The Ontario Curriculum
Exemplars
Grade 11
Technological Education
Construction Technology
Transportation Technology

Samples of Student Work: A Resource for Teachers

Printed on recycled paper
ISBN 1-4249-0685-7 (Print)
ISBN 1-4249-0686-5 (PDF)
© Queen’s Printer for Ontario, 2006
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>3</td>
</tr>
<tr>
<td>Purpose of This Document</td>
<td>4</td>
</tr>
<tr>
<td>Features of This Document</td>
<td>4</td>
</tr>
<tr>
<td>The Tasks</td>
<td>5</td>
</tr>
<tr>
<td>The Rubrics</td>
<td>5</td>
</tr>
<tr>
<td>Use of the Student Samples</td>
<td>5</td>
</tr>
<tr>
<td>Teachers and Administrators</td>
<td>5</td>
</tr>
<tr>
<td>Parents</td>
<td>6</td>
</tr>
<tr>
<td>Students</td>
<td>6</td>
</tr>
<tr>
<td><strong>Construction Technology, Workplace Preparation (TCJ3E)</strong></td>
<td>7</td>
</tr>
<tr>
<td>A Wall Frame Corner Section</td>
<td>8</td>
</tr>
<tr>
<td>The Task</td>
<td>8</td>
</tr>
<tr>
<td>Expectations Addressed in the Exemplar Task</td>
<td>8</td>
</tr>
<tr>
<td>The Student Samples for This Task</td>
<td>8</td>
</tr>
<tr>
<td>Task Rubric</td>
<td>10</td>
</tr>
<tr>
<td>Student Samples</td>
<td>11</td>
</tr>
<tr>
<td>Teacher Package</td>
<td>40</td>
</tr>
<tr>
<td><strong>Transportation Technology, Workplace Preparation (TTJ3E)</strong></td>
<td>57</td>
</tr>
<tr>
<td>A Snowmobile Trailer Lighting System</td>
<td>58</td>
</tr>
<tr>
<td>The Task</td>
<td>58</td>
</tr>
<tr>
<td>Expectations Addressed in the Exemplar Task</td>
<td>58</td>
</tr>
<tr>
<td>Task Rubric</td>
<td>59</td>
</tr>
<tr>
<td>Student Samples</td>
<td>60</td>
</tr>
<tr>
<td>Teacher Package</td>
<td>84</td>
</tr>
</tbody>
</table>

This publication is available on the Ministry of Education’s website at http://www.edu.gov.on.ca.
The Ontario curriculum for secondary school students specifies both the knowledge and the skills that students are expected to develop and demonstrate in each grade. In the curriculum policy document for each discipline, teachers are provided with the curriculum expectations for each course within the discipline and an achievement chart that describes four levels of student achievement to be used in assessing and evaluating student work. Assessment and evaluation are based on the provincial curriculum expectations and the achievement levels outlined in the curriculum policy documents.

The ministry provides a variety of materials to assist teachers in improving their assessment methods and strategies and, hence, their assessment of student achievement. The present document is one of the resources intended to provide assistance to teachers in their assessment of student achievement. It presents samples (“exemplars”) of student work that was done in response to specific tasks in two Grade 11 technological education courses – Construction Technology, Workplace Preparation (TCJ3E), and Transportation Technology, Workplace Preparation (TTJ3E). The samples represent work at each of the four levels of achievement.

Teams of subject specialists from across the province developed the assessment materials for the Grade 11 exemplar project. They designed the tasks and scoring scales (“rubrics”) on the basis of selected Ontario curriculum expectations, and developed the teacher instructions. They field-tested the tasks in classrooms across the province, then they revised the tasks, rubrics, and instructions, using information gathered from the field-tests as well as suggestions for improvement from subject validation sessions. After the final administration of the tasks, a team of teachers for each subject scored the student work and chose samples of work that exemplified each of the four levels of achievement. (In some cases, in order to exemplify a level of achievement accurately with respect to all parts of a task, portions of the work of several students have been combined to create a representative sample. Such “composite” samples are provided in the case of Construction Technology.)

The selection of student samples that appears in this document reflects the professional judgement of teachers who participated in the exemplar project. No students, teachers, or schools have been identified.

The tasks, rubrics, and teacher’s notes and comments developed for this exemplar document can serve as a model for boards, schools, and teachers in designing assessment tasks within the context of regular classroom work, developing rubrics, assessing the achievement of their own students, and planning for the improvement of students’ learning.
The samples in this document will provide parents\(^1\) with examples of student work to help them monitor their children's progress. They also can provide a basis for discussions regarding student achievement and progress between teachers and parents and between teachers and students.

**Purpose of This Document**

This document was developed to:

- show the characteristics of student work at each of the four levels of achievement for Grade 11;
- promote greater consistency in the assessment of student work across the province;
- provide an approach to improving student learning by demonstrating the use of clear criteria applied to student work in response to a clearly defined assessment task;
- show the connections between what students are expected to learn (the curriculum expectations) and how their work can be assessed using the levels of achievement described in the curriculum policy document for the subject.

The samples in this document represent examples of student achievement obtained using only one method of assessment, called performance assessment. Teachers will also make use of a variety of other assessment strategies – such as tests, portfolios, and conferences – in evaluating student achievement in a course over a term or school year.

**Features of This Document**

This document contains the following, for each of the two technological education courses:

- a description of the performance task and of the final product that was handed in to the teacher for submission to the ministry
- the curriculum expectations related to the task
- the task-specific assessment chart, or rubric
- one sample of student work for each of the four levels of achievement
- Teacher's Notes for each sample, which indicate why the sample is assessed at a particular level for each criterion outlined in the four categories of knowledge and skills (i.e., Knowledge/Understanding, Thinking/Inquiry, Communication, and Application)
- Comments, which provide overall statements about the student's work
- Next Steps, which offer suggestions for improving performance
- the Teacher Package that was used by teachers in administering the task

This document does not include any student samples that were assessed using the rubric and judged to be below level 1. However, a list of characteristics of student work assessed at “below level 1” is provided, and precedes the student samples. The characteristics of these students' work should be reviewed in relation to the criteria outlined in the rubric. Teachers are expected to work with students whose achievement is below level 1, as well as with their parents, to help the students improve their performance.

---

1. In this document, parent(s) refers to parent(s) and guardian(s).
Introduction

The Tasks
The performance tasks represented in this document were based directly on curriculum expectations selected from two Grade 11 courses outlined in the curriculum policy document for technological education: Construction Technology, Workplace Preparation, and Transportation Technology, Workplace Preparation. Each task encompassed the four categories of knowledge and skills (i.e., Knowledge/Understanding, Thinking/Inquiry, Communication, and Application), requiring students to integrate their knowledge and skills in a meaningful learning experience. Each task also gave students an opportunity to demonstrate how well they could apply the knowledge and skills they had acquired in the course in a new context.

The Rubrics
In this document, the term rubric refers to a scoring scale used to assess student work that is done in response to a specific task. Task rubrics are developed in relation to the achievement chart in the curriculum policy document for a subject.

The task rubrics consist of a set of achievement criteria related to the four categories of knowledge and skills, as well as descriptions of the levels of achievement for each of the criteria. The rubrics contain the following components:

- an identification (by number) of the expectations on which student achievement in the task was assessed
- the four categories of knowledge and skills
- the relevant criteria for evaluating performance of the task
- descriptions of student performance at the four levels of achievement (level 3 on the achievement chart in the curriculum policy document is considered to be the provincial standard)

The teachers who administered the tasks for this exemplar document were required to explain the scoring criteria and descriptions of the levels of achievement (i.e., the information in the task rubric) to the students before they began the task.

Use of the Student Samples
Teachers and Administrators
The samples of student work included in this document will assist teachers and administrators by:

- providing student samples and criteria for assessment that will assist them in helping students improve their achievement;
- providing a basis for conversations among teachers, parents, and students about the criteria used for assessment and evaluation of student achievement;
- facilitating discussions regarding the curriculum expectations, levels of achievement for the course, and the criteria and standards for high-quality performance;
- promoting fair and consistent assessment within subjects and courses.
Teachers may choose to:
- use the task, rubric, and teaching/learning activities in this document with their classes;
- use the samples of student work at each level as reference points when assessing student work;
- use the task and rubric provided as models for other tasks and rubrics, to be developed independently or in collaboration with colleagues in the same school and/or in other schools.

Administrators may choose to:
- encourage and facilitate teacher collaboration regarding standards and assessment;
- provide training to ensure that teachers understand the role of the exemplars in assessment, evaluation, and reporting;
- establish an external reference point for schools in planning student programs and for school improvement.

Parents
Parents may wish to use the samples of student work as a source of information to help their children monitor their achievement and improve their performance. They may also use the exemplars as a basis for discussing their children’s progress with their teachers.

Students
Students can use the document to:
- develop their understanding of the relationship between curriculum expectations and specific tasks;
- learn how a rubric can be used to improve their performance on a task;
- develop the ability to discuss their achievement with their teachers and parents more effectively, and to ask more focused questions about their progress;
- learn how to better assess their own performance and identify the steps needed to improve their performance.
A Wall Frame Corner Section

The Task
Students were presented with the following scenario and instructions:

Construct a wall frame consisting of two walls that connect at a 90° angle. Wire one of the walls with a 120 v, 15 A. duplex receptacle and a wall-mounted light fixture controlled by a single-pole switch. Also prepare working drawings indicating your plan for the assembly of the frame structure and the electrical wiring. In all of your work, take into consideration building and electrical safety codes, and provide for the addition of finishing materials.

Final Product
Each student was to submit:

• a written statement explaining the properties and features of both the framing portion and the electrical portion of the project;
• complete, neat framing diagrams (providing measurements, labelling parts, and indicating stud placement, electrical box placement, electrical cable routing and support);
• a cutting list of the lumber components required for the structure;
• a neat working drawing showing the wiring layout and wiring connections;
• a list of the materials required for this project.

Expectations Addressed in the Exemplar Task
This task gave students the opportunity to demonstrate achievement of all or part of each of the following selected expectations from the Theory and Foundation and the Skills and Processes strands.

Students will:
1. describe the properties and application of building materials, and of construction techniques and processes;
2. use a variety of appropriate tools, equipment, and materials to complete a construction project;
3. prepare and interpret electrical and mechanical drawings, and identify the components of the electrical and mechanical systems used in a variety of construction projects;
4. identify the building codes, regulations, and standards applicable to construction, including those for electrical, mechanical, and structural systems;
5. design and install, where appropriate, the mechanical systems of a building project (including electrical, plumbing, heating, ventilation, and air-conditioning systems) in accordance with building codes, regulations, and standards.

The Student Samples for This Task
In order to exemplify each level of achievement accurately with respect to all parts of the task, portions of the work of several students have been combined to create a representative sample for each level. For this reason, there are discrepancies in details.
between the various components of each sample (e.g., between the diagrams and the completed wall frame corner sections shown in the paragraph).

