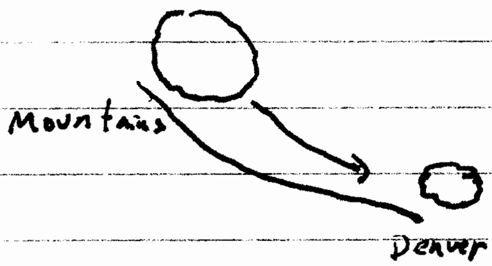
19.49 ••• Chinook. During certain seasons strong winds called chinooks blow from the west across the eastern slopes of the Rockies and downhill into Denver and nearby areas. Although the mountains are cool, the wind in Denver is very hot; within a few minutes after the chinook wind arrives, the temperature can climb 20 C° ("chinook" refers to a Native American people of the Pacific Northwest). Similar winds occur in the Alps (called foehns) and in southern California (called Santa Anas). (a) Explain why the temperature of the chinook wind rises as it descends the slopes. Why is it important that the wind be fast moving? (b) Suppose a strong wind is blowing toward Denver (elevation 1630 m) from Grays Peak (80 km west of Denver, at an elevation of 4350 m), where the air pressure is 5.60×10^4 Pa and the air temperature is -15.0°C. The temperature and pressure in Denver before the wind arrives are 2.0°C and 8.12×10^4 Pa. By how many Celsius degrees will the temperature in Denver rise when the chinook arrives?

Young-Freedman 19.49 Chinook



assume the same quantity of air, n moles, is compressed adiabatically. (If the wind moves quickly, there is not time for Q to leave.)

$p_i = 5.60 \times 10^4 \, Pa$

$T_i = -15°C + 273.15 = 258.15\,K$ (round off later)

$p_f = 8.12 \times 10^4 \, Pa$

$T_f = ?$

$\gamma = 1.40$ (assume mostly N_2).

$$p_i V_i^\gamma = p_f V_f^\gamma$$

What is V? Use $V = nRT/p$

$$p_i \left(\frac{nRT_i}{p_i}\right)^\gamma = p_f \left(\frac{nRT_f}{p_f}\right)^\gamma$$

$p_i^{1-\gamma} T_i^\gamma = p_f^{1-\gamma} T_f^\gamma$, or taking ratios,

$$\left(\frac{T_f}{T_i}\right)^\gamma = \left(\frac{p_i}{p_f}\right)^{1-\gamma}$$

$$T_f = T_i \left(\frac{p_i}{p_f}\right)^{\frac{1-\gamma}{\gamma}} = 258.15\,K \left(\frac{5.6}{8.12}\right)^{\frac{-0.4}{1.4}}$$

$$T_f = 287.06\,K = \boxed{13.9°C.}$$

Since the previous temperature (given) was $+2.0°C$,

$$\boxed{\Delta T = 11.9°C}$$