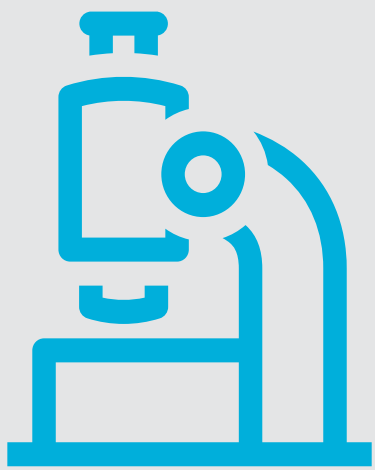


Classroom Assessment  
Materials and Examples  
Science 30



Alberta Provincial Diploma Examinations  
2018–2019

This document was written primarily for:

Students	✓
Teachers	✓ of Science 30
Administrators	✓
Parents	
General Audience	
Others	

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## *Introduction*

The items and projects here are intended to promote the use of extended-response items and hands-on inquiry-based activities in high-quality classroom assessments. Teachers may wish to use these resources in a variety of ways to improve the degree to which students develop and demonstrate an understanding of the concepts described in the Science 30 Program of Studies.

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## *Assessment of Communication Skills in the Classroom*

Although written-response questions are not part of the Science 30 Diploma Examination, we encourage the use of written-response questions in classroom assessment.

Using written-response items can allow for more complete coverage of the outcomes in the program of studies, particularly those outcomes with higher cognitive expectations.

The following pages give examples of written-response questions, together with scoring rubrics and examples of student work.

In science, there is a stringent set of rules for proper scientific communication. Communication skills are most evident in, and can be directly assessed on, the written-response questions.

# Generic Scoring Guides

The generic scoring guides below may be useful for classroom assessment.

## Scoring Guide for Knowledge

Score	Scoring Description
<b>4 Standard of Excellence</b>	The response is <b>well organized</b> and addresses <b>all</b> the major points of the question using <b>appropriate and clear</b> communication strategies. The description of relevant scientific, technological, and/or societal concepts is <b>explicit</b> . Descriptions, explanations, and/or interrelationships of the concepts provided are correct and <b>reflect a thorough understanding</b> of the question.
<b>2 Acceptable Standard</b>	The response is <b>generally organized</b> and addresses most of the major points of the question using <b>adequate</b> communication strategies. The relevant scientific, technological, and/or societal concepts <b>are described</b> . Descriptions of the concepts provided are <b>generally correct</b> and <b>reflect an adequate understanding</b> of the question.

## Scoring Guide for Skills

Score	Scoring Description
<b>4 Standard of Excellence</b>	The problem is <b>thoroughly understood</b> . An <b>appropriate</b> and <b>practical</b> design is presented. The data are <b>accurately</b> and <b>completely</b> analyzed. <b>Accurate</b> interpretations and conclusions are made <b>based on an analysis of the data</b> . The evaluation of the overall study is based on a <b>thorough understanding</b> of the principles of scientific inquiry.
<b>2 Acceptable Standard</b>	The problem is <b>understood</b> . The design is <b>generally appropriate</b> , or a <b>practical</b> procedure with <b>some omissions or errors</b> is presented. The data are <b>adequately</b> analyzed. Interpretations and conclusions are <b>generally based on an analysis of the data</b> . The evaluation of the overall study is based on an <b>adequate understanding</b> of the principles of scientific inquiry.

## Scoring Guide for STS

Score	Scoring Description
<b>4 Standard of Excellence</b>	The design and function of the technological device are clearly explained. The interrelationships between science, technology, and society are <b>thoroughly understood</b> . Risks and benefits are <b>thoroughly evaluated</b> . <b>Insightful</b> and <b>convincing</b> arguments are used to support a decision or judgement, and <b>a range of viewpoints is considered</b> .
<b>2 Acceptable Standard</b>	The design and function of the technological device are <b>described</b> . The interrelationships between science, technology, and society are <b>generally understood</b> . Risks and benefits are <b>listed</b> . <b>Logical</b> arguments are used to support a decision or judgement, and <b>viewpoints are considered</b> .

## Short-answer Questions for Classroom Assessment

Although open-ended questions are no longer part of the Science 30 Diploma Examination, open-ended questions should be used freely as part of classroom assessment. In this way, there can be a broad-based assessment of all the outcomes included in the program of studies.

Students' answers can be scored using a holistic scoring guide. The guide describes the characteristics of students' answers that correspond to one of five values: 4, 3, 2, 1, or 0.

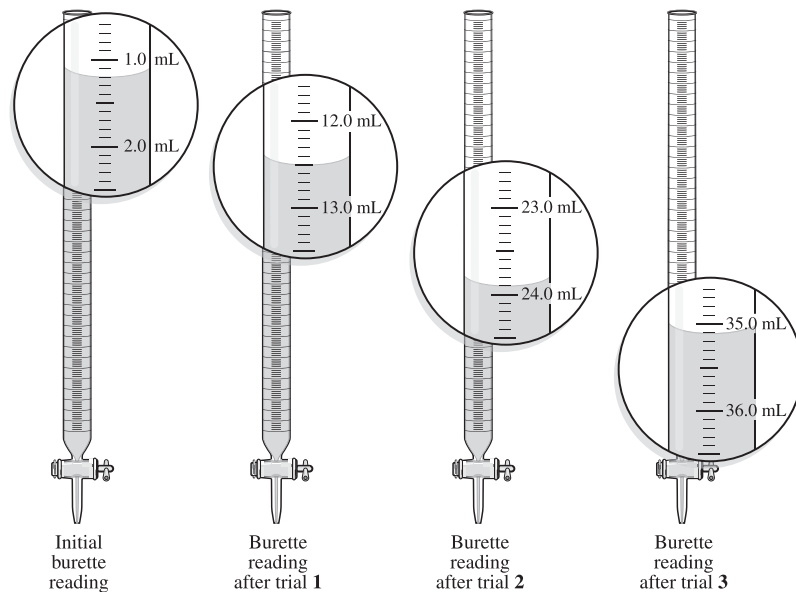
The following section presents the short-answer question from Part A of the January 2008 Diploma Examination along with examples of students' responses and the scoring guides that were used to score them.

