3.7 $\lambda_{max} = 420nm$

a) $\Phi = \frac{hc}{\lambda_{max}} = \frac{1240\ eV\ nm}{420 nm} = 2.95\ eV$

b) $\lambda = 300nm$

$KE_{max} = E_{photon} - \Phi = \frac{hc}{\lambda} - \Phi = \frac{1240\ eV\ nm}{300\ nm} - 2.95eV = 1.18\ eV$

c) $I = 20\ mW/cm^2$, $E_{ph} = \frac{hc}{\lambda} = \frac{1240 eV\ nm}{300nm} = 4.13\ eV\left(\frac{1.6\times10^{-19} J}{1 eV}\right) = 6.61\times10^{-19} J$

$I = \frac{Power}{Area} = \frac{Energy/time}{Area} = \frac{N_{ph}\ E_{ph}/time}{Area} = \underbrace{\left(\frac{N_{ph}}{Area \cdot time}\right)}_{\Gamma_{ph} = \text{photon flux}} \cdot E_{ph} = \Gamma_{ph} E_{ph}$

$\Gamma_{ph} = I / E_{ph}$

if each photon releases one electron, then the electron flux will equal the photon flux: $\Gamma_{e^-} = \Gamma_{ph}$

Current density is the charge flux:

$$J = e\Gamma_{e^-} = e\Gamma_{ph} = e\frac{I}{E_{ph}} = (1.6\times10^{-19}C)\frac{20\times10^{-3} W/cm^2}{6.61\times10^{-19} J} = 0.0048\ A/cm^2$$

$= 4.8 mA/cm^2$

3.9 $\Phi = 1.6\,eV$

$A = 0.5\,cm^2$

$\lambda = 420\,nm \rightarrow E_{ph} = \frac{hc}{\lambda} = \frac{1240\,eV\,nm}{420\,nm} = 2.95\,eV = 4.72\times10^{-19}\,J$

$I = 50\,mW/cm^2$

a) $QE = .15 = \frac{N_e}{N_{ph}} = \frac{\Gamma_e}{\Gamma_{ph}}$, $I = \Gamma_{ph} E_{ph}$ (from problem 3.7 or 3.8)

$J = e\Gamma_e = .15 e\Gamma_{ph} = .15 e \frac{I}{E_{ph}} = .15(1.6\times10^{-19}C)\frac{50\,mW/cm^2}{4.72\times10^{-19}\,J} = 2.54\,mA/cm^2$

$KE_{max} = E_{ph} - \Phi = 2.95\,eV - 1.6\,eV = 1.35\,eV$

b) The voltage to extinguish the current is $-1.35\,V$

c) $\lambda = 600\,nm \rightarrow E_{ph} = \frac{1240\,eV\,nm}{600\,nm} = 2.07\,eV = 3.31\times10^{-19}\,J$

$QE = .05$

$J = 2.54\,mA/cm^2$

$J = e\Gamma_e = QE\, e\,\Gamma_{ph}$

$I = \Gamma_{ph} E_{ph} = \frac{J}{e\,QE}\cdot E_{ph} = \frac{2.54\,mA/cm^2}{(1.6\times10^{-19}C)(0.05)}\cdot(3.31\times10^{-19}J) = 105\,mW/cm^2$