1. Find the weight of 25 cu ft of dry air at a dry-bulb temperature of 70 F and at atmospheric pressure.

Absolute pressure p=14.7psi

Volume v=25cu ft

Constant for air B=0.37

Absolute temperature T=70F

Weight of the quantity of gas W=?

pv=WBT

$$14.7 \times 25 = W \times 0.37 \times (460 + 70)$$

$$W = \frac{14.7 \times 25}{0.37 \times (460 + 70)}$$

W=1.87 lbs

2. A room having a sensible heat gain of 4,000 Btu per hour is to be maintained at a temperature of 78 F when the outside temperature is 93 F. The temperature of the air entering the room is to be 68 F. Determine the number of pounds of fresh air per minute that must be used if 75% of the total air is recirculated.

Since the temperature of the air entering the room will drop from 93F to 78F. Air entering the room will absorb (78-68) F/55 Btu for each cubic foot in heating.

The number of cubic feet of air required per minute $\frac{4000}{60} \div \frac{93-78}{55}$

Number of pounds of fresh air per minute =244.44

3. It is desired to air-condition a small one-room store located on the first floor of a building several stories in height. The store is 20 ft wide and 40 ft deep, and the ceiling height is 12 ft. The front wall, which faces north, may be considered as 100% glass. The partitions between this store and the stores on either side are 4-i n. cinder tile, plastered on both sides ; and the rear wall, which contains 40 sq ft of glass, is of 4-in

brick backed by 8-in. concrete blocks with furred metal lath and plaster on the inside surface . The floor construction consists of a 6·in concrete slab with 1/8 in asphalt-tile flooring laid directly on the concrete. There is no ceiling in the basement. The store ceiling construction consists of a 3-in. concrete slab with a suspended metal-lath and plaster ceiling below the supporting steel joists, and a double wood floor on sleepers above the slab.

The store is to be kept at 80 F and 50% relative humidity when the outside temperature is 95 F and the relative humidity is 50%. The stores on either side are not air-conditioned, nor are the offices on the floor above. The temperature in the basement may be assumed to be 7.5 deg warmer than the store.

Assume that there will be an average of 20 persons in the store and that about 2,000 watts of fluorescent lighting will be used.

What are the coefficients of heat trans mission for walls, ceiling, floor, and partitions?

<u>Walls</u>

Glass →1.13

Cinder tile plated on both sides →2x0.43=0.86

4-in brick backed by 8-in concrete blocks with furred metal lath and plaster on the inside surface→0.23

Inside surface →0.61

Outside surface →0.17

Air space → 0.91

The coefficient of wall= 1/(1.13+0.86+0.23+0.61+0.17+0.91)= 0.255

<u>Floor</u>:

6in concrete slab with 1/8 in asphalt-tile flooring → 0.58

Inside surface → 0.61

Outside surface → 0.17

Air space → 0.91

Coefficient of floor=1/(0.58+0.61+0.17+0.91)=0.44

Ceiling:

3in concrete slab with a suspended metal-lath and plaster ceiling → 0.25

Inside surface → 0.61

Outside surface → 0.17

Air space → 0.91

Coefficient of floor=1/(0.25+0.61+0.17+0.91)=0.515

4. Calculate the sensible heat gain of the store described in question 3. Do not include infiltration.

Area	U	Degree difference	Btu
Wall			
Glass area = 240 sq ft	1.13	15	240x1.13x15 = 4068
Side walls area = 2x480 =860	0.40	15	860x0.40x15 = 5160
Glass area on rear side = 40 sq ft	1.13	15	40x1.13x15 = 678
Wall area on rear side = 200 sq ft	0.28	15	200x0.28x15 = 840
Sun effect			40x30 =1200
Floor = 800 sq ft	0.58	7.5	800x0.58x7.5 = 3480
Ceiling = 800 sq ft	0.25	10	800x0.25x10 = 2000
Body heat = 20 persons			20x220 = 4400
Total without infiltration			21826

5. For the same store, find the number of pounds of fresh air needed per minute if 75% of the air is recirculated and 25% is fresh air.

The saving in the cost of refrigeration equipment and in the operation of the equipment is considerable when 75% of the air is recirculated, using a 25% fresh air make-up. Under these conditions about 400 cfm (cubic feet per minute) can be treated with one ton of ref rigeration, while with 100 % fresh air, one ton of refrigeration could handle only about 240 cfm. This is a saving of 40% in the size of the refrigeration plant required. A similar reduction is made in the operational cost of the refrigeration equipment, which requires about one horsepower per ton. These savings are possible because recirculated air needs only to be cooled from the room temperature of 80 F, instead of from an outside temperature of 95 F. At the maximum the moisture would be about 15 grains per pound of air, while the moisture to be removed from the outside air would be about 75 grains per pound of air.

