. Teachers must guide them at this early stage to find variables which will give useful results. Measuring voltage and current flow with a multimeter will give quantitative results that can be used in calculations later, but it is also a fair test of a wet cell to see if it will, for instance, illuminate a flashlight bulb or an LED. Qualitative results are as important as quantitative ones in developing concepts.

The students themselves may come to the realization that better and more useful results could be generated if the class were to pool their results to get a wider range of data. The goal should be to have them come up with some kind of chart to complete, such as the following:
It is easy to see that quite a large amount of data can be generated. Displaying the results can best be done by having each group prepare charts of their results then enter them in a consolidated class chart.

**Questions to be Answered**

- Which fruits and vegetables make the best wet cells? Why
- Which electrodes work the best?
- Is there a combination of metals which give better results than others?
- Do all fruits of the same type give the same results? Why?
- What could you do to a “bad” fruit to make it work better?

**Extensions**

Once students see that wet cells are nothing special and that valuable results and data can be obtained from ordinary materials they could go on to investigate further:

- connect various fruit cells in series
- determine whether or not the voltage produced by each is additive

While students may not have been exposed to the idea of series and parallel circuits, they could easily make the connection if they can show in the laboratory that a lemon plus an orange can actually give a predictable result. In other words, if a lemon produces 0.3V and an orange 0.2V, does the combination give 0.5V? This works fairly well; however, care must be taken to accumulate the result quickly because fruit cells tend to have a very short shelf life.

As stated in the rationale, the entire requirement for this course with respect to series and parallel circuits could be met with their fruit cells, but students will tire of this quickly and it is better to get on with using real cells as
quickly as possible.

Appendix D: Using the Math Studyworks

When you start Math Studyworks, the Control Center opens.

![Math Studyworks Resource Center](image)
It is very useful to familiarize yourself with all its options. A very valuable tool is the library.
The section dealing with physics has many items of use for electrotechnologies:

Physics Contents - Resource Center

Physics Made Simple

Forces
+ Newton's First and Third Laws of Motion
+ Newton's Second Law of Motion
+ Law of Universal Gravitation
+ Mass and Weight
+ Frictional Forces
+ Box on a Frictionless Inclined Plane
+ Box on an Inclined Plane with Friction
+ Centripetal Force
+ Restoring Force of a Spring
+ Torque
+ Vector Basics
Here is an example of the electric field of a point charge:

Any charged particle will produce an radial electric field that is uniform in every direction. This is similar to the concept of a gravitational field.

The magnitude of this electric field is directly proportional to the magnitude of the charge and is inversely proportional to the square of distance away from the charge.
The Weblink requires a connection to the Internet and is a browser to the Math Studylinks site. The browser and file format are proprietary, so viewing the site with an ordinary browser will not yield the same results as the program itself. Here is the opening screen at the site:

It is recommended that the teacher browse through all the sections to see what they hold.
The Calculator Connection includes instructions on how to use various models of calculators:
Math Studyworks has a complete on-line guide to using all its various features. For example:

Math Studyworks is, more than anything, a mathematical word-processor. It allows you to type in equations, edit them, graph them, and even read data files from the disk.
Appendix E: Building DC Motors from Common Materials

A kit can be made up of things gathered from around the school. In most cases these items will be readily available:

- one piece of wood 10 cm by 10 cm (from industrial arts wood shop or scraps from a lumberyard) on which to mount the motor
- five paper clips for bearings
- 3 finishing nails 10 cm long for the spindle and field coils
- a one inch cork for the field coil
- a piece of paper foil to construct the commutator (the commutator can simply be extensions of the armature coil)
- a piece of very thin cardboard or heavy paper to insulate the commutator from the spindle
- one or two metres of thin varnished wire for connections and to wrap coils
- a dozen heavy thumb tacks to mount the items on the wood base
- a diagram to show how the wiring is connected in the final motor

Teachers and students may wish to organize a competition, perhaps at lunch time or after school, where students present their motors. The teachers and students could judge the motors as to construction and operation, in much the same way as science fair projects are judged.

Once the students have completed their individual projects and are familiar with the basic concepts of the operation of DC motors, another project could be assigned to small groups in which the students actually design and construct a motor themselves and go through the same kind of demonstration process; this could be a very good introduction to the design process.

If sufficient interest is shown, there is no reason why individual students should not be encouraged to build low voltage AC motors. They may need guidance in the construction of commutators for such motors.
Appendix F: Choosing Electrotechnologies Projects

EDnet maintains a website for the Electrotechnologies 11 course. It is a clearinghouse for ideas shared among teachers and students in all aspects of the course. Its address is

Links to the websites mentioned here can be found on the Electrotechnologies 11 website.

The following suggestions may be valuable for students who need help in deciding on a project topic:

- Design and manufacture an electronic device to meet a specified need, for example:
  - a telephone amplifier for the hearing impaired
  - an automatic tracking system for the school’s astronomical telescope
  - an intercom system to be used at home to monitor nurseries
  - a timer to control an automatic watering system for a greenhouse

- Design and create an Internet website to explain an electronic principle to other students. The site could outline and describe the work of a person who made significant contributions to the development of some aspect of electronics or technology. Michael Faraday, for example, was known for being one of the greatest teachers of his time as well as for advancing electromagnetic theory. Another possibility is to outline the work done in one of the present-day electronic research facilities such as Bell Laboratories of Northern Electric.

