Grade 5 Learning Experiences: Mechanisms & Structures

Experience 3: Permafrost Demo

Long Range Plan: Grade 5 Model 2

Students will develop their knowledge in multiple science strands by investigating how natural and man-made structures are impacted by the effects of forces acting upon structures. During the final phase of this learning experience, students will prototype durable, energy-efficient residential designs which can better withstand some of the effects of natural disasters.

Overview of learning experiences	Students will learn about forces acting upon structures. They will analyze the effects of forces from natural phenomena on structures in natural and built environments. They will assess various ways in which humans mitigate the impacts of forces from natural phenomena on structures in urban, rural, and remote communities. Lastly, students will follow the engineering design process to better understand forces resulting from natural phenomena that can have severe consequences for human-built structures and iterate solutions for catastrophe-resistant structures. The learning experiences outlined here relate to the Long Range Plan: Grade 5 Model 2
Prior Knowledge / Prior Skill Set(s)	**Background Knowledge and Concepts (Teacher)** ● Aware of health & safety procedures (i.e. PPE & MDMS) ● Maintain safe facilities & laboratory equipment ● Identify potential workplace hazards & mitigation measures ● Aware of Global Competencies & Transferable Skills; ● Aware of Culturally Relevant & Responsive Pedagogy ● Understand how to implement the UDL framework ● Understand how to engage in an Engineering Design Process ● Understand basic block-based coding concepts, platforms, functions and algorithms for software such as Scratch, Makecode Arcade, and Minecraft EDU. **Background Knowledge and Skills (Students)** - ● Follow safe work or preventative measures as instructed ● Norms of Collaboration ● Prior knowledge & experience with basic block-based coding

concepts, for software such as Scratch is an asset

- Permafrost is ground that has been frozen for at least two years. In Nunavut, all of the ground consists of continuous permafrost, meaning that the permafrost layer stays frozen all year round.
- With climate change, one of the impacts is that Arctic temperatures are starting to increase. As the temperature increases, permafrost can start to thaw.
- Infrastructure (buildings, roads, bridges, airport runways, etc.) is built on permafrost. Frozen soils are more stable than unfrozen soils. The way we build on permafrost is important for creating stable structures that will last a long time.
- There are a few different ways we can build on permafrost. If permafrost starts to thaw and the buildings are not built properly for the type of ground or building, then buildings can move, shift, or slant.
- To build context around Indigenous Ways of Knowing & Doing as well as connections to Climate Change and the Inuit, consult the Climate Atlas of Canada: Inuit and Climate Change

Students may hold a variety of misconceptions about….

The web page Children's misconceptions about science provides a list of misconceptions in several areas of physical science, including forces. Here are a few that you might hear in your own classroom.

Students may think…	**Instead of thinking …**
If an object is at rest, no forces are acting on that object.	External forces act upon an object at rest.
Only animate objects exert a force.	Inanimate objects can exert a force.
Large objects exert a greater force than small objects.	The force which is exerted depends on the mass of the object.

Strand A - STEM Investigation and	**STEM Investigation and Communication Skills:**

Communication Skills	The learning experiences described below focus on science, technology, engineering, and mathematics (STEM) skills, coding and emerging technologies, practical applications of science and technology, and contributions that people with diverse lived experiences have made to science and technology. **Students will:**  **A1.1** use a scientific research process and associated skills to conduct investigations  **A1.2** use a scientific experimentation process and associated skills to conduct investigations  **A1.5** communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes  **A3.2** investigate how science and technology can be used with other subject areas to address real-world problems
Overview / Big Ideas / Fundamental Concepts	**Overview:** Students will explore ways to limit nature's destructive effects on organic and man-made structures, by prototyping catastrophe-resistant structural solutions. **Big Ideas:** Students will explore the impacts of natural forces on structures and assess the need for residential homes that limit the impact of nature's destructive effects, without sacrificing comfort, energy efficiency or aesthetics. **Fundamental Concepts:** ● Focus on the interrelationship between the function or use of a natural or human-made object and the form that the object takes. ● Sustainability is the concept of meeting the needs of the present without

