Chapter-18

1. Why is the following situation impossible? A thin brass ring has an inner diameter 10.00 cm at 20.0oC. A solid aluminum cylinder has diameter 10.02 cm at 20.0oC. Assume the average coefficients of linear expansion of the two metals are constant. Both metals are cooled together to a temperature at which the ring can be slipped over the end of the cylinder.

Ans:

We solve for the temperature *T* at which the brass ring would fit over the aluminum cylinder.

 

 

The situation is impossible because the 

1. Review. The Golden Gate Bridge in San Francisco has a main span of length 1.28 km, one of the longest in the world. Imagine that a steel wire with this length and a crosssectional area of 4.00 X 10-6 m2 is laid in a straight line on the bridge deck with its ends attached to the towers of the bridge. On a summer day the temperature of the wire is 35.0oC. (a) When winter arrives, the towers stay the same distance apart and the bridge deck keeps the same shape as its expansion joints open. When the temperature drops to 210.0oC, what is the tension in the wire? Take Young’s modulus for steel to be 20.0 X 1010 N/m2. (b) Permanent deformation occurs if the stress in the steel exceeds its elastic limit of 3.00 X 108 N/m2. At what temperature would the wire reach its elastic limit? (c) What If? Explain how your answers to parts (a) and (b) would change if the Golden Gate Bridge were twice as long

Ans:

We model the wire as contracting according to  and then stretching according to

 

 (a) We find the tension from

 

 (b) 

 To increase the stress the temperature must decrease to .

 (c) 

1. **Review.** The mass of a hot-air balloon and its cargo (not including the air inside) is 200 kg. The air outside is at 10.0oC and 101 kPa. The volume of the balloon is 400 m3. To what temperature must the air in the balloon be warmed before the balloon will lift off? (Air density at 10.0oC is 1.244 kg/m3.)

Ans:

The density of the air inside the balloon,  must be reduced until the buoyant force of the outside air is at least equal to the weight of the balloon plus the weight of the air inside it:

 

 

where  *V* = 400 m3, and *mb* = 200 kg.

From *PV* = *nRT*, . This equation means that at constant pressure the density is inversely proportional to the temperature. Thus, the density of the hot air inside the balloon is

 

 Substituting this result into the condition  gives

 