For information on the process used to prepare students for the task and on the materials and resources required, see the Teacher Package, reproduced on pages 40–56 of this document.
## Task Rubric – A Wall Frame Corner Section

<table>
<thead>
<tr>
<th>Expectations*</th>
<th>Criteria</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge/Understanding</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The student:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>– accurately describes the properties of the wall construction and the electrical system in the written statement</td>
<td>– describes the properties of the wall construction and the electrical system with limited accuracy</td>
<td>– describes the properties of the wall construction and the electrical system with some accuracy</td>
<td>– describes the properties of the wall construction and the electrical system with considerable accuracy</td>
<td>– describes the properties of the wall construction and the electrical system with a high degree of accuracy</td>
</tr>
<tr>
<td><strong>Thinking/Inquiry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The student:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>– accurately lists the requirements of the project (e.g., materials needed, cutting list)</td>
<td>– lists the requirements of the project with limited accuracy</td>
<td>– lists the requirements of the project with some accuracy</td>
<td>– list the requirements of the project with considerable accuracy</td>
<td>– lists the requirements of the project with a high degree of accuracy</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The student:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>– clearly communicates the layout for the wall plates and electrical system in the working drawings</td>
<td>– communicates the layout for the wall plates and electrical system in the working drawings with limited clarity</td>
<td>– communicates the layout for the wall plates and electrical system in the working drawings with some clarity</td>
<td>– communicates the layout for the wall plates and electrical system in the working drawings with considerable clarity</td>
<td>– communicates the layout for the wall plates and electrical system in the working drawings with a high degree of clarity</td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The student:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2, 4, 5</td>
<td>– effectively constructs and installs a wall section with a safe working electrical system</td>
<td>– constructs and installs a wall section with a safe working electrical system with limited effectiveness</td>
<td>– constructs and installs a wall section with a safe working electrical system with some effectiveness</td>
<td>– constructs and installs a wall section with a safe working electrical system with considerable effectiveness</td>
<td>– constructs and installs a wall section with a safe working electrical system with a high degree of effectiveness</td>
</tr>
</tbody>
</table>

*The expectations that correspond to the numbers given in this chart are listed on page 8.

*Note: A student whose overall achievement at the end of a course is below level 1 (that is, below 50%) will not obtain a credit for the course.*
**Teacher’s Notes**

The following is a list of characteristics found in student work that was submitted for this task and assessed at “below level 1”. (A sample of student work is not included.)

Degree of achievement can vary widely in student performance that falls below level 1. Consequently, the following list includes characteristics of achievement at various degrees below level 1. Taken together, some or all of the characteristics outlined below may justify assessment at “below level 1”. Most of the characteristics noted relate to the criteria specified in the task rubric, but some are more broadly defined.

**Knowledge/Understanding**

The student:
- demonstrates little or no understanding of the task;
- demonstrates little or no knowledge of the properties of the wall construction or the electrical system;
- omits many or most of the components required for the task;
- shows little or no awareness of the relevant requirements in the Ontario Building Code and the Ontario Electrical Safety Code;
- provides insufficient detail to explain the construction.

**Thinking/Inquiry**

The student:
- omits many or most of the materials needed for the task;
- includes inappropriate or unsafe materials;
- omits a cutting list;
- provides an inaccurate or inappropriate cutting list.

**Communication**

The student:
- provides unclear or incomplete working drawings;
- includes inaccurate calculations;
- provides a wiring diagram that is unrealistic or unsafe;
- fails to understand the function of the cable in the construction.

**Application**

The student:
- installs a wall section that is unstable or unsafe;
- does not connect the cables correctly;
- does not install the studs accurately;
- does not allow for the application of drywall.

**Comments**

The student demonstrates minimal or no understanding of the requirements of the task and inadequate knowledge of building code requirements. He or she also demonstrates a lack of understanding of the components required for the task, the requirements for working drawings and wiring diagrams, and the way in which materials and components should be installed and/or connected.

**Next Steps**

In order to improve his or her performance, the student needs to:
- address all of the requirements of the task;
- learn about the properties of the wall construction and the electrical system and study building code requirements;
- list all of the materials needed and provide an accurate cutting list;
- work on completing clear and accurately labelled working drawings and wiring diagrams;
- ensure that the wall section is stable and safely installed and that all cables are connected properly.
A Wall Frame Corner Section

Written Statement

While installing the electrical boxes, I took my knowledge and time to do it the right way, by putting the boxes about 18” from the floor for convenience. I left the boxes out 1/2” so it would fit flush with the drywall. Also I placed the fixture at about 52” from the ground where most people put their light switches. I put the light on the ceiling where it would have provided the most light about. In the real world you would have a electrical inspector. I placed my studs at 16” on center.
Appendix B: Framing Diagram for Short Wall and Cutting List

Draw the wall using the scale 1” = 1’ on an 8 1/2” x 14” (legal size) piece of paper.

Appendix C: Wiring Diagram

Colour-code the wiring and explain coding in legend below.

Legend (wiring diagram)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Live</td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td></td>
</tr>
<tr>
<td>Ground</td>
<td></td>
</tr>
</tbody>
</table>

Power Source
# Appendix E: Materials List

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description of Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>box</td>
</tr>
<tr>
<td>1</td>
<td>Light bulb</td>
</tr>
<tr>
<td>1</td>
<td>6' of wire</td>
</tr>
<tr>
<td>1</td>
<td>Riciprical</td>
</tr>
<tr>
<td>2</td>
<td>16' x 2&quot; x 4&quot;</td>
</tr>
<tr>
<td>1</td>
<td>8' x 2&quot; x 4&quot;</td>
</tr>
<tr>
<td>1</td>
<td>Octahgonul box</td>
</tr>
<tr>
<td>1</td>
<td>2 ½ nails (pound bag)</td>
</tr>
</tbody>
</table>
Teacher’s Notes

Knowledge/Understanding
- The properties of the wall construction and the electrical system are described with limited accuracy. In the written statement, an understanding of relative heights of electrical device boxes is demonstrated (e.g., “about 18” from the floor for convenience”). The statement also indicates that the boxes need to be installed in such a way as to allow for \( \frac{1}{2} \)" of drywall. However, the wall components (e.g., double top plates, bottom plates, corner plate) are not described, and the purpose of an electrical inspection is not explained.

Thinking/Inquiry
- The requirements of the project are listed with limited accuracy. Several basic items are omitted from the materials list (e.g., staples, screws, marrette connector, lampholder, wire connectors, device covers). The cutting list includes a number of pieces and cutting dimensions. However, part names are not provided on the cutting list nor are the dimensions given in proper sequence (e.g., thickness \( \times \) width \( \times \) length).

Communication
- The layout for the wall plates and electrical system is communicated in the working drawings with limited clarity. Some of the wall components are named and the overall wall dimensions are included, but without dimension and extension lines. The lines on the short wall diagram are drawn freehand and the corner backing is not labelled. The double top plate on the long wall diagram is too long. The electrical wires are colour-coded, but the legend has not been completed to explain the coding. Further, the neutral wire appears to be touching the ground screw at the receptacle box. Also, the neutral wire is not shown on the diagram to be marretted at either the switch box or the receptacle box. The ground path to the outlet is incorrect, and the diagram does not show the cable or wires entering or exiting boxes.
**Application**

The wall section is constructed and installed with limited effectiveness. Boxes are installed correctly, with provision for \( \frac{1}{2} \)" drywall. Wall components are cut to the correct length and the double top plate ties the two walls together. However, the double top plate is not nailed down adequately, the wall appears to be out-of-square (from top view), wall studs are not on 16" centres, and the drywall backing is installed incorrectly. The cables are run and supported in a satisfactory manner. However, excessive sheath in the octagon box would prevent the lampholder from being installed safely. The marrette and terminal eye connections are substandard (e.g., excessive wire is exposed, the terminal eye is backwards).

**Comments**

This work is representative of a level-1 performance. A limited degree of achievement of the expectations is demonstrated in all four categories of knowledge and skills.

**Next Steps**

In order to improve this performance, a student would need to:

- identify all wall components;
- describe the purpose of an electrical inspection;
- list all materials needed to complete the project;
- accurately calculate the lumber requirements;
- label all components on the cutting list;
- provide dimensions in proper sequence;
- label all parts in the working drawings;
- include dimension and extension lines;
- provide clear and accurate diagrams;
- complete the legend provided;
- include placement of marrettes in the wiring diagram;
- show where the cable and wires enter and exit the boxes;
- ensure that all wall components are installed according to the Ontario Building Code.
A Wall Frame Corner Section

LEVEL 2

Appendix A: Framing Diagram for Long Wall

Draw the wall using the scale \( \frac{1}{4}'' = 1'' \) on an 8½'' x 14'' (legal size) piece of paper.

**A**

**WRITTEN STATEMENT**

I placed the electrical boxes over hanging a \( \frac{1}{2} \) inch from the studs so that they would fit inside the drywall and be flush with the drywall. The support for the cables that I did was the staples that I stapled to the stud and the holes that I drilled for the wire to run through. I ran a top plate to ensure that the structure remains square. I did not use any temporary bracing because the structure was only two feet high. The electrical portion of a project should be inspected by a proper authority so there is no accidents or mistakes and so that there is no fires. Face plates are placed to prevent shock and to prevent dust from getting in the circuit boxes which could start a fire. That is my essay on my project.

**B**
Appendix B: Framing Diagram for Short Wall and Cutting List

Draw the wall using the scale $\frac{1}{4}" = 1"$ on an 8½" x 14" (legal size) piece of paper.

Appendix C: Wiring Diagram

Colour-code the wiring and explain coding in legend below.
## Appendix E: Materials List

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description of Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Light switch</td>
</tr>
<tr>
<td>6 ft</td>
<td>Wire</td>
</tr>
<tr>
<td>1</td>
<td>Recipical</td>
</tr>
<tr>
<td>1</td>
<td>Light bulb</td>
</tr>
<tr>
<td>1</td>
<td>Octagonal</td>
</tr>
<tr>
<td>1</td>
<td>Box of two inch spikes</td>
</tr>
<tr>
<td>1</td>
<td>16 ft 2 x 4</td>
</tr>
<tr>
<td>1</td>
<td>12 ft 2 x 4</td>
</tr>
<tr>
<td>1</td>
<td>8 ft 2 x 4</td>
</tr>
<tr>
<td>2</td>
<td>boxes</td>
</tr>
</tbody>
</table>
LEVEL 2

G

H
Teacher’s Notes

Knowledge/Understanding
- The properties of the wall construction and the electrical system are described with some accuracy. Some understanding of the applicable building codes is demonstrated by the identification of some elements of framing (e.g., “... top plate to ensure that the structure remains square”). Also mentioned is the need to consider drywall installation, as well as the electrical inspection requirement, including safety considerations (e.g., device covers). However, not enough detail is provided about framing (e.g., there is no mention of studs or corner blocks) or about the electrical system (e.g., the relative height of boxes). Although support of the cables is mentioned, there is no indication of where the support is to be placed.