Differentiated learning opportunities	compromising the ability of future generations to meet their needs. ● Stewardship involves understanding that we need to use and care for the natural environment in a responsible way and making the effort to pass on to future generations no less than what we have access to ourselves. Values that are central to responsible stewardship are as follows: using non-renewable resources with care. Recognize that there is an inherent choice, multiple entry points, and a variety of assessment opportunities inherent within the learning experiences to honour learner variability in classrooms. Below are additional supports and considerations to consider as part of these learning experiences. Listed below are assistive technology tools that can be used to improve a student's functioning and independence and can help give children an increased level of autonomy and independence as they overcome learning challenges; **Instructional Accommodations** - Word Prediction, Speech-to-Text and Text-to-Speech Software such as Read & Write for Google Chrome helps students to respond orally, help communicate their thinking, and support writing demands. **Instructional Accommodations - Presentation Software** - Software such Lumio, Peardeck, and Nearpod support visual, audio, and organizational instructional strategies and can assist in accommodating students with special needs. If educators have access to smartboard technology, they can provide additional opportunities for differentiation and student engagement. These student-centered pathways help students to engage with learning, to self-pace, to self-regulate, and to provide opportunities for socio-emotional check-ins. **Assessment Accommodations via Assistive Technology Organizers & Presentation Software** - Apps such as Flip, audio recordings, and graphic organizers as offered by Jamboard, Lumio, Microsoft Whiteboard, and/or Mindomo can be used to provide visual reinforcement and to assist students with processing ideas. They can also be used by students to demonstrate their understanding of concepts/skills, and communicate their thinking. **Learning Environment Accommodations** - Students who struggle with social interactions and physical movement can be supported through accommodations within the environment itself. Opportunities for body breaks and calming apps such as Art of Glow and Quiver can help students to self-regulate. Transitions between activities can be less disruptive to students who experience difficulty with time management and self-regulation through

	the use of visual timers. The use of noise-canceling headphones, microphones, and FM systems as required can help students to remain focused and reduce threats and negative distractions.
Learning Goals / Success Criteria	**Learning Goals:** We are learning about internal forces (tension, compression, torsion, and shear) as well as external forces and providing examples of each force. We are investigating the methods that people have devised for building homes that are able to withstand forces from natural phenomena (e.g., earthquake-proof or flood-proof homes). We are exploring how climate change can overwhelm the capacity of ecosystems to mitigate extreme events and natural disturbances, such as wildfires, floods, and drought. **Success Criteria:** **Note:** Educators are encouraged to co-create success criteria with students and share "I Can Statements" based on the curricular expectations. ● I can identify the internal and external forces acting upon structures. ● I can describe various features that help structures to withstand forces from natural phenomena (e.g., earthquakes and floods). ● I can explain how structures are vulnerable to climate change, and explain how to adapt infrastructure to a rapidly changing climate. ● I can design and build a prototype of a catastrophe-resistant structure. **Ministry of Education Key Points:** The key points listed below will be addressed within these experiences. ● **STEM Skills and Connections**: Students construct a small structure on a permafrost model. ● **Research and Experimentation Processes**: Students will investigate permafrost and how climate change can impact permafrost. ● **Hands-on, Experiential Learning**: Students will construct a small structure on a permafrost model and predict what will happen to the