### January 2008 Diploma Examination Short-answer Questions, Scoring Guides, Sample Responses, and Rationales

Use the following information to answer the next question.

In order to determine the concentration of a solution of  $\text{NaOH}(\text{aq})$ , a student titrates a 10.00 mL sample of  $\text{NaOH}(\text{aq})$  with a 0.500 mol/L solution of  $\text{HNO}_3(\text{aq})$ .

The diagram below shows the volume of  $\text{HNO}_3(\text{aq})$  added for each of three titration trials.



**Note:** The burette is **not** refilled after each trial.

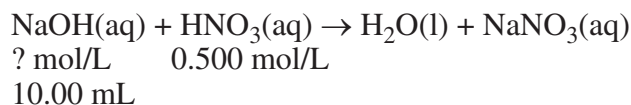
**Short Answer**

- a. Use the information on the previous page to complete the following table. The volume of  $\text{HNO}_3(\text{aq})$  added in trial II has been provided for you.

	<b>Trial I</b>	<b>Trial II</b>	<b>Trial III</b>
<b>Final volume of <math>\text{HNO}_3(\text{aq})</math> (mL)</b>			
<b>Initial volume of <math>\text{HNO}_3(\text{aq})</math> (mL)</b>			
<b>Volume of <math>\text{HNO}_3(\text{aq})</math> added (mL)</b>		11.40	

Use the following additional information to answer the next part of the question.

The reaction that occurs during the titration is represented by the equation below.



- b. Use the average volume of  $\text{HNO}_3(\text{aq})$  from trials I through III to calculate the concentration of  $\text{HNO}_3(\text{aq})$ . Show your work.

**Sample Response**

a.

	<b>Trial I</b>	<b>Trial II</b>	<b>Trial III</b>
<b>Final volume of <math>\text{HNO}_3(\text{aq})</math> (mL)</b>	12.50	23.90	35.10
<b>Initial volume of <math>\text{HNO}_3(\text{aq})</math> (mL)</b>	1.20	12.50	23.90
<b>Volume of <math>\text{HNO}_3(\text{aq})</math> added (mL)</b>	11.30	11.40	11.20

b.

$$\text{Average Volume of } \text{HNO}_3(\text{aq}) \text{ added} = (11.30 + 11.40 + 11.20)/3 = 11.30 \text{ mL}$$

$$n = CV$$

$$\text{mol of } \text{HNO}_3 = 0.01130 \text{ L} \times 0.500 \text{ mol/L} = 0.00565 \text{ mol}$$

$$C = n/V$$

$$C \text{ of NaOH} = 0.00565 \text{ mol}/0.0100 \text{ L} = \mathbf{0.565 \text{ mol/L}}$$

**OR**

$$C_1V_1 = C_2V_2$$

$$C_1 = C_2V_2/V_1$$



## Scoring Guide – Short-answer Question

Score	Short-answer Scoring Descriptions
4 <b>Standard of Excellence</b>	The values in the table of burette readings are complete and accurate. The work is <b>well organized and correct</b> . The concentration of NaOH(aq) is <b>correct</b> .
3	The values in the table of burette readings are complete and <b>mostly accurate</b> . The work is <b>organized and generally correct</b> . The concentration of NaOH(aq) is <b>correct or reflects minor errors in computation</b> OR the answer is correct with little work shown.
2 <b>Acceptable Standard</b>	<b>Most</b> of the values in the table of burette readings are entered and <b>generally correct</b> . The work is <b>reasonably well organized</b> . The concentration of NaOH(aq) is <b>consistent with the results from the table and calculations presented in the work</b> .
1	The table of burette readings is incomplete and inaccurate. The work is <b>not organized</b> . The concentration of NaOH(aq) is <b>incorrect</b> .
0	The response does not address any of the major points of the question at an <b>appropriate level</b> for a 30-level course.

### Student Response 1

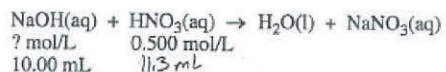
Short Answer—5%

- a. Use the information on the previous page to complete the following table. The volume of HNO<sub>3</sub>(aq) added in trial II has been provided for you.

	Trial I	Trial II	Trial III
Final volume of HNO <sub>3</sub> (aq) (mL)	12.5 mL	23.9 mL	35.1 mL
Initial volume of HNO <sub>3</sub> (aq) (mL)	1.2 mL	12.5 mL	23.9 mL
Volume of HNO <sub>3</sub> (aq) added (mL)	11.3 mL	11.40	11.2 mL

Use the following additional information to answer the next part of the question.

The reaction that occurs during the titration is represented by the equation below.



