E45 - Fall 2011
Solutions to Exam #1

1

1. Yield Strain = $\sigma_Y / E = \frac{240\ MPa}{110{,}000\ MPa} = 0.0022$ (8)

Change in length at yield = $(0.0022)(380mm) = 0.829mm$ (8)

(4) Since the change in length is 1.9mm, which is > the yield strain, the sample has plastically deformed.

(5) Since no information is provided about the plastic portion of the σ-ϵ curve, it is not possible to determine the stress (or load) required to lengthen the sample by 1.9 mm.

2. The energy of hydrogen's single electron depends only on n:

$$E_n = -\frac{13.6}{n^2}\ eV$$

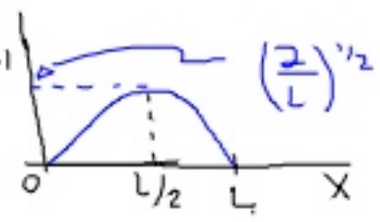
(15) $\therefore E_{n=5} = \frac{-13.6}{(5)^2}\ eV = -0.544\ eV$ (E=0 = absolute zero of energy)

3. excited configurations = c., d., e., f (12)

forbidden configuration = b. (3)

ground state configuration = a. (3)

4. Wave function of lowest energy state (n=1) is: $\psi_{n=1} = \left(\frac{2}{L}\right)^{1/2} \sin\frac{\pi x}{L} \Rightarrow$



$|\psi_{n=1}(x)|^2$ is a maximum $\left(=\frac{2}{L}\right)$ at $x = L/2$ (10)

b. E = total energy = KE + PE

$$\left[-\frac{\hbar^2}{2m}\nabla^2 + PE\right]\psi = E\psi$$

Since PE = 0

$$E = KE$$

$$-\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\left(\frac{2}{L}\right)^{1/2}\sin\frac{n\pi x}{L}\Big] = E\left(\frac{2}{L}\right)^{1/2}\sin\frac{n\pi x}{L}$$

$$+\frac{\hbar^2}{2m}\left(\frac{2}{L}\right)^{1/2}\frac{n^2\pi^2}{L^2}\sin\frac{n\pi x}{L} = E\left(\frac{2}{L}\right)^{1/2}\sin\frac{n\pi x}{L}$$

(10) $\frac{1}{8m}\left(\frac{nh}{L}\right)^2 = E_n \qquad n = 1, 2, 3, \ldots$

(c) $E_n = \frac{1}{8m}\left(\frac{nh}{L}\right)^2 \qquad n = 1, 2, 3, \ldots$

$$E_{n=2} - E_{n=1} = \frac{1}{8m}\frac{h^2}{L^2}(4-1)$$

$$0.025\,eV = \frac{3}{(8)\,9.1085\times10^{-28}\,g}\,\frac{(6.625\times10^{-34}\,J\cdot s)^2}{L^2}\left(\frac{10^7\,erg}{J}\right)^2$$

$$0.025\,eV\;\; 1.602\times10^{-19}\,\frac{coul}{e^-}\;\frac{1\,J}{Volt\cdot coul}\;\frac{10^7\,erg}{J} = \frac{3}{(8)\,9.1085\times10^{-28}\,g}\,\frac{(6.625\times10^{-34})^2\,(10^7)^2}{L^2}\;erg\cdot cm^2$$

$$L^2 = \frac{1.807\times10^{-26}}{4.01\times10^{-14}}\,cm^2 = 6.7\,nm \qquad (10)$$

5. $\Delta EN > 1.7 \Rightarrow$ primarily ionic

$\Delta EN < 1.7 \Rightarrow$ primarily covalent

$\Rightarrow$

Bond	Δ(EN)	Bond	
MgO	2.13	Primarily Ionic	(3)
MgF	2.67	Primarily Ionic	(3)
MgN	1.73	50-50 Ionic-Covalent (or Primarily Ionic)	(3)
MgC	1.24	primarily Covalent	(3)