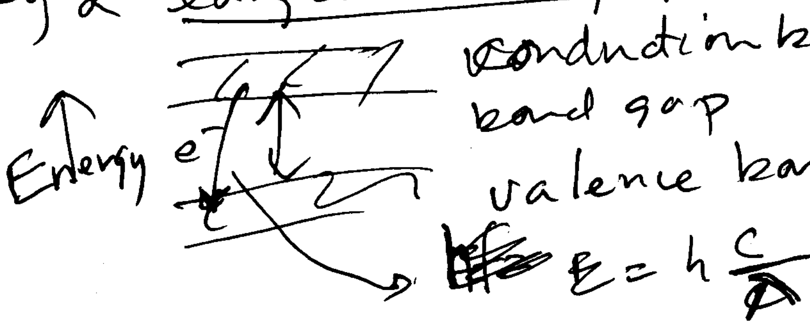
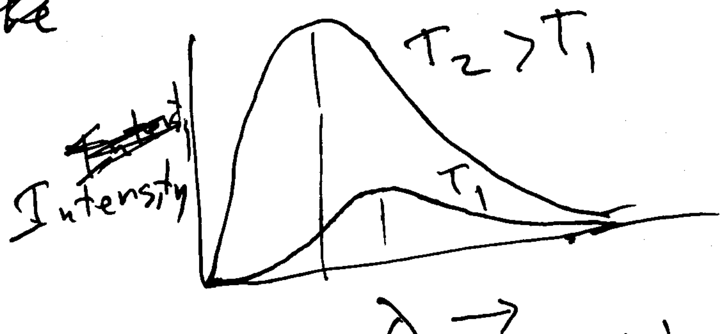
Physics 1C
Winter 2010
Quiz 4 form A

1) The light produced by a light emitting diode (LED) results from an electron dropping from the conduction band to the valence band across the band gap. To decrease the wavelength, a higher energy photon is required. This can be accomplished by a <u>larger band gap</u>

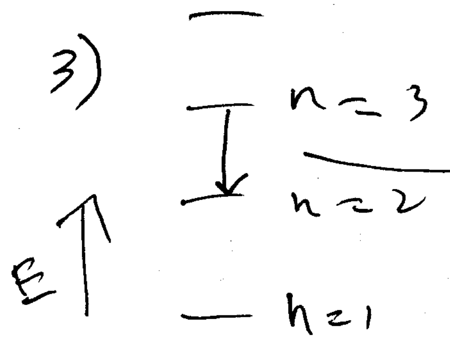


2)



The spectrum of blackbody radiation shows an <u>increase in intensity</u> & <u>decrease in peak wavelength</u> as the temperature increases

3)



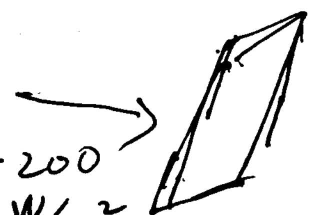
For the hydrogen atom the photon energy

$$\Delta E = E_0 \left(\frac{1}{n^2_{final}} - \frac{1}{n^2_{initial}} \right)$$

$$\Delta E = 13.6 \left(\frac{1}{2^2} - \frac{1}{3^2} \right) eV$$

$$\Delta E = 1.9 \ eV$$

4)



$I = 200 \ W/m^2$

$\lambda = 500nm \quad A = 10 \ m^2$

Total energy

$$\Delta E = I A t$$

$$\Delta E = \left(200 \frac{W}{m^2}\right)\left(10 \ m^2\right)\left(1s\right) = 2000J$$

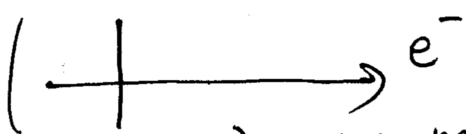
$$\Delta E = n h \frac{c}{\lambda}$$ where n = no. of photons

$$n = \frac{\Delta E \lambda}{hc} = \frac{(2000 J)(500 \times 10^{-9} m)}{(6.6 \times 10^{-34} J \cdot s)(3 \times 10^8 m/s)}$$

$$n = 5.1 \times 10^{21}$$

5) A laser is based on the principle of stimulated emission in which the interaction of a photon in resonance with a electron in an excited state induces a transition to the ground state.

6) de Broglie wavelength



$KE = \frac{1}{2}mv^2 = e\Delta V$

ΔV $\quad \lambda = 0.1\,nm$

$\lambda = \frac{h}{mv}$, $mv = \frac{h}{\lambda}$

Solve for ΔV

$$\frac{1}{2}mv^2 = e\Delta V$$

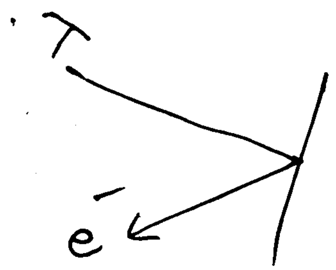
$$\frac{1}{2}m^2v^2 = me\Delta V = \frac{1}{2}\left(\frac{h}{\lambda}\right)^2$$

$$\Delta V = \frac{1}{2me}\left(\frac{h}{\lambda}\right)^2$$

$$\Delta V = \frac{1}{2(9.1\times10^{-31}\,kg)(1.6\times10^{-19}\,C)}\left(\frac{6.6\times10^{-34}\,J\cdot s}{0.1\times10^{-9}\,m}\right)^2$$

$$\Delta V = \boxed{150\ V}$$

7)



$\phi = 4.2\,eV$

$V_s = 5.3\,V$

$$h\frac{c}{\lambda} = eV_s + \phi = 5.3 + 4.2\ eV$$

$$\lambda = \frac{hc}{eV_s + \phi} = \frac{(6.6\times10^{-34}\,J\cdot s)(3\times10^{8}\,m/s)}{(5.3\,eV + 4.2\,eV)(1.6\times10^{-19}\,J/eV)}$$

$$\lambda = 1.3\times10^{-7}\,m = \boxed{130\,nm}$$

8) For an atom with an electron in the n=4 state, the number of possible quantum states

n	l	m_l	m_s	no states	
4	0	0	$\pm\frac{1}{2}$	2	2
	1	-1	$\pm\frac{1}{2}$	2	6
		0	$\pm\frac{1}{2}$	2	
		+1	$\pm\frac{1}{2}$	2	
	2	-2	$\pm\frac{1}{2}$	2	10
		-1	$\pm\frac{1}{2}$	2	
		0	$\pm\frac{1}{2}$	2	
		1	$\pm\frac{1}{2}$	2	
		2	$\pm\frac{1}{2}$	2	
	3	-3	$\pm\frac{1}{2}$	2	14
		-2	$\pm\frac{1}{2}$	2	
		-1	$\pm\frac{1}{2}$	2	
		0	$\pm\frac{1}{2}$	2	
		1	$\pm\frac{1}{2}$	2	
		2	$\pm\frac{1}{2}$	2	
		3	$\pm\frac{1}{2}$	2	

Total = **32**