	structure when the permafrost begins to thaw and melt. • **Engineering Design Process**: Students will prototype their small structure to build on a permafrost model. • **Climate Change**: Students analyze the long-term impacts of climate change by exploring a Google Earth virtual reality tour.
Learning Experience(s)  **A.1.1, A.1.5**  A.1.1.Scientific Research  A.1.5.Communication	**Minds On** (20 mins) **Option 1: Weather Patterns & Climate Change Provocation** Students analyze the long-term impacts of Climate Change via a Google Earth Tour entitled "Climate Change's Impact". After the Google Earth Tour, educators can facilitate a large group discussion based on the guiding questions listed below. As an alternative instructional approach, educators can invite students to record their responses to these discussion prompts using a flipped learning model and a tool like Microsoft Flip. Adobe Spark or Brightspace Voice Notes. Students might also choose to record their ideas in a science journal or use a student learning framework. **Guiding Questions** 1. What is one thing that surprised you after taking the tour? a. **Suggested Response**: Answers will vary. 2. How do internal and external forces affect a structure? a. **Suggested Response**: A force that acts on an object from outside is known as the external force. Any force that acts on a structure from within is known as the internal force. External forces produce internal stresses within the materials from which the structure is made. These internal stresses can change or deform the shape or size of a structure. This deformation can lead to repair of the damage to the structure, or failure of the structure. 3. What features allow structures to withstand forces from natural phenomena? a. **Suggested Response**: To withstand collapse from natural phenomena such as earthquakes and wind storms, buildings must redistribute forces that travel through them. Shear walls,

	cross braces, and diaphragms can help to redistribute forces. 4. What are some consequences on the environment if we do not take action? a. **Suggested Response:** If we do not take action on global climate change, the planet is likely to see global temperatures rise by as much as 2-4 °C by the end of the century. Increased planetary temperatures will result in heavier precipitation events, including rainfall and snowfall. Air pollution, greenhouse gasses, and carbon dioxide emissions will rise, resulting in poorer air quality. Increased planetary temperatures will also result in the melting of polar ice caps, which will lead to sea level rise, erosion of beaches, inundation of deltas, loss of wetlands, and submersion of coastal communities. Food and water insecurity will increase, threatening the health and well-being of billions of people around the planet, and ultimately leading to the loss of life. 5. How might your community be impacted by climate change? a. **Suggested Response**: Answers will vary. 6. How might remote communities be disproportionately impacted by natural forces and weather phenomena? a. **Suggested Response**: Rural and remote communities often experience environmental, social, economic, cultural, and health impacts from climate change disproportionately compared with urban centres. Compared to urban centres, remote communities often experience greater impacts from climate change, particularly in the Arctic and Subarctic regions where changes in climate are occurring more rapidly than elsewhere in the country. These areas, and the communities located within them, are home to residents that are often highly dependent on natural resources and ecosystems for cultural purposes, livelihoods, transportation, and well-being. These communities also tend to have fewer institutional and financial resources with which to respond to these changes. 7. How might marginalized communities, such as Indigenous communities be disproportionately impacted by natural forces and weather phenomena? a. **Suggested Response**: Climate related changes are leading to social disruption. Demographic changes such as an aging population or the movement of young adults and retirees away

A.1.1, A1.2, A.1.5

from their homes to amenity-rich locations can impact the social well-being of rural or remote communities. These changes can have negative implications on the labour force, services, business opportunities, and transmission of intergenerational knowledge.

Option 2: Climate Change Cartoons

Invite students to examine the climate change cartoons (or see Appendix A: Jamboard) pictured above and ask them to write down 5 things that they see, notice, and/or wonder.

As a large group, invite students to list everything that they can collectively remember about the provocations. During this portion of the activity, the educator is encouraged to act as a facilitator and not play the role of “expert”. As the discussion continues, paraphrase each student’s observations and make connections with the observations of other students.

Educators can use an organizer like Google Jamboard to observe provocations and document student thinking. If you choose to use a digital tool to make student thinking visible, invite students to collectively document their observations and wonderings online before engaging in a large group discussion about their findings. If students do not have a device, project the images and use a Think-Pair-Share strategy in order to hold a discussion with the class.

