Building Science: Insulation and Environmental Impact

Learning Objectives

- Understand thermal principles and insulation materials
- Calculate R-values and heat loss in building systems
- Evaluate environmental impact of different insulation materials
- Apply practical installation knowledge

Part 1: Material Properties Investigation

Match each insulation material with its correct properties by drawing lines between them:

Materials:

- Mineral Wool
- Expanded Polystyrene (EPS)
- Extruded Polystyrene (XPS)
- Cellulose

Properties:

- Fire-resistant, sound-absorbing, non-combustible
- Lightweight, good thermal resistance, moisture-sensitive
- High compression strength, water-resistant, durable
- Recycled content, eco-friendly, good fire resistance

Part 2: R-Value Calculations

Problem 1: Calculate the R-value for the following wall assembly:

Given:

- Wall thickness (d) = 25cm = 0.25m
- Thermal conductivity (λ) = 0.040 W/mK
- Formula: R = d/λ

Show your work here:

Part 3: Thermal Bridge Investigation

Study the building section diagram below and identify potential thermal bridges:

[Building Section Diagram]

Location	Why is it a thermal bridge?	Proposed Solution

Part 4: Cost Analysis Exercise

Calculate the following for a residential wall insulation project:

Given:

- Wall area: 120m²
- Material cost: 45 lei/m²
- Labor cost: 30 lei/m²
- Expected energy savings: 25 lei/m²/year

a) Calculate total installation cost:

b) Calculate payback period in years:

Part 5: Environmental Impact Assessment

Complete the following impact assessment matrix for different insulation materials:

Material Type	Manufacturing Energy (1-5)	Transportation Impact (1-5)	Installation Waste (1-5)	Recyclability (1-5)	Overall Score
Mineral Wool					
EPS					
XPS					
Cellulose					

Based on your completed matrix, answer the following questions:

1. Which material has the lowest environmental impact? Explain why.

2. What factors make some materials more environmentally friendly than others?

3. How could the environmental impact of these materials be reduced?

Part 6: Installation Techniques Laboratory

Document the proper installation sequence for cavity wall insulation:

Step	Procedure	Safety Considerations
1. Preparation		
2. Inspection		
3. Installation		
4. Finishing		

Part 7: Moisture Control Analysis

Case Study: Residential Building in Humid Climate

A two-story residential building in a coastal area is experiencing condensation issues within its wall assembly. Review the following data and propose solutions:

- External temperature: 5°C
- Internal temperature: 21°C
- Relative humidity (internal): 65%
- Wall construction: Brick-cavity-block

Part 8: Energy Performance Calculations

Exercise 1: Heat Loss Calculation

Calculate the heat loss through a wall using the following formula:

$$Q = U \times A \times \Delta T$$

Where:

- Q = Heat loss in watts (W)
- U = U-value of wall (W/m²K)
- A = Area of wall (m²)
- ΔT = Temperature difference (K)

Given values:

- Wall U-value = 0.28 W/m²K
- Wall area = 85m²
- External temperature = -5°C
- Internal temperature = 20°C

Show your calculations here:

Part 9: Building Regulations Compliance

Review the following building regulations and mark compliance:

Requirement	Compliant?	Reference
Minimum U-value for external walls		BR443
Fire resistance of insulation materials		BS476
Vapor barrier installation		BS5250

Part 10: Sustainable Design Integration

Green Building Challenge:

Design an energy-efficient wall assembly that meets the following criteria:

- Maximum U-value: 0.15 W/m²K
- Minimum 30% recycled content
- Local sourcing (within 100km)
- Zero VOC emissions

Complete the design specification:

Layer	Material	Thickness	R-value
External			
Layer 2			
Layer 3			
Internal			

Part 11: Final Assessment

Complete the following questions to demonstrate understanding:

1. Explain the relationship between thermal conductivity and R-value.

2. Describe three methods to prevent thermal bridging in building construction.

3. Compare and contrast the environmental impact of mineral wool and EPS insulation.

4. Calculate the payback period for an insulation upgrade project given:

   - Installation cost: 15,000 lei
   - Annual energy savings: 2,500 lei
   - Maintenance cost: 200 lei/year

Final Notes

Remember to submit your completed worksheet to your instructor. Make sure you have:

- Completed all calculations and shown your work
- Filled in all tables and matrices
- Provided detailed explanations where required
- Double-checked your environmental impact assessments

Additional Resources:

- Building Science Reference Guide
- Thermal Calculations Handbook
- Environmental Impact Assessment Guidelines