*. (12 points) Answer the following.

a. (4 points) Based on the conversions between Celsius and Fahrenheit and between Celsius and Kelvin, determine absolute zero on the Fahrenheit scale.

$$\left.\begin{aligned} T^{(K)} &= T^{(C)} + 273 \\ T^{(F)} &= \tfrac{9}{5} T^{(C)} + 32 \end{aligned}\right] \Rightarrow 0\,K = -273^\circ C = \boxed{-459.4^\circ F}$$

b. (4 points) The Rankine temperature scale is related to Fahrenheit in the same way that Kelvin is related to Celsius (i.e., 0 R corresponds to absolute zero and 1 R = 1 F° as a temperature difference). Determine the boiling point of water on the Rankine scale.

$$0\,R = 0\,K = -459.4^\circ F \Rightarrow T^{(R)} = T^{(F)} + 459.4$$

$$\text{boiling pt} = 212^\circ F = \boxed{671.4\,R}$$

c. (4 points) Determine kT for room temperature, where k is Boltzmann's constant (you will need to look up the value). Express the answer in electron-volts.

Room temperature $\approx 300\,K$ (actually $293\,K = 20^\circ C$)

$k = 1.381 \times 10^{-23}\ J/K$ $\qquad 1\,eV = 1.602 \times 10^{-19}\ J$

$$kT = (1.381 \times 10^{-23}\ J/K)(293\,K) = 4.046 \times 10^{-21}\ J$$
$$= 0.02526\ eV$$

or $\quad (1.381 \times 10^{-23}\ J/K)(300\,K) = 4.143 \times 10^{-21}\ J$
$$= 0.02586\ eV$$

Usual rule of thumb, $kT \sim \frac{1}{40}\ eV$ at room temperature