- b. Use the average volume of HNO<sub>3</sub>(aq) from trials I through III to calculate the concentration of NaOH(aq). Show your work.

$$\frac{C_i V_i}{V_i} = \frac{C_f V_f}{V_i} \quad C_i = \frac{0.500 \text{ mol/L} \times 0.113 \text{ L}}{0.100 \text{ L}}$$

$$C_i = \frac{C_f V_f}{V_i} \quad C_i = 0.565 \text{ mol/L}$$

The concentration of NaOH(aq) is 0.565 mol/L

### Score—4 Rationale

This example meets the requirements of the *standard of excellence*.

The data table is complete and mostly accurate. There is a minor error of using litres instead of millilitres, but it doesn't interfere with the calculation. The calculation is correct and consistent with the data in the table.

## Student Response 2

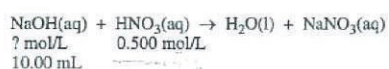
Short Answer—5%

- a. Use the information on the previous page to complete the following table. The volume of  $\text{HNO}_3(\text{aq})$  added in trial II has been provided for you.

	Trial I	Trial II	Trial III
Final volume of $\text{HNO}_3(\text{aq})$ (mL)	12.50	23.90	35.10
Initial volume of $\text{HNO}_3(\text{aq})$ (mL)	1.20	12.50	23.90
Volume of $\text{HNO}_3(\text{aq})$ added (mL)	11.30	11.40	11.20

Use the following additional information to answer the next part of the question.

The reaction that occurs during the titration is represented by the equation below.



- b. Use the average volume of  $\text{HNO}_3(\text{aq})$  from trials I through III to calculate the concentration of  $\text{NaOH}(\text{aq})$ . Show your work.

$$C = \frac{n}{V}$$

$$C = \frac{0.500 \text{ mol/L}}{0.01 \text{ L}}$$

$$C = ?$$

$$V = 10.00 \text{ mL} = 0.01 \text{ L}$$

$$n = 0.500 \text{ mol/L}$$

$$C = 50 \text{ mol/L}$$

The concentration of  $\text{NaOH}(\text{aq})$  is  $50 \frac{\text{mol}}{\text{L}}$ .

## Score—2 Rationale

This example meets the *acceptable standard*.

The correct values are entered into the table for the burette volumes, and the calculations in the table are done properly. However, the data from the table are not carried over into part b. The response demonstrates minimal understanding of calculations related to determining the concentration of the  $\text{NaOH}(\text{aq})$ .

## Long-answer Questions for Classroom Assessment

The following section presents two open-response long-answer questions with examples of students' responses from Part A of the January 2008 Diploma Examination as well as the scoring guides that were used to score them.

Each student's answer is scored using holistic scoring guides. The guide describes the characteristics of students' answers that correspond to one of five values: 4, 3, 2, 1, or 0.

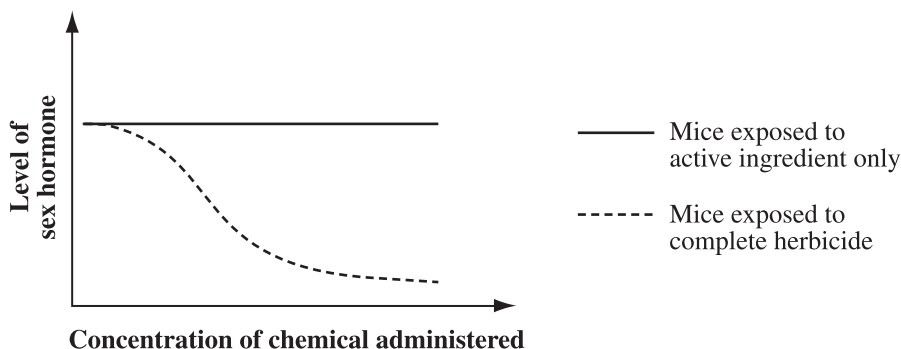
### January 2008 Diploma Examination Long-answer Questions, Scoring Guides, Sample Responses, and Rationales

Use the following information to answer the next question.

Environmentalists are concerned that manufacturers of herbicides are not required to list all of the ingredients that are in their products. Manufacturers are required to list only the active ingredients, which are the substances that kill the pest. Inert substances, which are often not listed, include solvents in which the herbicides' active ingredients are dissolved and other additives.

In one study, a group of mice was exposed to an increasing concentration of only the active ingredient in a herbicide. A second group of mice was exposed to an increasing concentration of the complete herbicide. The level of sex hormones that were produced by each group of mice was monitored. The results of the experiment are graphed below.

**Effect of a Particular Herbicide on the Level of Sex Hormones in Mice**



#### Long Answer 1

- Manufacturers are required to disclose the active ingredients in their herbicides. **Explain** how the information presented in the graph above supports the argument that manufacturers should disclose **all** of the ingredients in their herbicides.
- State** one major advantage and one major disadvantage of pesticide use. **Describe** two actions that you think society should take in dealing with pests, and **explain** the benefits of these actions.

