Smarter Science Better Buildings
Western Development Museum - Saskatoon

Workstation Guiding Questions Answer Key – Pages 1 - 6

Heating and Cooling

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. What factors make ***cellulose insulation*** an environmentally beneficial insulation choice? **(Student choice, options below)**

   The following factors make cellulose insulation an environmentally beneficial choice:

   - It's made of recycled materials, typically recycled newspaper.
   - Reduced transportation kilometres. This insulation is manufactured in Canada, specifically Manitoba and Alberta, and is trucked up to 800km rather than other insulation that may be shipped from across the globe.
   - Long lasting, it lasts for the life of the house (20/30 years).
   - It's reusable, biodegradable, and can be recycled after use as insulation in homes.
   - R-value is 3.70/inch, making it more efficient as an insulating material when compared to fiberglass batts or some of the other insulation choices.
   - Uses fewer chemicals in its production process than other types of insulation material.

2. ***Heat Pumps*** use electrical energy to move heat energy from one location to another. Compare the size of the blue "electrical energy coming in" arrow, to the size of the red "heat energy coming out" arrow. What does that tell you about the efficiency of the heating system?

   The blue arrow for the "electrical energy coming in" is much smaller than the red arrow for the "heat energy coming in". From this, diagram, we can see that heat pumps systems can heat or cool a home by using a relatively low amount of electrical energy as input.

   Heat pumps can move much more energy (in the form of heat) than it consumes. In this case, heat pumps move two times as much energy as it consumes. Making it one of the most highly efficient choices for heating and cooling homes (above -20 ºC).

3. Name three things ***Beardy's and Okemasis' Cree Nation*** wanted to accomplish with their new homes**. (Student choice, options below)**

- Create healthy, comfortable, and accessible homes.
- Make homes energy efficient with lots of insulation in walls, roof, and flooring.
- Reduce energy costs by 35%.
- Have homes be ready to be retrofitted with solar panels if the owner chooses.
- Create small, compact homes that are designed well.

4. In ***How Heat Moves***, which home would be warmer and less drafty in winter? Which home uses the least amount of energy?

The Radiance Cohousing (Passive House) would be warmer and less drafty in the winter. This home uses the least amount of energy at only **53 GJ/year!**

It is much more efficient than the Eaton's home which uses **759 GJ/year.**

The diagram in the display shows that the heat loss arrows are MUCH larger in the cross-section of the Eaton's house wall than in the cross-section of the Radiance Cohousing wall. This shows how efficient the design and the amount of insulation is in the Passive House.

5. Set the ***thermostats*** in the display to 15ºC. If you set the thermostat in your home back to 15ºC at night, how would it help you to save energy?

Setting a lower temperature on the thermostat either manually or by programming it helps you save energy by reducing heating at night in the home or during the day when no one is home. This reduces energy consumption (gas or electricity), lowers heating costs, and reduces greenhouse gas emissions.

If you have a programmable thermostat, you can program and set an automatic schedule for when your home heating should increase or decrease. Programmable thermostats make it easier to put this type of sustainable behaviour in action in your home - so you don't forget!

Setting the thermostat back by 2ºC can save up to 5% on your heating bill!

Net Zero Home

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. List the things that make up the ***building envelope***. Why is it important for the envelope to be airtight and have good insulation?

The building envelope includes the wall, roof, windows, and doors. It separates the inside environment from the outside environment. An airtight home doesn't let air leak in and out, wasting energy. Good insulation reduces heat loss through walls, roof, and the foundation.

2. ***Canada's National Energy Code:*** How much more energy efficient is a tier 4 than the current SK code? List three actions that would increase a home's energy efficiency.

Tier 4 is 60% more energy efficient than the current SK code (tier 1).

(Student choice, options below)

- LED Lighting
- Add LOTS of insulation (ie., in the walls, foundation, and attic)
- Choose Energy Star appliances and lighting.
- Install energy-efficient windows and doors.
- Install heat pumps or a high-efficiency furnace.
- Install solar panels.
- Efficient water systems (tankless water heater, drain water heat recovery).
- Include efficient ventilating and air conditioning systems.

3. What is **thermal bridging** and how does the double wall construction reduce it?
Thermal bridging is when heat is lost by **conduction** through wood or joins in construction. Double wall construction surrounds wood studs, and joins with uninterrupted insulation, reducing heat loss.

4.

$$Q = \frac{A \times \Delta T}{R}$$

When you "turned down" the thermostat (ΔT), what happened to the power (Q), consumption of the house? Why?

