1)

a)

1. I Energy in food like ~~hohlenhydrates~~ carbon or fats is in fats or carbs ~~cirt~~ carbs in the body

II $E = c \cdot x$ $x \hat{=}$ consumed kcal

$E = 4{,}184 \frac{J}{g \cdot °C} \cdot 2500\,kcal = 4{,}184 \frac{J}{g \cdot °C} \cdot 2500 \cdot 10^3\,g\,°C = 10{,}46 \cdot 10^6\,J$

$= 10{,}46\,MJ$

III $P = \frac{E}{t} = \frac{10{,}46\,MJ}{1\,day} = \frac{10{,}46\,MJ}{24 \cdot 60 \cdot 60\,s} = 121{,}1\,W$

2. I electrical Energy to thermal energy

II $E = U \cdot I \cdot t = 100 \cdot 10^6\,V \cdot 100 \cdot 10^3\,A \cdot 30 \cdot 10^{-6}\,s = 0{,}3 \cdot 10^9\,VAs = 0{,}3\,MJ$

III $P = U \cdot I = 100 \cdot 10^6\,V \cdot 100 \cdot 10^3\,A = 10 \cdot 10^{12}\,W = 10\,TW$

3. I chemical energy to thermal energy

II $E_C = 4\,eV$ ~~let~~ $q = 1{,}6022 \cdot 10^{-19}\,C = 1{,}6022 \cdot 10^{-19}\,As$

$N = \frac{1}{12} \cdot 6{,}0022 \cdot 10^{23}\,\frac{1}{mol}$ in 1 g carbon

$E = m \cdot q \cdot E_C \cdot N = 1000\,g \cdot 1{,}6022 \cdot 10^{-19}\,As \cdot 4\,eV \cdot \frac{1}{12} \cdot 6{,}0022 \cdot 10^{23}\,\frac{1}{mol}$

$E = 32{,}1\,MJ$

III $P = \frac{E}{t} = \frac{32{,}1\,MJ}{60 \cdot 60\,s} = 8{,}92\,kJ\,W$

4. I electrical energy to thermal energy

II $E = m \cdot c \cdot \Delta T = 1\,kg \cdot 4{,}184 \frac{J}{g \cdot K} \cdot 80\,K = 334{,}72\,kJ$

III $P = \frac{E}{t} = \frac{334{,}72\,kJ}{3 \cdot 60\,s} = 1{,}86\,W$

5. I ~~electrical energy to chemical energy~~ electromagnetic solar energy to electrical energy

II $E = A \cdot E_e = 6 \cdot 8\,m^2 \cdot 1000\,\frac{Wh}{m^2} = 48\,MWh$

$= 48 \cdot 60 \cdot 60\,MWs = 172{,}8\,GWs = 172{,}8\,GJ$

III $P = \frac{E}{t} = \frac{172{,}8 \cdot 10^9\,J}{356 \cdot 24 \cdot 60 \cdot 60\,s} = 5{,}62\,kW$

6. I electrical in energy to chemical energy

II $E = V \cdot C_N = 1{,}5\,V \cdot 2{,}3\,Ah = 1{,}5\,V \cdot 2{,}3\,A \cdot 60 \cdot 60\,s = 12{,}42\,kJ$

III $P = \frac{E}{t} = \frac{12{,}42\,kJ}{3 \cdot 60 \cdot 60\,s} = 1{,}15\,W$

7. I. electrical energy in light, ~~heat~~ the electro magnetic energy, thermal energy

III. $P = n \cdot P = 7 \cdot 10^9 \cdot 1{,}5\,kW = 10{,}5 \cdot 10^{12}\,W = 10{,}5\,TW$

II. $E = P \cdot t = 10{,}5 \cdot 10^{12}\,W \cdot 365 \cdot 24 \cdot 60 \cdot 60\,s = 0{,}331 \cdot 10^{21}\,J = 331\,EJ$

8. I solar energy to thermal energy (electro magnetic)

III $A = \pi r^2 \quad P = A \cdot E_e = \pi \cdot (6{,}378 \cdot 10^3\,m)^2 \cdot 1361 \frac{W}{m^2} = 174\,PW$

II $E = P \cdot t = 174 \cdot 10^{15}\,W \cdot 60 \cdot 60\,s = 626\,EJ$

b) 6. 4. ~~2.~~ ~~1.~~ 5. 3. 7. 8.

c) 6. 4. 1. 5. 3. 2. 7. 8.