Thinking/Inquiry
- The requirements of the project are listed with some accuracy. Some of the required materials are listed (e.g., studs, plates, receptacle, octagon box), but other items are missing (e.g., lampholder, marrette connectors, device covers) and some materials are not identified correctly (e.g., measurement of lumber, size of nails). The cutting list is complete and accurate; however, the thickness and width of the wood is not stated for all framing members.

Communication
- The layout for the wall plates and electrical system in the working drawings is communicated with some clarity. The overall wall dimensions are shown, along with the electrical elements, and the wall parts are named. However, the framing diagrams lack details (e.g., height and length of studs, length of double top plate, centre spacing of studs). As well, the drywall backing is not drawn correctly, and the first stud spacing on the long wall is shown as being measured from the edge of the top plate instead of the double top plate. The electrical wires are colour-coded and the wires are shown as leading to the correct terminals. However, the electrical diagram lacks detail (e.g., the neutral wires to the switch and the receptacle are not marretted, the ground path to the outlet is incorrect). In addition, the cable/wires are not shown entering or exiting the boxes.
Application
- A wall section with a safe working electrical system is constructed and installed with some effectiveness. All components are present, but they are not always in their proper places (e.g., studs are not laid out at 16" on centre). The drywall backing is installed, but it is shown as being cut too short. All necessary elements of the electrical system are installed, and two of the device boxes are positioned $\frac{1}{2}"$ out to accommodate the drywall. As well, the switches in the devices are wired correctly. However, the cables are not stapled properly and the cable sheathing is too long. In addition, the outlet and switch wires are not terminated properly to the receptacle and lampholder. Wires are on the wrong side of the screws to which they are attached, and the receptacle box does not extend $\frac{1}{2}"$ past the stud.

Comments
This work is representative of a level-2 performance. The expectations are met to some degree in all four categories of knowledge and skills.

Next Steps
In order to improve this performance, a student would need to:
- provide more detail about framing and the electrical system in the written statement;
- list all materials required for the project;
- identify all materials correctly (e.g., provide accurate measurements);
- include thickness and width of the wood in the cutting list;
- provide all necessary details in the layout for the wall plates;
- obtain further information about correct wiring procedures;
- ensure that all components of the wall sections are constructed and installed according to the Ontario Building Code.
A Wall Frame Corner Section

**LEVEL 3**

**Appendix A: Framing Diagram for Long Wall**

Draw the wall using the scale 1" = 1/4" on an 8 1/2" x 14" (legal size) piece of paper.

**WRITTEN STATEMENT**

While installing the electrical boxes, I took my time to do it the right and safe way, by placing the boxes about 18" from the floor. For convenience I left the boxes out 1/2" so the box would fit flush with the drywall. I placed the light fixture fairly high about 2' from the ceiling to provide the most efficient light. I placed the light switch about 50" from the floor for easy access. I placed the electrical outlet about 36" from the floor.

When building my wall I did not feel the need for a temporary brace for the simple reason that this was not built to scale. If it was to scale I would recommend that you use one. I placed the studs 16" on center because the building code requires the builder to do so. An “L” corner was used to allow for interior drywall finish.

Residential wiring should always be inspected by an approved electrical inspector to prevent the risk of having improper wiring that could lead to a fire hazard.
Appendix B: Framing Diagram for Short Wall and Cutting List

Draw the wall using the scale ½" = 1' on an 8 ½“ x 14“ (legal size) piece of paper.

Appendix C: Wiring Diagram

Colour-code the wiring and explain coding in legend below.
## Appendix E: Materials List

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description of Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2” x 4” x 8’</td>
</tr>
<tr>
<td>6’</td>
<td>14/2 wire</td>
</tr>
<tr>
<td>1</td>
<td>marette</td>
</tr>
<tr>
<td>1</td>
<td>switch</td>
</tr>
<tr>
<td>1</td>
<td>receptical</td>
</tr>
<tr>
<td>2</td>
<td>boxes</td>
</tr>
<tr>
<td>1</td>
<td>light bulb</td>
</tr>
<tr>
<td>1</td>
<td>lamp holder</td>
</tr>
<tr>
<td>1</td>
<td>octagon box</td>
</tr>
<tr>
<td>1</td>
<td>1lb of nails 3/1/2”</td>
</tr>
</tbody>
</table>
Teacher’s Notes

Knowledge/Understanding
- The properties of the wall construction and the electrical system are described with considerable accuracy in the written statement. Most of the wall and electrical components are referenced (e.g., wall studs, drywall, receptacles, light switch); however, in addition to the minor omissions (e.g., bottom plate, cable staples), there is no mention of the top plate. The sample also shows evidence of an understanding of the building code as it applies to wall construction (e.g., wall stud centre, relative height of electrical fixture). However, some other features are omitted (e.g., nailing patterns, cable supports). As well, the electrical outlet is placed at 36" from the floor, which is not common practice.

Thinking/Inquiry
- The requirements of the project are listed with considerable accuracy. A comprehensive materials list (e.g., lumber and electrical supplies required) is compiled. However, there are minor omissions (e.g., device covers, cable staples, screws). A complete cutting list for the wood frame components (e.g., quantity, part name) is included, but the length of the double top plate for the long wall is incorrectly stated as 4' instead of 44 1/2". As well, the order of listing lumber measurements is incorrect.

Communication
- The layout for the wall plates and the electrical system is communicated in the working drawings with considerable clarity. The wall framing plan is neatly drawn to scale. Most dimensions are included and wall components are labelled. The wall framing layout is accurately drawn and includes a functional electrical layout and wiring diagram. However, some dimensions are omitted, specifically the first wall stud from the corner, which should be 15 1/4". Also, the electrical cable is not shown as running to the boxes and the wire is not shown as splitting from the boxes. The wiring procedure at the receptacle is not according to code (i.e., the neutral wire is not marretted at the receptacle box).
应用
- 墙壁的构造是有效的（例如，主梁是16” centred，双层墙板重叠适当，钉子的位置正确，角块安装正确）。然而，双层墙板在短墙处略微延伸到长墙处。一个安全的工作电气系统已安装（例如，正确的电线在适当的终端上，盒子已安装以允许1/2” drywall，电缆正确地固定到盒子和结构）。然而，在一些情况下，电线短，接线板的中性排列不符合规定（例如，使用marrette 连接器和pigtail 未被用于给接线板供电）。

评论
这项工作代表了3级的表现。在所有四个方面的知识和技能方面都实现了相当大的成就。

下一步
为了改进这种表现，学生需要：
- 包括墙的全部组件和电气系统；
- 确保所有组件准确描述；
- 列出所有在项目中使用的材料；
- 包括工作图纸中的所有尺寸；
- 检查尺寸的准确性；
- 精确切割所有部件以保持框架结构；
- 对电气安全规定进行更仔细的检查，确保符合当前规定。
While installing the electrical boxes, I decided where to put my boxes on the wall. I made it as easy as possible but I made it as convenient as possible too. I didn’t put the boxes to standard height because my wall wasn’t at standard height. If it was a real 8 foot wall I would of put my receptical boxes at 18 inches to the top of the box. And I would of put my switch at 52 inches to the top of the box. I put my plug down lower than my switch because a plug is generally lower than a switch and I put my light higher than my switch because then it looks better that way when it is all finished. A two foot wall is kind of small to be doing all these things to. I left my boxes out a half of an inch so that when I put my drywall on it will be flush with the box. The cable is supported in the box by a clamp and the sheathing must be trimmed to within a 1/4” of the clamp. In a real residential situation circuits are protected using fuses or circuit breakers. You need an electrical inspector to inspect the electrical to see if it was done properly and make sure that there won’t be a short anywhere where there can be a fire started. I didn’t use any temporary bracing because it was such a small wall it could stay up by itself. I put the wall studs at 16” centres and nailed them with two nails per end, an “L” corner, to accommodate drywall on the inside of the wall and sheathing on the exterior. The double top plate locks the two walls together. A corner block was installed to provide backing for drywall.
Appendix B: Framing Diagram for Short Wall and Cutting List

Draw the wall using the scale $\frac{1}{4}'' = 1''$ on an 8½" x 14" legal size piece of paper.

Appendix C: Wiring Diagram

Colour-code the wiring and explain coding in legend below.

<table>
<thead>
<tr>
<th>Legend (wiring diagram)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
<tr>
<td>Ground</td>
</tr>
</tbody>
</table>

Power Source
### Appendix E: Materials List

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description of Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2&quot; x 4&quot; x 8'</td>
</tr>
<tr>
<td>1</td>
<td>6' 14/2 wire</td>
</tr>
<tr>
<td>2</td>
<td>2104 LL E1 electrical boxes</td>
</tr>
<tr>
<td>1</td>
<td>switch</td>
</tr>
<tr>
<td>1</td>
<td>recepticle</td>
</tr>
<tr>
<td>2</td>
<td>marrette</td>
</tr>
<tr>
<td>1</td>
<td>1 lb of nails 3 1/2&quot;</td>
</tr>
<tr>
<td>1</td>
<td>light bulb</td>
</tr>
<tr>
<td>1</td>
<td>lampholder</td>
</tr>
<tr>
<td>1</td>
<td>octagon box</td>
</tr>
<tr>
<td>2</td>
<td>device covers</td>
</tr>
<tr>
<td>4</td>
<td>staples</td>
</tr>
</tbody>
</table>
Teacher’s Notes

Knowledge/Understanding
- The properties of the wall construction and the electrical system are described with a high degree of accuracy in the written statement. The wall and electrical components are listed with only minor omissions (e.g., bottom plate and cable staples). The work reflects a high degree of awareness of the building codes applicable to this project. A connection is made between the placement of studs and the installation of interior and exterior finish materials, subject to project specifications. Specific detail is provided for nailing the structure together (e.g., “I put the wall studs at 16” centres and nailed them with two nails per end…”).

Thinking/Inquiry
- The requirements of the project are listed with a high degree of accuracy. A very comprehensive materials list is compiled (e.g., with the exception of wood screws, the list includes minor items such as cable staples and device covers, as well as the major items). A complete and accurate cutting list is included for the wood frame components (e.g., all quantities, part names, and dimensions are included).

Communication
- The layout for the wall plates and the electrical system is communicated in the working drawings with a high degree of clarity. All dimensions and the stud layout are included in the framing diagrams, and the location of the first stud is clearly located \(15\frac{1}{4}”\) from the outside corner. The wiring diagram is highly accurate, complete, and functional (e.g., the cable is shown entering and exiting the boxes).

Application
- The sample demonstrates the construction of a highly effective wall section. Walls are nailed together properly and squared; stud spacing is 16” on centre; cables are stapled prior to entering all boxes; wires are stripped to the proper length and terminated correctly on the devices, illustrating a safe electrical installation. Boxes extend \(\frac{1}{2}”\) past wall studs to allow for drywall.
Comments
This work is representative of a level-4 performance. A high degree of achievement of the expectations is demonstrated in all four categories of knowledge and skills.