- Present the work of a famous Nova Scotian or Maritimer who advanced human understanding in Electrotechnologies. Most students are aware that Baddeck was the home of Alexander Graham Bell for many years. It was during his residency there that he let his creativity loose to explore many topics in addition to his most famous, the telephone. The Bell museum is a very good source of project material. It may be reached through the Internet. The Nova Scotia Museum is a good starting point for project ideas in many areas. Parks Canada also maintains a list of historic sites, for instance Signal Hill in Newfoundland, the site of the first transatlantic radio transmission.

  - Alexander Graham Bell Museum
  - Nova Scotia Museum
  - Signal Hill

- Present an analysis of design and marketing for electronic devices created by local entrepreneurs in their own communities. Students may be aware of possibilities near where they live, but teachers should be prepared to help them search for information. Chambers of Commerce are good starting points for a search.

- As part of a design team, participate in a robotics competition. An annual competition is held throughout the Maritime provinces. Information is available from the Association of Science Teachers.

- Other websites that are useful sources of ideas for technology fair projects include the following:

  - PEI Science Fairs
  - Canada Wide Science Fair 1999
  - Canada Wide Science Fair 2000
  - School Science Fairs
Many other websites worldwide maintain science fair information. An Internet search will identify many of them which will lead you to others.

- Design and construct a radio-controlled model such as an airplane or boat
  
  Many hobby supply companies have interesting sites, for example,
  
  AGR Hobbies
  Remote Controlled Flying Saucer
  RC Aerowatch EM ag

- Design and build a technology fair project to create an electronic device. (See the Internet links above for ideas).
- Design and build an binary adder using simple gate circuits.
- Design and build a series of small control devices to illustrate gate circuits.
- Design and build a radio.
- Design and build a stereo amplifier.
- Analyse and explain the operation of several types of atomic particle accelerators.

Helpful websites include the following:

Fermilab
Stanford Linear Accelerator
CERN

- Obtain an amateur radio license and present guideline for doing so to other students.

Canadian Amateur Radio on the Internet

- Construct a working computer from discarded parts. Old computers are often available at little or no cost. One of the best places to look for information is the buy and sell news groups on the Internet.

- Design and construct a video monitoring system to prevent theft in schools. Local security companies would no doubt be willing to help in a project of this sort.

- Work with Nova Scotia's Technology Recycling Program
Appendix G: Project Rubric

This simple tool provides an example for teachers and students to use in defining project expectations, negotiating a mark, and monitoring progress. Not all of these elements will be useful for all projects.

<table>
<thead>
<tr>
<th></th>
<th>Does not yet meet expectations: 1 Point</th>
<th>Meets expectations: 2 Points</th>
<th>Exceeds expectations: 3 Points</th>
<th>Self Evaluation</th>
<th>Teacher Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topic/Content</strong></td>
<td>includes some essential information/elements with few details</td>
<td>includes essential information/elements with enough elaboration to give audience an understanding of the topic</td>
<td>covers topic completely and in depth, encourages audience to reflect or enquire further</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Analysis/Development</strong></td>
<td>information/ideas presented for simplification and analysis</td>
<td>information/ideas selected, organized, and assessed</td>
<td>information/ideas selected and analyzed comprehensively</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Product/Solution/Inquiry</strong></td>
<td>has limited effectiveness or is not effective</td>
<td>is effective</td>
<td>results are elegant, sophisticated, or comprehensive</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Specific Requirements</strong></td>
<td>includes ___ or less ___ (to be filled in by teacher and student)</td>
<td>includes at least ________</td>
<td>includes at least ___ or more_____</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Format</strong></td>
<td>includes several inappropriate, incorrect, or ineffective elements</td>
<td>elements are generally used effectively, appropriately, and correctly</td>
<td>elements are used to enhance, clarify, and emphasize</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group Work</strong></td>
<td>works with others, but has difficulty sharing decisions and responsibilities with others</td>
<td>works well with others, takes part in decisions, and contributes fairly to group</td>
<td>works well with others, assumes a clear role and related responsibilities, motivates others to do their best</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Presentation Skills</strong></td>
<td>some difficulty communicating ideas</td>
<td>communicates ideas with adequate preparation, and some enthusiasm</td>
<td>communicates ideas with enthusiasm, clarity, and control</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Points
Appendix H: Key Concepts in the Design Process

The following is taken from the Ontario Ministry of Education website. The entire document is available online.

The design process described below has five stages. Sections in italic in parentheses indicate the instructions for each stage that could be addressed to the student(s) designing the product or providing the service.

1. Developing a Focus
The students identify the problem or challenge and begin keeping a record of the design process (a technological report or design brief). Initially, students should use the design brief to outline the broad aims of the project and describe in a general way what needs to be done to achieve those aims. As work progresses on the project, students may periodically revise the initial broad plan to reflect what is actually happening. (Meet with your client or the group for whom your product or service is being developed. Discuss the project with them to determine what you must accomplish and to establish goals for completing the product or delivering the service.)