2) $P_{day} = P_{Sun} \cdot \eta \cdot t = 1409\,W \cdot 24\,h \cdot 0{,}15 \frac{1}{day} = 504 \frac{GWh}{day}$

$\eta_{year} = \frac{P_{used\,day} \cdot 356\,days}{P_{Sun}} = \frac{504 \frac{GWh}{day} \cdot 356\,days}{20200\,TWh} = 0{,}9\,\%$

3)

$P_S = \sigma \cdot A_S \cdot T^4 \qquad A_S = 4\pi r^2$

$P_S \approx P_{AM0} \cdot 4\pi r^2$ because $d_{earth\,sun} >> r_{earth}$

$P_S \approx P_{AM0} \cdot 4\pi d^2_{earth\,sun}$

$P_{AM0} \cdot 4\pi d^2_{earth\,sun} = \sigma A_S \cdot T^4$

$T = \sqrt[4]{P_{AM0} \cdot \frac{4\pi d^2_{earth\,sun}}{\sigma\, 4\pi r^2_{sun}}} = \sqrt[4]{P_{AM0} \cdot \frac{d^2_{earth\,sun}}{\sigma\, r^2_{sun}}} = \sqrt[4]{1350 \frac{W}{m^2} \cdot \frac{(1{,}5 \cdot 10^{11}\,m)^2}{5{,}67 \cdot 10^{-8} \frac{W}{m^2 K^4} \cdot (6{,}96 \cdot 10^8\,m)^2}}$

$T = ~~5770~~\,5767\,K$

4) $\alpha = 90° - \varphi \pm \delta \qquad \delta = 23{,}5° \quad \varphi = 65{,}8°\,N$

21st March: $\alpha = 90° - \varphi = 90° - 65{,}8° = 24{,}2°$

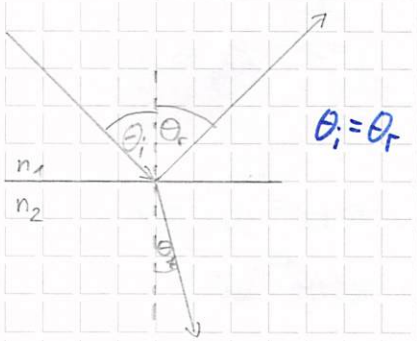
21st June: $\alpha = 90° - \varphi + \delta = 90° - 65{,}8 + 23{,}5° = 47{,}7°$

21st Dec: $\alpha = 90° - \varphi - \delta = 90° - 65{,}8 - 23{,}5° = 0{,}7°$

5) Fresel equations:

$$R_s = \left(\frac{n_1 \cos(\theta_i) - n_2 \cos(\theta_t)}{n_1 \cos(\theta_i) + n_2 \cos(\theta_t)}\right)^2 \qquad R_p = \left(\frac{n_1 \cos(\theta_t) - n_2 \cos(\theta_i)}{n_1 \cos(\theta_t) + n_2 \cos(\theta_i)}\right)^2$$

$$R = \tfrac{1}{2}\left(R_s^2 + R_p^2\right) \qquad R(\theta_i) \quad R(\theta_i = 0) = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2 \text{ if } \theta_i = 0$$