Next Steps
To improve this performance, the student could be more specific in the cutting list (e.g., listing studs as 2" x 4"s).
Title: A Wall Frame Corner Section

Time Requirement: 5 periods of 75 minutes each (suggested timeline)

Expectations Addressed in the Exemplar Task
This task gives students the opportunity to demonstrate achievement of all or part of each of the following selected expectations from the Theory and Foundation and the Skills and Processes strands.

Students will:
1. describe the properties and application of building materials, and of construction techniques and processes;
2. use a variety of appropriate tools, equipment, and materials to complete a construction project;
3. prepare and interpret electrical and mechanical drawings, and identify the components of the electrical and mechanical systems used in a variety of construction projects;
4. identify the building codes, regulations, and standards applicable to construction, including those for electrical, mechanical, and structural systems;
5. design and install, where appropriate, the mechanical systems of a building project (including electrical, plumbing, heating, ventilation, and air-conditioning systems) in accordance with building codes, regulations, and standards.

Description of the Task
Provide the following instructions to students:

Construct a wall frame consisting of two walls that connect at a 90° angle. Wire one of the walls with a 120 v., 15 A. duplex receptacle and a wall-mounted light fixture controlled by a single-pole switch. Also prepare working drawings indicating your plan for the assembly of the frame structure and the electrical wiring. In all of your work, take into consideration building and electrical safety codes, and provide for the addition of finishing materials.
Final Product
Each student will submit:
• a written statement explaining the properties and features of both the framing portion and the electrical portion of the project;
• complete, neat framing diagrams (providing measurements, labelling parts, and indicating stud placement, electrical box placement, electrical cable routing and support) (see Appendices A and B );
• a cutting list of the lumber components required for the structure (see Appendix B );
• a neat working drawing showing the wiring layout and wiring connections (see Appendix C );
• a list of the materials required for this project (see Appendix E ).

Assessment and Evaluation
The task-specific rubric provided* will be used to assess and evaluate the final product. Introduce the rubric to the students when you introduce the task. Review the rubric with the students and ensure that each student understands the criteria and the descriptions for achievement at each level. Allow ample time for a thorough reading and discussion of the assessment criteria outlined in the rubric.

Some students may perform below level 1. Although the rubric does not include descriptions of achievement below level 1, the characteristics of these students' work should be reviewed in relation to the criteria outlined in the rubric.

Note: For the purpose of this exemplar task, the completed wall frame corner sections were scored from photographs submitted to the ministry. Each project was photographed six times to show all the required components.

Teacher Instructions
Prior Knowledge and Skills
To complete this task, students are expected to have some experience in, or some knowledge and skills relating to, the following:
• health and safety issues related to construction, and shop safety practices
• application of the Ontario Building Code and the Ontario Electrical Safety Code
• framing techniques
• installation of residential electrical wiring
• technical drawings
• writing project reports and descriptions

Accommodations
Accommodations that are normally provided in the regular classroom for students with special needs should be provided in the administration of this performance task.

Note: It is the responsibility of the classroom teacher to ensure that all students have received the required health and safety instruction and that they use safe practices in completing this task.

*The rubric is reproduced on page 10 of this document.
Materials and Resources

- 36' 2" x 4" framing material (2" x 6" material can be ripped to 2½" to reduce costs)
- 6' 14/2 NM D 90 house wiring cable
- 1 single-pole switch rated at 15 A.
- 1 120 v., 15 A. duplex receptacle
- 1 octagon fixture box
- 2 device boxes (for the receptacle and the switch)
- 1 switch cover
- 1 receptacle cover
- 1 plastic lampholder
- 2 marrette wire connectors
- 4 cable staples
- 40+ 3½" nails (common nails will allow for easier dismantling)
- 6 #8 x 1" wood screws
- 1 light bulb

The use of scrap ends or used lumber is recommended for this project to reduce costs. Some or all of the above materials could be obtained through donations solicited from local industry, the local home builders association, lumber suppliers, and electricians and carpenters locals.

Minimum Tool Requirements

- framing squares
- tape measures
- hammers
- pencils
- rulers
- saws (hand or power)
- needle-nose pliers
- wire strippers
- utility knives
- flat-blade and Robertson screwdrivers
Task Instructions

Day 1
• Introduce the performance task and the rubric and discuss them with the students.
• Introduce and discuss the construction specifications for the wall frame corner section (see pp. 5–6 of this teacher package).
• Outline the sequence of activities involved in the task.
• Present Appendices A, B, C, D, and E to the students.
• Instruct students to begin developing their cutting and materials lists, using Appendices B and E.
• Have students start their sketches of the framework, using Appendices A and B.

Day 2
• Have students complete their cutting and materials lists.
• Have students complete their sketches of the framework of the wall sections.
• Provide students with the materials to begin framing.
• Instruct students to prepare a layout and to begin framing.
  Note: All layouts are to start from the outside corner, that is, from the intersection of the two walls.
• Have students begin the sketches of their wiring diagram and complete the wiring diagram legend (see Appendix C).
  Note: Students are to colour-code (or otherwise distinguish) the three wires (live, neutral, and ground) in the diagram, and to give an appropriate explanation of their coding in the legend provided in Appendix C.

Day 3
• Have students continue and/or complete the framing of their wall sections.
• Have students complete their wiring diagrams.
• Provide students with the materials to begin wiring.
• Have students begin wiring, roughing in the cable and installing the boxes and devices for inspection.
• Conduct in-progress evaluations of the device wiring for safety, before the devices are fastened into the device boxes.
Day 4
• Have students complete the construction of their wall frame corner sections.
• Have students complete their wiring after the rough-in safety inspection.
• Have students check their completed work, using the checklist provided in Appendix F.
• Review the requirements for the written statement, and have students begin their written statements.

Day 5
• Have students check and finalize the construction of their wall frame corner sections, using the checklist provided in Appendix F.
• With each student, test the operation of his or her electrical circuit.
• Have students complete their written statements, using the checklist provided in Appendix F.
• Have students submit all supporting material for their wall sections, including diagrams and written statements.

Specifications
The wall frame structure is to consist of two wall sections that connect at a 90° angle. These wall sections are to be constructed of 2” x 4” lumber (16” on centre), and are to be a minimum of 2’ high. One of the walls is to be long enough to include at least 4 studs; the other is to be long enough to include 3 studs. Spacing and placement of studs must be in accordance with the project specifications, good trade practice, and consideration for the future installation of finishing materials.

The project will be constructed so that the following finishing features could be installed:
• 1⁄2” drywall wall covering
• 2½” baseboard installed after the installation of a 5⁄8” subfloor, a 3⁄8” underlay, and a ceramic tile finish
• a “coach light” style light fixture, as a later upgrade of the wall-mounted fixture described below.

A wall-mounted light fixture controlled by a single-pole switch and a 120 v., 15 A. duplex receptacle are to be installed. All of the wiring devices must be installed on the longer of the two wall sections. The order of the cable runs should be as follows:
• The light fixture is fed by a cable running from the switch box.
• The switch box is fed from the duplex outlet box.
• The outlet box is fed from the power source.

1. If it is more convenient, other wall heights may be used (e.g., if this wall section is completed as part of a larger project, such as the construction of a shed).
2. The teacher will outline how the connection between the outlet box and the power source is to be made for testing the circuit.
Using the checklist provided in Appendix F, students are to prepare a written statement explaining the following:

- features of the electrical installation, including consideration given to the placement of the boxes (particularly with regard to their relative height above the floor), the support of cables, the circuit protection devices, and the need for approval by an electrical inspection authority
- features of the wall structure, including all wall components, their position, and their purpose with regard to provision for the installation of interior and exterior wall finishes

Notes for the teacher

- In testing the students’ device wiring, it is the responsibility of the teacher to ensure that no one comes in contact with live electrical wiring. It is recommended that the teacher restrict access to the power source connecting device and perform the tests personally. For the purposes of testing the electrical circuit, the teacher will need to devise a method of connecting the circuit to a 120 v. power source. The following three methods are suggested as possibilities:
  - Have the students attach a 120 v. male plug as the connection from the receptacle to the power source.
  - Arrange to connect the cable feeding the receptacle box to a circuit breaker panel, as is the usual practice in wiring a house, or test circuits with a battery-powered continuity tester.
  - Arrange for a temporary method of connecting the circuit to a 120 v. power source, such as using a power cord with alligator clips to connect the live, neutral, and ground wires to the circuit.
- If access to power tools is limited, arrange to have part of the class prepare for the electrical portion of the task while the other students do their cutting.

List of Appendices

Appendix A: Framing Diagram for Long Wall
Appendix B: Framing Diagram for Short Wall and Cutting List
Appendix C: Wiring Diagram
Appendix D: Excerpts from the Ontario Electrical Safety Code
Appendix E: Materials List
Appendix F: Checklist

Additional Appendices for Teachers Only

Appendix G: Sample Materials List
Appendix H: Sample Framing Diagram for Long Wall
Appendix I: Sample Framing Diagram for Short Wall and Cutting List
Appendix A: Framing Diagram for Long Wall

Draw the wall using the scale $\frac{3}{4}'' = 1''$ on an 8 1/2" x 14" (legal size) piece of paper.
Appendix B: Framing Diagram for Short Wall and Cutting List

Draw the wall using the scale $\frac{3}{4}$" = 1" on an 8½" x 14" (legal size) piece of paper.
Appendix C: Wiring Diagram

Colour-code the wiring and explain coding in legend below.

<table>
<thead>
<tr>
<th>Legend (wiring diagram)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
<tr>
<td>Ground</td>
</tr>
</tbody>
</table>

Power Source
Appendix D: Excerpts from the Ontario Electrical Safety Code

Summary of Wiring Rules for Alternating Current

Key Terms and Definitions

- **Neutral wire** – the grounded conductor of the circuit. The neutral wire’s connection to ground provides a return pathway to the source in case the live wire is accidentally connected to the ground, a situation known as a “short circuit”. In the case of a short circuit, the neutral wire’s connection to ground allows the fuse or circuit breaker to function to open the circuit (“blow”). The neutral wire is never to be switched with another wire or to have fuses/circuit breakers connected in series with it.

- **Live wire** – the ungrounded side of the ac power source. The supply voltage, whether 120 v. or 240 v., appears between the live wire and the ground. The live supply wire has the fuse/circuit breaker connected in series with it. All switching is done on the live side of the load of the circuit.

- **Ground** – the connection of the electrical system to the earth, using it as a common connection system, such as ground wires, metal conduit, or the metal of boxes and panels. The ac system is connected to the earth at each panel entering a building.

Wire Connections

- Terminal eye connections are to wrap in a clockwise direction around terminal screws, so that the wire makes at least a 180° wrap.

- Marrette connectors are to be used in such a way that the wires are twisted together; no conductor is to be exposed.

- A minimum of 15 cm of free conductor is to be left to make any type of connection. It is recommended that no more than 20 cm be left.

- Only one wire is to be connected to a terminal screw by way of a terminal eye.

Installation of NMD 90 (NMSC) Cables

- Cables must be clamped securely to the box using either an internal box connector or an external (installed) connector.

- The cable sheath should extend 4 mm or ¼” beyond the cable clamp into the box. (It is recommended that no more and no less than this amount be extended.)

