Smarter Science Better Buildings
Western Development Museum - Moose Jaw

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 Moose Jaw Exhibits Visit Guiding Questions – Pages 7 - 15

You and your classmates will work your way through the Museum building and exhibits, answering questions provided and discussing what you see.

Use the map found on page 15 to locate the artifacts and exhibits.

Enter the Museum Galleries

Stop as you enter the Museum galleries and look up and around, past the exhibits at the Museum building to examine the roof, doors, lights and walls. Do you notice what a big space it is?

The WDM Moose Jaw opened in 1976. The Museum was built to provide lots of space for cars, trains, planes, people and more.

Think about the size of the building. Pay attention to the doors, walls, heaters and lights as you go through the Museum as we will ask you more about them later.

Move to the Railway Station Replica

53 sq. metres (577 sq. feet) ERS Rating: 1 Energy Consumption: 449 GJ

In 1885, Canada was linked from coast to coast by the Canadian Pacific Railway. Every 12 km (8 miles) on the prairies, the railway built a siding complete with station, section houses and a name. These places would later become mail, market and supply centres for settlers farming within driving distance. In 1882, the CPR reached Moose Jaw, which became a divisional point for the railway. This railway station is a replica of a 1935 CPR station.

1. Estimate the thickness of the walls: 7 – 10 cm (3 – 4 inches)

2. Can you guess what the insulation in the walls might have been?
It may have been straw, dirt or newspapers. Some buildings had no insulation at all.

3. Where might cold air or water have leaked into this building?
Through open doors and windows or around cracks in doors, windows & the roof.

4. Why might it be harder for businesses to be energy efficient, compared to a home?
Doors open frequently or may not be shut properly. Doors to loading bays may be open constantly allowing cold and damp inside. Some businesses have large open spaces that are hard to keep heated.

Move to the Hodge Coal Truck

Most homes and small businesses today are heated by natural gas. However, there are also homes that are heated by wood, electricity and oil. Large buildings such as schools and apartment buildings may be heated using boilers, instead of furnaces. Boilers heat buildings using water and steam that are heated by natural gas. Do you know what kind of fuel you use to heat your home?

Estimated efficiency of furnaces over time:

Heat Source/Year	Fuel Source	% Efficiency
Wood stove/ 1880-1910	Wood	<30%
Furnace/ 1920- 1940	Coal	30-40%
Furnace/ 1950-1970	Oil/Natural Gas	90%
Furnace: ENERGY STAR/2010	Natural Gas	95-98%

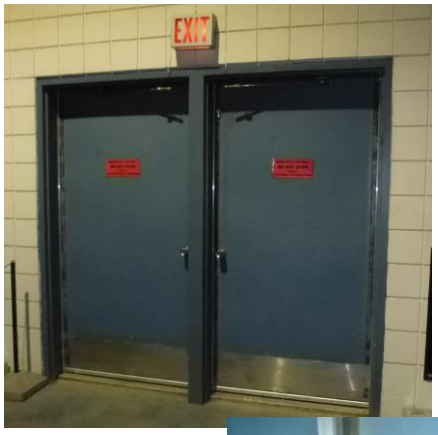
1. From 1920 - 40, many buildings were heated using coal. How was coal hauled to homes and businesses? By truck or horse & wagon

2. Think about how home heating fuel is transported to homes and businesses today? Do you think heating fuel is transported the same as it was 100 years ago in Saskatchewan? How do you think we move heating fuel today?
   Some heating fuel is transported the same as in the past by train or truck. Today heating fuel can be transported by train, tanker trunk or pipeline. Pipelines can be above or below ground.

3. When people used coal to heat their homes they needed a large space to store the coal. Do you need a place to store heating fuel in your house? Why or why not?
   If your home is heated by natural gas or with a boiler (using heated water to create steam), you do not need storage as this fuel is piped into your home. If you use wood, then you need a place to store firewood in your basement or a wood shed.

Museum Exterior Doors

Located near the Railway Station are some of the Museum's exterior doors. Let's take a closer look at them.



1. Without opening the door, do you feel air coming in around the door?
   If you feel air then the door is not sealing properly so heat is escaping & cool air is coming in.

2. Is daylight visible around the door?

   If you feel air then the door is not sealing properly so heat is escaping & cool air is coming in.

3. In the winter, frost can collect on and around doors. This happens if there is air or moisture leaking in around the door. What can be done in a home, business or school to help stop air from leaking around doors?
   Put weather stripping around the door (& windows too) to stop heat loss. Put a door snake (cloth tube) along the bottom of the door.

Move to the Auto Repairs Building

In the early years of cars, also known as automobiles, there were few places where they could be repaired. Cars and trucks were sold by farm machinery dealers who didn't always know a lot about them. Between 1910 and 1920, cars became more common in Saskatchewan and more garages and repair shops were opened.

This auto repair shop was built by Museum staff using photographs to guide them.

1. List the materials that were used to build this garage? Where would local builders get these materials?
If there were trees then you could get your own lumber but there weren't many trees if you lived in southern SK. You would purchase lumber that would be brought in by train from another province or, if you were lucky, northern SK.

2. Estimate the thickness of this building's walls in cm: 7 – 10 cm (3 – 4 inches)

3. Notice the stove. What fuel was used to heat this building? Coal.

4. What provided light for this building?
This building has electricity and electric lights. If the electricity is unreliable, light could be provided by a kerosene oil lantern or sunlight through the windows.

