Smarter Science Better Buildings
Western Development Museum - Yorkton

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 Yorkton Exhibits Tour Guiding Questions – Pages 7 - 17

You and your classmates will work your way through the Museum building and exhibits, answering questions provided and discussing what you see. You will explore the Settler's Cabin and Showcase Room exhibits as the *100 Years of Saskatchewan History* exhibit.

Use the map found on page 17 to locate the artifacts and exhibits.

Enter the Museum Exhibit 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 Yorkton was originally housed in an airplane hangar at the airport. This building opened in 1972. The Museum was built to provide lots of space for exhibits and visitors.

Think about the size of the building.

Why might it be harder for businesses and museums 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.
- Lights are on in most spaces all day.
- Some businesses have large open spaces that are hard to keep heated.

Do you have any suggestions that would help make it easier to heat (or cool) a large building?

Students should use their imaginations here. Some suggestions are:

- To re-insulate the roof and walls to help keep heat in & 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 *Yorkton Local History* Exhibit

1. As you move through the Museum, keep an eye out for different building materials and how they have been used in constructing local buildings. Make a list below.

Material	Building(s)
Bricks	Original flour mill (1883, Local History)
Logs	Yorkton's first schoolhouse (model, Local History)
Animal skins, wooden poles	Tipis (100 Years of Saskatchewan History - exhibit introduction)
Logs, earth	Settler's cabin (100 Years of Saskatchewan History)
Stone	Flour mill model (Local History)

BONUS QUESTION: What year did air-conditioned banking come to Yorkton? 1961

HINT - Find the newspaper in the Local History Exhibit.

Move to the Settler's Cabin

14 sq. metres (152 sq. feet) ERS Rating: 54 Energy Consumption: 185 GJ

Over 120 years ago, trees were cut to make this home near Theodore. It was moved into the Museum in 2003.

1. List the materials that were used to build this home. Where would local builders get these materials?

- Logs, wood, earth, prairie grass.
- Most materials were found locally. If there weren't trees nearby. Split wood may have been purchased at local sawmills or it may have been shipped by rail from elsewhere.
- Windows were likely purchased from a local hardware store or shipped from a larger city.

2. What technique was used to make the original roof? Thatching

VOCABULARY: What is thatching? A thatched roof is made of many layers of rye (grain) stalks. The stalks of rye are tied into bundles. The bundles are laid onto each other to create layers just like today's shingles. The thick bundles and layering keep the rain from coming through. A well-thatched roof lasts about 30 years, is waterproof and provides excellent insulation.

3. Estimate the area (length x width) of this home in meters squared (m^2):

3.7 length in meters
x 3.6 width in meters
= 13.32 m^2

a. How does this compare to your home today? It is much smaller.

b. How does the size of a home impact the amount of energy required to heat or cool it? It is easier to heat and cool a smaller space than a large space.

4. Estimate the thickness of this building's walls in cm: 20 cm (7.5 inches)

5. Notice the wall hangings along the back wall. They are called kylyms. How might they add energy efficiency to this home? 20 cm_(7.5 inches)

6. What was used to heat this building? Piche Oven

VOCABULARY: What is a piche (pronounced peach) oven? Originally, Ukrainian *piche* ovens would have been made with a base platform of poplar logs, over which coarse gravel or small stones were laid, and then covered with a several coats of clay. Supple green willow stalks were bent to form the frame. Clay mixed with straw or grass was plastered over the willow frame, followed by several more layers of clay.

7. Can you find the 'hidden' bed? What benefits are there to the bed's placement in the home?
Warm in winter and it doesn't take up very much space in the small home.

8. What provided light for this building?
- Kerosene oil lantern
- Sunlight through windows
- Candles on side wall

9. How many windows are there? Two

10. How many panes of glass are in the windows? One

Move to the British Showcase Room

This parlour represents the story of immigration from the British Isles. Many people from Scotland, Ireland, England and Wales moved to Canada to escape economic hardship and poverty.

Vocabulary: What is kerosene?
A flammable chemical distilled from petroleum. It is used in heating, fueling vehicles and in home lanterns.

1. What provides light in this room? Lamp

2. How is this different than the way we light our homes today?
   It is a lot easier today, we just flip a switch. We don't have to buy fuel (kerosene) or wicks, worry about running out of fuel, fill our light bulbs with fuel, light them, or clean them.

