

HW 11 Help

25. ORGANIZE AND PLAN We convert °F to °C using:

$$T(^{\circ}\text{C}) = \frac{5}{9}(T(^{\circ}\text{F}) - 32^{\circ})$$

SOLVE $T(^{\circ}\text{C}) = \frac{5}{9}(5^{\circ}\text{F} - 32^{\circ}) = -15^{\circ}\text{C}$

REFLECT 32°F corresponds to 0°C, the temperature at which water freezes.

33. ORGANIZE AND PLAN We use the equation to convert from °C to °F:

$$T(^{\circ}\text{F}) = \frac{9}{5}T(^{\circ}\text{C}) + 32$$

SOLVE

$$T(^{\circ}\text{F}) = \frac{9}{5}(38.2^{\circ}\text{C}) + 32 = 100.76^{\circ}\text{F}$$

REFLECT Fever (also known as pyrexia, from the Greek *pyretos* meaning fire, or a febrile response, from the [Latin](#) word *febris*, meaning fever, and archaically known as ague) is a frequent [medical sign](#) that describes an increase in internal [body temperature](#) to levels above normal. Fever is most accurately characterized as a temporary elevation in the body's thermoregulatory set-point, usually by about 1–2°C (1.8–3.6°F). Fever is caused by an elevation in the thermoregulatory set-point, causing typical body temperature (generally and problematically considered to be 37°C or 98.6°F; see below for specifics) to rise, and effector mechanisms are enacted as a result. A feverish individual has a general feeling of [cold](#) despite an increased body temperature, and increases in [heart rate](#), [muscle tone](#), and [shivering](#), all of which are caused by the body's attempts to counteract the newly perceived [hypothermia](#) and reach the new thermoregulatory set-point. Fever differs from [hyperthermia](#) in that hyperthermia is an increase in body temperature over the body's thermoregulatory set-point, due to excessive heat production or insufficient [thermoregulation](#), or both. A fever is considered one of the body's [immune](#) mechanisms to attempt a neutralization of a perceived threat inside the body, be it bacterial or viral. [Carl Wunderlich](#) discovered that fever is not a disease, but the body's response to a disease.

37. ORGANIZE AND PLAN We use the equation for linear expansion, $\frac{\Delta L}{L} = \alpha \Delta T$, **solved** for ΔL , and with the expansion coefficient of steel, α , from Table 12.1, to calculate the change in length due to the different temperature. The temperature difference ΔT can be positive or negative. Then we add the change in length to the original length.

SOLVE

(a)

$$\Delta L = \alpha \Delta TL = (1.2 \times 10^{-5} \text{ } ^\circ\text{C}^{-1}) \times (12 \text{ } ^\circ\text{C}) \times (50 \text{ m}) = 0.0072 \text{ m}$$

$$L(32 \text{ } ^\circ\text{C}) = 0.0072 \text{ m} + 50 \text{ m} = 50.0072 \text{ m}$$

(b)

$$\Delta L = \alpha \Delta TL = (1.2 \times 10^{-5} \text{ } ^\circ\text{C}^{-1}) \times (-30 \text{ } ^\circ\text{C}) \times (50 \text{ m}) = -0.018 \text{ m}$$

$$L(-10 \text{ } ^\circ\text{C}) = -0.018 \text{ m} + 50 \text{ m} = 49.982 \text{ m}$$

REFLECT Using the tape at temperatures significantly different from 20°C can result in relevant measuring errors.

40. ORGANIZE AND PLAN We use the equation for volume thermal expansion, $\frac{\Delta V}{V} = \beta \Delta T$, and **solve** for the change in volume.

SOLVE $\Delta V = \beta \Delta TV = (9.5 \times 10^{-4} \text{ } ^\circ\text{C}^{-1}) \times (39 \text{ } ^\circ\text{C} - 12 \text{ } ^\circ\text{C}) \times (378.5 \text{ L}) = 9.7 \text{ L}$

REFLECT The gasoline expanded by about 2.5%, making the expansion tank absolutely necessary.

47. ORGANIZE AND PLAN We use the equation for a two dimensional expansion, $\frac{\Delta A}{A} = 2\alpha \Delta T$, and assume room temperature as 25°C. Since the temperature is increased, the area of the hole will increase.

