

المملكة العربية السعودية

وزارة التعليم

MINISTRY OF EDUCATION



لكل المهتمين و المهتمات
بدروس و مراجع الجامعية

هام

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PROBLEMS (Temperature and Expansion)

P# 1 Body temperature is normal at 98.6°F. What is the corresponding temperature on the Celsius scale? (Ans. 37.0°C)

$$T_c = \frac{5}{9}(T_f - 32) = \frac{5}{9}(98.6 - 32) = 37^\circ\text{C}$$

P# 2 The boiling point of oxygen is -297.35°F. Express this temperature in Kelvin and degrees Celsius. (Ans. 90.0 k, -183°C)

$$T_c = \frac{5}{9}(-297.35 - 32) = -183^\circ\text{C} + 273 = 90\text{ K}$$

P# 3 A wall of firebrick has an inside temperature of 313°F and outside temperature of 73°F. Express the difference in surface temperature in Celsius degrees and in Kelvin. (Ans. 133 k)

$$T_c = \frac{5}{9}(313 - 73) = 156^\circ\text{C} + 273 = 429\text{ K} \quad 429 - 296 = 133\text{ K}$$

$$T_c = \frac{5}{9}(73 - 32) = 23^\circ\text{C} + 273 = 296\text{ K}$$

P# 4 A piece of copper tubing is 6 m long at 20°C. How much will it increase in length when heated to 80°C? [copper: $\alpha = 1.7 \times 10^{-5} / \text{C}^\circ$] (Ans. 6.12 mm)

$$\Delta L = \alpha L_0 \Delta T = (1.7 \times 10^{-5}) \times 6\text{ m} \times (80 - 20) = 6.12 \times 10^{-3}\text{ m} \Rightarrow 6.12\text{ mm}$$

P# 5 The diameter of a hole in a steel plate is 9 cm when the temperature is 20°C. What will be the diameter of the hole at 200°C? [steel: $\alpha = 1.2 \times 10^{-5} / \text{C}^\circ$] (Ans. 9.02 cm)

$$A = A_0(1 + \alpha \Delta T) = (4.5^2 \pi) (1 + (2 \times 1.2 \times 10^{-5})) (200 - 20) = 63.9\text{ cm}^2 = r^2 \pi \rightarrow r = \sqrt{\frac{63.9}{\pi}} = 4.51 \times 2 = 9.02\text{ cm}$$

P# 6 What is the increase in volume of 16 liters of ethyl alcohol when [it is heated from 20 to 50°C] temperature is increased by 30°C? [ethyl alcohol: $\beta = 11 \times 10^{-4} / \text{C}^\circ$] (Ans. 0.528L)

$$\Delta V = \beta V_0 \Delta T = (11 \times 10^{-4}) \times 16 \times 30 = 0.528\text{ L}$$

P# 7 If 200 cm³ of benzene exactly fills an aluminum cup at 40°C and the system cools to 18°C, how much benzene (at 18°C,) can be added to the cup without overflowing? [Benzene: $\beta = 12.4 \times 10^{-4} / \text{C}^\circ$, Aluminum: $\alpha = 2.4 \times 10^{-5} / \text{C}^\circ$] (Ans. 5.14 cm³)

$$\Delta V_{\text{Aluminum}} = V_0 \alpha \Delta T = 200 \times 22 \times 2.4 \times 10^{-5} = 0.3168\text{ cm}^3$$

$$\Delta V_{\text{Benzene}} = V_0 \beta \Delta T = 200 \times 22 \times 12.4 \times 10^{-4} = 5.456\text{ cm}^3$$

$$\Delta V = 5.456 - 0.3168 = 5.1392\text{ cm}^3$$

P# 8 A round brass plug has a diameter of 8.001 cm at has an inside temperature of 28°C. To what temperature must the plug be cooled if it is to fit snugly into an 8.000 cm hole? [Brass: $\alpha = 1.8 \times 10^{-5} / \text{C}^\circ$] (Ans. 21.1°C)

$$\Delta A = \gamma A_0 \Delta T \Rightarrow 0.0125 = (3.6 \times 10^{-9})(50.278)(28 - T)$$

$$0.0125 = 1.81 \times 10^{-3}(28 - T)$$

$$\frac{0.0125 \times 10^3}{1.81} = 28 - T$$

$$T = 28 - \left(\frac{0.0125 \times 10^3}{1.81}\right) = 21.1^\circ\text{C}$$

$$A_0 = 4.0005^2 \pi = 50.278\text{ cm}^2$$

$$A = 4^2 \pi = 50.265\text{ cm}^2$$

$$\Delta A = 0.0125\text{ cm}^2$$