The total sensible heat gain for the typical room without an infiltration gain is 21826 Btu per hour. Therefore, the number of cubic feet of air required per hour is

21826 X 3.67 = 80101.42.

For 75% recirculated air and 25% fresh air, the quantity of air that must be supplied to the room is 80101.42cu ft per hour, or 1335.0236 cu ft per minute. This amounts to 1335.0236x3/40= 100.126 lb of air per minute.

6. Compute the number of tons of refrigeration required to air-condition the store.

It is necessary to extract 0. 24 Btu from one pound of air to lower its temperature 1 deg if under constant pressure, then the number of Btu which must be extracted from the 75% recirculated air per minute in lowering its temperature 15 deg is 100.126 X0.75 X0.24 X15= 270.3402.

The number of Btu per minute which must be removed from the 25% outside air in order to cool it from 95F to 80 F, or 15 deg below outside temperature, is 100.126x0.25x0.24x15=90.1134.

when air at 95 F is saturated it contains 256 grains per pound of air. Hence, the outside air at 95 F and 50% relative humidity contains 0.50X256 = 128 grains per pound of dry air.

Each person in the room at 80 F will give off 1,225 grains of moisture per hour.

20x 1,225 = 24500 grains per hour = 408.33 grains per minute.

the number of grains per pound of air per minute picked up in the room equals 408.33/100.126 = 4.07

The number of grains per pound of air per minute desired in the room to maintain 50% relative humidity at 80 F may be taken as 50% of the saturated value 0.50 X 156 = 78

Therefore, the entering air must contain 78 -4.07 = 73.93 grains per pound of air. Hence, the number of grains of moisture which must be removed from each pound of outside air is 128- 73.93 =54.07. Since the outside air constitutes 25% of the total air supplied to the room, the actual number of grains to be removed per minute is 100.126x0.25 X54.07 =1353.453.

It is assumed that approximately 1,000 Btu are removed to condense each pound of vapor. And since one pound of water contains 7000 grains, the total number of Btu per minute to be removed to condense the water vapor is

$$\frac{1353.453 \times 1000}{7000} = 193.3504$$

The total number of Btu per minute to be handled by the refrigeration is

Cooling the recirculated air = 270.3402.

Cooling the outside air = 90.1134

Dehumidifying the outside air and removing latent heat due to occupants = 193.3504

Total =270.3402+90.1134+193.3504 = 553.804

Since one ton of refrigeration will remove 200 Btu per minute, the number of tons of refrigeration needed to cool the room is

$$\frac{553.804}{200} = \mathbf{2.76}$$

refrigeration needed to cool the room is 2.76

7. Determine the coefficient of heat transfer for an exterior wall having 4in of brick veneer, 1in nominal fir sheathing and building paper, 31in -studs 16in on centers, and metal lath and plaster.

The symbols f_i and f_0 are always used to indicate the inside and outside surface heat-transfer coefficients.

The value of the factor f_i for ordinary practice in computing heat transfer through barriers is 1.65.

The value of f_0 as determined by research, for a wind blowing parallel to the wall at 15 mph (miles per hour) is 6.

The thermal transmittance or over-all coefficient of heat transmission of a barrier that may be made up of a number of different materials and air spaces, is denoted by U.

The resistance for an air space is 1/1.10 or 0.91.

$$U = \frac{1}{\frac{1}{f_i} + \frac{1}{f_o} + \frac{1}{a} + \frac{x1}{k1} + \frac{x2}{k2} + \frac{x3}{k3} + .. + \frac{xn}{kn}}$$

$$U = \frac{1}{\frac{1}{1.65} + \frac{1}{6} + \frac{1}{1.10} + \frac{4}{0.44} + \frac{1}{1.16} + \frac{16}{0.23}} = 0.0123$$

8. Outside air at 85 F dry bulb and 70% relative humidity is to be cooled to an inside temperature of 70 F dry bulb and 50% relative humidity. Compute the number of grains of moisture per pound of dry air which must be removed.

when air at 85 F is saturated it contains 184 grains per pound of air (from table I). Hence, the outside air at 85 F and 70% relative humidity contains 0.70X184 = 128.8 grains per pound of dry air.

when air at 70 F is saturated it contains 110 grains per pound of air (from table I). Hence, the outside air at 70 F and 50% relative humidity contains 0.50X110 = 55 grains per pound of dry air.

Number of grains of moisture per pound of dry air which must be removed =128.8 – 55 =73.8

9. Determine the number of cubic feet of air per minute required to cool a room having a sensible heat gain of 4,500 Btu per hour to a temperature of 78 F dry bulb, if the air enters the room at a temperature of 63 F and the outside temperature is 93 F.

The number of cubic feet of air required per minute = $\frac{4500}{60} \div \frac{93-78}{55}$

Number of pounds of fresh air per minute =275

10. What is the effective temperature corresponding to a dry-bulb temperature of 75 F and a wet-bulb temperature of 65 F?

By observing the COMFORT CHART we get

Ans: 70F