Educator's Guide

Climate Controlled: Comfort and Quality

Curriculum Collection Description:

In this module, students will be introduced to the science, technology, and people who ensure the comfort and quality of the air in our climate-controlled spaces. Many people worldwide spend a great deal of their daily lives inside buildings like our homes, workplaces, shopping areas, and medical centers. Heating, Ventilation, and Air Conditioning (HVAC) systems in these buildings offer us protection and comfort. Often, we only become aware of these systems when they don't work! HVAC-R technicians create, maintain, and repair climate-control systems that provide us with comfortable and safe environments where we work, play, and sleep.

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Stage 1: Feeling Air - Feeling Comfortable and Staying Safe

Description:

In this stage, students are introduced to all the factors that influence thermal comfort for occupants in an indoor space. Through interviewing peers and family members they begin to learn the skills necessary to provide quality customer service. In addition, they will explore the importance of sensors in monitoring indoor environments to ensure the safety of the occupants and the materials found in those spaces.

Target Grade level or Course:

High school STEM, physics, chemistry

Time frame:

1 week or five 50-minute class periods

Learning Outcomes:

Students will be introduced to:

- The factors that influence thermal comfort
- Effective communication skills
- Temperature mapping indoor space
- The importance of sensors to monitoring indoor environments for homes, businesses, and industry.

Key Vocabulary:

Chamber of Commerce day, thermal comfort, physiological, physical, socio-psychological, temperature, ASHRAE, built environment, humidity, airspeed, metabolic rate, clothing insulation, verbal, nonverbal, comfort factors, thermal sensation, metabolic rate, rapport, cadence, monotone, inflection, succinct, jargon, fidgeting, heat map, magnitude, heat transfer, conduction, convection, radiation, floor plan, insulator, conductor, IR thermometer, returns, anemometer, IR thermometer, pressure gauge, smoke detector, humidity sensor, carbon monoxide detector, carbon dioxide sensor, moisture sensor, sensor, temperature, infrared (IR) thermometer

Resource Table:

Type of Resource	Name of Resource	Description of Resource
Video	STEM Role Model Chuck Atkins, HVAC Service Technician, Morrison, Inc.	Meet STEM Role Model Chuck Atkins and learn about the work he does and his career pathway.
Article	Describing Comfortable Indoor and Outdoor Spaces	In this activity, you will identify the characteristics of comfortable indoor and outdoor spaces. You'll then be introduced to ASHRAE's model for thermal comfort.
Video	HVAC Investigations	STEM Role Model Chuck Atkins shares insights on how to approach solving HVAC issues like a detective solving a mystery.
Activity	Investigative Interviews: Gathering Information from Your Customers	In this activity, you will assume the role of a "climate-controlled system investigator" and develop effective verbal and nonverbal communication skills while conducting a Thermal Comfort Survey.
Article	Effective Communication with Customers	This article and accompanying video highlight the skills and implementation strategies needed to effectively communicate with customers, including verbal communication, nonverbal communication, and cultural considerations.
Activity	Heat or Temperature Mapping an Indoor Space	In this activity, you will practice gathering information about "the scene" of an HVAC-R mystery and explore important HVAC-R concepts related to heat.
Activity	Tools of the Trade in HVAC-R	In this activity, you will identify the ideal climate-controlled conditions for a variety of indoor environments. You will research and learn about the tool used by HVAC-R technicians to monitor indoor environments.
Video	HVAC Tools	STEM Role Model Chuck Atkins describes some of the most important tools you will use as an HVAC technician.
Article	Climate Control with Sensors	This article will introduce you to sensors involved in HVAC-R.
Assessment	Assessment 1 - Climate Controlled	This assessment will gauge your understanding of thermal comfort, types of communication, and heat mapping.

Pacing Guide:

Time (based upon a 50-minute class period)	Resources utilized presented in recommended sequence
Day 1	• Feeling Air Video (3 minutes) • Describing Comfortable Indoor and Outdoor Spaces (1 to 2 classes)
Day 2	• HVAC Investigative Video (1 minute) • Investigative Interviews: Gathering Information from Your Customers (1 class) • Effective Communication with Customers (15 minutes)
Day 3	• Heat or Temperature Mapping an Indoor Space (1 to 2 classes)
Days 4-5	• Tools of the Trade in HVAC-R (1 class) • HVAC Tools Video (30 seconds) • Climate Control with Sensors (20 minutes) • Assessment Stage 1 (5-10 minutes)

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Stage 2: Moving Air - Controlling How Air Moves In Spaces

Description:

In this stage, students are introduced to all the factors that influence how air and energy move through indoor spaces as well as through the building envelope. Students will evaluate floor plans and video tours of residential and commercial buildings to infer natural ventilation, HVAC air flow and then make recommendations for improving air flow. In addition, they will be introduced to key components of an HVAC system.

Target Grade level or Course:

High school STEM, physics, chemistry

Time frame:

1 week or five 50-minute class periods

Learning Outcomes:

Students will be introduced to:

- How HVAC systems are designed to move air and energy throughout indoor spaces
- The roles pressure, pressure gradient, and convection play in air movement.
- Interpreting floor plans and blueprints.
- Interviewing and receiving feedback from room occupants on their comfort levels.

