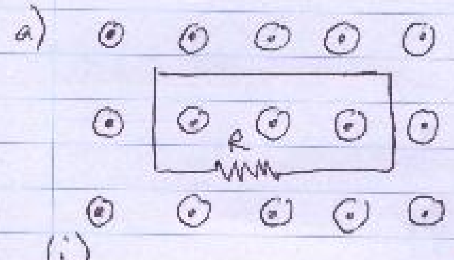
KEY

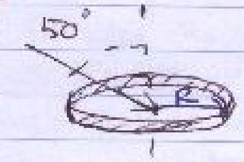
PHY 407 - Apr 13^{th} 09 Question Number

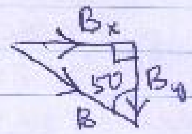
Test 3 - 31 + 44 = 75

Question 1 6 + 14 + 11 = 31

a)







$B_y = B\cos 50°$

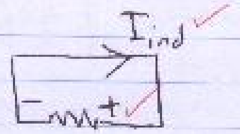
. B_y is the field ⊥ to surface of coil & penetrate the surface

(i)

Since B in increasing the current will be induced in the loop in order to produce an induced B to oppose the increase.

Since B points out of the page & increasing so the induced B must be pointing into the page. Hence the induced I in the loop will be clockwise

(6)



ii) The ϕ flux that pass thru the surface of the coil is $\phi = (B\cos 50°)A = \pi R^2 (B\cos 50°)$

For N turns then the flux is $\Phi = N\phi = N(\pi R^2)(B\cos 50°)$

The induced emf is caused by a change in flux. $EMF = -\frac{\Delta\Phi}{\Delta t}$

and by using Ohm's Law $Emf = I_{ind}R = -\frac{\Delta\Phi}{\Delta t}$

So, $Emf = (4\times10^{-3}A)(10\,\Omega) = 40\times10^{-3}$ volts $= 40$ mV.

So, $\frac{\Delta\Phi}{\Delta t} = 40$ mV

Since $\Phi = N\pi R^2 B\cos 50°$

Then $\frac{\Delta\Phi}{\Delta t} = \frac{\Delta B}{\Delta t}(N\pi R^2 \cos 50°)$

So, $\frac{\Delta B}{\Delta t} = \frac{40\text{mV}}{N\pi R^2\cos 50°} = \frac{40\times10^{-3}}{(100)(8\times10^{-4})(\cos 50°)} = .77\ \frac{T}{s}$ 5

$\frac{\Delta B}{\Delta t} = \frac{1}{2\cos 50} = \frac{1}{2(0.6428)} = 0.77\ T/s$

(14)

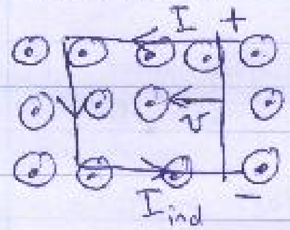
Since B is +ve (increase) then the induced I must produce induce B to oppose the increase, ie pointing up. Hence, I counterclockwise

PHY 407 - April 13th 09

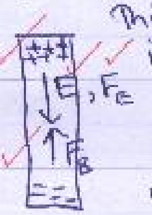
Test 3

Question Number

Question 1



Since I is as shown, then the E field along ~~Along the bar, the charges are moving to the left & using RHR #1~~ the conducting bar must be downwards. This can only happen when there is a magnetic force F_B acting in the opposite direction to F_E since the induced current will only be constant when $F_B = F_E$ but in opposing direction.



So, using RHR #1, the +ve charges ~~electrons~~ in the bar will be pushed upwards only if B is out of the page.

The induced current is ~~due to B field induced B inducing B out of the page~~. caused by piling of electrons at the bottom of the conducting bar causing a potential difference to develop between the top & bottom of the conducting bar.

(11)

PHY 407 - Apr 13th 2009

Question Number

Test 3

Question 2 (a) -3+4+4+8 = 19 (b) 8+7+2+8 = 25

144

(a) (i) A wave-particle duality explains that under certain conditions a particle can exhibit wave properties such as the Young's Double Slit experiment where electrons shot between 2 slits produce dark & bright interference patterns. (3)

Bonus 5+7 = 12

Similarly, light waves can also exhibit particle properties as discovered in the photoelectric effect experiment where light waves with frequency beyond the threshold frequency of the impinging metal when shine on the metal surface can produce photoelectric current, the movement of electrons which are particles.

