CHEM 1440

HW# 1

SOLUTIONS

1.3) From De Broglie Wavelength

$$\lambda = \frac{h}{mv} = \frac{h}{m\sqrt{\frac{3kT}{m}}} = \frac{h}{m^{1/2}\sqrt{3kT}} \Rightarrow T = \frac{h^2}{3km\lambda^2}$$

$$m_{He} = \frac{4.0*10^{-3}\,kg}{6.02*10^{23}} = 6.64*10^{-27}\,kg \quad He \quad atom$$

$$T_{He} = \frac{h^2}{3km\lambda^2} = \frac{(6.626*10^{-34}\,Js)^2}{3*(0.2*10^{-9}\,m)^2*1.38*10^{-23}\,J*K^{-1}*6.64*10^{-27}\,kg} \approx 40 \quad K$$

$m_{Ar} = 6.63*10^{-26}\,kg \quad Ar \quad atom$

$T_{Ar} \approx 4 \quad K$

1.6)

a) E = 0.10 J and Δt =10 ns = $10*10^{-9}$ s = 10^{-8} s

P= E/ Δt =10^7 Js^{-1} = 10^7 W

b)

$$E_{photon} = \frac{hc}{\lambda} = \frac{(6.626*10^{-34}\,Js)(3*10^8\,m/s)}{(1000*10^{-9}\,m)} \approx 1.99*10^{-19}\,J$$

$$n_{photon} = \frac{E}{E_{photon}} = \frac{0.1J}{1.99*10^{-19}\,J} \approx 5.0*10^{17}\ photons$$

1.11)

Work Function (***I_{WF}***) & Planck's Constant (***h***)

$E_{Kinetic} = E_{photon} - I_{WF}$

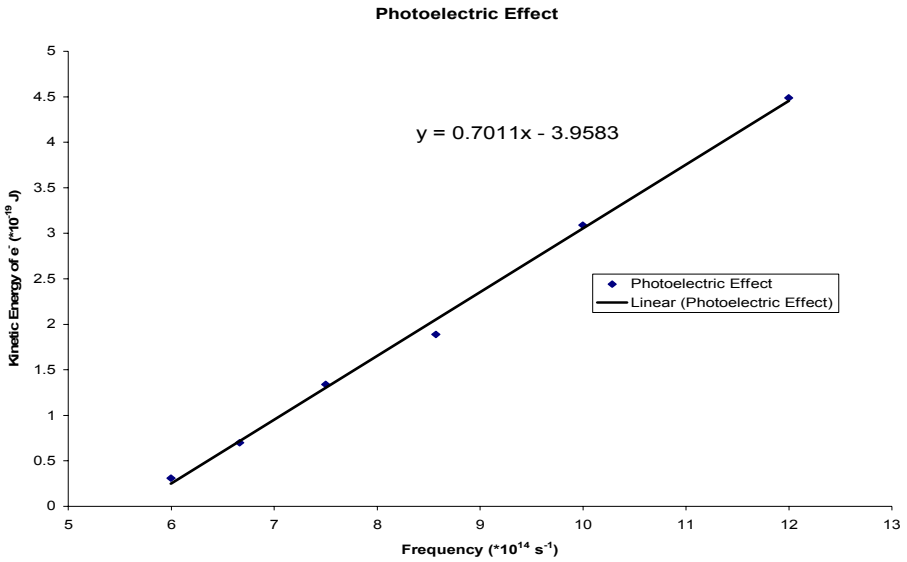
***** Kinetic Energy given in the question should be 10^{-19} J not 10^{19} J.***

Kinetic Energy (10^{-19} J)	4.49	3.09	1.89	1.34	0.700	0.311
Wavelength (nm)	250	300	350	400	450	500
Frequency (10^{14} s^{-1}) ($\upsilon = hc/\lambda$)	12	10	8.57	7.5	6.67	6.0

From the best line ($E_{kinetic}$ vs the frequency of photons)

$$E_{kinetic} = 0.7011\upsilon - 3.96;$$

$\rightarrow I_{WF} = 3.96 * 10^{-19}$ J ≈ 2.5 eV & $h = 0.7011*10^{-19}$ J$/10^{14}$ s$^{-1} \approx 7.0*10^{-34}$ Js



1.21)

$I_{WF} = 5.65$ eV $= 9.05*10^{-19}$ J

$E_{Kinetic} = E_{photon} - I_{WF}$;

For minimum frequency $\rightarrow$ $\boldsymbol{E_{Kinetic} = 0}$;

$\rightarrow E_{photon} = I_{WF} = 9.05*10^{-19}$ J

$$h\nu_{\min} = 9.05*10^{-19} J \Rightarrow \nu_{\min} = \frac{9.05*10^{-19} J}{6.626*10^{-34} Js} = 1.37*10^{15} s^{-1}$$

If λ =150 nm then $E_{photon} = \frac{hc}{\lambda} = \frac{(6.626*10^{-34} Js)(3.0*10^{8} ms^{-1})}{150*10^{-9} m} = 13.2*10^{-19} J$

$E_{Kinetic} = E_{photon} - I_{WF} = 4.20*10^{-19}$ J

$$\frac{1}{2} m_e v_e^2 = 4.20*10^{-19} \text{ J}$$

$$v_e^2 = \frac{2*4.20*10^{-19} \text{ J}}{m_e} = \frac{8.40*10^{-19} \text{ J}}{9.1*10^{-31} kg} = 9.23*10^{11} m^2 s^{-2}$$

$$v_e = 9.6*10^{5} ms^{-1}$$