When equilibrium is established, the amount of heat flowing through any component part of a construction is the same for each square foot of area.

Therefore,

$$U\,[80 - (-10)] = 1.65\,(80 - 65)$$

where

U is the transmittance of the insulated roof.

Solving the equation, $U = 0.275$.

The resistance of the insulated roof $= \dfrac{1}{0.275} = 3.64$.

The resistance of the uninsulated roof $= \dfrac{1}{0.72} = 1.39$.

The resistance of the insulation $= 3.64 - 1.39 = 2.25$.

Resistance per inch of insulation $= \dfrac{1}{0.33} = 3.0$.

Since a resistance of 2.25 is required, and 1 in. of insulation has a resistance of 3, one inch will be sufficient to prevent condensation.

The same result might have been obtained by selecting an insulated 4-in. concrete slab having a U of less than 0.275 from Table 11, Chapter 5. This 4-in. concrete slab with 1-in. rigid insulation has a U of 0.23 which is safe.

2 ● What inside dry-bulb temperatures are usually assumed for: (a) homes, (b) schools, (c) public buildings?

Referring to Table 1:

a. 70 to 72 F.

b. Temperature varies from 55 to 75 F, depending on the room. Classrooms, for instance, are usually specified as 70 to 72 F.

c. 68 to 72 F.

3 ● How is the outside temperature selected for use in computing heat losses?

The outside temperature used in computing heat losses is generally taken from 10 to 15 F higher than the lowest recorded temperature as reported by the Weather Bureau during the preceding 10 years for the locality in which the heating system is to be installed. In some cases where the lowest recorded temperature is extremely unusual, the design temperature is taken even higher, than 15 F above the lowest recorded temperature.

4 ● What are the effects of wind movement on the heating load?

a. Wind movement increases the heat transmission of walls, glass, and roof; it affects poor walls to a much greater extent than good walls.

b. Wind movement materially increases the infiltration (inleakage) of cold air through the cracks around doors and windows, and even through the building materials themselves if such materials are at all porous.

5 ● Calculate the heat given off by eighteen 200-watt lamps.

$200 \times 18 \times 3.415 = 12{,}294$ Btu per hour.

6 ● A two-story, six room, frame house, 28-ft by 30-ft foundation, has the following proportions:

Area of outside walls, 1992 sq ft.
Area of glass, 333 sq ft.
Area of outside floors, 54 sq ft.
Cracks around windows, 440 ft.
Cracks around doors, 54 ft.
Area of second floor ceiling, 783 sq ft.
Volume, first and second floors, 13,010 cu ft.
Ceilings, 9 ft high.

The minimum temperature for the heating season is −34 F, and the required inside temperature at the 30-in. level is 70 F. The average number of degree days for a heating season is 7851, and the average wind velocity is 10 mph, northwest.

The walls are constructed of 2-in. by 4-in. studs with wood sheathing, building paper, and wood siding on the outside, and wood lath and plaster on the inside. The windows are single glass, double-hung, wood, without weatherstrips. The second floor ceiling is metal lath and plaster, without an attic floor. The roof is of wood shingles on wood strips with rafters exposed. The area of the roof is 20 per cent greater than the area of the ceiling. Select values for the following: (a) U for walls; (b) U for glass; (c) U for second floor ceiling; (d) U for roof; (e) U for ceiling and roof combined; (f) air leakage, cubic feet per hour per foot of window crack; (g) air leakage, cubic feet per hour per foot of door crack.

a. 0.25 (Table 5, Chapter 5).
b. 1.13 (Table 13, Chapter 5).
c. 0.69 (Table 8, Chapter 5).
d. 0.48 (Table 12, Chapter 5).
e. 0.236 (Equation 6, Chapter 5).
f. 21.4 (Table 2, Chapter 6).
g. 42.8, which is double the window leakage.

7 ● Using the data of Question 6, calculate the maximum Btu loss per hour for the various constructions, and show the percentage of the total heat which is lost through each construction described.

Assume 2 per cent rise in temperature for each foot in height. The average temperature will be 72.8 F for walls, doors, and windows, and 79.1 F for the second floor ceiling.

a. Outside walls	46,200 Btu loss	37.2 per cent of total
b. Glass	34,950 Btu loss	28.1 per cent of total
c. Doors	5,670 Btu loss	4.6 per cent of total
d. Second floor ceiling	17,840 Btu loss	14.3 per cent of total
e. Air leakage, windows	15,750 Btu loss	12.7 per cent of total
f. Air leakage, doors	3,865 Btu loss	3.1 per cent of total
Total	124,275 Btu loss	100.0 per cent of total

8 ● For the house in Question 6, place 1-in. insulation in the outside walls and second floor ceiling; k for insulation = 0.34. Use weatherstrip on doors and windows, and double glass on the windows; C_a = 0.55. Calculate or select the following values: *(a)* U for walls; (b) U for glass; (c) U for second floor ceiling; (d) U for combination of ceiling and roof; (e) Air leakage, cubic feet per hour per foot of door crack; (f) air leakage, cubic feet per hour per foot of window crack.

a. 0.144.
b. 0.55.
c. 0.23.
d. 0.13.
e. 15.5.
f. 31.0.

9 ● Calculate the maximum Btu loss per hour and show the percentage loss by each channel for the house as insulated in Question 8.

a. Outside walls	26,650 Btu loss	36.2 per cent of total
b. Glass	17,000 Btu loss	23.1 per cent of total
c. Doors	5,670 Btu loss	7.7 per cent of total
d. Ceiling	10,070 Btu loss	13.7 per cent of total
e. Air leakage, windows	11,400 Btu loss	15.5 per cent of total
f. Air leakage, doors	2,795 Btu loss	3.8 per cent of total
Total	73,585 Btu loss	100.0 per cent of total