2. Developing a Framework
The students identify various possible solutions and the resources required to achieve them; they determine whether the various resources are available and record their findings in the design brief. During this stage they may discover that they need to redefine the problem or challenge. (Identify various ways in which the possible solutions could be achieved. Evaluate each of these alternatives in terms of quality, cost, durability, expectations, etc. As at any other stage in the process, you may need to redefine what you want to accomplish.)

3. Choosing the Best Solution
The students consider such factors as what materials, tools, and resources are available, the amount of time needed to carry out different procedures, and any relevant ergonomic and aesthetic requirements. If necessary, they construct and evaluate a model. Based on the results of these activities, they choose the solution that seems best. They record the reasons for choosing a particular solution in the design brief. (Draw up a technical report that sets out for your client the recommendations or best alternatives. Develop a draft plan of action, which may include preliminary drawings.)

4. Implementing a Plan
The students try out different ways of achieving the best solution and construct the product, process, or system. For physical products, they make a full-sized prototype using production-type materials, tools, and equipment. As they assess every aspect of the construction phase, they may make changes to the production plan. They may even modify the original conception of the product to reflect ideas that emerge during construction or to solve problems they did not think of when they began the process. The students record any and all such changes in the design brief. (Develop a final plan, including final working drawings and a prototype for the approval of your client. Make the product, or provide the service, to your client’s specifications.)

5. Reflecting on the Process and the Product
The students evaluate the process used and the end result in light of their own expectations and the reactions of peers and the client. As a result of their evaluation, they may decide to modify the production process, the product, or even the original definition of the problem or challenge. Also at this stage they complete the design brief or technological report and communicate their results. (As a group, evaluate the final product or
service, including your client's reaction to it. Redesign and make changes to the process or product that will be incorporated when filling subsequent orders. Prepare reports and marketing strategies. Outline quality-control procedures that should be used for further products or services).

The steps or techniques used in solving a problem are known as the problem-solving process. In technological studies, this process is often called "the design process". At the beginning of a design process the student analyses a given set of conditions in order to identify a problem, challenge, or need. The student then works through a number of identifiable stages in order to arrive at a solution.

A design process includes all the stages in the development of a product or process. Designing is not necessarily a linear activity, however, but may require the student to reformulate or restate the problem, or revise the plan for solving it, or both. Although the process may have distinct stages, those stages will not necessarily be followed in a rigid sequence. For example, students must evaluate (reflect on) their work at each stage of the process. As they do so, they may discover that they need to return to an earlier stage to make modifications; or they may decide to complete a particular step sooner than was originally planned.

The projects that students develop and work on must be closely monitored by the teacher to ensure that students acquire the knowledge, skills, and values that have been identified as the learning outcomes for the course. Before approving a student's project, the teacher must analyse it carefully to determine whether it will promote the necessary learning. Teacher and students must collaborate to ensure that safety issues have been taken into account and that the required resources, learning aids, tools, equipment, and materials are identified and obtained for each project.

Students should be aware that they are required to participate in their own evaluation. When they find themselves in the world of work, they will often be called upon to make judgements about their own work before it is seen by others, and in some cases the only quality control will be in the hands of the original designer.

A project must not necessarily be successful in order for it to achieve a valid educational result. Risk taking and imagination on the part of students is a valuable indicator of learning, if the lessons taken from it are understood.
Appendix I: Facts about Number Systems

The word binary actually means “two” which makes sense since it expresses two states, (ON/OFF, TRUE/FALSE, etc.). Components recognize “ON” as 1 and “OFF” as 0. In this way computers can make decisions. For example, by grouping sets of 1s and 0s together, computers can recognize letters and symbols known as ASCII (letters and numbers).

Computers and Binary Numbers

Without Binary the modern day computer would cease to exist. Everything entered into a computer is converted into binary. If you type in the letter “B” it is converted to the Binary "01000010" by your keyboard which sends the information to the CPU (Central Processing Unit). Binary is somewhat like Morse code it is sent to the CPU in a series of electronic pulses. High voltage pulses are considered 1’s and low voltage pulses are considered 0s.

A single 1 or 0 is one bit. There are eight bits in a byte (That is why each letter consists of eight ones or zeros). This means that one 1.44 Meg disk holds over 1 million letters or characters (which means that it holds over 8 million 1s and 0s in total!).

CD-ROMs are based on Binary (whether or not a hole (Micropit) is present on the CD-ROM (the laser picks this up))

- John Atanasoff was the first person to think of using Binary with computers.
- Electronic circuits use Binary in logic decisions (True/False etc.)
- Binary was a counting system long before computer as we know them were even thought of.