## Sample Response

- a. *Mice exposed to the complete herbicide experienced a decrease in sex hormone levels, but mice exposed to only the active ingredient from a pesticide preparation did not experience any decrease in sex hormone levels. These data appear to indicate that chemicals, other than the active ingredient, within the complete herbicide application have an effect on the ability of mice to produce sex hormones. Disclosing the list of all chemicals in the commercial pesticide will identify those ingredients that may have unknown effects, have been the focus of previous investigations, or require further testing.*
- b. *One major advantage of herbicide use is that it reduces the size of pest populations and increases crop yield. One major disadvantage is that some herbicides are not target specific. One action for dealing with pests would be to control populations by exposing them to natural predators. Another action would be to use genetically modified species that are resistant to the pests. The benefits of both actions would be the reduction of chemical use and a decrease in the potential harm to the environment that results from possible biomagnification or reactions with unknown additives.*

The response should clearly provide one advantage or one disadvantage of herbicide use. The response should indicate two appropriate actions for dealing with pests. The benefits of each action should be identified and may be politically, economically, or environmentally focused.

*Some other advantages are easy application and relatively low cost compared with non-chemical methods. Some other disadvantages of herbicide use are biomagnification; disruption of food chains; and long-term, low-level exposure.*

*Some other actions society could take in dealing with pests (such as weeds, for example) would be to manually remove them. Insects have been successfully controlled through the use of pheromone attractants or the introduction of sterilized individuals into the population.*

## Scoring Guide January 2008 – Long-answer 1

Score	Long-answer Scoring Descriptions
4 <b>Standard of Excellence</b>	The response is <b>well organized</b> and addresses <b>all</b> the points of the question. The data from the graph are accurately interpreted. The response reflects a <b>thorough</b> understanding of pesticide use and presents a <b>sophisticated</b> description of how society should deal with pests.
3	The response is <b>organized</b> and addresses the major points of the question. The data from the graph are <b>accurately</b> interpreted. The response reflects a <b>good</b> understanding of pesticide use and presents a <b>reasonable</b> description of how society should deal with pests.
2 <b>Acceptable Standard</b>	The response is <b>generally organized</b> and addresses <b>most of</b> the major points of the question. The data from the graph are <b>adequately</b> interpreted. The response reflects an <b>adequate</b> understanding of pesticide use and presents a <b>simple</b> description of how society should deal with pests.
1	The response is <b>not well organized</b> and <b>does not</b> address the major points of the question. The data from the graph are <b>not accurately</b> interpreted. The response reflects a <b>poor</b> understanding of pesticide use and presents a <b>superficial</b> description of how society should deal with pests.
0	The response does not address any of the major points of the question at an <b>appropriate level</b> for a 30-level course.

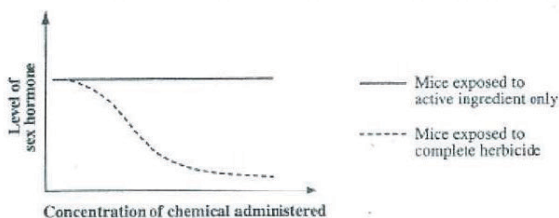
## Student Response 1

Use the following information to answer the next question.

Environmental scientists are concerned that manufacturers of herbicides are not required to list all of the ingredients that are in their products. Manufacturers are required to list only the active ingredients, which are the substances that kill the pest. Inert (inactive) substances, which are often not listed, include solvents in which the herbicides' active ingredients are dissolved and other additives.

In one study, a group of mice was exposed to an increasing concentration of only the active ingredient in a herbicide. A second group of mice was exposed to an increasing concentration of the complete herbicide. The level of sex hormones that were produced by each group of mice was monitored. The results of the experiment are graphed below.

Effect of a Particular Herbicide on the Level of Sex Hormones in Mice



Long Answer—15%

- a. Manufacturers are required to disclose the active ingredients in their herbicides. Explain how the information presented in the graph above supports the argument that manufacturers should disclose all of the ingredients in their herbicides.

The second group of mice shows that their level of sex hormones are decreasing. However, the first group of mice are not. This means that inert substances are causing the problem. Manufacturers should disclose all of the ingredients so people can be aware of the inert substances that might affect themselves or environment. Not using them without even knowing what ingredients might affect other organisms.

- b. State one major advantage and one major disadvantage of pesticide use. Describe two actions that you think society should take in dealing with pests, and explain the benefits of these actions.

When pesticide is used, people can very easily protect their garden or field. It can kill off a lot of pests at one time. However, it has a side effect. When pesticide is used, it might kill other organisms that is not targetted. Using pesticide can affect environment greatly. Thus I think people must find ways that don't use chemicals when dealing with pests. First, they maybe have to grow different plants and use different crops at every season. This way you don't have to use chemicals and it can prevent from the same pest to attack the same plant again and again. Secondly, people can put the pest's predator to their field. In this way people don't have to use chemicals, so it's less affecting the environment.

## Score—4 Rationale

This example meets the requirements of the *standard of excellence*.

The response is well organized and includes an accurate interpretation of the graph and study. The advantages and disadvantages of pesticide use are explained. Actions to reduce the use of pesticides are provided along with specific examples. The answer could have been improved by using phrases such as “target-specific pesticides” and “crop rotation for reducing the use of pesticides.”

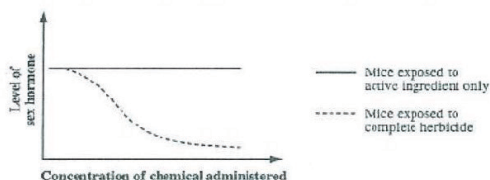
## Student Response 2

Use the following information to answer the next question.

Environmental scientists are concerned that manufacturers of herbicides are not required to list all of the ingredients that are in their products. Manufacturers are required to list only the active ingredients, which are the substances that kill the pest. Inert (inactive) substances, which are often not listed, include solvents in which the herbicides' active ingredients are dissolved and other additives.