Discussion Prompts:

1. What is climate change and how does climate change affect our lives?
    a. **Suggested Response:** Climate change refers to long-term shifts in temperature and/or weather patterns. Climate change occurs naturally but has been amplified by human activities, including the burning of fossil fuels resulting in an increased concentration of atmospheric carbon dioxide. If we do not take action on global climate change, the planet is likely to see

	global temperatures rise by as much as 2-4 °C by the end of the century. Increased planetary temperatures will result in heavier precipitation events, including rainfall and snowfall. Air pollution, greenhouse gasses, and carbon dioxide emissions will rise, resulting in poorer air quality. Increased planetary temperatures will also result in the melting of polar ice caps, which will lead to sea level rise, and the erosion of beaches, inundation of deltas, loss of wetlands, and submersion of coastal communities. Food and water insecurity will increase, threatening the health and well-being of billions of people around the planet, and ultimately leading to the loss of life. 2. What actions can we take to lessen the impacts of climate change? a. **Suggested Response:** We need to be good energy stewards. This means that we must use and care for the natural environment in a responsible way. Values that are central to responsible stewardship are as follows: using non-renewable resources with care; reusing and recycling what we can; and switching to renewable resources. 3. How might remote communities be disproportionately impacted by natural forces and weather phenomena related to climate change? a. **Suggested Response**: Rural and remote communities often experience environmental, social, economic, cultural and health impacts from climate change disproportionately compared with urban centres. Compared to urban centres, remote communities often experience greater impacts from climate change, particularly in the Arctic and Subarctic regions where changes in climate are occurring more rapidly than elsewhere in the country. These areas, and the communities located within them, are home to residents that are often highly dependent on natural resources and ecosystems for cultural purposes, livelihoods, transportation and well-being. These communities also tend to have fewer institutional and financial resources with which to respond to these changes. 4. How might marginalized communities, such as Indigenous communities be disproportionately impacted by climate change? a. **Suggested Response**: Climate-related changes are leading to social disruption. Demographic changes such as an aging population or the movement of young adults and retirees away from their homes to amenity-rich locations can impact the social well-being of rural or remote communities. These

	changes can have negative implications on the labour force, services, business opportunities, and transmission of intergenerational knowledge.
A1.2.	**Action** (1.5 hrs) **Activity 3. Scientific Experimentation: Permafrost Demo -** (40 mins) Students will learn about permafrost and how climate change can affect permafrost. They will then discuss the challenges of building on permafrost, and explain why permafrost is important in northern communities, particularly Indigenous communities. Finally, they will construct a small structure on a permafrost model and predict what will happen to the structure when the permafrost begins to thaw and melt. Makedo materials may be beneficial during the prototyping phase of this experience. **Note:** Educators will need to prepare the permafrost model the day before the activity and keep the permafrost frozen (in a freezer or outside) until just before the activity begins. **Step 1.** Pour 2/ 3 of the soil into the container **Step 2.** Add water until moist and mix. **Step 3.** Freeze overnight (several hours). **Step 4.** Place ice cubes on top (to mimic ice wedges) **Step 5.** Add the last 1/ 3 of moist soil. **Step 6.** Freeze for a minimum of 3 hours.  **Laboratory Experiment - Procedure:** **Step 1**. Split the class into groups of 2-4 students. Each group is tasked with building the most stable, force-resistant house/ structure they can with the available resources. The structure must fit in the permafrost container, so make sure the size of the structure is appropriate. **Step 2**. Hand out house-building supplies to each group. **Step 3.** Each group builds a house, taking into consideration structure type,

	and how they will connect the structure to the permafrost. **Step 4.** The houses are then placed on the permafrost. Leave the permafrost alone for a few hours until it begins to thaw and melt. **Step 5.** Invite students to note what happens as the permafrost thaws. (e.g., Notice the "swampy" areas, and the depressions in the ground where the ice wedges melted). **Debrief & Possible Discussion Questions:** ● What happens to the surface of the ground when the permafrost thaws? How does the thaw affect the tundra, plants, and animals? ● How can you make sure that houses in northern settlements aren't affected when permafrost thaws? ● How would you build your house differently to reduce the impact of permafrost thaw? ● Permafrost contains large amounts of stored organic carbon, and also methane deposits. What might happen to these greenhouse gasses if permafrost thaws?
Science and Technology Expectations	**Strand D1: Structures & Mechanisms** **Topic:** Relating Science and Technology to our Changing World **D1.1** analyze the effects of forces from natural phenomena on structures in natural and built environments **D1.2** assess various ways in which humans mitigate impacts of forces from natural phenomena on structures in urban, rural, and remote communities **Strand D2: Structures & Mechanisms** **Topic:** Exploring & Understanding Concepts **D2.1** identify internal forces acting on a structure, and describe their effects on the structure **D2.2** identify external forces acting on a structure, and describe their effects on the structure