SOLVE The difference in surface is

$$\frac{\Delta A}{A} = 2\alpha \Delta T$$

$$\Delta A = 2\alpha \Delta TA$$

$$\Delta A = 2\alpha \Delta T A = (0.250 \text{ m}^2) \times 2 \times (1.7 \times 10^{-5} \text{ } ^\circ\text{C}^{-1}) (400 \text{ } ^\circ\text{C} - 25 \text{ } ^\circ\text{C}) = 3.19 \times 10^{-3} \text{ m}^2$$

The new hole size is then:

$$A(\text{hole}) = 2\alpha \Delta TA = 0.250 \text{ m}^2 + 3.19 \times 10^{-3} \text{ m}^2 = 0.253 \text{ m}^2$$

REFLECT The hole increased by a little over 1% in area.

50. ORGANIZE AND PLAN We use Boyle's law, which states that the product of P and V is constant for a constant temperature and amount of gas. Furthermore, we replace the volume as: $V = \frac{4}{3}\pi r^3$

SOLVE

$$P_{\text{before}} V_{\text{before}} = P_{\text{after}} V_{\text{after}}$$

$$P_{\text{before}} \frac{4}{3}\pi r_{\text{before}}^3 = P_{\text{after}} \frac{4}{3}\pi r_{\text{after}}^3$$

$$P_{\text{before}} r_{\text{before}}^3 = P_{\text{after}} r_{\text{after}}^3$$

$$r_{\text{after}} = r_{\text{before}} \sqrt[3]{\frac{P_{\text{before}}}{P_{\text{after}}}} = (0.12 \text{ m}) \times \sqrt[3]{\frac{(1.00 \text{ atm})}{(0.85 \text{ atm})}} = 0.127 \text{ m}$$

REFLECT The change in radius of the balloon is small.

54. ORGANIZE AND PLAN We use the ideal gas law at two different conditions and realize that the amount of gas and the volume at both conditions is the same.

SOLVE For the two different conditions we obtain:

$$n_1 = n_2$$

$$\frac{RT_1}{P_1V} = \frac{RT_2}{P_2V}$$

$$\frac{T_1}{P_1} = \frac{T_2}{P_2}$$

$$T_2 = \frac{P_2T_1}{P_1} = \frac{(1.65 \text{ atm}) \times (298.15 \text{ K})}{(1.00 \text{ atm})} = 491.9 \text{ K}$$

REFLECT When the [University of Heidelberg](#) hired [Robert Bunsen](#) in 1852, the authorities promised to build him a new laboratory building. Heidelberg had just begun to install [coal-gas](#) street lighting, so the new laboratory building was also supplied with illuminating gas. Illumination was one thing; a source of heat for chemical operations something quite different. Previous laboratory lamps left much to be desired regarding economy and simplicity, as well as the quality of the flame; for a burner lamp, it was desirable to maximize the temperature and minimize the luminosity. While his building was still under construction late in 1854, Bunsen suggested certain design principles to the university's talented mechanic, Peter Desaga, and asked him to construct a prototype. The Bunsen/Desaga design succeeded in generating a hot, sootless, non-luminous flame by mixing the gas with air in a controlled fashion before combustion. Desaga created slits for air at the bottom of the cylindrical burner, the flame igniting at the top. By the time the building opened early in 1855, Desaga had made fifty of the burners for Bunsen's students. Bunsen published a description two years later, and many of his colleagues soon adopted the design.

60. ORGANIZE AND PLAN (a) We use the ideal gas law. We need to convert all units to SI units and also calculate the volume of the cylinder using $V = Ah = \pi r^2 h$, where A and h are the area and height of the cylinder, respectively. In part (b) we solve the ideal gas law for the volume and use the result from part (a), since the number of gas molecules is the same.

SOLVE

(a)

$$n(\text{air}) = \frac{PV}{RT} = \frac{(180 \text{ atm}) \times \left(\frac{101325 \text{ Pa}}{1 \text{ atm}}\right) \times \pi \times (0.1 \text{ m}^2) \times (1.0 \text{ m})}{(8.314 \text{ J K}^{-1} \text{ mol}^{-1}) \times (298.15 \text{ K})} = 231.2 \text{ mol}$$

(b)

$$V(\text{air}) = \frac{nRT}{P} = \frac{(231.2 \text{ mol}) \times (8.314 \text{ J K}^{-1} \text{ mol}^{-1}) \times (298.15 \text{ K})}{(1 \text{ atm}) \times \left(\frac{101325 \text{ Pa}}{1 \text{ atm}}\right)} = 5.66 \text{ m}^3$$

REFLECT The size of the cylinder is 0.03 m^3 , which means that the volume that the air would take up at 1 atm increases by a factor of about 185!