In one study, a group of mice was exposed to an increasing concentration of only the active ingredient in a herbicide. A second group of mice was exposed to an increasing concentration of the complete herbicide. The level of sex hormones that were produced by each group of mice was monitored. The results of the experiment are graphed below.

Effect of a Particular Herbicide on the Level of Sex Hormones in Mice



Long Answer—15%

- a. Manufacturers are required to disclose the active ingredients in their herbicides. Explain how the information presented in the graph above supports the argument that manufacturers should disclose all of the ingredients in their herbicides.

The mice that have only the active ingredient, have a higher sex hormone. They can reproduce and not have any problems. The mice with the complete herbicides, don't have very high sex hormone. So they cannot reproduce as good. The higher the concentration of complete herbicide the lower the sex level of hormones. They should list all the ingredients on the label, so people know that it doesn't kill the animals. It makes them reproduce better.

## Score—2 Rationale

This example meets the *acceptable standard*.

The response is organized and addresses all the points of the question. The interpretation of the graph is generally correct. Bioaccumulation is correctly described and given as a disadvantage of pesticide use. Development of resistance to pesticides is incorrectly presented as an advantage of pesticide use. Pesticides are incorrectly mentioned as a cause of algal bloom.

## Student Response 2 continued

- b. State one major advantage and one major disadvantage of pesticide use. Describe two actions that you think society should take in dealing with pests, and explain the benefits of these actions.

One major disadvantage of pesticide use is; It kills organisms. The pesticides get higher in concentration as they go up the food chain, The animals and organisms die from eating the plants sprayed with pesticides. As the pesticide moves up the food chain it can harm the tertiary consumers, The animals in the highest trophic level suffer the worst. The pesticides being used will also cause pollution, to the lakes or rivers; If the pesticides reach the lakes or rivers; It can cause an algal bloom. An Algal bloom will kill off all the aquatic life.

One major advantage of using pesticides, would be; that the organisms that are reproduced could have a mutant gene. The pesticides would not hurt the organisms, because their mutation will allow them to withstand the pesticides. Two actions, society should take in dealing with pests are; to bring amphibians into the picture. The amphibians will kill the insects eating the crops or plants. They could also use a stronger fertilizer, or pesticide for the time being.

Use the following information to answer the next question.

As oil, natural gas, and coal reserves become depleted, alternative energy sources will need to be significantly developed in order to provide the energy required to sustain the current standard of living. Decisions about the use of alternative energy technologies should include information from ecological, economic, societal, and political perspectives.

### Alternative Energy Technologies

Nuclear power plant  
Wind turbine  
Hydroelectric power plant  
Photovoltaic cell  
Tidal power plant  
Geothermal power plant

### Long Answer 2

From the list above, **select one** alternative energy technology used to produce electricity.

- **List** the energy conversions involved in using the technology.
- **Explain** the advantages and disadvantages of using the selected technology from two of the following perspectives: ecological, economic, societal, and political.
- **Describe** how the selected alternative energy technology should be used in the future.

### Sample Response

*The first part of the sample response is summarized in the table that follows.*

*Any future use of a selected technology should occur after the identification and analysis of the possible advantages and disadvantages, as well as emerging improvements on existing technology, to ensure that actions can be taken to minimize risks as much as possible.*

*Students may indicate that the use of alternative technologies could be part of a balanced approach (use a variety of alternative technologies) or could be used to produce larger amounts of power (nuclear, hydroelectric).*

*Students may indicate the use of some technologies as supplementary sources to meet higher demand times on an individual scale or a large scale.*

*(Continued)*



		Perspectives				
		Conversions	Environmental	Economic	Societal	Political
<b>Energy Technology</b>			<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• no gaseous emissions other than water vapour</li> <li>• high energy-to-mass-of-fuel ratio</li> <li>• uranium reserves are more plentiful than fossil fuel in terms of stored energy content</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• lower operating costs than conventional thermal power plants</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• produces a large amount of power to support energy demands of society</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• is a means to reduce the emission of greenhouse gases</li> </ul>
Nuclear fission reactors	<p>potential (intranuclear)</p> <p>→ thermal</p> <p>→ kinetic</p> <p>→ electrical</p>	<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• radioactive wastes</li> <li>• thermal pollution</li> <li>• risk of meltdown</li> <li>• non-renewable</li> </ul>	<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• plants are more costly to build than other thermal plants</li> </ul>	<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• danger to workers and public if radiation not contained</li> <li>• danger to uranium miners</li> <li>• perception that nuclear reactors pose a danger to society</li> </ul>	<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• nuclear materials can be used to develop nuclear weapons</li> <li>• risk of sabotage</li> </ul>	