	D2.3 describe forces resulting from natural phenomena that can have severe consequences for human-built structures, and identify structural features and materials that can allow such structures to withstand these forces **Strand C: Matter and Energy** **Topic:** Exploring & Understanding Concepts **C2.3** describe changes of state of matter observed at home, in the community, or in the natural environment **C2.5** describe chemical changes in matter as changes that result in the formation of different substances, and identify signs that a chemical change has occurred **C2.6** explain how changes of state can occur when matter absorbs or releases thermal energy **Strand E: Earth and Space Systems** **Topic:** Relating Science & Technology to our Changing World **E1.1** analyze long-term impacts of human uses of energy and natural resources, on society and the environment, including climate change, and suggest ways to mitigate these impacts
Science and Technology Vocabulary	- Architect - Climate Change - Disaster Manager - Environmental Scientist - Earthquake-Proof Home - External Forces - Flood-Proof Home - Green Buildings - Internal Forces (i.e. Tension, Compression, Torsion, Shear) - Load (i.e. Static Load & Dynamic Load) - Meteorologist - Natural Phenomena - Permafrost - Seismologist - Structures (i.e. Organic Structure & Man-Made Structure) - Urban, Rural and Remote communities

<table>
<tr><td>Equipment and Materials</td><td>
Science Lab Items

1 clear container (approximately 9”x13”)

Ice cubes – 1 tray

1 bag of soil or sand

2 cups of water

Household Items

Toothpicks or Skewers

Modeling clay

Popsicle sticks

Cardstock or paper

Tape, Glue & Scissors

Felt, Styrofoam & String

Pipe Cleaners
</td></tr>
<tr><td>Timeline and Preparation</td><td>
The time frames indicated below are suggested and may vary.

Mind’s On - Climate Provocation 20 minutes

Mind’s On - Climate Cartoons 20 minutes

Activity - Lab Experiment 60 minutes
</td></tr>
<tr><td>Safety Considerations</td><td>
Be sure to review safety guidelines for all experiments and activities and instruct students to follow safety guidelines. Please remember to check the safety notes at the end of the Long Range Plans for additional ideas.

Safety Considerations for “Playdough” & “Permafrost” Experiment:

• Students may need to ask an adult for permission to use materials, including scissors or makedo cardboard construction tools
• Students may need to be reminded of safety considerations such as no consumption of substances and washing their hands after handling soils and substrates.
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	Refer to these safety resources: Safety in Elementary Science and Technology (STAO) Safe Activity Foundations in Education Document (SAFEdoc) Science and Technology, Grades 1-8 (OCTE) Ontario Curriculum Program Planning – Health and Safety
Opportunities For Assessment	According to the Ministry of Education Growing Success Document (2010) assessment is about improving student learning! **Assessment FOR Learning:** Occurs frequently and in an ongoing manner during instruction, while students are still gaining knowledge and practicing skills and is used by teachers to monitor students' progress towards achieving the overall and specific expectations, so that teachers can provide timely and specific descriptive feedback to students, scaffold next steps, and differentiate instruction and assessment in response to student needs. **Assessment AS Learning:** Occurs frequently and in an ongoing manner during instruction, with support, modelling, and guidance from the teacher and is used by students to provide feedback to other students (peer assessment), monitor their own progress towards achieving their learning goals (self-assessment), make adjustments in their learning approaches, reflect on their learning, and set individual goals for learning. **Assessment OF Learning:** Occurs at or near the end of a period of learning, and may be used to inform further instruction and is used by the teacher to summarize learning at a given point in time. This summary is used to make judgements about the quality of student learning on the basis of established criteria, to assign a value to represent that quality, and to support the communication of information about achievement to students themselves, parents, teachers, and others **NOTE:** The assessment in the learning experiences are intentionally assessment for learning and assessment as learning. The assessment modality is intentionally conversations and observations. This is to help move away from only product based assessment. Throughout the learning experiences students will have many opportunities to demonstrate their understanding through doing, talking and engaging in self-assessment. By collecting assessment for/as learning data teachers can be responsive and provide meaningful feedback. Teachers have been provided with assessment tools to collect evidence of student learning. Assessment opportunities are embedded throughout the learning experiences.