65. ORGANIZE AND PLAN (a) We use the equation for the rms speed as $v_{\text{rms}} = \sqrt{\frac{3 k_B T}{m}}$, where we find the mass of one H_2 molecule by dividing by Avogadro's number, N_A . For part (b), we repeat the calculation for the higher temperature.

SOLVE

(a)

$$v_{\text{rms}} = \sqrt{\frac{3 k_B T}{(M/N_A)}} = \sqrt{\frac{3 (1.38 \times 10^{-23} \text{ J K}^{-1}) \times (273.15 \text{ K})}{(2.02 \times 10^{-3} \text{ kg mol}^{-1}) / (6.022 \times 10^{23} \text{ mol}^{-1})}} = 1836.1 \text{ m/s}^{-1}$$

(b)

$$v_{\text{rms}} = \sqrt{\frac{3 k_B T}{(M/N_A)}} = \sqrt{\frac{3 (1.38 \times 10^{-23} \text{ J K}^{-1}) \times (546.0 \text{ K})}{(2.02 \times 10^{-3} \text{ kg mol}^{-1}) / (6.022 \times 10^{23} \text{ mol}^{-1})}} = 2595.9 \text{ m/s}^{-1}$$

REFLECT The rms speed increases with the square root of the increase in temperature.

70. ORGANIZE AND PLAN We use the equation for the rms speed and solve for temperature.

SOLVE $v_{\text{rms}} = \sqrt{\frac{3k_{\text{B}}T}{(M/N_{\text{A}})}}$

$$T = \frac{(M/N_{\text{A}}) v_{\text{rms}}^2}{3k_{\text{B}}} = \frac{(44 \times 10^{-3} \text{ kg mol}^{-1} / 6.022 \times 10^{23} \text{ mol}^{-1}) \times (652 \text{ m s}^{-1})^2}{3 \times (1.38 \times 10^{-23} \text{ J K}^{-1})} = 750.3 \text{ K}$$

REFLECT Venus is the second-closest [planet](#) to the [Sun](#), orbiting it every 224.7 Earth days. The planet is named after [Venus](#), the [Roman goddess](#) of love. After the [Moon](#), it is the brightest natural object in the night sky, reaching an [apparent magnitude](#) of -4.6 . Because Venus is an [inferior planet](#) from [Earth](#), it never appears to venture far from the Sun: its [elongation](#) reaches a maximum of 47.8° . Venus reaches its maximum brightness shortly before sunrise or shortly after sunset, for which reason it is often called the *Morning Star* or the *Evening Star*. Classified as a [terrestrial planet](#), it is sometimes called Earth's "sister planet" because they are similar in size, gravity, and bulk composition. Venus is covered with an opaque layer of highly reflective [clouds](#) of [sulfuric acid](#), preventing its surface from being seen from space in [visible light](#). Venus has the densest [atmosphere](#) of all the terrestrial planets, consisting mostly of [carbon dioxide](#), as it has no [carbon cycle](#) to lock carbon back into rocks and surface features, nor organic life to absorb it in biomass. A younger Venus is believed to have possessed Earth-like oceans, but these totally evaporated as the temperature rose, leaving a dusty, dry desertscape with many slablike rocks. The water has most likely dissociated, and, because of the lack of a planetary magnetic field, the hydrogen has been swept into interplanetary space by the [solar wind](#). The [atmospheric pressure](#) at the planet's surface is 92 times that of the Earth. Venus' surface was a subject of speculation until some of its secrets were revealed by [planetary science](#) in the twentieth century. It was finally mapped in detail by Project [Magellan](#) in 1990–91. The ground shows evidence of extensive [volcanism](#), and the [sulfur](#) in the atmosphere may indicate that there have been some recent eruptions. However, it is an enigma why no evidence of [lava](#) flow accompanies any of the visible [caldera](#). There are a low number of [impact craters](#), demonstrating that the surface is relatively young, approximately half a billion years old. There is no evidence for [plate tectonics](#), possibly because its crust is too strong to [subduct](#) without water to make it less [viscous](#). Instead, Venus may lose its internal heat in periodic massive resurfacing