Connecting Industry to Mathematics Instruction
NSF ATE Award # 1954291

Let's Get Mechanical: Outside Air Requirements and Heating Load

A Practice Understanding Task

Purpose: To determine outside air requirements and heating loads required for building design.

Career Field: Mechanical Engineering

In partnership with

Moseley Architects

WTCC Associate Program of Study and Contact Person:
Mechanical Engineering Technology
Steve Hudnut

NC Math 4 Standards:
N/A

Unit Alignment:
WTCC Math 121: During unit 3 (Geometry)
WTCC Math 110: During unit 2 (Chapter 3 Geometry Lab/Application)

Common Core State Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.

Prerequisite Skills

These skills could be reviewed in a warm-up and are addressed in the Desmos Activity

- Converting units
- Dimensional analysis
- Evaluating expressions
- Proportions
- Special right triangles
- Areas, perimeters

Time Required
The time required to complete this activity is approximately 120 minutes.

Materials Needed
- Floor Plan
- Student Activity Sheet

The Teaching Cycle:
Launch: Have students complete the Desmos Launch Activity (opens in a new window) [plain text link: https://teacher.desmos.com/activitybuilder/custom/5f887897eaecb40cb730a401?collections=5f6cae0049988f0bfcd6f9f8]. Hand out student activity sheet and floor plan. As an option, hand out student activity sheet and floor plan one or two classes in advance.

Glossary of Terms

Heating Load - The maximum heat loss (typically expressed in BTU/hr or kW) during the heating season. The maximum heat load occurs when the outside temperature is the lowest.

U-Value - Rate of transfer of heat through a material or construction induced by temperature difference between the environments on each side $\frac{BTU}{hr \cdot ft^2 \cdot °F}$.

Explore 1: In groups of 2-3, have students work through the first task together to answer the questions and determine the amount of ventilation required for each room in the floor plan.

Discuss 2: Have one or two groups share their answers for each of the rooms. Discuss why the answers may not be exactly the same.

Explore 2: Have the same groups of students work through the second task together to answer the questions and to determine the heating load of the exterior walls and windows.

Discuss 2: After the students have finished working through the second task, call on a couple of groups to give their answers and then consider the following questions:

1. For each room above (corner office, conference room, library) determine the component which contributes the most to the heating load.
2. Explain why all three rooms did not have the same component that contributed the most to the heating load.
3. Why is it not enough to just compare the area of windows to the area of walls?
4. Consider the formula for the heating load $Q = UA(T_i - T_o)$.
    a. What will happen to the heating load if the height of the wall is decreased?
    b. Suppose another wall assembly is chosen with “better” insulation. Should this correspond to a greater or smaller U-value?
    c. Which month(s) of the year will the heating/cooling bills be most expensive? How does this relate to the formula?

Exit Ticket: What is one new thing you learned today and one thing you still have questions about?