How Computers Recognize Letters and Numbers (Ascii)

Here is the conversion chart from Binary to Ascii:

<table>
<thead>
<tr>
<th>A</th>
<th>01000001</th>
<th>S</th>
<th>01010011</th>
<th>k</th>
<th>01101011</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>01000010</td>
<td>T</td>
<td>01010100</td>
<td>l</td>
<td>01101100</td>
</tr>
<tr>
<td>C</td>
<td>01000011</td>
<td>U</td>
<td>01010101</td>
<td>m</td>
<td>01101101</td>
</tr>
<tr>
<td>D</td>
<td>01000100</td>
<td>V</td>
<td>01010110</td>
<td>n</td>
<td>01101110</td>
</tr>
<tr>
<td>E</td>
<td>01000101</td>
<td>W</td>
<td>01010111</td>
<td>o</td>
<td>01101111</td>
</tr>
<tr>
<td>F</td>
<td>01000110</td>
<td>X</td>
<td>01011000</td>
<td>p</td>
<td>01110000</td>
</tr>
<tr>
<td>G</td>
<td>01000111</td>
<td>Y</td>
<td>01011001</td>
<td>q</td>
<td>01110001</td>
</tr>
<tr>
<td>H</td>
<td>01001000</td>
<td>Z</td>
<td>01011010</td>
<td>r</td>
<td>01110010</td>
</tr>
<tr>
<td>I</td>
<td>01001001</td>
<td>a</td>
<td>01100001</td>
<td>s</td>
<td>01110011</td>
</tr>
<tr>
<td>J</td>
<td>01001010</td>
<td>b</td>
<td>01100010</td>
<td>t</td>
<td>01110100</td>
</tr>
<tr>
<td>K</td>
<td>01001100</td>
<td>c</td>
<td>01100011</td>
<td>u</td>
<td>01110101</td>
</tr>
<tr>
<td>L</td>
<td>01001110</td>
<td>d</td>
<td>01100100</td>
<td>v</td>
<td>01110110</td>
</tr>
<tr>
<td>M</td>
<td>01010001</td>
<td>e</td>
<td>01100101</td>
<td>w</td>
<td>01111011</td>
</tr>
<tr>
<td>N</td>
<td>01010110</td>
<td>f</td>
<td>01100110</td>
<td>x</td>
<td>01111000</td>
</tr>
<tr>
<td>O</td>
<td>01011100</td>
<td>g</td>
<td>01101000</td>
<td>y</td>
<td>01111001</td>
</tr>
<tr>
<td>P</td>
<td>01011110</td>
<td>h</td>
<td>01101000</td>
<td>z</td>
<td>01111010</td>
</tr>
<tr>
<td>Q</td>
<td>01010001</td>
<td>i</td>
<td>01101001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>01010010</td>
<td>j</td>
<td>01101010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period</td>
<td>00101110</td>
<td>Other Miscellaneous Characters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>----------</td>
<td>-------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comma</td>
<td>00101100</td>
<td>! 00100001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space</td>
<td>00100000</td>
<td>&quot; 00100010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numbers</td>
<td></td>
<td># 00100011</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$ 00100100 (Money counts even in binary!)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>00110000</td>
<td>% 00100101</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>00110001</td>
<td>&amp; 00100110</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>00110010</td>
<td>; 00100111</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>00110101</td>
<td>( 00101000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>00110110</td>
<td>) 00101001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>00110111</td>
<td>* 00101010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>00111000</td>
<td>+ 00101011</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>00111001</td>
<td>, 00101100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>00111010</td>
<td>; 00101111</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>00111011</td>
<td>- 00101111</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Appendix J: Sample Rubric for Workshop and Laboratory Procedures and Health and Safety Practices

<table>
<thead>
<tr>
<th>Rating</th>
<th>Criteria</th>
</tr>
</thead>
</table>
| **Resource** | The student  
* prepares self for task  
* organizes and works in an orderly manner  
* identifies appropriate tools and resources |
| **Lab Routines** | The student  
* follows established routines  
* recognizes and avoids unsafe acts and conditions  
* demonstrates responsibility for housekeeping  
* is aware of first aid and emergency practices  
* uses time effectively |
| **Tools and Equipment** | The student  
* identifies appropriate tools and equipment  
* uses tools and equipment in a safe manner  
* uses personal protective equipment  
* stores tools, materials, and equipment as instructed |

**Rating Scale**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>The student exceeds defined outcomes, makes plans, and solves problems effectively and creatively in a self-directed manner. Tools, materials and/or processes are selected and used efficiently, effectively, and with confidence. Quality, particularly details and finishes, and productivity are consistent and exceed expectations. Leads others to contribute to team goals.</td>
</tr>
<tr>
<td>3</td>
<td>The student meets defined outcomes, makes plans, and solves problems in a self-directed manner. Tools, materials, and/or processes are selected and used efficiently and effectively. Quality and productivity are consistent. Works co-operatively and contributes ideas and suggestions that enhance team effort.</td>
</tr>
<tr>
<td>2</td>
<td>The student meets defined outcomes, makes plans, and solves problems with limited assistance. Tools, materials, and/or processes are selected and used appropriately. Quality and productivity are reasonable and consistent. Works co-operatively to achieve team goals.</td>
</tr>
<tr>
<td>1</td>
<td>The student meets defined outcomes, and, with guidance, follows a guided plan of action. The student makes appropriate use of a limited range of tools, materials, and/or processes. Quality and productivity are reasonable and consistent. Works co-operatively.</td>
</tr>
<tr>
<td>0</td>
<td>The student has not completed defined outcomes. The student does not make appropriate use of tools, materials, and/or processes are used inappropriately.</td>
</tr>
</tbody>
</table>