5. How many panes of glass thick are the windows? One

6. Find two of the places where heat would escape from this building:

1) Around open doors (doorways & garage doors) or around gaps when the doors are closed.
2) Around windows. Through gaps in the wood siding.

7. List three things in this building that did not use electricity in the early 1900s, but today require electricity: Possible answers:

1) Cash register (today's equivalent - computerized till with debit/credit machine)
2) Kerosene lamp (today's equivalent - electric lighting)
3) Clocks (today's equivalent - electronic clocks)
4) Typewriter (today's equivalent - computer)

8. Stop and listen while standing in front of the Auto Repair Shop. Do you hear the Museum's heating system and can you feel heat? Can you see where the Museum's heaters are located (look up)?

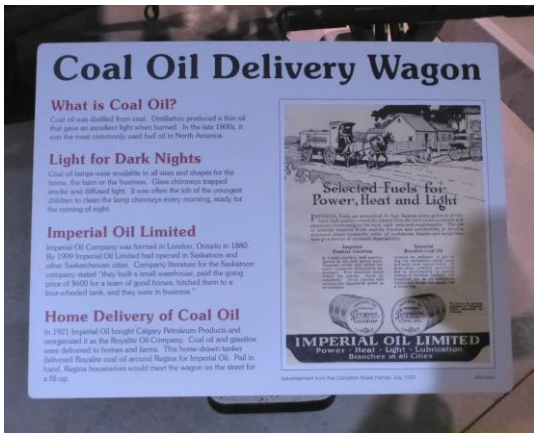
1. Do you know what type of heat it is? Heat from a boiler that uses heated water to create steam. The heat created is then circulated by a fan.

2. Is this similar to how your school is heated? Most schools are heated in a similar way but it can vary between schools. Many large buildings are heated using a boiler.

9. It is hard for businesses in large buildings, like museums, to heat their buildings efficiently. Do you have any suggestions that would help make it easier to heat (or cool) a large building? **(Student choice)**
   Some ideas:
   - To re-insulate the roof and walls to help keep heat in and cold out.
   - Ensure there is good weather stripping around doors and windows.
   - Do not leave doors and windows open in cool or damp weather.
   - Ensure that heating systems are running efficiently. This may include upgrading old systems.
   - Using wind turbines and solar power to generate power to run heating appliances.

Move to the Coal Oil Delivery Wagon

Coal was used to heat homes and businesses from around 1910 - 40.



1. What is coal oil? Coal oil is distilled from coal. Distillation produced a thin oil that gave excellent light when burned.
2. What was coal oil used for? Stoves, heaters, lamps, automobiles, tractors
3. Is coal oil a renewable resource? No
4. How did homes get coal oil? By horse-drawn tanker (wagon)

Our homes, schools and businesses are only one part of living sustainably. Let's explore other ways that we can live sustainably.

Move to the 1929 Streetcar

In early Saskatchewan, hardly anyone owned a car. Just like today, booming cities needed public transit.

1. How is using public transit good for the environment?
   Less cars on the road creating fumes & less fuel used means cleaner air. Emissions from cars can cause greenhouse gases that, unnaturally, heat the planet.

2. What kind of energy powered the 1929 Streetcar? Electricity provides power through overhead lines.

3. Why did streetcars become unpopular? Streetcars were replaced by cheaper, rubber-tired buses and trolleys that were not restricted to rails.

4. Cities like Los Angeles and Atlanta have considered a return to streetcars in recent years. Why do you think they may be considering this? Streetcars will mean less cars in congested downtown areas. Electric streetcars do not require gasoline so they do not produce emissions harmful to people and the environment. They are also quieter. These cities will also use them to attract tourists to their communities.

Move to the 1951 Trolley Coach

1. What kind of energy powered the 1951 Trolley? Electricity. Trolleys had an electric motor which got power from an overhead line (like a streetcar).

2. What are two advantage trolleys had over streetcars?
    1. Trolleys weren't restricted to rails and could pick up passengers at the curb.
    2. Trolleys had rubber tires that made them quieter than streetcars.

3. What replaced trolley cars? Diesel-powered (gasoline) buses.

Move to the *100 Years of Saskatchewan History* exhibit - Weather Display

In Saskatchewan, we have all kinds of weather from very hot to very cold. Today, we are lucky to have electricity in our homes that provides power for furnaces to keep us warm in the winter. Electricity also powers air conditioners and fans to keep us cool in the summer. How did people keep warm or cool before we had electricity?

Prior to 1949, only about one percent of Saskatchewan's farms had electricity. A few communities had electricity, but it was considered a luxury enjoyed by people in the cities. In the 1950s and 1960s, electricity came to many rural areas. Let's take a look at the weather display.

1. What are some ways that Saskatchewan people coped with extremely warm weather? **(Students Choice)** Some ideas:
    - Using hand fans and hats to keep cool.
    - Going for a swim.
    - Staying in the shade.
    - If they had electricity, you could use an electric fan.

2. What are some ways to cope with extremely cold weather? **(Students choice)**
    - Using bed/foot warmers and water bottles under blankets or next to the body.
    - Extra blankets or warm, wool mittens, toques and scarves.
    - Building a fire in a fireplace or stove. Building a campfire when outdoors.

3. How would you heat the things that kept you warm?
    Use a fire in a fireplace, stove or campfire using wood or coal to create heat. The fie would:
    - Heat hot water that is put inside hot water bottles to make them warm.
    - Heat coals or stones on a fire to be put inside foot/bed warmers to heat them.