- Cable clamps should press down on the flat of 2 wire cables, not on the side of the cable.

- Cable sheath should be stripped with care so that the wire insulation is not cut into. If the insulation is damaged, it should be taped over with electrical tape, or the cable sheath should be stripped back further (i.e., try again). If the wire itself is cut into or nicked, it will be necessary to strip back more sheath.
• Sufficient sheath should be removed from the cable before installing it into the box so that a minimum of 15 cm of free insulated conductor is left inside the box after connections are made.

• NMD 90 cable is to be installed only in wooden structures. If it is to be run along a section of concrete or metal, it should be enclosed in a conduit or run along a wooden running board.

• Cables are to be supported every metre (as a minimum), and within 30 cm of each box. If cable staples are used, they are to be driven in so that they do not cause damage to the cable or to the wire within. Cables are considered to be “supported” where they pass through holes drilled in structural members of the building. Cables run through structural members must be a minimum of 30 mm from the outside surface.

Mounting of Boxes

• Device and connection boxes are to be mounted at an appropriate height so that they are accessible (i.e., not concealed with drywall or by other building features), convenient for use, and do not interfere with other building features (such as baseboard or trim), and so that damage to the wiring system, or any appliances connected to it, will not result. Receptacles mounted in the floor are to be installed in a box designed specifically for that purpose (e.g., a “floor castle”).

• Boxes are to protrude beyond the rough surface of the wall frame, so that the opening edge of the boxes will be flush with the outer surface of the finished wall.

Installation of Receptacles

• Live wire is to be installed to the smaller slot/gold screw side of the receptacle; neutral wire is to be installed to the larger slot/silver screw side.

• The receptacle is to be grounded to the box by way of a minimum of 15 cm of bare or green insulated wire. The ground screw on a receptacle is the green screw.

Installation of Lampholders

• Lampholders are to be installed so that the outer screw shell that the light bulb threads into is connected to the neutral wire.

• Wiring should be arranged so that the only white wire connected to the lampholder is neutral. Wire colours should be arranged so that two white wires (one being a switched “live”) are never connected to the same lampholder.

Identification and Connection of Live, Neutral, and Ground Wires

• Neutral wires are to have white or grey insulation.

• Ground wires are to be bare or have green insulation.

• Live wires are to have insulation of a colour other than white, grey, or green.
• In situations where it is necessary to use a white or grey wire as other than a neutral wire, the wire is to be marked or coloured (e.g., painted or taped) in such a way as to indicate that it is not a neutral wire.

• In situations such as “switch loops”, where the white wire of a cable is used as a live wire, it is often sufficient that the white wire is connected with a live-coloured wire, or is connected to a switch, and additional marking is not required. Check with the inspector to be sure.

Neutral Wire Connections

The neutral wire of a circuit is to connect from the power source/panel directly to the load. Where a neutral wire continues from one cable to another through a box, a marrette connector is to be used. In these situations, a “pigtail” is to be used to connect into the neutral side of any receptacle or lampholder in the box (see diagrams below).

Ground Connections

• It is important that all exposed metal parts of electrical wiring systems and equipment be grounded.

• The ground wire of each cable entering an electrical box is to be connected to the box.

• Ground connections to boxes are to be made to the designated ground screws, which are threaded into the metal of the box. Using mounting (wood) screws as ground connections is not permitted.

• It is not good practice to wrap ground wires around the ground screws in most electrical boxes. Most boxes are designed to have the wire placed in straight, on one side of the screw. Ground screws in these boxes are designed to accept up to two ground connections.

(correct method)                                                     (incorrect method)
# Appendix E: Materials List

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description of Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Descriptions of all wood materials are to include thickness, width, and length.)</td>
</tr>
</tbody>
</table>
## Appendix F: Checklist

<table>
<thead>
<tr>
<th>Written Statement (Knowledge/Understanding)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Features of electrical installation are described.</td>
</tr>
<tr>
<td>Features of wall structure are described.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Materials and Cutting Lists (Thinking/Inquiry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials list (shopping list) is complete.</td>
</tr>
<tr>
<td>Cutting list (correct cutting dimensions) is complete.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Working Drawings (Communication)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stud spacing is shown.</td>
</tr>
<tr>
<td>Overall dimensions are shown.</td>
</tr>
<tr>
<td>Corner blocking is in proper place.</td>
</tr>
<tr>
<td>Double top plate is in proper place.</td>
</tr>
<tr>
<td>Wiring box placement and wire placement are shown.</td>
</tr>
<tr>
<td>Wiring diagram is complete and accurate.</td>
</tr>
<tr>
<td>Legend is complete.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Practical Task (Application)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stud spacing is 16&quot; O.C and begins at 15½&quot;.</td>
</tr>
<tr>
<td>Corner block is installed properly.</td>
</tr>
<tr>
<td>Walls are nailed together properly and squared.</td>
</tr>
<tr>
<td>Double top plate locks both walls.</td>
</tr>
<tr>
<td>Device boxes are fastened to extend ½&quot; past surface of 2&quot; x 4&quot; stud.</td>
</tr>
<tr>
<td>Drilled holes are a minimum of 30 mm (1¼&quot;) from stud surfaces</td>
</tr>
<tr>
<td>(in centre of 2&quot; x 4&quot; stud).</td>
</tr>
<tr>
<td>Cable is supported within 30 cm (12&quot;) of device box.</td>
</tr>
<tr>
<td>Cable is clamped with internal/external device box connector.</td>
</tr>
<tr>
<td>Cable sheath is stripped, leaving 4 mm (¼&quot;) in device box.</td>
</tr>
<tr>
<td>Wires are stripped to proper length.</td>
</tr>
<tr>
<td>Terminal eyes are wrapped according to direction of tightening of screw.</td>
</tr>
<tr>
<td>Minimum of 15 cm (6&quot;) of free conductor is left for connections in boxes.</td>
</tr>
</tbody>
</table>
### Appendix G: Sample Materials List (for teacher use only)

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description of Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2&quot; x 4&quot; x 8' spruce</td>
</tr>
<tr>
<td>6</td>
<td>14/2 NM D 90 house wiring cable</td>
</tr>
<tr>
<td>1</td>
<td>single-pole switch</td>
</tr>
<tr>
<td>1</td>
<td>120 v., 15 A. duplex receptacle</td>
</tr>
<tr>
<td>1</td>
<td>octagon fixture box</td>
</tr>
<tr>
<td>2</td>
<td>device boxes (receptacle and switch)</td>
</tr>
<tr>
<td>1</td>
<td>switch cover</td>
</tr>
<tr>
<td>1</td>
<td>receptacle cover</td>
</tr>
<tr>
<td>1</td>
<td>plastic lampholder</td>
</tr>
<tr>
<td>2</td>
<td>marrette wire connectors</td>
</tr>
<tr>
<td>4</td>
<td>cable staples</td>
</tr>
<tr>
<td>40+</td>
<td>3 ¼&quot; nails</td>
</tr>
<tr>
<td>6</td>
<td>#8 x 1&quot; wood screws</td>
</tr>
<tr>
<td>1</td>
<td>light bulb</td>
</tr>
</tbody>
</table>

(Descriptions of all wood materials are to include thickness, width, and length.)
Appendix H: Sample Framing Diagram for Long Wall (not to scale) (for teacher use only)

Students can draw the wall using the scale \( \frac{3}{4}'' = 1'' \) on an 8 1/2" x 14" (legal size) piece of paper.
Appendix I: Sample Framing Diagram for Short Wall and Cutting List (not to scale) (for teacher use only)

Students can draw the wall using the scale 3⁄4" = 1" on an 8 1⁄2" x 14" (legal size) piece of paper.

<table>
<thead>
<tr>
<th>Qty</th>
<th>Part Name</th>
<th>T x W x L</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Studs</td>
<td>2 x 4 x 19 1⁄2</td>
</tr>
<tr>
<td>2</td>
<td>Plates – Long Wall</td>
<td>2 x 4 x 48</td>
</tr>
<tr>
<td>2</td>
<td>Plates – Short Wall</td>
<td>2 x 4 x 28 1⁄2</td>
</tr>
<tr>
<td>1</td>
<td>Dbl. Top Plate – Long Wall</td>
<td>2 x 4 x 44 1⁄2</td>
</tr>
<tr>
<td>1</td>
<td>Dbl. Top Plate – Short Wall</td>
<td>2 x 4 x 32</td>
</tr>
<tr>
<td>1</td>
<td>Backing</td>
<td>2 x 4 x 19 1⁄2</td>
</tr>
</tbody>
</table>
Transportation Technology Workplace Preparation (TTJ 3E)
A Snowmobile Trailer Lighting System

The Task

Students were presented with the following scenario and instructions:

You are asked to design, construct, and test a tail-light trailer-wiring circuit (brake lights, turn signals, licence-plate light, tail lights) for a new model of snowmobile trailer that is to be mass-produced. (The trailer is used to haul snowmobiles and is pulled by a car or truck.) You will develop a presentation package for the snowmobile company containing a design brief, one top-view and one bottom-view drawing of the trailer, a schematic detailing the lighting system circuit, and steps for constructing an artefact of the circuit.

You will construct and test your circuit (i.e., the artefact) in accordance with existing regulations and recognized safety standards. Materials provided for this construction must be used effectively and efficiently with little waste.

Final Product

Each student was to submit a presentation package containing:

- a design brief that outlines how the lighting system works, and that includes a list of the wiring circuit’s parts, and explanations of the function of each part and of how the design will satisfy the snowmobile company;
- a schematic of the circuit;
- one top-view and one bottom-view drawing of the trailer;
- construction steps for the artefact;
- safety standards for the construction of the artefact;
- an artefact consisting of a trailer wiring circuit that is scaled down to fit onto a board that is approximately 200 mm x 300 mm. The circuit must work and be securely mounted onto the board in a way that simulates its location on the final product. All connections must meet industry standards, and the circuit must contain all the components required by law for highway operation.

Expectations Addressed in the Exemplar Task

This task gave students the opportunity to demonstrate achievement of all or part of each of the following selected expectations from the Theory and Foundation strand.

Students will:

1. explain the use of each component of a vehicle system;
2. gather and record information, and establish a plan of procedures [to solve a transportation technology challenge];
3. explain how human needs or wants related to transportation can be met through a new or improved vehicle or system;
4. produce presentation and working drawings, sketches, graphics, mathematical and physical models, or a prototype of the best solution [to a transportation technology challenge];
5. apply the design process to develop solutions, products, processes, or services in response to challenges or problems in transportation technology.