		Perspectives			
Energy Technology	Conversions	Environmental	Economic	Societal	Political
Solar	solar → electrical (photovoltaic cells)  solar collectors → thermal → electrical	<i>Advantages</i> <ul style="list-style-type: none"> <li>• no gaseous emissions during electrical energy production</li> <li>• renewable</li> </ul>	<i>Advantages</i> <ul style="list-style-type: none"> <li>• long lifespan</li> <li>• little maintenance</li> <li>• easily installed</li> <li>• plentiful</li> <li>• no fuel costs</li> </ul>	<i>Advantages</i> <ul style="list-style-type: none"> <li>• perceived as environmentally friendly</li> <li>• permits individuals or smaller-scale facilities to generate power</li> </ul>	<i>Advantages</i> <ul style="list-style-type: none"> <li>• is a means to reduce the emission of greenhouse gases</li> </ul>
		<i>Disadvantages</i> <ul style="list-style-type: none"> <li>• large amount of space required</li> <li>• photovoltaics require toxic metals such as cadmium and arsenic</li> <li>• harvesting heavy metals could damage sea floors</li> </ul>	<i>Disadvantages</i> <ul style="list-style-type: none"> <li>• more costly than conventional systems</li> <li>• each unit produces a small amount of energy</li> <li>• sunlight is intermittent and variable</li> <li>• conversion to electrical energy is not as efficient as other renewable sources</li> </ul>	<i>Disadvantages</i> <ul style="list-style-type: none"> <li>• cannot meet current energy demand</li> <li>• visual pollution</li> </ul>	<i>Disadvantages</i> <ul style="list-style-type: none"> <li>• high cost of energy is not popular with consumers</li> </ul>

		Perspectives			
Energy Technology	Conversions	Environmental	Economic	Societal	Political
		<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• no gaseous emissions</li> <li>• many suitable sites available</li> <li>• renewable</li> <li>• land beneath a turbine can still be used for farming</li> </ul> <p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• large amount of land required</li> <li>• danger to birds and bats</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• no fuel costs</li> <li>• long lifespan for turbines with minimal operating costs</li> <li>• self-sufficient</li> <li>• land can also be used for agriculture</li> <li>• easily installed</li> </ul> <p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• few ideal sites</li> <li>• more costly than conventional systems</li> <li>• wind is variable and intermittent – often lowest during peak-demand months</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• perceived as environmentally friendly</li> <li>• permits individuals or smaller-scale facilities to generate power</li> </ul> <p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• cannot meet current energy demand</li> <li>• visual or noise pollution</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• is a means to reduce the emission of greenhouse gases</li> </ul> <p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• high cost of energy is not popular with consumers (Denmark had to offer tax rebates to offset higher prices and maintain demand)</li> </ul>
Wind turbines	<p>solar → gravitational potential (falling air masses create wind) → kinetic (wind) → kinetic (turbine) → electrical</p>				

		Perspectives				
		Conversions	Environmental	Economic	Societal	Political
<b>Energy Technology</b>	Hydroelectric dam	solar → thermal → gravitational potential → kinetic (water) → electrical	<i>Advantages</i> <ul style="list-style-type: none"> <li>• no gaseous emissions</li> <li>• renewable</li> </ul>	<i>Advantages</i> <ul style="list-style-type: none"> <li>• plentiful sites in Canada</li> <li>• no fuel costs</li> <li>• plants have a long lifespan</li> <li>• efficient process with large energy yield</li> <li>• cost per kilowatt-hour of energy produced is relatively low</li> </ul>	<i>Advantages</i> <ul style="list-style-type: none"> <li>• can create recreational areas</li> <li>• provides a considerable amount of power</li> </ul>	<i>Advantages</i> <ul style="list-style-type: none"> <li>• is a means to reduce the emission of greenhouse gases</li> </ul>

<b>Energy Technology</b>	<b>Conversions</b>	<b>Perspectives</b>			
		<b>Environmental</b>	<b>Economic</b>	<b>Societal</b>	<b>Political</b>
Hydroelectric dam (continued)		<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• large amount of land is covered by reservoir</li> <li>• impacts aquatic ecosystem</li> <li>• can change chemical balance in waterways</li> <li>• increases erosion</li> <li>• changes water distribution patterns</li> <li>• methane and carbon dioxide can be produced as a result of decay of dying organisms caught in the dam</li> </ul>	<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• more costly to build than other facilities</li> <li>• buildup of silt reduces longevity of power production</li> </ul>	<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• may involve displacement of people or loss of archeological sites and artifacts (Aswan dam in Egypt)</li> <li>• visual pollution</li> </ul>	<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• development of projects is highly contentious (Aboriginal land claims)</li> </ul>

		Perspectives			
Conversions		Environmental	Economic	Societal	Political
Energy Technology	gravitational → kinetic (turbine) → electrical	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• no gaseous emissions</li> <li>• renewable</li> </ul> <p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• affects marine ecosystems (e.g., fish migration)</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• no fuel costs</li> <li>• long lifespan</li> <li>• plentiful</li> </ul> <p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• more costly than conventional systems</li> <li>• few ideal sites</li> <li>• tidal energy is only available at certain times of day (when tides are coming in and leaving)</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• perceived as environmentally friendly</li> </ul> <p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• cannot meet current energy demand</li> <li>• visual pollution</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• is a means to reduce the emission of greenhouse gases</li> </ul> <p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• high cost of energy is not popular with consumers</li> </ul>
Tidal dam					