**Reflections/Comments**
# Appendix K: Sample Rubric for an Electricity/Electronics Investigation

<table>
<thead>
<tr>
<th>Rating</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Student Fundamentals</strong></td>
<td>states the function of system/circuit&lt;br&gt;explains the operation of system/circuit&lt;br&gt;explains electrical/electronics concepts involved</td>
</tr>
<tr>
<td><strong>Planning and Preparation</strong></td>
<td>uses schematics, manuals, resources&lt;br&gt;creates/uses block diagram(s), flow chart(s)&lt;br&gt;identifies and locates components&lt;br&gt;creates/uses a circuit layout&lt;br&gt;identifies system(s), sub system(s), component(s)&lt;br&gt;states component value, characteristics&lt;br&gt;identifies component placement&lt;br&gt;applies computer simulation of circuit&lt;br&gt;installs and configures software</td>
</tr>
<tr>
<td><strong>Constructing/Prototyping</strong></td>
<td>constructs electrical/electronic prototype&lt;br&gt;installs materials/components cabling for given application&lt;br&gt;uses correct tools, equipment, and procedures&lt;br&gt;applies correct connecting techniques</td>
</tr>
<tr>
<td><strong>Evaluation/Testing</strong></td>
<td>shows how system operates within given parameters&lt;br&gt;analyses basic electrical circuit&lt;br&gt;uses correct voltage source&lt;br&gt;uses multimeter (analog and digital)&lt;br&gt;uses voltmeter/ammeter/ohmmeter&lt;br&gt;uses an oscilloscope&lt;br&gt;is able to interpret results</td>
</tr>
<tr>
<td><strong>Problem Solving</strong></td>
<td>identifies system/sub system problem area&lt;br&gt;research steps to solve problem&lt;br&gt;follows flow chart&lt;br&gt;is able to correct problem&lt;br&gt;performs routine maintenance</td>
</tr>
</tbody>
</table>
APPENDIX K

Rating Scale

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>The student exceeds defined outcomes, makes plans, and solves problems effectively and creatively in a self-directed manner. Tools, materials and/or processes are selected and used efficiently, effectively, and with confidence. Quality, particularly details and finishes, and productivity are consistent and exceed expectations. Leads others to contribute to team goals.</td>
</tr>
<tr>
<td>3</td>
<td>The student meets defined outcomes, makes plans, and solves problems in a self-directed manner. Tools, materials, and/or processes are selected and used efficiently and effectively. Quality and productivity are consistent. Works co-operatively and contributes ideas and suggestions that enhance team effort.</td>
</tr>
<tr>
<td>2</td>
<td>The student meets defined outcomes, makes plans, and solves problems with limited assistance. Tools, materials, and/or processes are selected and used appropriately. Quality and productivity are reasonable consistent. Works co-operatively to achieve team goals.</td>
</tr>
<tr>
<td>1</td>
<td>The student meets defined outcomes, and, with guidance, follows a guided plan of action. The student makes appropriate use of a limited range of tools, materials, and/or processes. Quality and productivity are reasonable consistent. Works co-operatively.</td>
</tr>
<tr>
<td>0</td>
<td>The student has not completed defined outcomes. The student does not make appropriate use of tools, materials, and/or processes are used inappropriately.</td>
</tr>
</tbody>
</table>

Reflections/Comments:

Adapted from G. 18/Electro-Technologies, C T S Assessment Tools (1997) © Alberta Education, Alberta, Canada
## Appendix L: Sample Framework for Assessing Workshop or Laboratory Investigations