For information on the process used to prepare students for the task and on the materials and resources required, see the Teacher Package, reproduced on pages 84–94 of this document.
# Task Rubric – A Snowmobile Trailer Lighting System

<table>
<thead>
<tr>
<th>Expectations*</th>
<th>Criteria</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge/Understanding</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The student:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>accurately describes the lighting system (e.g., provides a complete list of its parts, explains the function of each part)</td>
<td>describes the lighting system with limited accuracy</td>
<td>describes the lighting system with some accuracy</td>
<td>describes the lighting system with considerable accuracy</td>
<td>describes the lighting system with a high degree of accuracy</td>
</tr>
<tr>
<td><strong>Thinking/Inquiry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The student:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>provides detailed and logical steps for the construction of the artefact</td>
<td>provides steps for the construction of the artefact that are detailed and logical to a limited degree</td>
<td>provides steps for the construction of the artefact that are somewhat detailed and logical</td>
<td>provides steps for the construction of the artefact that are detailed and logical to a considerable degree</td>
<td>provides steps for the construction of the artefact that are detailed and logical to a high degree</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The student:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>clearly explains in the design brief how the proposed lighting system will satisfy the snowmobile company</td>
<td>explains with limited clarity how the proposed lighting system will satisfy the snowmobile company</td>
<td>explains with some clarity how the proposed lighting system will satisfy the snowmobile company</td>
<td>explains with considerable clarity how the proposed lighting system will satisfy the snowmobile company</td>
<td>explains with a high degree of clarity how the proposed lighting system will satisfy the snowmobile company</td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The student:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>effectively demonstrates the interdependence of the circuit components through the schematic and the drawings</td>
<td>demonstrates the interdependence of the circuit components with limited effectiveness</td>
<td>demonstrates the interdependence of the circuit components with some effectiveness</td>
<td>demonstrates the interdependence of the circuit components with considerable effectiveness</td>
<td>demonstrates the interdependence of the circuit components with a high degree of effectiveness</td>
</tr>
<tr>
<td>5</td>
<td>constructs an effective snowmobile trailer lighting system</td>
<td>constructs a trailer lighting system of limited effectiveness</td>
<td>constructs a trailer lighting system of some effectiveness</td>
<td>constructs a trailer lighting system of considerable effectiveness</td>
<td>constructs a trailer lighting system that is highly effective</td>
</tr>
</tbody>
</table>

*The expectations that correspond to the numbers given in this chart are listed on page 58.

*Note: A student whose overall achievement at the end of a course is below level 1 (that is, below 50%) will not obtain a credit for the course.*
A Snowmobile Trailer Lighting System B E L O W  L E V E L  1

Teacher’s Notes
The following is a list of characteristics found in student work that was submitted for this task and assessed at “below level 1”. (Samples of student work are not included.)

Degree of achievement can vary widely in student performance that falls below level 1. Consequently, the following list includes characteristics of achievement at various degrees below level 1. Taken together, some or all of the characteristics outlined below may justify assessment at “below level 1”. Most of the characteristics noted relate to the criteria specified in the task rubric, but some are more broadly defined.

Knowledge/Understanding
The student:
- omits many or most of the items required for the circuit;
- includes inappropriate items on the list of required parts;
- fails to provide enough information to demonstrate understanding of the task;
- does not explain the function of each of the lighting system’s components;
- makes many errors when explaining the functions of the parts;
- shows a lack of knowledge and understanding of technical terms.

Thinking/Inquiry
The student:
- omits many or most of the steps required for the construction of the artefact;
- provides only a few of the main steps and omits many relevant details;
- produces a set of construction steps that are not in logical order;
- includes illogical or unnecessary steps.

Communication
The student:
- shows no awareness of the target audience;
- does not include a design brief;
- writes a design brief that is unclear;
- provides no description of how components would be protected against the elements.

Application
The student:
- does not provide a schematic and/or technical drawings;
- produces a schematic that does not accurately represent a circuit (e.g., wires are not attached to other components of the device);
- produces drawings of objects that do not resemble the actual objects;
- fails to show the interdependence of the circuit components;
- produces an artefact that does not work.

Comments
The student’s work demonstrates little or no understanding of the requirements of the task, and inadequate skill in communicating the details of his or her proposal.

Next Steps
In order to improve his or her performance, the student needs to:
• study the task requirements more closely;
• review the presentation package format instructions (Appendix C);
• ensure that all the components of the system are listed and the functions of each of them explained;
• list all the steps needed to construct the artefact and make sure they are in logical order;
• acknowledge the client-supplier relationship in the design brief;
• include all of the required components in the schematic and drawings;
• develop an understanding of industry-standard circuit-construction techniques;
• thoroughly test the artefact before submitting it;
• keep a log of his or her work for reference.
Design Brief

My design idea is to produce an effective lighting system on a snowmobile trailer. My company will use the best material possible but also charge a low price.

The light lenses will be sealed from water, salt, dirt, etc. and the wires will be coated with a waterproof material to ensure the longevity of the wire. All the connection will be sealed from everything.

We will make the trailer as light as possible and use as little wiring as we can. Our company will produce this product as inexpensively as possible. There will be a warranty on anything to do with the lighting system of the trailer.

Construction steps

1. I strapped on the light bulbs with tie straps and then fed the wires through the holes to hold it on the board.
2. Hot glued the ground wires to the bulbs and hooked up the three grounds to the one and then soldered it.
3. Connected the positive wires to the bulbs and then soldered it.
4. Put caulking all around the connections to seal them.
LEVEL 1

C

D

TOP VIEW
Teacher’s Notes

Knowledge/Understanding
- The lighting system is described with limited accuracy. Although some of the required components are listed, no mention is made of their function as they are introduced (e.g., “... and the wires will be coated with a waterproof material ...”).

Thinking/Inquiry
- Steps provided for the construction of the artefact are detailed and logical to a limited degree. The steps are clear and listed in a logical sequence. However, there is not enough information in them to construct the artefact and the wording of some instructions does not meet industry standards (e.g., “4. Put caulking all around the connections to seal them”).

Communication
- The way in which the proposed lighting system will satisfy the snowmobile company is explained with limited clarity. The need to protect the circuit’s parts and connections is addressed; however, the measures proposed are vague (e.g., “All the connection will be sealed from everything”). The client-supplier relationship between the snowmobile company and the product designer is not acknowledged.

Application
- The interdependence of the circuit components is demonstrated with limited effectiveness. A schematic that shows circuit components and current flow is provided. However, the symbols and layout do not reflect typical industry-standard schematics (e.g., there are no labels identifying the wires). The drawing is colour coded to correspond with the colours of the wires in the artefact. However, whereas the instructions specify a top- and a bottom-view drawing of the trailer, only one is supplied, and the circuits in the drawing appear to be incomplete.

- The trailer lighting system constructed is of limited effectiveness. The artefact works, and thought and care are evident in the routing of wires. However, although the circuit connections are weatherproofed, they do not meet industry standards, and the way the wires are routed would hinder diagnostic testing (e.g., the weaving of wires through existing holes in the artefact board). The circuit also contains bare, open-ended wires that could cause an unintentional ground.

Comments
This work is representative of a level-1 performance. A limited degree of achievement of the expectations is demonstrated in all four categories of knowledge and skills.

Next Steps
In order to improve his or her performance, the student needs to:
• study the task requirements more closely;
• make sure all of the required components are listed and their individual functions explained;
• provide steps for the construction of the artefact that are more detailed and expressed according to industry standards;
• keep a log of his or her work for reference;
• acknowledge the client-supplier relationship in the design brief;
• develop an understanding of industry-standard circuit-construction techniques;
• review the presentation package format instructions (Appendix C in Teacher Package) prior to final submission.
A Snowmobile Trailer Lighting System

Transportation Technology
Grade 11

Contents

Page 1 - Title Page
Page 2 - Contents Page
Page 3 - Design Brief
Page 4-5 - Drawings
Page 6 - Schematic
Page 7 - Construction Steps
Page 7 - Safety Standards
**Design Brief**

The ‘special’ considerations I had in mind when I designed the wiring system for this trailer were that I had to make sure to weather proof all bare wire and any place the wire joined. I also ensured that the system worked before I permanently connected everything together. This saved in construction time and it made for a neater finished product. I also made sure that I matched the colors of the wires to enable easier wiring.

- 4 pin Trailer connector- This enables the wired system to receive power from the vehicle.

- Yellow, brown and green wires- used to transmit energy to the lights on the back of the trailer.

- White wire- Used to ground out the circuit.

- Heat Shrink- used to weather prove the bare wire where the wire joins.

- Black Electrical Tape- used to hold spliced wires together
**Construction Steps**

**All connections should be protected by heat shrink or some other type of weather proof protector**

- Connect the 4 pin trailer connector to the other loose wires making sure that the wire colors are matched.
- Connect the colored wires to the correct sides (yellow to the left, green to the right).
- Connect the light sockets to the board and connect the yellow and green wires to them.
- Connect the brown wire to both the light sockets and then connect the brown license plate wire to the right brown wire.
- Connect the white wire (the ground) to all sockets (including the license plate socket).
- Place light bulbs into sockets and test for proper wiring.

**Safety Standards**

- Always make sure there is no power running through the circuit before you work on it so that you do not get a shock.
- Never cut towards you always away from you.
Teacher’s Notes

Knowledge/Understanding
- The lighting system is described with some accuracy. A list of the components required for the lighting system is supplied. However, the list is incomplete, and the explanations of the parts’ functions are somewhat insufficient (e.g., “White wire – Used to ground out the circuit”).

Thinking/Inquiry
- Steps provided for the construction of the artefact are somewhat detailed and logical. The steps are clear and easy to follow. However, they do not contain enough detail for the artefact to be reconstructed (e.g., the word “Connect” does not sufficiently explain how the wires are joined).

Communication
- The way in which the proposed lighting system will satisfy the snowmobile company is explained with some clarity. Special considerations for weather-proofing are included (e.g., “the ‘special’ considerations I had in mind when I designed the wiring system for this trailer were that I had to make sure to weather proof all bare wire and any place the wire joined”). However, the method to be used for weatherproofing the connections is not included, and there is no acknowledgement of the client-supplier relationship between the snowmobile company and the product designer in the design brief.

Application
- The interdependence of the circuit components is demonstrated with some effectiveness. The schematic shows the correct current flow from the power source to the ground, with all required connections made. However, the symbols used and the layout do not reflect typical industry-standard schematics (e.g., the battery is pictorial rather than schematized, and splices are not clearly identified; incorrect single-filament bulbs are shown). The drawings have some wire-designation labelling and contain the correct dual-filament bulbs. However, the task instructions specify top- and bottom-view drawings of the trailer, not the artefact.
- The trailer lighting system constructed is of some effectiveness. The artefact works and follows the design shown in the drawings and schematic. Although the circuit connections are weatherproofed, they do not meet industry standards (e.g., the use of silicone sealant to protect electrical connections is not acceptable practice). The circuit also contains bare, open-ended wires that could result in an unintentional ground.

Comments
This work is representative of a level-2 performance. Some degree of achievement of the expectations is demonstrated in all four categories of knowledge and skills.