(ii) Paschen Series are a series of photons produced when hydrogen atoms which are excited return to the ~~first 2nd~~ 2nd excited state (n=3). (4)

(iii) Heisenberg uncertainty principle states that if the position of a particle can be determined exactly, then its speed cannot be determined exactly but the product of the uncertainty between the position and its momentum must be greater than the Planck's constant $\Delta x \Delta p \geq \frac{h}{2\pi}$ or $\Delta E \Delta t \geq h/2\pi$ (4)

(iv) Rutherford's scattering is the experiment that leads to the discovery of massive positively charged nucleus at the center of an atom. This conclusion was reached upon observation that helium particles are strongly deflected and even repelled when used to bombard hydrogen atoms. (8)

9

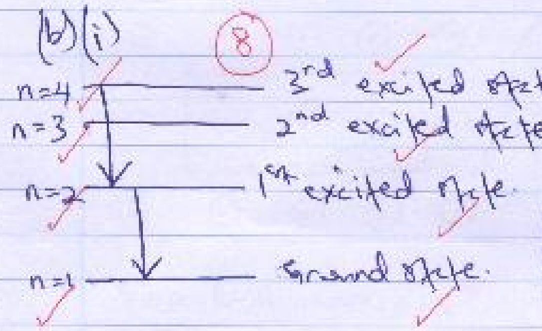
PHY 407 - Apr 13th 09

Test 3

Question Number

Question 2 (b) - 8+7+2+8 = 25

(b)(i) (8)



(ii) (7)

$E_3 = \frac{E_0}{n^2} = -\frac{13.6}{4^2} = -0.85\,eV$

$E_2 = \frac{E_0}{n^2} = -\frac{13.6}{3^2} = -1.51\,eV$

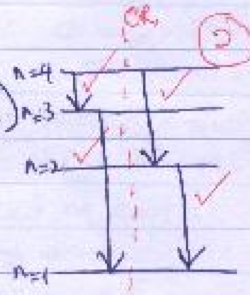
$E_1 = \frac{E_0}{n^2} = -\frac{13.6}{2^2} = -3.4\,eV$

$E_0 = -13.6\,eV$

(iii) There are ~~many~~ 2 alternatives: (2)

$n=4 \rightarrow n=2$ then $n=2 \rightarrow n=1$ (as shown)

OR $n=4 \rightarrow n=3$ then $n=3 \rightarrow n=1$



(iv) For alternative (1) (8)

$\Delta E_{13} = E_1 - E_3 = hf_{13} = -3.4 - (-0.85) = -2.55\,eV$

$\frac{hc}{\lambda} = 2.55\,eV$, so $\lambda = \frac{hc}{2.55\,eV} = \frac{(6.6\times10^{-34})(3\times10^8)}{(2.55)(1.6\times10^{-19})} = 485\,nm$ or 4.85×10^{-7}

$\Delta E_{01} = E_0 - E_1 = -13.6 - (-3.4) = -10.2\,eV$

$\frac{hc}{\lambda} = 10.2\,eV$. So, $\lambda = \frac{hc}{10.2\,eV} = \frac{(6.6\times10^{-34})(3\times10^8)}{10.2\times(1.6\times10^{-19})} = 122\,nm$ or $1.22\times10^{-7}\,m$

OR

For alternative (2)

$\Delta E_{23} = E_2 - E_3 = -1.51 - (-0.85) = -0.66\,eV$

So, $\lambda = \frac{hc}{0.66\,eV} = \frac{(6.6\times10^{-34})(3\times10^8)}{0.66\times(1.6\times10^{-19})} = 1875\,nm$ or $18.75\times10^{-7}\,m$

$\Delta E_{02} = E_0 - E_2 = -13.6\,eV - (-1.51\,eV) = -12.09\,eV$

So, $\lambda = \frac{hc}{12.09\,eV} = \frac{(6.6\times10^{-34})(3\times10^8)}{(12.09)(1.6\times10^{-19})} = 102\,nm$ or $1.02\times10^{-7}\,m$

11