<table>
<thead>
<tr>
<th></th>
<th>Meets minimum expectations</th>
<th>Meets expectations</th>
<th>Exceeds expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The student prepares self for task</td>
<td>The student prepares self for task</td>
<td>The student prepares self for task</td>
<td></td>
</tr>
<tr>
<td>organizes and works in an orderly manner</td>
<td>organizes and works in an orderly manner</td>
<td>organizes and works in an orderly manner</td>
<td></td>
</tr>
<tr>
<td>carries out instructions accurately</td>
<td>carries out instructions accurately</td>
<td>carries out instructions accurately</td>
<td></td>
</tr>
<tr>
<td>uses time effectively</td>
<td>uses time effectively</td>
<td>uses time effectively</td>
<td></td>
</tr>
<tr>
<td><strong>Teamwork</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>co-operates with group members</td>
<td>co-operates with group members</td>
<td>co-operates with group members</td>
<td></td>
</tr>
<tr>
<td>shares work appropriately among group members</td>
<td>shares work appropriately among group members</td>
<td>shares work appropriately among group members</td>
<td></td>
</tr>
<tr>
<td>negotiates solutions to problems</td>
<td>negotiates solutions to problems</td>
<td>negotiates solutions to problems</td>
<td></td>
</tr>
<tr>
<td><strong>Use of Equipment and Materials</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>selects and uses appropriate equipment/materials</td>
<td>selects and uses appropriate equipment/materials</td>
<td>selects and uses appropriate equipment/materials</td>
<td></td>
</tr>
<tr>
<td>follows safe procedures/techniques</td>
<td>follows safe procedures/techniques</td>
<td>follows safe procedures/techniques</td>
<td></td>
</tr>
<tr>
<td>weighs and measures accurately</td>
<td>weighs and measures accurately</td>
<td>weighs and measures accurately</td>
<td></td>
</tr>
<tr>
<td>returns clean equipment/materials to storage areas</td>
<td>returns clean equipment/materials to storage areas</td>
<td>returns clean equipment/materials to storage areas</td>
<td></td>
</tr>
<tr>
<td><strong>Investigative Techniques</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gathers and applies information from at least one source</td>
<td>gathers and applies information from at least one source</td>
<td>gathers and applies information from at least one source</td>
<td></td>
</tr>
<tr>
<td>makes predictions that can be tested</td>
<td>makes predictions that can be tested</td>
<td>makes predictions that can be tested</td>
<td></td>
</tr>
<tr>
<td>sets up and conducts experiments to test a prediction</td>
<td>sets up and conducts experiments to test a prediction</td>
<td>sets up and conducts experiments to test a prediction</td>
<td></td>
</tr>
<tr>
<td>distinguishes between manipulated/responding variables</td>
<td>distinguishes between manipulated/responding variables</td>
<td>distinguishes between manipulated/responding variables</td>
<td></td>
</tr>
<tr>
<td>obtains results that can be used to determine if some aspect of the prediction is accurate</td>
<td>obtains results that can be used to determine if some aspect of the prediction is accurate</td>
<td>obtains results that can be used to determine if some aspect of the prediction is accurate</td>
<td></td>
</tr>
<tr>
<td>summarizes important experimental outcomes</td>
<td>summarizes important experimental outcomes</td>
<td>summarizes important experimental outcomes</td>
<td></td>
</tr>
<tr>
<td><strong>Use of Equipment and Materials</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>selects and uses appropriate equipment/materials</td>
<td>selects and uses appropriate equipment/materials</td>
<td>selects and uses appropriate equipment/materials</td>
<td></td>
</tr>
<tr>
<td>follows safe procedures/techniques</td>
<td>follows safe procedures/techniques</td>
<td>follows safe procedures/techniques</td>
<td></td>
</tr>
<tr>
<td>weighs and measures accurately</td>
<td>weighs and measures accurately</td>
<td>weighs and measures accurately</td>
<td></td>
</tr>
<tr>
<td>practices proper sanitation procedures</td>
<td>practices proper sanitation procedures</td>
<td>practices proper sanitation procedures</td>
<td></td>
</tr>
<tr>
<td>minimizes waste of materials</td>
<td>minimizes waste of materials</td>
<td>minimizes waste of materials</td>
<td></td>
</tr>
<tr>
<td>advises of potential hazards and necessary repairs</td>
<td>advises of potential hazards and necessary repairs</td>
<td>advises of potential hazards and necessary repairs</td>
<td></td>
</tr>
<tr>
<td><strong>Investigative Techniques</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uses relevant information to explain observations</td>
<td>uses relevant information to explain observations</td>
<td>uses relevant information to explain observations</td>
<td></td>
</tr>
<tr>
<td>makes predictions that can be tested</td>
<td>makes predictions that can be tested</td>
<td>makes predictions that can be tested</td>
<td></td>
</tr>
<tr>
<td>plans, sets up, and conducts experiments to test a prediction</td>
<td>plans, sets up, and conducts experiments to test a prediction</td>
<td>plans, sets up, and conducts experiments to test a prediction</td>
<td></td>
</tr>
<tr>
<td>identifies and explains manipulated/responding variables</td>
<td>identifies and explains manipulated/responding variables</td>
<td>identifies and explains manipulated/responding variables</td>
<td></td>
</tr>
<tr>
<td>obtains accurate results that confirm/reject the prediction</td>
<td>obtains accurate results that confirm/reject the prediction</td>
<td>obtains accurate results that confirm/reject the prediction</td>
<td></td>
</tr>
<tr>
<td>summarizes and applies experimental outcomes</td>
<td>summarizes and applies experimental outcomes</td>
<td>summarizes and applies experimental outcomes</td>
<td></td>
</tr>
</tbody>
</table>
Appendix M: Occupational Health and Safety Act

Internal Responsibility System

The foundation of this Act is the Internal Responsibility system which is based on the principle that employers, contractors, constructors, employees and self-employed persons at a workplace, and the owner of a workplace, a supplier of goods or provider of an occupational health or safety service to a workplace or an architect or professional engineer, all of whom can affect the health and safety of persons at the workplace, share the responsibility for the health and safety of persons at the workplace;

Required instruction in principles

The curricula of
(a) a trade school or home study course within the meaning of the Trade Schools Regulation Act;
(b) a program of instruction within the meaning of the Community Colleges Act; and
(c) any other educational institution or class of educational institution designated pursuant to the regulations, shall include instruction in the principles of occupational health and safety contained in this Act. 1996, c. 7, s. 1996, c. 7, s.