Key Vocabulary:

blueprints, architectural, building envelope, energy efficiency, ventilation, insulation, air sealing, moisture control, window-to-wall ratio, conduction, convection, radiation, R-value, vapor barrier, builder-grade materials, air flow, convection, thermal comfort, efficiency, conduction, convection, radiation, pressure, cross-ventilation, forced convection, venue, floor plan, schematic drawing, conduction, convection, radiation, thermal comfort, compass rose, damper, air conditioning, forced air system, radiant heat system

Resource Table:

Type of Resource	Name of Resource	Description of Resource
Activity	Interpreting HVAC Design Elements	In this activity, you will interpret HVAC blueprints and explore planning forms that are used to gather data for HVAC system designs.
Article	A Peek Inside the Building Envelope	This article will introduce you to the concept of the building envelope and explore the elements that make up the building envelope.
Activity	Which Way Does the Wind Blow? Observing Moving Air	In this activity, you will make observations and hypotheses about how air moves in an indoor environment.
Activity	It's a Breeze: Explaining Air Movement	In this activity, you will learn the underlying principles related to air movement and why air flows in specific ways.
Assessment	Assessment 2.1 - Climate Controlled	This assessment will gauge your understanding of HVAC design elements, the building envelope, and air exchange.
Activity	A New Kitchen in the Hall	In this activity, you will use your knowledge of thermal comfort and airflow to select an optimal location for a commercial kitchen in a historic Ohio property.
Activity	Air Movement Through an HVAC System	In this activity, you will investigate how air moves through an HVAC system and how all of the components in an HVAC work together.
Article	Components of Residential and Commercial HVAC-R Systems	This article will introduce the basic components of residential and commercial HVAC systems.
Assessment	Assessment 2.2 - Climate Controlled	This assessment will gauge your understanding of types of energy transfer, the function of HVAC equipment, and the use of zones in HVAC design.

Pacing Guide:

Time (based upon a 50-minute class period)	Resources utilized presented in recommended sequence
Day 1	• Interpreting HVAC Design Elements (1 class) • A Peek Inside the Building Envelope (15 minutes)
Day 2	• Which Way Does the Wind Blow? Observing Moving Air (1 class)
Day 3	• It's a Breeze: Explaining Air Movement (2 classes) • Assessment 2.1 (5-10 minutes)
Day 4	• A New Kitchen in the Hall (2 classes)
Day 5	• Air Movement Through an HVAC System (1 class) • Components of Residential and Commercial HVAC-R Systems (20 minutes) • Assessment 2.2 (5-10 minutes)

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Stage 3: Thermoregulating Air - Keeping Indoor Air Comfortable

Description:

In this stage, students are introduced to the concept of thermoregulation in the context of HVAC. Students will consider the various influences on maintaining certain temperatures in an indoor environment and how to calculate the heat load of a building prior to HVAC installation. Finally, they will consider the cost effectiveness and environmental benefits of ENERGY Star appliances.

Target Grade level or Course:

High school STEM, physics, chemistry

Time frame:

1 week or five 50-minute class periods

Learning Outcomes:

Students will be introduced to:

- How evaporation and humidity can affect temperature and thermal comfort
- The different climate control needs of different industries in a variety of locations
- How to calculate heat load
- The meaning of ENERGY Star certification and energy efficiency

Key Vocabulary:

thermoregulation, perspiration, evaporation, humidity, climate control, metabolic rate, thermal energy, heat, temperature, state of matter, solid, liquid, gas, phase change, compress, saturated liquid, subcooled liquid, superheated vapor, refrigerant, refrigeration cycle, compressor, evaporator, condenser, metering device, latent heat of vaporization, building envelope, heat load, square footage, efficiency, r-value, slab, crawl space, BTU, insulation, humidity, energy efficiency, climate change, Environmental Protection Agency (EPA)

Resource Table:

Type of Resource	Name of Resource	Description of Resource
Video	Humidity in HVAC	STEM Role Model Chuck Atkins explains the effects of humidity on thermal comfort.
Activity	Evaporation and Thermoregulation	In this activity, you will conduct an experiment to determine how evaporation, air flow, and humidity affect thermal comfort.
Activity	Location, Location, Location!	In this activity, students will consider the influences on climate control needs in different industries.
Article	The Refrigeration Cycle	This article will introduce students to the refrigeration cycle and how we use it to thermoregulate our air.
Activity	Calculating Heat Load	In this activity, you will learn how to calculate the square footage of a space and you will perform a heating analysis for a space.
Assessment	Assessment 3.1 - Climate Controlled	This assessment will gauge your understanding of heat transfer, thermoregulation, calculating square footage, and the refrigeration cycle.
Activity	Thermoregulating Air Moisture	In this activity, you will examine how temperature and humidity affect thermal comfort in terms of actual temperature and “feels like” temperature, and you will consider how you might affect thermal comfort through humidity control.
Activity	ENERGY STAR: Increasing Efficiency	In this activity, students will learn about the ENERGY STAR certification process, how to read an Energy Guide tag, and how to perform calculations to determine the savings over the lifetime of an appliance.
Assessment	Assessment 3.2 - Climate Controlled	This assessment will gauge your understanding of humidity, heat index, and ENERGY STAR designation.

