Building Insulation Materials: Technical Construction Workshop

Learning Objectives

- Understand fundamental thermal properties and their units of measurement
- Calculate R-values and U-values for different insulation materials
- Analyze and compare various insulation materials for construction
- Apply theoretical knowledge to practical construction scenarios

Warm-Up Exercise: Thermal Properties Match-Up (10 minutes)

Working individually, connect each thermal property with its correct unit and definition.

Property	Unit	Your Answer
Thermal conductivity (λ)	W/mK, W/m²K, m²K/W, or °C	
R-value	W/mK, W/m²K, m²K/W, or °C	
U-value	W/mK, W/m²K, m²K/W, or °C	

Practical Calculations: R-Value Workshop (25 minutes)

Using the formula $R = d/\lambda$, calculate the R-values for the following insulation scenarios:

Problem 1: Calculate the R-value for 100mm mineral wool (λ = 0.040 W/mK)

Work space:

Formula: $R = d/\lambda$

d = _____ m (convert from mm)

λ = _____ W/mK

R = _____ m²K/W

Problem 2: Calculate the R-value for 150mm expanded polystyrene (λ = 0.035 W/mK)

Work space:

Formula: $R = d/\lambda$

d = _____ m (convert from mm)

λ = _____ W/mK

R = _____ m²K/W

Material Classification Exercise (30 minutes)

Complete the following comprehensive material analysis table:

Material	Density (kg/m³)	λ Value (W/mK)	Fire Class	Applications
Mineral Wool				
EPS				
XPS				

Material Properties Analysis

For each material, circle the correct properties and explain your choices:

Mineral Wool Properties:

Circle: [Water resistant] [Fire resistant] [Lightweight] [Sound insulating]

Explain your choices:

EPS Properties:

Circle: [Moisture resistant] [Compressible] [High density] [UV resistant]

Explain your choices:

Advanced Wall Assembly Calculation (45 minutes)

Working in pairs, analyze the following wall assembly and perform the required calculations:

Wall Assembly Components (inside to outside):

- Gypsum board (12.5mm, $\lambda = 0.25$ W/mK)
- Mineral wool (150mm, $\lambda = 0.040$ W/mK)
- Air gap (25mm, $R = 0.18$ m²K/W)
- Brick (240mm, $\lambda = 0.77$ W/mK)

Step 1: Calculate R-value for each layer

Gypsum: R = _____ m²K/W

Mineral wool: R = _____ m²K/W

Air gap: R = _____ m²K/W

Brick: R = _____ m²K/W

Step 2: Calculate total R-value

R_{total} = _____ m²K/W

Step 3: Calculate U-value

$U = 1/R_{total}$ = _____ W/m²K

Thermal Bridge Analysis (40 minutes)

Identify and analyze potential thermal bridges in common construction scenarios:

Scenario 1: Window Installation

Thermal Bridge Location	Mitigation Strategy

Scenario 2: Balcony Connection

Thermal Bridge Location	Mitigation Strategy

Vapor Barrier Implementation (35 minutes)

Complete the following vapor barrier analysis worksheet:

1. Vapor Barrier Placement Analysis

Climate Zone	Recommended Position	Reasoning
Cold Climate		
Hot-Humid Climate		
Mixed Climate		

2. Material Selection Guide

Material Type	Permeability Rating	Best Application
Polyethylene Sheet		
Kraft Paper		
Smart Vapor Retarder		

Cost-Benefit Analysis Project (50 minutes)

Complete a comprehensive cost-benefit analysis for different insulation strategies:

Project Scenario: 200m² residential building renovation

Insulation Strategy	Initial Cost	Annual Energy Savings	Payback Period
Basic (100mm Mineral Wool)			
Enhanced (150mm Mineral Wool)			
Premium (200mm Mineral Wool)			

Energy Cost Calculations:

Annual Heating Cost = Floor Area × Heat Loss × Heating Degree Days × Energy Cost

Basic Strategy:

_____ m² × _____ W/m²K × _____ × _____ = _____

Environmental Impact Assessment (45 minutes)

Evaluate the environmental impact of different insulation materials:

Material	Embodied Carbon	Recyclability	Lifespan
Mineral Wool			
EPS			
Natural Fiber			

Carbon Footprint Calculation:

Material Production CO_2e: _____ kg CO_2e/m^2

Transportation CO_2e: _____ kg CO_2e/m^2

Installation CO_2e: _____ kg CO_2e/m^2

End-of-life CO_2e: _____ kg CO_2e/m^2

Total Life Cycle CO_2e: _____ kg CO_2e/m^2

Final Assessment Project (60 minutes)

Design a complete insulation strategy for a residential building:

Project Requirements:

- Three-bedroom house
- Mixed climate zone
- Budget constraints
- High energy efficiency targets

1. Wall Assembly Design

Layer 1 (interior): _____

Layer 2: _____

Layer 3: _____

Layer 4 (exterior): _____

Calculated U-value: _____ W/m²K

2. Roof Insulation Strategy

Primary insulation: _____

Thickness: _____ mm

Vapor control: _____

Calculated U-value: _____ W/m²K

3. Foundation Insulation

Material selection: _____

Thickness: _____ mm

Installation method: _____

Calculated U-value: _____ W/m²K

Assessment Criteria

Criteria	Points Available	Score
Calculation accuracy	30	
Material analysis	25	
Technical understanding	25	
Participation	20	

Additional Notes

Teacher comments:

Student reflection: