1a) 3.3708567 x 10^{-19} J

b) 5.9332098 x 10^{20} photons

2a) 7.4245799 x 10^{-19}

b) 4.6340583 eV

3) 3.38945138 m/s

4) Consider a blackbody radiator at temperature T. We know the energy density, $\frac{E_{total}(T)}{V}$, is given by $\int_0^\infty \rho(\nu,T)\,d\nu=\int_0^\infty \frac{8\pi h\nu^3}{c^3(e^{\frac{h\nu}{k_BT}})-1}d\nu.$ Let $x=\frac{h\nu}{k_BT}$, then we have $dx=\frac{h}{k_BT}d\nu \Rightarrow d\nu=\frac{k_BT}{h}dx$ and then $x^3=(\frac{h}{k_BT})^3\nu^3 \Rightarrow \nu^3=(\frac{h}{k_BT})^3x^3.$ Substituting these formulae into the original equation we arrive at $\frac{E_{total}(T)}{V}=\frac{8\pi h}{c^3}\int_0^\infty \frac{k_B{}^3T^3h^{-3}x^3}{e^x-1}(k_BTh^{-1})dx=\frac{8\pi k_B{}^4T^4}{(hc)^3}\int_0^\infty \frac{x^3}{e^x-1}dx=(\frac{8\pi k_B{}^4T^4}{(hc)^3})(\frac{\pi^4}{15})=\sigma T^4$ where $\sigma=(\frac{8}{15})\frac{\pi^5k_b{}^4}{(hc)^3}$ is a constant. Therefore the energy depends on temperature as T^4.

5a) 5.2728591 x 10^{-26} J

b) 0.0317538996 J·mol^{-1}

6a) 6329.9109 Å

b) 15798.011 cm^{-1}

c) 299709770 m/s

7a) For X-Rays of wavelength 3.00 x 10^{-10} m (3.00 Å) incident at an angle of 90° = $\frac{\pi}{2}$ radians the change in wavelength is described by the equation $\Delta\lambda=\frac{(1-\cos\theta)h}{m_ec}=\frac{(1-\cos(\frac{\pi}{2}))h}{m_ec}=\frac{h}{m_ec}=2.4263102\,x\,10^{-12}\,m$ so the final wavelength of the scattered X-Rays is $\lambda_{final}=\lambda_{intial}+\Delta\lambda=3.0242631\,x\,10^{-10}\,m.$

b) The initial energy of the incoming X-Ray photon is given by $E=h\nu=\frac{hc}{\lambda}=6.6214862\,x\,10^{-16}\,J,$ by the same relation we know that the final energy of the scattered photon is $6.5683632\,x\,10^{-16}\,J$ and because energy is conserved (even if momentum is not because this is an inelastic collision) we know that the energy lost by the scattered X-Ray photon will be equal to the kinetic energy gained by the scattered electron. Thus we have $KE_{electron} = \Delta E_{photon} = E_f - E_i = 5.3122957 \, x \, 10^{-18} J = \frac{1}{2} m_{electron} v^2 \Rightarrow v = \sqrt{\frac{2(KE_{electron})}{m_{electron}}}$ which is equal to $3.41516443 \, x \, 10^6 \frac{m}{s}$.

8a)