Power consumption went down. When the thermostat is lower, less energy is needed to keep the house at that temperature.

The mathematical answer is: if you reduce the value of the numerator of the right side of an equation, it will reduce the value of the left side of the equation.

5. What is the connection between the energy our home uses and ***climate change?***

The gas, electricity, and water we use daily in our homes create greenhouse gas emissions like carbon dioxide. Greenhouse gases cause climate change. We have the knowledge and tools to take action on climate change now.

Good insulation, energy-efficient technology and behaviour, and using renewable power sources in our homes all reduce greenhouse gas emissions.

There are things you can do to act on climate change in your home:

- Adding insulation to the attic.
- Turning down the thermostat at night.
- Close the blinds at night.
- Seal drafts around windows and doors.
- Fix leaking toilets.
- And many others students may name

Lighting and Appliances

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. ***Innovative Design:*** How does the reflective material bring natural light into the interior of the buildings?

Daylighting is when natural light is brought deep into the building using reflective surfaces. These reflective surfaces can be mirror ducts, light shelves, or light pipes. These reflective surfaces bounce, reflect, and direct natural light into the rooms and interior of the building.

Daylighting reduces energy use by increasing available natural light and reducing the need for electrical lighting within the building or home.

2. The ***average Saskatchewan home*** uses a lot more electricity than the Vereco NET ZERO home. Name three ways the NET ZERO home uses less. **(Student choice, options below)**

Electricity is reduced in the NET ZERO home through:

- LED lighting; ENERGY STAR appliances; occupancy sensors; solar panels; designing a smaller-sized home and efficiently using space.

3. Look at the circle graph of household electricity use. Check (✓) ways you think you and your family could make changes to save electricity. (**Student choice)**

Use LED lights	Turn out lights that aren't needed	Dry clothes on a clothesline
Use timers for lights and vehicle block heaters	Use a power bar to turn off phantom load	Unplug electronics not in use
Buy ENERGY STAR® appliances	Reduce Air Conditioner use by setting the thermostat to 24ºC or higher	Other:

4. Look at the ***light display***. Excluding the exit lamp, which light uses the least amount of power?

The Bright LED uses 9W. The soft LED uses 9.5W.

5. ***Energy = Power x Time.*** If your lamp has two, 15watt bulbs, and you have them on for five hours, how much energy do they use?

Energy (watt hours) 150 kWh = 2(15w) x 5hrs

Explain how reducing power (W) and time (hrs) can reduce overall energy use?

Power is the number of watts a lightbulb uses. A good technology change is reducing the overall energy use in a home by replacing less efficient lightbulbs that use more watts, like fluorescent and compact fluorescent with more efficient lightbulbs like LEDs.

Time is the number of hours that a lightbulb is on. A good behaviour change is turning off lights when they are not needed. This habit reduces overall energy use by reducing the number of hours lights are on in your home.

The mathematical answer: Reducing the value of the numbers on the right side of the equation reduces the value of the left side of the equation.

Water

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. How does the **drain water heat recovery Powerpipe** use **conduction** to save energy? Look at the large copper pipe on the left side of the display.

   Warm wastewater from the shower flows down the drain inside the copper pipe, cool fresh water is pumped up and passes the warm wastewater. Warmth is transferred to the cool water by conduction through the copper pipes on its way to the shower.

   Drain Water Heat Recovery (DWHR) can capture 40-75% of drain water heat.

2. Explain how the ***rain water system*** described here works to make use of rainwater.

   Rainwater is captured in a tank (or cistern), filtered, chlorinated, and pressurized for use in toilets or for watering outside (irrigation) instead of fresh treated water being used for those purposes.

3. What role do wetlands play in the ***Logan Green Water Management System?***

   The City of Yorkton filters its drinking water to remove iron and manganese. Previously, when filters were cleaned, a lot of “backwash” water was created that needed to be treated in their sewage treatment system.

   The Logan Green Water Management system now uses constructed and natural wetlands to treat this “backwash” water naturally. Water from the sedimentation ponds is filtered as it moves through constructed wetlands. Then, it continues to flow into the existing natural wetlands to be further filtered before it soaks back into the ground re-filling the aquifer and the greater watershed.

4. Check (✓) ways you could save water in your home and at school. **(Student Choice)**

Turn off the tap while brushing your teeth	Replace your old dishwasher with an ENERGY STAR® dishwasher	Take a shorter shower
Fix a leaking toilet	Turn off the tap after washing your hands	Install a low-flow showerhead
Collect rainwater to water your lawn/garden	Grow drought tolerant plants	Other:

5. ***Shorter Showers:*** if a showerhead has flow of 6 litres/minute, calculate the amount of water used for a five-minute shower, compared to a 20 minute shower.

