

9.29) COMPUTE THE FERMI SPEED FOR a) Ca ($E_F = 4.69 \text{ eV}$)
AND b) Be ($E_F = 14.3 \text{ eV}$).

THE FERMI SPEED IS FOUND BY SETTING THE KINETIC ENERGY EQUAL TO THE FERMI ENERGY:

$$\frac{1}{2} m u_F^2 = E_F \Rightarrow u_F = \sqrt{\frac{2E_F}{m}} \quad \text{p. 322}$$

FOR CONDUCTION ELECTRONS, $m_e = 9.11 \times 10^{-31} \text{ kg}$

$$\text{a) } E_{F, \text{Ca}} = 4.69 \text{ eV} \left(\frac{1.6 \times 10^{-19} \text{ J}}{1 \text{ eV}} \right) = 6.288 \times 10^{-19} \text{ J}$$

$$u_{F, \text{Ca}} = \sqrt{\frac{2(6.288 \times 10^{-19})}{9.11 \times 10^{-31}}}$$

$$\boxed{u_{F, \text{Ca}} = 1.17 \times 10^6 \frac{\text{m}}{\text{s}}} \quad \text{ZIPPY! } 0.4\% \text{ OF } c!$$

$$\text{b) } E_{F, \text{Be}} = 14.3 \text{ eV} \left(\frac{1.6 \times 10^{-19} \text{ J}}{1 \text{ eV}} \right) = 2.29 \times 10^{-18} \text{ J}$$

$$u_{F, \text{Be}} = \sqrt{\frac{2(2.29 \times 10^{-18})}{9.11 \times 10^{-31}}}$$

$$\boxed{u_{F, \text{Be}} = 1.82 \times 10^6 \frac{\text{m}}{\text{s}}} \quad \text{EVEN ZIPPIER! } 0.6\% \text{ OF } c!$$

- 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 $T_{\text{human}} = 98.6^\circ\text{F} = 37^\circ\text{C} = 310\text{K}$, WIEN'S LAW STATES

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

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

b) THE EMITTING AREA OF A CYLINDRICAL PERSON IS

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

STEFAN - BOLZEMANN GIVES THE EMITTED FLUX

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

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

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

TOTAL EMITTED POWER IS THEN

$$P_{\text{human}} = R_{\text{human}} A_{\text{human}} = (523.7)(1.43)$$

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

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

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

CONVERTING TO kcal,

$$E_{\text{human}} = 6.47 \times 10^7 \text{ J} \left(\frac{1 \text{ kcal}}{4.184 \times 10^3 \text{ J}} \right) = \underline{1.547 \times 10^4 \text{ kcal}}$$

$$\frac{E_{\text{human}}}{E_{\text{diet}}} = \frac{15,465}{2000} = \underline{7.73!} \quad \text{Now! WE SHOULD RADIATE OURSELVES TO DEATH!}$$

\Rightarrow EMISSIVITY IS LIKELY $\ll 1$!