The Act clearly stipulates that both employers and employees share responsibility for safety, therefore it is in a teacher's best interest to make himself aware of the further provisions of the Act.

A sample rubric for workshop and laboratory health and safety practice is found in Appendix J.

The entire Act is available for viewing on the Internet at

http://www.gov.ns.ca/legi/legc/statutes/occph&s1.htm

(d) provision for the preparation of written work procedures required to implement safe and healthy work practices.

(e) a hazard identification system that includes
   (i) evaluation of the workplace to identify potential hazards,
   (ii) procedures and schedules for regular inspections,
   (iii) procedures for ensuring the reporting of hazards and the accountability of persons responsible for the correction of hazards, and
   (iv) identification of the circumstances where hazards must be reported by the employer to the committee or representative, if any, and the procedures for doing so;

As well, the attention of teachers is drawn to the following sections for further reading:

Section 58
Restriction on use of chemicals
Where a biological, chemical or physical agent or a combination of such agents is used...
Section 59
Duty of employer to prepare list of chemicals
59 (1) Subject to Section 61, unless the employer has received from the Director specific written direction to the contrary and the direction has not been revoked by the Director, the employer shall prepare a list of all chemical substances regularly used.
Appendix N: WebQuest

A WebQuest is an Internet-based inquiry or problem-solving learning experience in which students, usually working in groups, have access to a range of on-line and other resources. Students gather information and ideas to build a scaffold of understanding leading to insights or solutions that they can share with others.

<table>
<thead>
<tr>
<th>introduction</th>
<th>use background information to articulate an engaging topic, issue, or question</th>
</tr>
</thead>
<tbody>
<tr>
<td>task</td>
<td>define the scope and limits of the task</td>
</tr>
<tr>
<td>plan</td>
<td>identify steps, develop a graphic organizer, guiding questions, and assessment</td>
</tr>
<tr>
<td>resources</td>
<td>make a list of Internet, text*, and human resources</td>
</tr>
<tr>
<td>process</td>
<td>analyse, evaluate, and synthesize ideas; organize, refine, and present results</td>
</tr>
<tr>
<td>conclusion</td>
<td>summarize, reflect on, and extend learning</td>
</tr>
</tbody>
</table>

*text describes any language event, whether oral written, or visual

**WebQuest Links**

<table>
<thead>
<tr>
<th>A WebQuest about WebQ uests</th>
<th><a href="http://edweb.sdsu.edu/courses/edtec596/webquest.webquest.html">http://edweb.sdsu.edu/courses/edtec596/webquest.webquest.html</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Blocks of a WebQuest</td>
<td><a href="http://edweb.sdsu.edu/people/bdodge/webquest/buildingblocks.html">http://edweb.sdsu.edu/people/bdodge/webquest/buildingblocks.html</a></td>
</tr>
<tr>
<td>Matrix of Example WebQuests</td>
<td><a href="http://www.esc20.net/techserv/projects/webquests.html">http://www.esc20.net/techserv/projects/webquests.html</a></td>
</tr>
<tr>
<td>Examples of WebQ uests</td>
<td><a href="http://edweb.sdsu.edu/people/bdodge/Professional.html">http://edweb.sdsu.edu/people/bdodge/Professional.html</a></td>
</tr>
<tr>
<td>Introduction to WebQ uests</td>
<td><a href="http://www.esc20.net/techserv/webquest/default.html">http://www.esc20.net/techserv/webquest/default.html</a></td>
</tr>
<tr>
<td>WebQuest In-service</td>
<td><a href="http://www.nde.state.ne.us/SS/webqinfo.html">http://www.nde.state.ne.us/SS/webqinfo.html</a></td>
</tr>
<tr>
<td>Thoughts About WebQ uests</td>
<td><a href="http://edweb.sdsu.edu/courses/edtec596/about_webquests.html">http://edweb.sdsu.edu/courses/edtec596/about_webquests.html</a></td>
</tr>
<tr>
<td>The WebQuest Page</td>
<td><a href="http://edweb.sdsu.edu/webquest/webquest.html">http://edweb.sdsu.edu/webquest/webquest.html</a></td>
</tr>
<tr>
<td>Triton Summer Symposium</td>
<td><a href="http://edweb.sdsu.edu/people/bdodge/Professional.html">http://edweb.sdsu.edu/people/bdodge/Professional.html</a></td>
</tr>
<tr>
<td>WebQuest Index (MISD)</td>
<td><a href="http://www.macomb.k12.mi.us/wq/webqindx.htm">http://www.macomb.k12.mi.us/wq/webqindx.htm</a></td>
</tr>
<tr>
<td>WebQuests Created by Teachers</td>
<td><a href="http://www.plainfield.k12.in.us/hschool/webquest.htm">http://www.plainfield.k12.in.us/hschool/webquest.htm</a></td>
</tr>
<tr>
<td>WebQuests for Learning</td>
<td><a href="http://edweb.sdsu.edu/edfirst/courses/webquest.html">http://edweb.sdsu.edu/edfirst/courses/webquest.html</a></td>
</tr>
<tr>
<td>WebQuests in Our Future</td>
<td><a href="http://www.capecod.net/schrockguide/webquest/wqsl1.htm">http://www.capecod.net/schrockguide/webquest/wqsl1.htm</a></td>
</tr>
<tr>
<td>Teaching with the Web</td>
<td><a href="http://www.thacher.pvt.k12.ca.us/weaving/ExampleWebQuests.html">http://www.thacher.pvt.k12.ca.us/weaving/ExampleWebQuests.html</a></td>
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</tbody>
</table>
# Appendix O: Suggested Learning Resources