Snell's laew:

$$n_1 \sin(\theta_i) = n_2 \sin(\theta_t)$$

a) $\theta_i = 0° = \theta_t \qquad \theta_t = \arcsin\left(\frac{n_1}{n_2} \sin(\theta_i)\right)$

$$R = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2 = \left(\frac{1 - 1{,}5}{1 + 1{,}5}\right)^2 = \left(\frac{-0{,}5}{2}\right)^2 = (-0{,}25)^2 = 6{,}25\,\%$$

b) $\theta_i = 30° \qquad \theta_t = \arcsin\left(\frac{n_1}{n_2} \sin(\theta_i)\right) = \arcsin\left(\frac{1}{1{,}5} \sin(30°)\right) = 19{,}5°$

$$R_s = \left(\frac{1 \cdot \cos(30°) - 1{,}5 \cdot \cos(19{,}5°)}{1 \cos(30°) + 1{,}5 \cos(19{,}5°)}\right)^2 = 5{,}8\,\% \qquad R_p = 2{,}5\,\% \qquad R = 4{,}15\,\%$$

6) a) $E_{e,\lambda} = \int_{\lambda_1}^{\lambda_2} I_{e\lambda}\, d\lambda = \int_{250\,nm}^{1000\,nm} 1 \cdot 10^9 \frac{W}{m^2 \cdot nm}\, d\lambda = \left[1 \cdot 10^9 \frac{W}{m^2 \cdot nm} \cdot \lambda\right]_{250\,nm}^{1000\,nm}$

$$= 1 \cdot 10^9 \frac{W}{m^2 \cdot m} (1000\,nm - 250\,nm) = 1 \cdot 10^9 \frac{W}{m^2 \cdot m} \cdot 750 \cdot 10^{-9}\,m$$

$$= 750\,\frac{W}{m^2}$$

$$E_{e,\lambda} = \int_{\lambda_1}^{\lambda_2} I_{e\lambda}\, d\lambda = \int_{1000\,nm}^{2000\,nm} 0{,}25 \cdot 10^9 \frac{W}{m^3} = 1000\,\frac{W}{m^2}$$

b) $E = h \cdot f = h \frac{c}{\lambda} \qquad \Phi_{ph} = \int I_{e\lambda} \cdot \frac{1}{E}\, d\lambda = \int I_{e\lambda} \cdot \frac{\lambda}{h \cdot c} d\lambda = \frac{1}{h c} \int I_{e\lambda} \cdot \lambda\, d\lambda$

$$\Phi_{ph_1} = \frac{1}{1{,}381 \cdot 10^{-23} \frac{J}{K} \cdot 300 \cdot 10^6\,m} \left[1 \cdot 10^9 \frac{W}{m^3} \cdot \tfrac{1}{2} \lambda^2\right]_{250\,nm}^{1000\,nm} = 2{,}36 \cdot 10^{21}\,\frac{1}{m^2}$$

$$\Phi_{ph_2} = \frac{1}{h \cdot c} \left[0{,}25 \cdot 10^9 \frac{W}{m^3} \cdot \tfrac{1}{2} \lambda^2\right]_{1000\,nm}^{2000\,nm} = 1{,}89 \cdot 10^{21}\,\frac{1}{m^2}$$

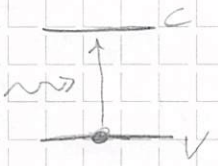
$$\Phi_{ph_{ges}} = 4{,}25 \cdot 10^{21}\,\frac{1}{m^2}$$

7)

a) IV b) I c) II d) III e) IV

8) $E_{ph} = 1{,}38\,eV$ $E_{kin} = 0{,}27\,eV$

$\Rightarrow E_{Bg} = 1{,}38\,eV - 0{,}27\,eV = 1{,}08\,eV$



9)

$n_i p_i = n_i^2 = n \cdot p$ law of mass action

$p = 10^{16}\,1/cm^3$ $n_i = 1{,}5 \cdot 10^{10}\,1/cm^3$

$n = \frac{n_i^2}{p} = \frac{(1{,}5 \cdot 10^{10}\,1/cm^3)^2}{10^{16}\,1/cm^3} = 2{,}25 \cdot 10^{4}\,1/cm^3$