6 litres/minute x 5 minutes = **30 litres**
6 litres/minute x 20 minutes = **120 litres**

How much water do you save by taking the shorter shower?

90 litres of water are saved with a shorter shower.

Solar

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. What parts of Canada have the highest ***annual photovoltaic potential***? What part of Saskatchewan has the highest potential?

The parts of Canada with the highest annual photovoltaic potential are the southern parts of the prairie provinces, Alberta, Saskatchewan, and Manitoba.

The southern region of Saskatchewan, south of Prince Albert, has the highest potential overall for photovoltaic potential.

2. Try the ***solar panel*** display. What difference do the clouds make to how much the meter moves? Why?

The clouds block sunlight and reduce the amount of power that the solar panels can produce.

3. ***Innovative designs:***

a. LightLeaf panels – where would you use these panels?

These panels are flexible and lightweight. They are best used for things that move. These panels are molded to fit the surfaces of boats, campers, and other vehicles.

b. Mitrex building integrated panels – what makes these solar panels innovative?

The solar cells are like the filling in a sandwich with a structure of lightweight honeycomb backing on one side and protective tempered glass on the other. The honeycomb backing provides structure and a cooling effect that helps to increase the solar panel efficiency.

These solar panels can become siding material – which allows buildings to be converted into solar power plants!

4. The ***Pesâkâstêw Solar Project*** powers 2,500 homes and eliminates more and 15,000tC02e/year. List the benefits of this project for the two First Nations involved. **(Student Choice)**

The benefits of this project for the two First Nations Involved:

- Reduce the energy costs in the communities by powering homes with renewable energy.
- Provide jobs and technical training in each community.
- Creates a revenue (money) source for the two First Nations communities.
- Offers the potential for expanding solar energy production and future opportunities for constructing more facilities like this.

5. If your home uses 7500 kWh/yr and the average panel produces 400 kWh/yr, how many panels will you need to produce enough electricity for your home? If you live in Saskatoon, check MyHEAT Solar to see the solar potential of your address.

$\frac{7500}{400}$ = 19 panels (18.75, rounded up)

Retrofits

Spend some time looking over the materials at the display. Use these questions to help focus your investigations.

1. Compare the ***EnerGuide® ratings*** of the historical and modern houses. What factors helped the older homes use less energy? What factors help the modern homes use less energy?

   In the older homes:
   - Smaller houses use less energy.
   - Small windows lose less energy.

   In the modern homes:
   - Better insulation reduces heat loss.
   - Better constructed windows and walls mean fewer air leaks.

2. Put your hands on the ***window display***. Which types of glass allow more heat to escape? Which window keeps more heat in? Explain how the window's design and construction contribute to heat loss and retention.

   You can feel that the clear 3 pane window allows more heat to escape.

   - **Insulated window frames reduce heat loss** and condensation.
   - Triple glazing – three panes of glass that have **air or gas-filled spaces to reduce heat loss.**
   - Air-tight design – the **joins between the panes reduce air leakage** into and out of the home.
   - Low-e Glass – Special coatings reflect radiant heat, keeping heat inside in winter and outside in summer.
   - Window Gas Fills **- Inert gases between the panes reduce heat loss by convection.**

   Note, that heat lost through windows can account for up to 15% of a heating bill.

3. Try out the home retrofit samples like **weather stripping, pipe and wall plate insulation**. Which would be useful in your home and where would you use them? **(Student Choice)**

   - Weather stripping – can be used to seal air leaks around doors and windows.
   - Pipe insulation – can be used to insulate hot water pipes to reduce heat loss.
   - Plate insulation – reduces air leaks into and out of the home from outlets on exterior walls.
   - Other ideas students suggest.

4. What are some of the benefits the Prairie South SD achieved by putting new windows and lighting in these Moose Jaw ***heritage schools?***

Some of the benefits achieved by the Prairie South School Division are:

- The well-sealed and efficient windows feel warmer in winter and reduce drafts, which reduces energy use. They also allow summer ventilation. All of this creates more comfortable spaces.
- The LED gym lights improve brightness and reduce energy use.

The things that aren't specifically named are:

- Reduction in energy use and cost.
- Overall, more comfortable buildings.

