

Name: _____ 34 PTS

Social Security #: _____

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A 56.0 kg hypothermia victim is running a body temperature of 91.0°F. The victim is far away from any immediate medical treatment. Her friends decide to treat the hypothermia victim by placing the victim in a sleeping bag with one of her friends and use the heat from the friend to raise the victim's body temperature. Take the specific heat of the human body to be $C_{\text{body}} = 3.48 \times 10^3 \text{ J/kg}^\circ\text{C}$. Assume that the sleeping bag acts like a perfect calorimeter and also assume no heat is lost to or obtained from the sleeping bag. Finally, assume all the heat that warms the hypothermia victim comes from the basic metabolic heat produced by the body of the victim's friend in the sleeping bag with her and that metabolism is rated at $2.00 \times 10^6 \text{ cal/day}$, and that the victim's metabolism is negligible.

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(a) How much heat must be added to the victim's body to get her temperature up to 98.0°F?

$m = 56.0 \text{ kg}$
 $C = 3.48 \times 10^3 \text{ J/kg}^\circ\text{C}$
 $\Delta T = 7^\circ\text{F} = \frac{5}{9} (7)^\circ\text{C}$

$Q_{\text{ADDED}} = mC\Delta T = (56.0 \text{ kg})(3.48 \times 10^3 \text{ J/kg}^\circ\text{C})(\frac{5}{9})(7)^\circ\text{C}$
 $= 7.58 \times 10^5 \text{ J}$

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(b) How long must the victim remain in the sleeping bag with her friend to achieve this temperature change?

HEAT FROM FRIEND
 $2.00 \times 10^6 \text{ cal/day} \cdot \frac{4.19 \text{ J}}{\text{cal}} \cdot \frac{1 \text{ day}}{24 \text{ hr}}$
 $= 3.49 \times 10^5 \text{ J/hr} = \frac{\Delta Q}{\Delta t}$

HEAT GAINED FROM FRIEND = $(\frac{\Delta Q}{\Delta t}) \Delta t$
 $= \text{HEAT ADDED TO VICTIM}$
 $(3.49 \times 10^5 \text{ J/hr}) \Delta t = 7.58 \times 10^5 \text{ J}$
 $\Delta t = \frac{7.58 \times 10^5 \text{ J}}{3.49 \times 10^5 \text{ J/hr}} = 2.17 \text{ hr}$

OR 2 HOURS, 10 MIN (AND 15 S)

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(c) This is a qualitative question. If the thermal characteristics of the sleeping bag are now taken into account, but still assuming no heat leaves or enters the sleeping bag, how will the answer to question (b) above be different?

SINCE SOME OF THE HEAT DERIVED FROM METABOLIC PROCESSES FROM THE FRIEND GOES TO HEATING THE SLEEPING BAG ITSELF THEN THE FRIEND MUST REMAIN IN THE BAG LONGER TO WARM NOT ONLY THE VICTIM, BUT ALSO THE BAG.