3. How might these differences have changed how we view and use light in our homes? Students should use their imagination. Some ideas:
   - We turn our lights on more often and leave them on for longer.
   - We don't pay as much attention to how much we use our lights.
   - We leave them on even when we are not in the room.
   - We worry less about the danger of fire.
   - Lighting quality was a lot lower with a kerosene lamp.
   - We don't clean lights as often as kerosene lamps had to be cleaned.

4. What heats this room? Fireplace, wood

5. Notice the gramophone and pump organ. What provides power for these musical instruments? Human power - the organ by pumping foot pedals and the gramophone by turning the crank.

Move to the German Showcase Room

This dining room represents the cultural heritage of German settlers. Germans have a long history of settlement in Eastern Canada. By the early 1900s, German-speaking groups were attracted to the Canadian West, mostly for its agricultural potential.

1. Notice the record player in the corner. It uses electricity. Why might a family whose home has electricity choose to continue to use kerosene lamps?
   - Habit
   - Comfort
   - Cheaper
   - The power might be turned off at night (small towns often did).
   - They can't afford to buy an electric lamp.

Move to the American Showcase Room

Many Americans came to the Canadian west at the beginning of the 1900s. American settlers sold their small corn or wheat farms and came north, with money and knowledge of dryland farming techniques.

1. What provides the power for the sewing machine in this room? Human power

2. Notice the water pitcher on the stand in the corner. What might this tell you about this family's home? It wasn't connected to a town water supply or indoor plumbing.

Move to the Ukrainian Showcase Room

Ukrainian settlers brought traditional cultural beliefs to Canada. In this room is the wheat which symbolized the spirits of fields and soil, embroidery work and pysanka which is decorated eggs.

1. What provided the heat for this room? Oven
2. What might be a downside to using the oven in the hot summer months?
   It heats up the home along with the food.
3. Does your family change how they cook in the summer to avoid adding extra heat to the house? If so, what do you do differently? Student's own story.

VOCABULARY: What is a summer kitchen?
Sometimes settlers would build a small building near their house where cooking was done in hot weather. This was called a summer kitchen.

Move to the 100 Years of Saskatchewan History Timeline

1911 – Saskatchewan's first electric railways began operation in which two cities?
Saskatoon and Moose Jaw

1916 – An unusual experiment. In the space below, draw the vehicle tested by the University of Saskatchewan in this year. What provided the fuel for this vehicle? Straw gas

1929 – Lighting up Saskatchewan. Regina had electric lights as early as 1890. How many electricity generating stations were in operation in Saskatchewan in 1929? 120

Did you know that electricity came to Yorkton in 1911?

1949 – What Act was passed that led to Saskatchewan Power Corporation extending power lines to thousands of farms? Rural Electrification Act

What two things does the farm woman quoted look forward to no longer having to do with her coal oil lamps? Clean lamp glasses, fill lamps

1951 – Which three cities used natural gas for heating in 1950?

Unity, Lloydminster, Kamsack

1959 – Two new generating stations opened this year. Where are they, what are their names, and what fuels do they use?

Location	**Name**	**Fuel**
Estevan	Boundary Dam	Lignite coal
Saskatoon	Queen Elizabeth	Natural gas

1959 – South Saskatchewan River Dam Project gets underway. Where are the dams?

Elbow and Outlook

1960 – What convenience made its way to rural homes through assistance from the Family Farm Improvements program beginning in 1960? Running water

1963 – A new generating station opened this year. Where is it, what is its name, and what fuel does it use?

Location	Name	Fuel
Nipawin	Squaw Rapids Hydroelectric Station	water

1977 – Canada's first energy efficient house was built in Regina.

1981 – A new generating station opened this year. Where is it, what is its name, and what fuel does it use?

Location	Name	Fuel
Coronach	Poplar River Power Station	coal

1989 – How many hydro plants make up the Athabasca Hydro System? Three

1992 – A new generating station opened this year. Where is it, what is its name, and what fuel does it use?

Location	Name	Fuel
Estevan	Shand Power Station	coal

What is the extra heat generated by this power station used for? Heating the Shand greenhouse which grows tree seedlings for conservation and reclamation projects.

2002 – What innovative new use for canola oil (a renewable resource) did the city of Saskatoon first test in 2002? Fuel for city buses

2002 – What renewable power source was first harnessed by SaskPower in 2002? Wind