abscissa value of 80 F. Curve *D* indicates a latent heat loss of 175 Btu per hour (left hand scale) or a moisture loss of 1190 grains per hour (right hand scale).

8 ● How much sensible heat, how much latent heat and how much water vapor will be added per hour to the atmosphere of an auditorium by an audience of 1000 adults, when the dry- and wet-bulb temperatures are 75 F and 63.5 F, respectively?

From Curve *D*, Fig. 7, find the sensible heat loss per person for a dry-bulb temperature of 75 F and still air to be 265 Btu per hour. From Fig. 8 find the latent heat loss per person for a dry-bulb temperature of 75 F to be 134 Btu per hour and the moisture added to be 905 grains per hour. Sensible heat = 1000 × 265 = 265,000 Btu. Latent heat = 1000 × 134 = 134,000 Btu. Water vapor added per hour to the air in the auditorium = 1000 × 905 = 905,000 grains or 129 lb.

The sensible and latent heat added to the air may also be found as follows: The effective temperature for dry- and wet-bulb temperatures of 75 F and 63.5 F, respectively, is 70.3 deg. From Curve *D*, Fig. 6, find 403 Btu as the total heat added to the air by a person for an effective temperature of 70.3 deg. From Fig. 9 find the percentage of sensible and latent heat at a dry-bulb temperature of 75 F to be 66.5 per cent and 33.5 per cent. The sensible heat added to the air in the auditorium is 1000 × 0.665 × 403 = 267,995 Btu per hour. The latent heat added is 1000 × 0.335 × 403 = 135,005 Btu per hour.

9 ● If the dry- and wet-bulb temperatures of the auditorium were 85 F and 63 F, respectively, how much heat and moisture would be dissipated to the atmosphere?

From Figs. 7 and 8, respectively, the sensible and latent heat losses per person for a dry-bulb temperature of 85 F are found to be 164 and 225 Btu per hour. The water vapor added to the atmosphere is 1520 grains per hour. The audience will then add 164,000 Btu sensible heat, 225,000 Btu latent heat and 1,520,000 grains or 217 lb of water vapor to the air in the auditorium per hour.

10 ● Neglecting the gain or loss of heat to an auditorium by transmission or infiltration through the walls, windows and doors, how many cubic feet of outside air, with dry- and wet-bulb temperatures of 65 F and 59 F, respectively, (63.1 deg ET) must be supplied per hour to an auditorium containing 1000 people in order that the inside shall not exceed 75 F (dry-bulb) and 65 F (wet-bulb), respectively?

Figs. 7 and 8 give 265 Btu sensible heat and 905 grains of moisture as the additions per person with a dry-bulb temperature of 75 F in the auditorium. Therefore, 265,000 Btu of sensible heat and 905,000 grains of moisture will be added to the air in the auditorium per hour.

Taking 0.24 as the specific heat of air, 2.4 Btu per pound of air will be required to raise the dry-bulb temperature from 65 to 75 F and $\frac{265{,}000}{2.4} = 110{,}400$ lb of air or 110,400 × 13.4 = 1,479,000 cfh of air will be required. This is equivalent to $\frac{1{,}479{,}000}{1000 \times 60} = 24.7$ cfm per person.

The moisture content of the inside air as taken from a psychrometric chart is 76 grains per pound of dry air and that of the outside condition is 65 grains. The increase in moisture content will therefore be 11 grains per pound of dry air. Hence $\frac{905{,}000}{11.0} =$ 82,300 lb of air at the specified condition will be required. This is equivalent to 82,300 × 13.4 = 1,103,000 cfh of air or $\frac{1{,}103{,}000}{1000 \times 60} = 18.4$ cfm of air per person.

The higher volume of 24.7 cfm per person will be required to keep the dry-bulb temperature from rising above the 75 F specified. The wet-bulb temperature will therefore not rise to the maximum of 65 F.

11 ● Assume that a man performs work at a rate equivalent to 50,000 ft-lb per hour, in an atmosphere having a dry-bulb temperature of 70 F. Estimate the sensible and latent heat given off per hour.

Since the net mechanical efficiency of the human body is about 20 per cent, the increase in metabolism due to work, over the resting metabolism, will be $\frac{50{,}000}{778[1] \times 0.20} = 320$ Btu per hour. Assuming a resting metabolism of 400 Btu per hour (see Fig. 6), the total metabolism during work will be 400 + 320 = 720 Btu per hour, and the total heat loss $720 - \frac{50{,}000}{778} = 656$ Btu per hour, approximately. In Fig. 9, follow a vertical line from a dry-bulb temperature of 70 F to a point midway between Curves *A* and *B*. The sensible heat loss is about 46 per cent of the total loss, or 0.46 × 656 = 302 Btu per hour, and the latent heat is 54 per cent of the total or 0.54 × 656 = 354 Btu per hour.

12 ● The characteristics of air supplied to ventilate a room are:

Carbon dioxide concentration	4 parts per 10,000
Wet-bulb temperature	45.2 F
Dry-bulb temperature	55.0 F
Moisture content	29.0 grains per pound of dry air

a. What will be the dry-bulb temperature of the air in the room if it is occupied by five adults, if the air change, including both ventilation and infiltration, is 50 cu ft per minute, and assuming that there is no heat gain or loss to the room from any source other than from the occupants?

b. What will be the carbon dioxide concentration of the air in the room under these conditions?

c. What will be the moisture content of the air in the room under these conditions?

d. What will be the wet-bulb temperature and the relative humidity of the air in the room under these conditions?

e. What would the temperature of the incoming air have to be to give a room a dry-bulb temperature of 70 F?

a. The air change is 10 cu ft per minute per occupant. From the bottom chart of Fig. 4 at the intersection of an incoming air dry-bulb temperature of 55.0 F and a rate of air supply of 10 cu ft per minute per occupant, find by interpolation between the 70 F and 80 F adult curves the dry-bulb temperature of the air in the room to be 78.0 F.

b. From the top chart of Fig. 4 find the increase in CO_2 concentration to be 10 parts of CO_2 per 10,000 parts of air. Therefore, the air in the occupied room will contain 14 parts of CO_2 per 10,000.

c. From the center chart in Fig. 4 find by interpolation between the 70 F and 80 F adult curves the increase in moisture content to be 23 grains per pound of dry air for adults in 78 F air. This gives a resultant moisture content of the air in the room of 52 grains per pound of dry air.

d. From the psychrometric chart, Fig. 3, find the resulting wet-bulb temperature and relative humidity for 78 F dry-bulb and 52 grains of moisture to be 61.0 F and 37 per cent, respectively.

e. From the bottom chart, Fig. 4, find the required incoming air temperature to be 42 F dry-bulb.

13 ● Name three factors that influence the feeling of warmth and the elimination of body heat.

Temperature, humidity, and air movement.

14 ● What is meant by effective temperature?

Effective temperature is a composite index which combines the measurements of temperature, air motion, and humidity into a single value. It is an arbitrary index of the degree of warmth or cold felt by the human body due to these factors.

15 ● Referring to the A.S.H.V.E. Comfort Chart (Fig. 3), list the conditions (dry-bulb, wet-bulb, effective temperature, and humidity) which will produce comfort at each corner of the average winter comfort zone and of the average summer comfort zone.

[1]Heat equivalent of mechanical work in foot-pounds per Btu.