<table>
<thead>
<tr>
<th>Description</th>
<th>Potential Supplier</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Software</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*ELECTRONICS WORKBENCH</td>
<td>Interactive Image Technologies Ltd</td>
<td>4:C</td>
</tr>
<tr>
<td></td>
<td>111 Peter St Suite 801</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toronto Ont M 5V 2H 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(on Authorized Learning Resources List)</td>
<td></td>
</tr>
<tr>
<td>CIRCUITS FOR USE WITH ELECTRONIC WORKBENCH</td>
<td>(on Authorized Learning Resources List)</td>
<td>4:C</td>
</tr>
<tr>
<td><strong>Equipment and Materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC POWER SUPPLY (12 VOLT)</td>
<td>RAE Industries</td>
<td>4:C</td>
</tr>
<tr>
<td></td>
<td>11 Morris Dr, Suite 103</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dartmouth N S B3B 1M 2</td>
<td></td>
</tr>
<tr>
<td>COPPER MAGNETIC WIRE (MOTOR)</td>
<td>WYCCO</td>
<td>6kg coil</td>
</tr>
<tr>
<td></td>
<td>2 Park Ave</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower Sackville N S B4C 4A3</td>
<td></td>
</tr>
<tr>
<td>TECHNICAL SET to demonstrate simple machines</td>
<td>LEGO Mindstorm</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><a href="http://www.legomindstorms.com">http://www.legomindstorms.com</a></td>
<td></td>
</tr>
<tr>
<td>PROTOBOARD (#10)</td>
<td>WYCCO</td>
<td>4:C</td>
</tr>
<tr>
<td></td>
<td>2 Park Ave</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower Sackville N S B4C 4A3</td>
<td></td>
</tr>
<tr>
<td>CRIMPING/CUTTING TOOL</td>
<td></td>
<td>4:C</td>
</tr>
<tr>
<td>CRIMP TERMINALS, SLOTTED</td>
<td>assorted</td>
<td></td>
</tr>
<tr>
<td>STUDENT PULL SPRING SCALE</td>
<td></td>
<td>4:C</td>
</tr>
<tr>
<td>METER STICKS</td>
<td></td>
<td>12:C</td>
</tr>
<tr>
<td>LEVER KNIFE EDGE CLAMP</td>
<td></td>
<td>4:C</td>
</tr>
<tr>
<td>HOOK WEIGHTS</td>
<td></td>
<td>4:C</td>
</tr>
<tr>
<td>Description</td>
<td>Potential Supplier</td>
<td>Quantity</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>STOP WATCHES, ELECTRONIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIGITAL MULTIMETER (GENERAL USE)</td>
<td>RAE Industries</td>
<td>4:C</td>
</tr>
<tr>
<td>WELLER #8200 Pk CSA SOLDERING GUNS</td>
<td>RAE Industries</td>
<td>2:C</td>
</tr>
<tr>
<td>ROLLS RESIN CORE SOLDER (wire) 1LB</td>
<td>RAE Industries</td>
<td>2:C</td>
</tr>
<tr>
<td>ASSORTED PLIERS</td>
<td>RAE Industries</td>
<td>1:C</td>
</tr>
<tr>
<td>SCREWDRIVER SETS (Robinson/Phillips/Slot) 25 pc set #57-3547-8</td>
<td>Canadian Tire 24 Forest Hills Parkway Dartmouth NS B2W 6E4</td>
<td>2:C</td>
</tr>
<tr>
<td>DRILL 3/8” 3.5 AMP</td>
<td>Canadian Tire 24 Forest Hills Parkway Dartmouth NS B2W 6E4</td>
<td>2</td>
</tr>
<tr>
<td>SET DRILL BITS (1/16-1/2), 29 pc #54-3619-4</td>
<td>Canadian Tire 24 Forest Hills Parkway Dartmouth NS B2W 6E4</td>
<td>2</td>
</tr>
<tr>
<td>TEACHER RESOURCES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*ESSENTIAL OF ELECTRONICS INSTRUCTOR’S RESOURCE GUIDE, 2nd Ed</td>
<td>IT Nelson (Delmar) (on Authorized Learning Resources List)</td>
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</tr>
<tr>
<td>*ESSENTIAL OF ELECTRONICS A SURVEY- STUDENT BASIC 2nd Ed</td>
<td>IT Nelson (Delmar) (on Authorized Learning Resources List)</td>
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