3.20) a) AT WHAT WAVELENGTH WILL A HUMAN'S RADIATION PEAK?
b) ESTIMATE THE TOTAL POWER RADIATED BY A PERSON BY ASSUMING A CYLINDER 1.75 m TALL AND RADIUS 13 cm.
c) COMPARE THE ENERGY RADIATED TO A 2000 k-CAL DIET.

a) FOR $T_{HUMAN} = 98.6°F = 37°C = 310K$, WIEN'S LAW STATES

$$\lambda_{MAX} = \frac{2.898 \times 10^{-3}\ mK}{310K} = 9.35 \times 10^{-6}\ m$$

$$\Rightarrow \boxed{\lambda_{MAX} = 9.35\ \mu m} \Rightarrow \text{IN THE IR BAND!}$$

b) THE EMITTING AREA OF A CYLINDRICA PERSON IS

$$A = 2\pi r h = 2\pi(0.13)(1.75) = 1.43\ m^2$$

STEFAN-BOLTZMANN GIVES THE EMITTED FLUX

$$R(T) = \varepsilon \sigma T^4 \ \frac{W}{m^2}$$

• ASSUMING $\varepsilon = 1$ (A BLACKBODY)

$$R_{HUMAN} = \sigma T^4 = (5.671 \times 10^{-8})(310)^4 = 523.7\ \frac{W}{m^2}$$

TOTAL EMITTED POWER IS THEN

$$P_{HUMAN} = R_{HUMAN} A_{HUMAN} = (523.7)(1.43)$$

$$\boxed{P_{HUMAN} = 748.9\ W} \Rightarrow \text{5 150 W LIGHT BULBS!}$$

c) IN A DAY, $E = Pt = P(24 \cdot 3600) = (8.64 \times 10^4\ s)P$

$$E_{HUMAN} = (8.64 \times 10^4)(748.9) = \boxed{6.47 \times 10^7\ J = E_{HUMAN}}$$

CONVERTING TO kCAL,

$$E_{HUMAN} = 6.47 \times 10^7\ J \left(\frac{1\ kCAL}{4.184 \times 10^3\ J}\right) = 1.547 \times 10^4\ kCAL$$

$$\frac{E_{HUMAN}}{E_{DIET}} = \frac{15,465}{2000} = 7.73!$$

WOW! WE SHOULD RADIATE OURSELVES TO DEATH!

$\Rightarrow$ EMISSIVITY IS LIKELY < 1!