Next Steps
In order to improve his or her performance, the student needs to:
- study the task requirements more closely;
- list all the components of the lighting system with thorough descriptions of each of their functions;
- improve the tracking of project requirements;
- acknowledge the client-supplier relationship in the design brief;
- demonstrate a better understanding of industry-standard circuit-construction techniques.
A Snowmobile Trailer Lighting System

Table of Contents
Page 1: Design Brief
Page 2-3: Drawings
Page 4: Photographs of Artefact
Page 5: Schematic
Page 6: Construction Steps
Page 7: Safety Standards
Design Brief

We chose to solder the wires together because we felt that solder would provide the best and strongest connection. We covered the soldered connections in shrink-wrap because it would protect the connections from the elements while in use on an actual trailer, as well as preventing a short circuit. We also used snap-on wire protector to further protect the wires from the salt and snow, which would corrode the wires, and to also provide an aesthetically pleasing set-up. Using snap-on wire protector enables one to attach the wires to the trailer using plastic ties, which are cheap and user-friendly to install.

Parts Used:
- 200 mm x 300 mm board - a non-conductive surface to which the wiring system is attached
- Trailer plug - this connects trailer lights to electrical system on vehicle.
- 16-gauge wire: 2 colours .5 metres of yellow and green - carries electrical current
- 16-gauge wire: 2 colours 1.0 metres of brown and white - carries electrical current
- 2 bulb sockets - double filament - housing for brake/blinker and tail-light light bulb
- 1 bulb socket - single filament - housing for license plate light bulb
- 2 bulbs: #1157 - double filament allows for blinker/brake light and tail light in one bulb
- 1 bulb: #1156 - license plate light bulb
- Hot glue, glue gun - fastens wire protector to board
- Metal brackets - holds light bulb sockets in place
- Screws - fastens brackets to board
- Soldering gun, solder - connects wires together
- Electrical tape - fastens wire protector together
- Shrink-wrap - covers wire connections
- Snap-on wire protector - covers and protects wires
Construction Steps

1. We had to cut our board out to the measurements provided. (200mm X 300mm)
2. We were given the proper length and colour of wire. We were given one metre of brown and white wire and half a metre of green and yellow wire.
3. We were given the proper bulbs and bulb sockets. (2 #1157 and 1 #1156 along with the corresponding sockets)
4. Our teacher gave us brackets to hold down the light bulb sockets.
5. We fastened the bulb sockets down with screws and brackets.
6. We wired up the light bulbs using solder to connect them and shrink wrap to cover the connection. We used a heat gun to shrink the shrink wrap.
7. We soldered the trailer plug to the wire system and test it to see if our connections worked properly.
8. We used snap on wire protector to cover and protect the wires. The wire cover gave it a pleasing look.
9. Now we used a little bit of hot glue to fasten the plastic covering to our board.
10. We then took our pictures of our circuit for our profile.
11. Drawing a schematic was our next step.
Teacher’s Notes

Knowledge/Understanding
- The lighting system is described with considerable accuracy. A complete list of circuit components and brief, accurate explanations of each of their functions is provided. However, the explanations are not expressed in technical terms (e.g., “trailer plug – this connects trailer lights to electrical system on vehicle”).

Thinking/Inquiry
- Steps provided for the construction of the artefact are detailed and logical to a considerable degree. The order of the steps is logical (e.g., “4. Our teacher gave us brackets to hold down the light bulb sockets. 5. We fastened the bulb sockets down with screws and brackets.”), and the steps provide enough information for the artefact to be duplicated. However, they are not expressed in industry-standard language (e.g., “We were given the proper length and colour of wire.”).

Communication
- The way in which the proposed lighting system will satisfy the snowmobile company is explained with considerable clarity. Special consideration is given to modifications for extreme weather conditions (e.g., “We also used snap-on wire protector to further protect the wires from the salt and snow.”). Technical information is provided, but there is no acknowledgement of the client-supplier relationship between the snowmobile company and the product designer.

Application
- The interdependence of the circuit components is demonstrated with considerable effectiveness. The schematic is neat, colour-coded, and correctly routed (e.g., the connector is of the flat, four-pin colour-coded variety, and the colour-coded wires are properly connected). The drawings are clearly labelled, and all components are in their proper location (e.g., the harness is shown to be zip-tied to the bottom of the trailer). However, improper bulb symbols are used on the schematic.

Safety Standards

1) When using the saw for cutting the board, be sure to:
   - wear safety goggles or glasses
   - remove all jewelry
   - tuck in all baggy clothing
   - tie back any long hair
   - set the saw guard to the appropriate setting
   - be careful not to cut yourself or others

2) When using the soldering gun:
   - only heat the gun up to the temperature that you need, don’t overheat it
   - only use enough solder to make a solid connection, don’t use too much solder
   - be very careful when around the hot tip; be sure not to burn yourself or others

3) When using the glue gun:
   - only use the necessary amount of glue
   - be very careful when around the hot tip; be sure not to burn yourself or others

4) When using the power supply:
   - be sure to have it on the correct setting
   - only connect the correct wires to the power supply
   - be careful not to shock yourself or others
LEVEL 3

- The trailer lighting system constructed is of considerable effectiveness. The artefact is a functioning, neatly wired lighting circuit, with proper connections and electrical components secured to the board.

Comments
This work is representative of a level-3 performance. A considerable degree of achievement of the expectations is demonstrated in all four categories of knowledge and skills.

Next Steps
In order to improve his or her performance, the student needs to:
- use technical terminology when describing components;
- acknowledge the client-supplier relationship in the design brief;
- ensure that proper symbols are used when producing a schematic.
A Snowmobile Trailer Lighting System

Table of Contents

- Table of Contents ................................................................. pg. 2
- Design Brief ................................................................. pgs. 3-4
- Drawings (top view) ......................................................... pg. 5
- Drawings (bottom view) .................................................... pg. 6
- Schematic ................................................................. pg. 7
- Construction Steps ......................................................... pg. 8
- Safety Standards ............................................................ pg. 9
Design Brief

In this project I will design, construct, and test a snowmobile trailer wiring circuit for a snowmobile company. This trailer will not have an actual trailer frame, but the wiring circuit will be connected to a small plywood board. All the bulbs are going to be connected to the wires, and then those are to be connected to the 4-way connector.

After the construction is finished, I will use a car to provide power for the lights, and check if they work. To provide power and a hook-up for the lights in a real snowmobile trailer, the vehicle’s 4-way plug will be plugged into the trailer’s 4-way connector.

Also, in this design brief, I will include all of the parts that are going to be used, and their function as well. The parts are:

- Plywood 200 mm X 300 mm
- Fastening devices: i) glue gun OR ii) tie wraps
- Trailer plug (4-way connector)
- 16 gauge wire
  - i) 0.5 m yellow wire
  - ii) 0.5 green wire
  - iii) 1 m brown wire
  - iv) 1 m white wire
- 2 bulb sockets – double filament
- 1 bulb socket – single filament
- 2 (1157) bulbs
- 1 (1156) bulb

The use of each part is described below:

- Plywood – is going to be like the trailer’s frame, and will hold the wires with the bulbs.
- Glue gun – can connect the wires to the frame, but in this situation will not be used, because it is not very useful for the weather conditions in which the trailer is going to be working.
- Tie wraps – are going to be used instead of the glue gun, because they are better for the weather conditions.
- Trailer plug (4-way connector) – is going to provide the power for the trailer’s components (lights), because the vehicle’s plug (also 4-wire connector) will be connected to the trailer’s connector.
- Yellow wire – will conduct current from the power source (car) to the left brake light, and left turn signal.
- Green wire – will conduct current from the power source (car) to the right brake light, and right turn signal.
- Brown wire – will conduct current from the power source to the license plate light, and tail lights.
- White wire – is for the ground use.
- 2 bulb socket (double filament) & 2 (1157) bulbs – are going to be used for license plate light.

I think that my design will satisfy the company’s requirements. I think so, because this trailer is not using too many building parts, the wires are going to be sealed with the waterproof caulk for extra protection from water and snow. The frame’s edges will be rounded so that they do not damage the wires, and I will try to put some waterproof material on the bulb sockets and bulbs so they work longer. I will also include some stickers on the trailer with some safety precautions on how to connect it to the vehicle, and if something is not functioning.
Construction Steps

1. Prepare all the parts and instruments.
2. Connect white, brown, green, and yellow wires to the same colour wires of the 4-way connector.
3. Make them shorter if necessary.
4. For the left turn signal bulb socket, connect black wire to the white wire of the connector, yellow wire to the yellow, and brown to the brown wire.
5. For the right turn signal bulb socket, connect black wire to the white wire, yellow wire to the green wire, and brown wire to the brown of the 4-way connector.
6. For the license plate and tail lights bulb socket, connect black wire to the brown wire of the connector.
7. Now solder all the wires together.
8. Put the completed work from previous steps on the plywood board, and arrange so it looks good.
9. Make sure that the turn signal sockets are on appropriate sides of the board.
10. Drill holes in the board for the tie wraps.
11. Connect the wires to the board by using tie wraps.
**Safety Standards**

In a real-life situation there are not very many safety concerns to be kept in mind for this work. Some of the safety steps to be followed are listed below:

1. Do not touch the soldering iron, because it is extremely hot.
2. Make sure not to leave your soldering iron plugged in, when you are done for the day, because it might cause fire in the building.
3. When drilling holes in the frame for tie wraps, put on safety glasses, and be careful with your hands.
4. Clean your work area when finished.
Teacher’s Notes

Knowledge/Understanding

- The lighting system is described with a high degree of accuracy. A complete list of circuit components and in-depth, accurate explanations of each of their functions are provided. In addition, correct technical language is used in these explanations (e.g., “Trailer plug (4-way connector) – is going to provide the power for the trailer’s components (lights), because the vehicle’s plug (also 4-wire connector) will be connected to the trailer’s connector”).

Thinking/Inquiry

- Steps provided for the construction of the artefact are detailed and logical to a high degree. The order of the steps is logical, and they are written in a way that closely resembles that of industry documents (e.g., “2. Connect white, brown, green, and yellow wires to the same colour wires of the 4-way connector. 3. Make them shorter if necessary”). The comprehensiveness of the steps ensures precise and high-quality duplication.

Communication

- The way in which the proposed lighting system will satisfy the snowmobile company is explained with a high degree of clarity. The design brief contains specific ways in which the system will appeal to the snowmobile company (e.g., “…this trailer is not using too many building parts, the wires are going to be sealed with the waterproof caulk …”).

Application

- The interdependence of the circuit components is demonstrated with a high degree of effectiveness. The schematic is comparable to an industry-standard document (e.g., the correct symbols and circuit orientation are used, and the power is shown to be flowing from source to ground). The drawings are clearly labelled and contain all required components. In addition, the student included two side marker lights referred to in the technical standards document (Appendix A).
The trailer lighting system constructed is highly effective. The artefact is a fully functioning lighting circuit that is built according to industry standards (e.g., use of side marker lamps) and uses industry-standard techniques (e.g., threaded fasteners to secure all components) in its construction.

Comments
This work is representative of a level-4 performance. A high degree of achievement of the expectations is demonstrated in all four categories of knowledge and skills.

Next Steps
In order to improve his or her performance, the student could consider producing a coloured schematic.
Title: A Snowmobile Trailer Lighting System

Time Requirement: 5 periods of 75 minutes each

Expectations Addressed in the Exemplar Task
This task gives students the opportunity to demonstrate achievement of all or part of each of the following selected expectations from the Theory and Foundation strand.