Energy Technology	Conversions	Perspectives			
		Environmental	Economic	Societal	Political
Geothermal	<p>potential (intranuclear)  → thermal  → kinetic (turbine)  → electrical</p>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• source is renewable</li> <li>• produces less pollution than fossil fuels</li> <li>• can be used to replace current methane-fuelled furnaces</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• no fuel costs</li> <li>• long lifespan</li> <li>• can be less costly than conventional systems</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• perceived as environmentally friendly</li> </ul>	<p><i>Advantages</i></p> <ul style="list-style-type: none"> <li>• is a means to reduce the emission of greenhouse gases</li> <li>• some governments allow funding for households wishing to replace methane-fuelled furnaces with geothermal heating and cooling</li> </ul>
		<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• some gaseous pollution (<math>H_2S(g)</math> and <math>CO_2(g)</math>)</li> <li>• acids formed from emissions can cause corrosion of metals in facility and acid deposition</li> <li>• thermal pollution</li> <li>• disruption to wildlife</li> </ul>	<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• few ideal sites for an electrical-energy production facility (only cost effective in areas where geological hot spots already exist)</li> <li>• not all sites are renewable</li> </ul>	<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• hydrogen sulfide smell often associated with development of sites</li> </ul>	<p><i>Disadvantages</i></p> <ul style="list-style-type: none"> <li>• some areas where suitable sites exist are politically unstable</li> </ul>

## Scoring Guide – Long-answer 2

<i>Score</i>	<i>Long-answer 2 Scoring Descriptions</i>
4 <b>Standard of Excellence</b>	The response is <b>well organized</b> and addresses <b>all</b> the points of the question. The list of energy conversions is <b>accurate</b> . The separate perspectives and the description of how energy should be used reflect a <b>sophisticated</b> understanding of energy issues.
3	The response is <b>organized</b> and addresses the major points of the question. The list of energy conversions is <b>mostly accurate</b> . The separate perspectives and the description of how energy should be used reflect a <b>good</b> understanding of energy issues.
2 <b>Acceptable Standard</b>	The response is <b>somewhat organized</b> and addresses <b>most</b> of the major points of the question. The list of energy conversions is <b>adequate</b> . The separate perspectives and the description of how energy should be used reflect a <b>reasonable</b> understanding of energy issues.
1	The response is <b>not well organized</b> and <b>does not</b> address the major points of the question. The list of energy conversions is <b>incorrect</b> . The separate perspectives and the description of how energy should be used reflect a <b>poor</b> understanding of energy issues.
0	The response does not address any of the major points of the question at an <b>appropriate level</b> for a 30-level course.



## Student Response 1

Use the following information to answer the next question.

As oil, natural gas, and coal reserves become depleted, alternative energy sources will need to be significantly developed in order to provide the energy required to sustain the current standard of living. Decisions about the use of alternative energy technologies should include information from ecological, economic, societal, and political perspectives.


### Alternative Energy Technologies

Nuclear power plant  
Wind turbine  
Hydro power plant  
Photovoltaic cell  
Tidal power plant  
Geothermal power plant

### Long Answer—15%

From the list above, select one alternative energy technology used to produce electricity.

- List the energy conversions involved in using the technology.
- Explain the advantages and disadvantages of using the selected technology from two of the following perspectives: ecological, economic, societal, and political.
- Describe how the selected alternative energy technology should be used in the future.

Wind Turbine 

Turbines are set up, usually, in places with known wind patterns. The wind spins the turbine which is in case, hooked up to a generator. The generator converts the energy from the spinning turbine into electricity, which can, in turn, be converted into thermal energy.  
Solar → Mechanical → electrical → thermal

It takes a lot of space and sometimes a lot of turbines for this technology to be highly effective. Some are also fairly expensive, so in the long run, is it worth it?

There also has to be a constant wind through areas with turbines or else energy will eventually run out. Since energy can be stored, but it can only be stored and used for so long until it runs out.

The turbines are also very big, I doubt anyone would want one hanging around in their backyard because they are not very visually appealing and it would look extremely tacky.

If they can improve this technology so that it is more effective then I think it would be a good substitute for burning limited, environmentally-harming fossil fuels.

Smaller space taking, efficient, and aesthetically pleasing wind turbines that can produce a lot of energy would be very useful in the future.

## Score—4 Rationale

This example meets the requirements of the *standard of excellence*.

The response is well organized and generally error-free. The list of energy conversions is accurate, including waste thermal energy. Separate perspectives are presented and a reasonable description of how energy should be used is given. The response demonstrates a fair degree of sophistication in presenting the solutions to the problems of energy production and use.

## Student Response 2

Use the following information to answer the next question.

As oil, natural gas, and coal reserves become depleted, alternative energy sources will need to be significantly developed in order to provide the energy required to sustain the current standard of living. Decisions about the use of alternative energy technologies should include information from ecological, economic, societal, and political perspectives.

### Alternative Energy Technologies

Nuclear power plant  
Wind turbine  
Hydro power plant  
Photovoltaic cell  
Tidal power plant  
Geothermal power plant

#### Long Answer—15%

From the list above, **select one** alternative energy technology used to produce electricity.

- List the energy conversions involved in using the technology.
- Explain the advantages and disadvantages of using the selected technology from two of the following perspectives: ecological, economic, societal, and political.
- Describe how the selected alternative energy technology should be used in the future.

In a Hydro Power Plant, water falls from a dam spinning a turbine. But it all starts from the sun where it gives kinetic energy to the moving river. When it's in the reservoir, it flows through the dam spinning the turbine making electricity. The advantages from Hydro Power electricity is that there are no harmful emissions, and it only takes water not our fossil fuels, so it saves resources for us. But with advantages there are disadvantages such as that it is very expensive to use, it can ruin ecosystems and can't be used in areas without lots of water, so it can't be used all over the world. In the future we could try to use it so the water doesn't flow right through ecosystems and ruin them, and also use it less so we don't spend so much money on building them everywhere.

