Answer on Question #62475-Physics-Molecular Physics-Thermodynamics

A mercury barometer is defective. it contains some air in the space above the mercury. when an accurate barometer reads 770mm, the defective one reads 760mm. when the accurate barometer reads 750mm, the defective one reads 742mm.

(a) What is the length of the air column, when the accurate barometer reads 770mm?

(b) What is the reading of the accurate barometer when the defective one reads 752mm?

Assume that the temperature remains constant.

Solution

Let the area of cross-section of the barometer tube be A and x cm the length of air column above 760 mm mark.

(a) The pressure of air in space above mercury, P_1 is reading of accurate barometer - reading of defective barometer:

$$P_1 = 770 - 760 = 10\ mm$$

The volume of air is $V_1 = xA$.

Similarly, $P_2 = 750 - 742 = 8\ mm$

The volume of air is

$$V_2 = (x + 76.0 - 74.2)A = (x + 1.8)A.$$

According to the Boyle's law

$$P_1V_1 = P_2V_2$$

$$(10)(xA) = (8)\big((x + 1.8)A\big)$$

$$x = 7.2\ cm.$$

(b) Suppose the reading of accurate barometer be P_0, then the pressure of air is $P = P_0 - 752$.

The volume of air is

$$V = (x + 76.0 - 75.2)A = (x + 0.8)A.$$

According to the Boyle's law

$$P_1V_1 = P_2V_2$$

$$(10)(xA) = (P_0 - 752)\big((x + 0.8)A\big)$$

$$x = 7.2\ cm.$$

$$(10)(7.2A) = (P_0 - 752)\big((7.2 + 0.8)A\big)$$

$$P_0 = 761\ mm.$$