Owen [illegible]

Phys283

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Further [illegible]

T7R.2, T8M.6

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~~T7~~R2

For the LA basin, if the wind blows from the east during the summer, one gets "Santa Ana" winds, which are hot and dry. This is due to air blowing from the high desert to the east of LA is adiabatically compressed as it descends into the basin. Suppose that it is a summer day @ 90°F in the Mojave desert @ 4000 ft, but a stiff wind is blowing from the east. What is the air temp as it reaches LA (@ 200 ft)

Let's model the atmosphere such that $P(z) = P_0 \cdot e^{-z/z_0}$, where $z_0 = 8500\,m$

The ideal gas law states that $P \cdot V = N \cdot k_B \cdot T \Rightarrow V = \frac{N \cdot k_B T}{P} \Rightarrow V(z) = \frac{N \cdot k_B \cdot T(z)}{P_0 \cdot e^{-z/z_0}}$.

For adiabatic processes, $P_i \cdot V_i^{\gamma} = P_f \cdot V_f^{\gamma}$, $T_i \cdot V_i^{\gamma-1} = T_f \cdot V_f^{\gamma-1}$, where γ = adiabatic index (1.4 for air)

$P(z_i) \cdot V(z_i)^{\gamma} = P(z_f) V(z_f)^{\gamma} \Rightarrow \cancel{P_0} \cdot e^{-z_i/z_0} \cdot \left(\frac{\cancel{N k_B} T_i}{\cancel{P_0} e^{-z_i/z_0}}\right)^{\gamma} = \cancel{P_0} e^{-z_f/z_0} \left(\frac{\cancel{N k_B} T_f}{\cancel{P_0} e^{-z_f/z_0}}\right)^{\gamma}$

$\Rightarrow e^{-z_i/z_0} \cdot T_i^{\gamma} \cdot e^{z_i \gamma/z_0} = e^{-z_f/z_0} \cdot T_f^{\gamma} \cdot e^{z_f \gamma/z_0}$

$\Rightarrow T_i^{\gamma} \cdot e^{(\gamma-1) z_i/z_0} = T_f^{\gamma} \cdot e^{(\gamma-1) z_f/z_0} \Rightarrow T_f = T_i \cdot \left(e^{(\gamma-1)(z_i - z_f)/z_0}\right)^{1/\gamma}$

$z_i = 4000\,ft \cdot \frac{1\,m}{3.28\,ft} = 1220\,m$ $\qquad T_i = \left(\frac{5K}{9°F}\right)(90°F + 459.67°F) = 305.4\,K$

$z_f = 200\,ft \cdot \frac{1\,m}{3.28\,ft} = 61\,m$

So $T_f = 305.4\,K \cdot \left(e^{(1.4-1)\cdot(1220-61\,m)/8500\,m}\right)^{1/1.4} = 305.4\,K \cdot \left(e^{0.4 \cdot 0.136}\right)^{1/1.4} = 305.4\,K \cdot 1.0397$

$T_f = \boxed{317.5\,K}$

It makes sense that T would increase because in an adiabatic compression, $\Delta U > 0$ and since $U \propto T$, $\Delta T > 0$.

We can apply Eq T7.16a, b because a large body of air flowing from the Mojave desert to the LA basin is a gradual and slow process so the ~~[illegible]~~ conditions are met.

This answer has the right units and is of a reasonable magnitude

T8M.6

Suppose we put a block of copper w/ a mass of 320 g and $T_i = -35°C$ into an insulated cup containing 420 g of water at 22°C

(a) When thermal equilibrium is reached, what is the change in the water's and the copper's entropy?

Let's assume the specific heats of the copper and water are consistent over the temperature range, and that their volumes do not significantly change, so we can use eq. T8.29

$c_w = 4186 \frac{J}{kg \cdot K}$ $\quad T_{iw} = \frac{1K}{1°C} \cdot (22°C + 273.15°C) = 295.15 K$

$\Delta S = m c \cdot \ln\left(\frac{T_f}{T_i}\right)$ $\quad c_{cu} = 387 \frac{J}{kg \cdot K}$ $\quad T_{icu} = \frac{1K}{1°C} \cdot (-35°C + 273.15°C) = 238.15 K$

So we need to find T_f:

No work is being done, so $\Delta U = Q$

For the block, $\Delta U = +Q$, for the water, $\Delta U = +Q$

From Eq. T1.4, we can say that $\Delta U = m \cdot c \cdot \Delta T$

$\Rightarrow -m_w c_w \cdot (T_f - T_{iw}) = m_{cu} \cdot c_{cu} \cdot (T_f - T_{icu})$

$\Rightarrow -T_f (m_w \cdot c_w) + T_{iw} m_w c_w = T_f (m_{cu} c_{cu}) - T_{icu} m_{cu} c_{cu}$

$\Rightarrow T_f = \frac{T_{iw} \cdot m_w \cdot c_w + T_{icu} \cdot m_{cu} \cdot c_{cu}}{m_{cu} c_{cu} + m_w \cdot c_w} = \frac{295.15 K \cdot 0.42 kg \cdot 4186 \frac{J}{kg \cdot K} + 238.15 K \cdot 0.32 kg \cdot 387 \frac{J}{kg \cdot K}}{0.42 kg \cdot 4186 \frac{J}{kg \cdot K} + 0.32 kg \cdot 387 \frac{J}{kg \cdot K}}$

$T_f = 291.40 K$

So $\Delta S_w = 0.42 kg \cdot 4186 \frac{J}{kg \cdot K} \cdot \ln\left(\frac{291.40 K}{295.15 K}\right) = -22.5 J/K$

$\Delta S_{cu} = 0.32 kg \cdot 387 \frac{J}{kg \cdot K} \cdot \ln\left(\frac{291.40 K}{238.15 K}\right) = 25 J/K$

b) Explain why the coating of ice that initially forms around the copper is irrelevant.

This is irrelevant because thermal energy is flowing to the copper from the water, and since the copper is NOT a thermal reservoir (nor the water), the presence of ice on the copper has a negligible effect on the process

T-Vals: T7R.2, Class Plus T8M.6: Iffy, made some assumptions that I am not certain about, would like explanation