## Score—2 Rationale

This example meets the *acceptable standard*.

The response is generally organized and addresses all points of the question. The advantages and disadvantages of using the selected technologies are generalized with a few specific examples. Some of the future solutions for future energy use are unsophisticated or unrealistic.

## *Project Resources for Science 30*

The following paragraph is from the *Rationale and Philosophy* section of the Program of Studies for the Science 20–30 program:

*Science is an experimental discipline requiring creativity and imagination. Methods of inquiry characterize its study. In Science 20–30, students further develop their ability to ask questions, investigate and experiment; to gather, analyze and assess scientific information; and to test scientific laws and principles and their applications. In the process, students exercise their creativity and develop their critical thinking skills. Through experimentation, and problem-solving activities that include the integration of technology and independent study, students develop an understanding of the processes by which scientific knowledge evolves.*

In order to promote the skills described in the above quotation, and in order to develop a standardized method of assessing these skills, Science 30 projects are available for students' overall assessment.

The project components and their scoring rubrics have been designed by Provincial Assessment Sector staff in collaboration with teachers. If teachers choose to use the posted projects, they will be responsible for scoring them. The projects developed to this point incorporate activities suggested or already developed by teachers that focus on designing a study for data collection, synthesis, and application of scientific knowledge to practical situations. Students will be encouraged to use a broad range of tools and technologies.

The project is not intended to be an “add-on” to the expectations of students and teachers. The project activities will be developed and validated by teachers and can be used within their scheme of activities in place of, or to complement, existing activities.

Science 30 is a course that develops a broad range of knowledge and skills in the interest of promoting science literacy. Teachers and other stakeholders have mentioned that in order to accomplish this desirable outcome, they often must sacrifice the opportunity to pursue some concepts in depth. The project provides teachers with this opportunity.

Presently, there is no systematized plan that allows teachers to introduce ICT outcomes into Science 30. It is hoped that the inclusion of ICT components in the projects will promote ICT skills along with the science skills necessary to achieve science literacy.

Projects include suggested step-by-step instructions for the teacher, scoring rubrics, and enrichment ideas for extending the project.

Alberta Education has produced [three projects](#) for Science 30. Teachers are encouraged to access those projects, which can be found on the Alberta Education website at [education.alberta.ca](http://education.alberta.ca). These projects are designed to be completed in three to five hours of student time. Use of these projects is optional, and teachers may choose to use them as part of their assessment.

If you have questions regarding the projects, please contact Stan Bissell, Science 30 Assessment Standards Team Lead, at [Stan.Bissell@gov.ab.ca](mailto:Stan.Bissell@gov.ab.ca) or at 780-422-5730.

## Project Focus and Assessment Strategies

The focus of project work for Science 30 is to provide an opportunity for students to demonstrate their learning and use of skills in unique ways. This project provides an opportunity to develop and assess ICT and inquiry skills. **Teachers may choose to use parts of this project, or certain assessment items, to articulate with the goals of their instruction, their assessment plan, or the resources available to them.** Throughout the project, suggestions are made in the Teacher Guide regarding the suitability of questions for either formative or summative assessment. The inclusion of scoring guides in both the student and teacher materials should provide an opportunity to discuss the expectations and standards for responses both before the response is prepared and after it has been assessed.

Computer-based learning objects have been developed to accompany the projects. The student booklet, teacher guide, learning objects, and the Excel files required to complete the projects can be downloaded from [www.learnalberta.ca](http://www.learnalberta.ca). The [student booklet](#) is also available at [education.alberta.ca](http://education.alberta.ca). The student textbook contains two CDs with multimedia segments, digital activities supporting related ICT outcomes, detailed answer keys to support textbook activities, digital copies of handouts, and a special folder for students involved in alternative learning environments such as distance learning, blended programs, and virtual school programs.

A comprehensive, digital *Science 30 Teacher Resource Guide* is also available. The TRG includes extensive support for assessment. Teachers will be able to print handouts from the PDF documents or customize them from the HTML versions provided. This digital resource also includes a distance learning teacher guide folder to support teachers instructing in that environment.

The Science 20 textbook and Science 30 textbook digital files can be accessed [here](#). They can be found under the T4T Courses tab. For further information on these two files, or for assistance, use the Contact Us feature on the LearnAlberta website.

## Website Links

Publication	Website
<a href="#">Project Downloads</a>	<p data-bbox="573 394 1365 491">www.learnalberta.ca There are two levels of access to Science 30 courses: a student version and a teacher version.</p> <p data-bbox="573 531 1421 732"><b>To access the student version</b>, you require a jurisdictional level username and password, which all schools should have. Once signed in, use the T4T Courses tab to browse to the course. In this case, select “Grade 12,” then select “Science,” then click on “Show me resources.” You will find the Science 30 course in the resulting list.</p> <p data-bbox="573 772 1421 1010"><b>To gain access to the Teacher version</b> of the Tools4Teachers and Learn EveryWare courses (which contain teacher-protected components), you must be signed into LearnAlberta.ca with a personal teacher account. You can sign up on the site for a teacher account if you have a teacher certification number and a LearnAlberta.ca jurisdictional username and password. Use the “Sign Up” link at the top right on LearnAlberta.ca.</p> <p data-bbox="573 1050 1421 1178">Once you are signed in to LearnAlberta.ca with your teacher account, you will be presented with both the student and teacher versions of the courses. Just use the instructions above to search or browse the courses.</p>