

Name: \_\_\_\_\_

Social Security #: \_\_\_\_\_

39 PTS

TA (circle one): Freier Jan Keller Laicher Razaghi Stigers

A 75.0 kg patient is running a fever of  $106^\circ\text{F}$  and is given an alcohol rubdown to lower his body temperature. Take the specific heat of the human body to be  $C_{\text{body}} = 3.48 \times 10^3 \text{ J/kg}^\circ\text{C}$ , the heat of evaporation of the rubbing alcohol to be  $L_v(\text{alcohol}) = 8.51 \times 10^4 \text{ J/kg}$ , and the density of the rubbing alcohol to be  $793 \text{ kg/m}^3$ . You may assume that all the heat removed from the febrile body goes into evaporating the alcohol, and that while the patient's body is cooling, his metabolism adds no measurable heat.

14 PTS  
(a) What quantity of heat must be removed from the body to lower its temperature to  $99.0^\circ\text{F}$ ?

$$m = 75.0 \text{ kg}$$

$$C = 3.48 \times 10^3 \text{ J/kg}^\circ\text{C}$$

$$\Delta T = -7^\circ\text{F} = -\left(\frac{5}{9}\right)(7)^\circ\text{C}$$

$$Q_{\text{REMOVED}} = m C \Delta T$$

$$= -(75 \text{ kg})(3.48 \times 10^3 \text{ J/kg}^\circ\text{C})\left(\frac{5}{9}\right)(7)^\circ\text{C}$$

$$Q_{\text{REMOVED}} = -1.02 \times 10^6 \text{ J}$$

14 PTS  
(b) What volume of rubbing alcohol is required?

$$Q_{\text{REMOVED}} = m L_v = 1.02 \times 10^6 \text{ J}$$

$$m = \frac{1.02 \times 10^6 \text{ J}}{8.51 \times 10^4 \text{ J/kg}} = 1.19 \text{ kg}$$

$$6 \text{ PTS} \quad V = \frac{m}{\rho} = \frac{1.19 \text{ kg}}{793 \text{ kg/m}^3} = 1.5 \times 10^{-3} \text{ m}^3 = 1.50 \text{ L}$$

(c) This is a qualitative question. Give an answer and explanation. Suppose you were told that the alcohol applied started at room temperature ( $\approx 70^\circ\text{F}$ ) and were given the specific heat for the alcohol. Thus, you now expect some of the body heat warming the alcohol to the temperature of the fever before evaporation occurs. How would this effect the result of the calculation in part (b)?

SINCE SOME OF  $Q_{\text{REMOVED}}$  FIRST WARMS THE RUBBING ALCOHOL, THEN LESS OF THE ALCOHOL NEEDS TO EVAPORATE TO REMOVE THE SAME TOTAL HEAT FROM THE BODY. SO

$$V_{\text{NEED}} < 1.50 \text{ L}$$