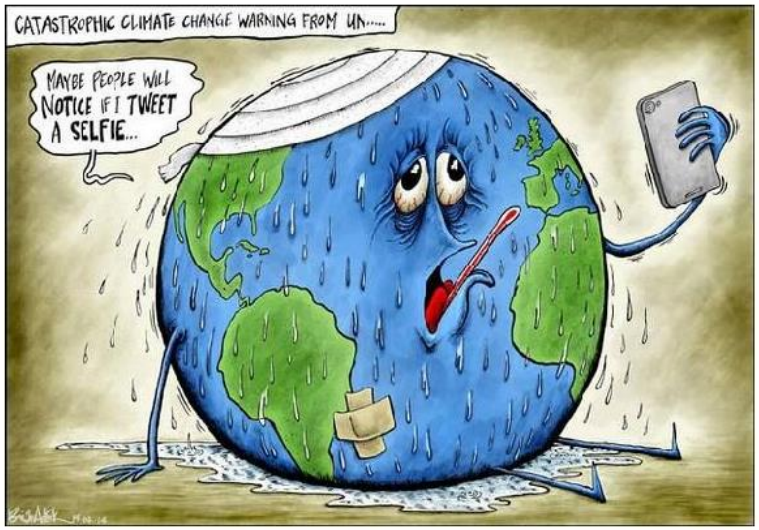
	Please use the following links for further reference: https://www.dcp.edu.gov.on.ca/en/assessment-evaluation https://www.edu.gov.on.ca/eng/policyfunding/growsuccess.pdf Educators must ensure that student learning is assessed and evaluated in a balanced manner with respect to the four categories (i.e. Knowledge & Understanding, Thinking, Communication & Application), and that achievement of particular expectations is considered within the appropriate categories. The emphasis on "balance" reflects the fact that all categories of the achievement chart are important and need to be a part of the process of instruction, learning, assessment, and evaluation. Consult the Achievement Chart for Science & Technology Provide a variety of means of assessment, including conversations, observations, and/or products. **Assessment of learning** may include learning maps, graphic organizers, (see Appendix B: Single Point Mastery Rubric) single point rubrics, or checklists.
Instructional Strategies and Adaptability	• Create a learning environment in which students feel safe, supported, and valued. • Embed culturally responsive student-centered instructional practices as well as diverse readings from a variety of voices and perspectives, particularly those voices which may fall outside of traditional canons. • Ensure that the learning experiences offered to students embody a "Universal Design for Learning" model by offering flexibility in the ways in which students access material, engage with course content, and demonstrate their learning. • Honour students' background knowledge and invite them to share what they know in ways that are meaningful to them. • Become a co-learner with students when uncovering content guided by students' wonderings. • Encourage students to ask good questions and give them the opportunity to find answers and/or solutions. • Support students as they carry out the scientific and engineering processes.

Additional Supporting Resources	• Science North: Tallest Tower • Indigenous Climate Hub • Climate Change Book Room
Cross-Curricular Opportunities	**Math:** Measuring, collecting data and tallies, and analyzing data use many mathematical skills found in the STEM activities in this unit. infographics: Have students analyze the flooding infographic from FloodSmart Canada and respond to the accompanying discussion prompts. **Language Arts:** Educators may wish to explore and discuss the interconnections between energy production, energy usage and climate change by visiting the "Climate Change Book Room" with their students and sharing read-alouds with students. **French as a Second Language:** FSL educators may wish to explore the interconnections between energy production, energy usage and climate change by visiting the virtual book room entitled "Le réchauffement climatique: une bibliothèque virtuelle".
Future Opportunities / Next Steps	Students can research and read books about energy and energy production, as well as issues related to energy. Teachers can provide reading materials or share virtual libraries, such as the "Climate Change Book Room". Students can explore the ideas behind 'Green Buildings' and research buildings that have been built using these technologies, such as the Toronto Dominion Centre and the Climate Pledge Arena in Seattle. Students present their findings by creating media works such as posters or multimedia presentations. Students can participate in a STEAM challenge designed by Let's Talk Science - How Can We Build A Structure that Protects People from the Wind. As the name suggests, their task is to design and build a structure that