5. ***Real Retrofit:*** The 2018 Energy Retrofits of the **1970s Split-Level** home will reduce the home's energy use by about 40% or 70GJ/year. Calculate the reduction in greenhouse gas emissions from making this retrofit to the home. Use this calculation:

70GJ/year x 50kgCO_2/GJ = **3500** kgCO_2/year reduction

Smarter Science Better Buildings

WDM North Battleford Exhibits Visit Guiding Questions – Pages 7 - 16

Explore Jakob Marjan's Shoe Repair Shop, the Hamelin Family House and the Grey Schoolhouse as well as the *100 Years of Saskatchewan History* exhibit. Use the map on page 16 to locate the buildings and exhibits.

With your classmates, you will work your way through the Museum exhibits, answering the questions provided and discussing what you see. You will explore three Museum exhibit buildings. Think about where air would leak into the buildings and where heat would be lost. Compare the exhibit buildings to each other. What factors make some of the buildings more energy efficient than others? What factors make modern buildings either more or less energy efficient than these buildings?

Move To Jakob Marjan's Shoe Repair Shop

This brick building was the business of Jakob Marjan. Jakob was a shoemaker who immigrated to Saskatchewan from Europe. In 1931, he had this little building built so he could run a shoe repair shop. His business was open on Railway Avenue in North Battleford for 37 years. Both Jakob and his wife, Leokadia, were very active in the community. Jakob's family still lives in North Battleford.

In 1991, the WDM saved Jakob's brick shoe repair shop from demolition and made it part of the Heritage Farm and Village.

Saskatchewan has a long history with brick as a building material. The Claybank Brick Plant in southern Saskatchewan, manufactured bricks made from clay found onsite from 1914 - 89. These bricks were used in the construction of several well-known buildings, including the Bessborough Hotel in Saskatoon and on NASA's rocket launch pads at Cape Canaveral in Florida.

Examine the building as you read the questions below *The answers to the questions below are given to students so that they can compare with the next building they will visit.*

1. Estimate the thickness of the walls in cm: 20 cm (8 inches) of brick and 2.5 cm (1 inch) of stucco = 22.5 cm wall thickness (9 inches)

2. Where could heat escape from this building?
   1. Under and around the front door
   2. Around windows
   3. Through the roof (there is no insulation)
   4. Through the walls (there is no insulation)

3. How many windows does the brick shop have? Three

4. Think about the thickness of brick when compared with the thickness of wood. Do you think a building made of brick keeps the building warm better or worse than a building made of wood? Why or why not?
   Although these bricks are thicker than a typical wood frame wall, brick does not insulate well. That means that the heat can move through the walls easily and escape the building.

5. As a business, the door of Jakob's shop would have been frequently opening and closing. How would this impact energy efficiency when compared with a home?
   Energy is lost each time the door opens. The door opens and closes more frequently in a shop than a home. More wood would have needed to be chopped to keep the building warm in winter. In summer, the breeze coming through the door would have helped to cool the building.

6. Compared with many businesses today, Jakob's shop is very small. If we are trying to conserve energy, what are some helpful things about a smaller building?
   Not as much energy is lost or wasted heating the building in the winter. It is easier to get air and heat to cycle through the building.

Move to the Hamelin Family House

This is the home of Dr. Joseph Jules Hamelin, one of the first doctors to practice in North Battleford. He arrived in 1911 when the town was booming. North Battleford had many amenities, including electricity and running water. Dr. Hamelin built this house on 99th Street. In 1970, this house was donated to the WDM and moved to the Heritage Village.

1. Estimate the thickness of the walls in cm: 10 - 15.5 cm (4 - 6 inches)

2. Where could heat escape from this building?

1) Under and around doors
2) Around windows
3) Around the chimney
4) Through the attic space as there is no insulation
5) Through the walls

3. How was this home heated? A wood or coal stove plus a wood burning fireplace.

4. How many panes of glass thick are the windows? One (single pane), but there are also storm windows which add a second pane to reduce air flow.

5. What are possible light sources for this building (name as many as you can think of)?
   1) Ceiling lights and lamps powered by electricity
   2) Sunlight through windows
   3) Kerosene or coal oil lamp
   4) Fireplace when a fire is lit

Compare the Hamelin Family House and Jakob Marjan's Shoe Repair Shop

Let's compare Jakob Marjan's Shoe Repair Shop and the Hamelin Family House now that we have looked at both buildings in the Heritage Farm and Village.

Which building is more energy efficient? Think about the size of the buildings, thickness of the walls, number and size of windows, type of heat, etc. Explain your choice.

Students can provide their own answer based on what they've seen in each of the houses.

Move to the Grey Schoolhouse

This school is known as Grey School. It was moved to the WDM from the Maymont area. The school opened in 1909 with 21 students. This was called a 'one room schoolhouse' as all of the grades were in the same room. The school was also used by the local community as a meeting place and as an entertainment centre.