Students will:
1. explain the use of each component of a vehicle system;
2. gather and record information, and establish a plan of procedures [to solve a transportation technology challenge];
3. explain how human needs or wants related to transportation can be met through a new or improved vehicle or system;
4. produce presentation and working drawings, sketches, graphics, mathematical and physical models, or a prototype of the best solution [to a transportation technology challenge];
5. apply the design process to develop solutions, products, processes, or services in response to challenges or problems in transportation technology.

Description of the Task
Present students with the following scenario:

You are asked to design, construct, and test a tail-light trailer-wiring circuit (brake lights, turn signals, licence-plate light, tail lights) for a new model of snowmobile trailer that is to be mass-produced. (The trailer is used to haul snowmobiles and is pulled by a car or truck.) You will develop a presentation package for the snowmobile company containing a design brief, one top-view and one bottom-view drawing of the trailer, a schematic detailing the lighting system circuit, and steps for constructing an artefact of the circuit.

You will construct and test your circuit (i.e., the artefact) in accordance with existing regulations and recognized safety standards. Materials provided for this construction must be used effectively and efficiently with little waste.
Note: A snowmobile trailer was chosen because it is used in harsher conditions than those in which a standard utility trailer is used and, therefore, offers a higher degree of design challenge. Students can, for example, give special consideration to weatherproofing and to ensuring that the harness is secure.

Final Product
Each student will submit a presentation package containing:

- a design brief that outlines how the lighting system works, and that includes a list of the wiring circuit's parts, and explanations of the function of each part and of how the design will satisfy the snowmobile company;
- a schematic of the circuit [see Appendix D];
- one top-view and one bottom-view drawing of the trailer [see Appendix E];
- construction steps for the artefact;
- safety standards for the construction of the artefact;
- an artefact consisting of a trailer wiring circuit that is scaled down to fit onto a board that is approximately 200 mm x 300 mm. The circuit must work and be securely mounted onto the board in a way that simulates its location on the final product. All connections must meet industry standards, and the circuit must contain all the components required by law for highway operation.

Assessment and Evaluation
The task-specific rubric will be used to evaluate the final product.* Introduce the rubric to the students when you introduce the task. Review the rubric with the students and ensure that each student understands the criteria and the descriptions for achievement at each level. Allow ample time for a thorough reading and discussion of the assessment criteria outlined in the rubric.

Some students may perform below level 1. Although the rubric does not include descriptions of achievement below level 1, the characteristics of these students' work should be reviewed in relation to the criteria outlined in the rubric.

Note: For the purpose of this exemplar document, the artefact was evaluated using photographs that were submitted to the ministry.

Teacher Instructions
Prior Knowledge and Skills Required
To complete this task, students are expected to have some experience in, or some knowledge and skills related to, the following:

- work-related safety
- electrical principles and circuit construction (Grade 9 science curriculum)
- measurement (Grade 9 mathematics curriculum)
- use of hand tools required to construct artefact
- basic wiring and jointing techniques
- single-view technical drawings (i.e., block diagrams)

*The rubric is reproduced on page 59 of this document.
• electrical schematic diagrams as they pertain to the transportation industry
• common ground-wiring systems (i.e., ground return systems)
• library and Internet research skills, and the computer use policies at their school
• the design process

**A ccommodations**
A ccommodations that are normally provided in the regular classroom for students with special needs should be provided in the administration of this performance task.

**M aterials**
- 200 mm x 300 mm board consisting of non-conductive material (e.g., plywood, drywall)
- fastening devices (e.g., soldering gun, nylon tie-wraps)
- 4-wire trailer plug
- .5 metre each of yellow and green 16-gauge wire
- 1 metre each of brown and white 16-gauge wire
- 2 bulb sockets – double-filament
- 1 bulb socket – single-filament
- 2 bulbs – #1157
- 1 bulb – #1156

*Note: See Classroom Management Strategy below for one method of keeping material costs to a minimum.*

**R esources**
- samples or pictures of a variety of trailer lamp assemblies
- Ministry of Transportation website at www.gov.on.ca (contains general information, including guides and regulations)
- Appendix A: Technical Standards Document
- Appendix D: Template for Wiring Diagram [for teacher use only]
- Appendix E: Template for Block-Format Drawing of Trailer [for teacher use only]

**Classroom Management Strategy**
To minimize expenses, teachers may wish to adopt the following strategy:
- Divide the class into groups of four to six students.
- Give each group a number for the purposes of identification and rotation. Have the first group construct the artefact.
- After the first group has constructed the artefact, tell the students in the group to disassemble it.
- Have the second group construct and then disassemble the artefact. Repeat until all of the groups have completed the task.
**Task Instructions**

**Day 1**
- Introduce students to the performance task and rubric.
- Present samples or pictures of a variety of lamp assemblies.
- Review wiring techniques.
- Have each student write a design brief that includes a list of the wiring circuit’s parts, and explanations of the use of each part and of how the design will satisfy the snowmobile company.

**Day 2**
- Review the technical standards document (Appendix A) with the students.
- Have students work on their drawings and on the schematic for their trailer wiring circuit using the design process.
- Approve each design before the student begins practical work.

**Day 3**
- Hand out materials for the construction of the artefact.
- Instruct students in the steps required to construct a wiring harness.
- Review wiring and connecting techniques.
- Have students mount components onto a board, reminding them to use shop equipment safely.

**Day 4**
- Have students finalize all connections.
- Tell students to test the operation of their circuit, completing the artefact operation checklist (Appendix B) as they carry out the test.

**Day 5**
- Review the presentation package format instructions (Appendix C) with students.
- Have students review all of the components of their presentation package for the snowmobile company.
- Allow students to make revisions to the components if required.
- Ask students to submit their presentation packages.
List of Appendices

Appendix A: Technical Standards Document
Appendix B: Artefact Operation Checklist
Appendix C: Presentation Package Format Instructions
Appendix D: Template for Wiring Diagram [for teacher use only]
Appendix E: Template for Block-Format Drawing of Trailer [for teacher use only]
Appendix A: Technical Standards Document

LAMPS, REFLECTIVE DEVICES AND
ASSOCIATED EQUIPMENT

S5.1.1.8 For each motor vehicle less than 9.1 m (30 feet) in overall length, the photometric minimum candlepower requirements for side marker lamps specified in SAE Standard J592e Clearance, Side Marker, and Identification Lamps, July 1972, may be met for all inboard test points at a distance of 4.6 m (15 feet) from the vehicle and on a vertical plane that is perpendicular to the longitudinal axis of the vehicle and located midway between the front and rear side marker lamps.

S5.1.1.9 A boat trailer whose overall width is 2.05 m (80 inches) or more need not be equipped with both front and rear clearance lamps, provided an amber (to front) and red (to rear) clearance lamp is located at or near the midpoint on each side so as to indicate its extreme width.

S5.1.1.10 Multiple license plate lamps and backup lamps may be used to fulfill the requirements of the SAE Standards.

S5.1.1.11 A stop lamp that is not optically combined, as defined by SAE Information Report J387, Terminology - Motor Vehicle Lighting, NOV87, with a turn signal lamp shall remain activated when the turn signal lamp is flashing.

S5.1.1.13 Each passenger car and each multipurpose passenger vehicle, truck, and bus of less than 2.05 m (80 inches) overall width shall be equipped with a turn signal operating unit designed to complete a durability test of 100,000 cycles.

S5.1.1.14 A trailer that is less than 760 mm (30 inches) in overall width may be equipped with only one tail lamp, stop lamp, and rear reflex reflector, which shall be located at or near its vertical centerline.

S5.1.1.15 A trailer that is less than 1.8 m (6 feet) in overall length, including the trailer tongue, need not be equipped with front side marker lamps and front side reflex reflectors.

S5.1.1.16 A lamp designed to use a type of bulb that has not been assigned a mean spherical candlepower rating by its manufacturer and is not listed in SAE Standard J573d, Lamp Bulbs and Sealed Units, December 1968, shall meet the applicable requirements of this TSD when used with any bulb of the type specified by the lamp manufacturer, operated at the bulb’s design voltage. A lamp that contains a sealed-in bulb shall meet these requirements with the bulb operated at the bulb’s design voltage.

S5.1.1.17 Except for a lamp having a sealed-in bulb, a lamp shall meet the applicable requirements of this TSD when tested with a bulb whose filament is positioned within ± 0.25 mm (± 0.010 inch) of the nominal design position specified in SAE Standard J573d, Lamp Bulbs and Sealed Units, December 1968, or specified by the bulb manufacturer.
S5.1.1.18 A backup lamp is not required to meet the minimum photometric values at each test point specified in Table I of SAE Standard J593c, Backup Lamps, February 1968, if the sum of the candlepower measured at the test points within each group listed in Figure 2 is not less than the group totals specified in that figure.

Appendix B: Artefact Operation Checklist

Test the operation of each of the following lighting subsystems in your artefact, using your method of choice, and place a checkmark in the appropriate table cell.

<table>
<thead>
<tr>
<th>Lighting Subsystem</th>
<th>Working</th>
<th>Intermittently Working</th>
<th>Not Working</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tail lights</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brake lights</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left signal light</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right signal light</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>License plate light</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C: Presentation Package Format Instructions

The presentation package you submit for evaluation must follow the format outlined below. Use the same headings and provide the requested content for each heading. All text is to be word processed or neatly written on 8½-x-11-inch paper, and pages are to be numbered.

Cover page
Provide project title, date, and course name.

Table of contents
Indicate the pages on which the components of your presentation package appear.

Design brief
In your own words describe your wiring system and any special considerations that you had in mind when designing it for the snowmobile company (e.g., weather protection for soldered joints). List each part used in your system and explain its function within the system (e.g., wire – to conduct current from one point to another).

Drawings
Create one top-view and one bottom-view drawing in block-diagram format (i.e., components are to be labelled to show their location on the trailer). The drawings need to be labelled so that the connection details and the method used to secure the components to the trailer are clear. Use a pencil and straight edge to produce neat drawings. Each drawing is to be on a separate 8½-x-11-inch page.

Schematic
Create a schematic based on the best design produced from the top-view diagrams. The schematic is to be neatly drawn, using a pencil and straight edge, on a separate 8½-x-11-inch page and use standard symbols.

Construction steps
List each of the steps you took to construct the artefact of your circuit. Include any revisions you had to make to your drawings. Explain the reasons for your decisions.

Safety standards
List all of the safety concerns to keep in mind when you or others are performing this type of work in a real-life situation.
Appendix D: Template for Wiring Diagram
Appendix E: Template for Block-Format Drawing of Trailer
The Ministry of Education wishes to acknowledge the contributions of the many individuals, groups, and organizations that participated in the development and refinement of this resource document.
The Ontario Curriculum
Exemplars
Grade 11
Technological Education

Construction Technology
Transportation Technology

Samples of Student Work: A Resource for Teachers

© Queen’s Printer for Ontario, 2006