	protects toy people from the wind. Students can create an algorithm, a step-by-step process, to draw or build a structure in the same way that Bees and 3D printers are guided by natural or computer-generated algorithms to create specific structures. This can be done in 2D on paper, or, optionally, expanded to three dimensions using 3D-doodler pens or another CAD design tool such as Tinkercad. Explore the lesson plan from Science North entitled (Structures by Algorithm) for step-by-step instructions. Explore current events around natural disasters and climate change through resources such as CBC Kids News and the Ten News Podcast.

Appendix A: Jamboard

Write down what you Notice and Wonder



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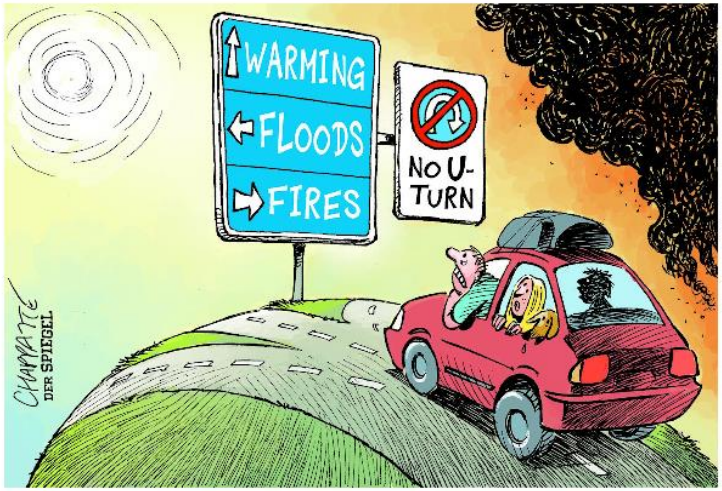

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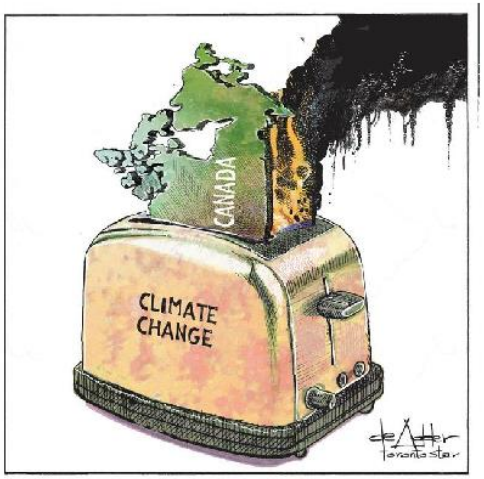

Appendix B: Single Point Mastery Rubric

Single Point Mastery Rubric

Glows Strong aspects of your work	**Outcomes**	**Grows** How you can improve your work
	Criteria #1 I framed questions and researched a variety of sources to select a problem.	
	Criteria #2 Problem is well laid out and clearly stated. Expressed empathy and made connections to the problem	
	Criteria #3 Research and planning are evident and include an outline, plan, or checklist.	
	Criteria #4 Clearly explain how energy is lost from a system when energy is transformed into other energy forms using an example from my design challenge	
	Criteria #6 Communicates ideas and concepts using appropriate scientific vocabulary/terminology	
	Criteria #7 Collaborates and participates in all aspects of the design process including planning, initiating, and presenting/communicating.	
	Criteria #8 Defines and understands the problem and generated ideas to solve the problem	