Pacing Guide:

Time (based upon a 50-minute class period)	Resources utilized presented in recommended sequence
Day 1	• HVAC Humidity Video (1 minute) • Evaporation and Thermoregulation (1 class)
Day 2	• Location, Location, Location! (1 class) • The Refrigeration Cycle (15 minutes)
Day 3	• Calculating Heat Load (1 class) • Assessment 3.1 (5 to 10 minutes)
Day 4	• Thermoregulating Air Moisture (1 class)
Day 5	• ENERGY STAR: Increasing Efficiency (1 class) • Assessment 3.2 (5 to 10 minutes)

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Portfolio Challenge - Climate Controlled: Comfort and Quality

Description:

In this challenge, you will use your knowledge and skills obtained in the Climate Controlled: Comfort and Quality Module to develop a long-term climate-control proposal that optimizes energy efficiency and occupant comfort and health on the warmest days of the year.

Target Grade level or Course:

Grades 9-12, physical science, physics, engineering, HVAC, construction

Time frame:

1 week or five 50-minute class periods

Learning Outcomes:

Students will be introduced to:

- Regulations related to HVAC installation and operation
- Ways in which air can be conditioned
- How air filtration can help to control the spread of pathogens
- The relationship between conditioning air and the future of climate change

Key Vocabulary:

constraints, consideration, climate controlled, indoor air quality, HVAC, envelope, Accusize Heating and Cooling Analysis

Resource Table:

Type of Resource	Name of Resource	Description of Resource
Activity	Challenge Guidelines for Climate Controlled: Comfort and Quality	In this challenge, you will use your knowledge and skills obtained in the Climate Controlled: Comfort and Quality Module to develop a long-term climate-control proposal that optimizes energy efficiency and occupant comfort and health on the warmest days of the year.
Activity	Proposal Rubric for the Climate Controlled: Comfort and Quality Challenge	This rubric will guide you as you create your Proposal and organize your digital portfolio for the Climate Controlled: Comfort and Quality Challenge. Evaluators will also use this rubric to provide feedback on your Proposal.
Article	Customer Pitch Rubric for the Climate Controlled: Comfort and Quality Challenge	This rubric will guide the creation of your Pitch for Climate Controlled: Comfort and Quality. Evaluators will also use this rubric to provide feedback on your Climate Controlled Plan, Estimate, and Pitch.

Pacing Guide:

Time (based upon a 50-minute class period)	Resources utilized presented in recommended sequence
Day 1-5	Student have a week to perform their analysis, create their Proposal, and develop their Pitch. They then deliver their Pitch.

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Master Materials List

In addition to a device with internet access and digital document software, you will need:

Stage 1: Feeling Air

Describing Comfortable Indoor and Outdoor Spaces

- Access to software that can be used to create an infographic

Investigative Interviews: Gathering Information from Customers

- A printed copy of the Thermal Comfort Survey

Heat or Temperature Mapping an Indoor Space:

- Sample Temperature Scale (see preparation directions)

Tools of the Trade in HVAC-R:

- A variety of sensors and tools including an anemometer, IR thermometer, pressure gauge, smoke detector, humidity sensor, carbon monoxide detector, carbon dioxide sensor, and moisture sensor

Stage 2: Moving Air

Interpreting HVAC Design Elements:

- Highlighters (blue, yellow, pink, orange)
- Printout of Residential Plans Examiner Review Form for HVAC System Design

Which Way Does the Wind Blow? Observing Moving Air:

- Heat map floor plans from Stage 1
- 1x3 inch strips of facial tissue paper or toilet tissue
- Tape (scotch or masking)
- Yardstick
- Markers
- Pencil
- Anemometer (optional)

Stage 3: Thermoregulating Air

Evaporation and Thermoregulation:

- Pipette (or q-tip)
- Small container of room temperature water labeled H2O (approximately one-quarter cup)
- Small covered container of room temperature rubbing alcohol labeled IA (approximately one-quarter cup tablespoon)
- Two thermometers (could be alcohol-based or digital) for each group
- Thread or elastic bands
- 3-4 cotton gauze strips for each group
- 2 stopwatches for each group
- Small fan
- Goggles for each student

Location, Location, Location!:

- Index cards

Calculating Heat Load:

- Digital measuring tape or standard 25 ft or larger measuring tape
- Calculator
- Accu-size Heating & Cooling Home Analysis Sheet

Thermoregulating Air Moisture:

- Materials for sketching or drawing (paper, pencil, colored pens or pencils)

Stage 4: Conditioning Air

Pathogens on a Planet: Filtering in Hospitals, Planes, and Closed Spaces

- Colored pencils or markers (specifically red, blue, and green)