The school stayed open year-round and only closed because of blizzards and illness. For example, the school was closed in 1916 for two weeks because of a measles outbreak and again for six weeks in 1918 due to the Spanish Flu Pandemic. The school building was donated to the WDM in 1965.

1. List the materials that were used to build this school. Where would local builders get these materials?
- Wood siding, shingles and walls - wood may have been found locally from sawmills in northern Saskatchewan. If local wood wasn't available, it may have been shipped by rail from larger cities.
- Stone foundation - stones would have been found in local fields.
- Windows were likely purchased from a local hardware store or shipped from a larger city.

2. Estimate the thickness of the walls in cm: 10 - 15.5 cm (4 - 6 inches)

3. Where could heat escape from this building?
- Around the door or when the door opens and closes
- Around windows
- Through the roof and through the walls

4. How was this building heated? Wood burning stove.

   Note: The school's first teacher, Miss Annie Arkley, would make a fire in the stove before students arrived so the school would be warm for the start of class. Sometimes older students would come early to school to help Miss Arkley get the fire started.

5. What provided light for this building? Sunlight through windows, kerosene lamp

6. How many windows are in the Schoolhouse? Eight

7. How many panes of glass thick are each? One

8. List three things in this Schoolhouse that did not use electricity in the 1920s but might need electricity in your classroom today.
   1) Pencil sharpener
   2) Blackboard (if classroom has an interactive white board/Smart Board)
   3) School Bell
   4) Heating/cooling system
   5) Lights
   6) Washrooms

Compare the Grey Schoolhouse with your School

The Museum's schoolhouse was built in the 1920s. Let's compare it with your school building today.

Which building is more energy efficient? Think about the size of the schools, thickness of the walls, number and size of windows, type of heat, etc. Explain your choice.

Students will provide their own answer based on what they've seen in the schoolhouse compared to their own school.

Move to the *100 Years of Saskatchewan History* Exhibit

Traditionally, nomadic Indigenous groups used easily transportable tipis or tents. Tipis were constructed, owned and set up by women. Women erected the tipis by constructing a framework of 15 - 17 wooden poles upon which a covering of 12 - 20 hides, usually bison, was overlaid and held in place using pegs. Smoke flaps near the top allowed for smoke to escape from the fire that was built within for cooking and heat. The tipi was waterproof, windproof, warm in winter and cool in summer, and portable - all important attributes to support a nomadic lifestyle in a changing climate.

Imagine you are standing in a real tipi.

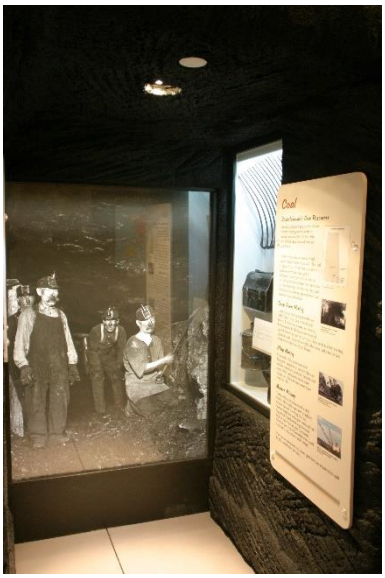
1. Why do you think tipis were warm in the winter?
   As tipis were not very big (compared to today's buildings) they were easier to heat. A small fire could be built inside to keep it warm. Tipis were made of animal hide, often buffalo, that was overlapped. By overlapping the animal hide it would prevent gaps where heat could be lost.

2. Which home do you think would be more comfortable in the winter – a tipi covered in bison hides or a wooden house? Explain your choice. Student answer.

Natural Resources

Near the tipi is an exhibit about natural resources in Saskatchewan.

Few places have been blessed with the richness of natural resources that Saskatchewan enjoys. Beneath our feet are natural resources such as coal, oil and natural gas. For many years we have used these natural resources to heat our homes. These natural resources are called non-renewable resources meaning that we cannot replenish them once they are gone. Solar and wind power are called renewable resources. In Saskatchewan we are starting to use more renewable resources. For example, the visitor centre at Fort Battleford has solar panels on the roof and a wind turbine to provide power to the building.



Enter the mine door when the light above the door is green. Make your way to the Coal display.

1. What is most of Saskatchewan's coal used for? To create power

2. What are modern mine operators required to do after they have removed all the coal from the ground?
   They are required to back fill or replace the earth that was removed so that the land can be used again.