EE 362 Electronic, Magnetic, & Optical Properties of Materials
Quiz 2 (Spring 2024)

Name Key A

Instructions: Open book & notes. Place answers in indicated spaces. Show all work. Use 4-5 significant figures.

Using the newly released QuEG (**Qu**antum **E**lectron **G**lue) by TomCo, 5 resting electrons are glued together to create a pentaelectron (5e-). Find the rest mass and charge of the pentaelectron. Next, the pentaelectron is accelerated by an electrostatic potential of 0.5 V in a vacuum chamber. Determine the kinetic energy (eV and J), momentum (kg•m/s), velocity (m/s), and de Broglie wavelength (Å) of the pentaelectron.

$m_{5e^-} = 5 m_0 = 5(9.1093837 \times 10^{-31}\ kg) = 4.5547 \times 10^{-30}\ kg$

$q_{5e^-} = 5(-1.602177 \times 10^{-19}\ C) = -8.0109 \times 10^{-19}\ C$

$KE_{5e^-} = (5\ electrons)(0.5\ Volts) = 2.5\ eV$

$\times 1.6022 \times 10^{-19}\ \frac{J}{eV}$

$= 5(+1.6022 \times 10^{-19} C)(0.5\ V) = 4.0054 \times 10^{-19}\ J$

$momentum_{5e^-} = \sqrt{2 m_{5e^-} KE_{5e^-}} = \sqrt{2(4.555 \times 10^{-30})(4.0054 \times 10^{-19})}$

$= m_{5e^-} v_{5e^-} = 4.555 \times 10^{-30}(4.1938 \times 10^{5}) = 1.9102 \times 10^{-24}\ kg\ m/s$

$v_{5e^-} = \frac{p_{5e^-}}{m_{5e^-}} = \sqrt{\frac{2 KE_{5e^-}}{m_{5e^-}}} = \sqrt{\frac{2(4.0054 \times 10^{-19})}{4.5547 \times 10^{-30}}} = 4.1938 \times 10^{5}\ m/s$

(2.3) $\lambda_{5e^-} = h / p_{5e^-} = \frac{6.62607 \times 10^{-34}}{1.9102 \times 10^{-24}} = 3.4689 \times 10^{-10}\ m$

$= 3.4689\ Å$

$m_{5e^-} =$ 4.5547 × 10^-30 kg $q_{5e^-} =$ −8.0109 × 10^-19 C

$KE_{5e^-} =$ 2.5 eV = 4.0054 × 10^-19 J $momentum_{5e^-} =$ 1.9102 × 10^-24 kg m/s

$v_{5e^-} =$ 419,380.3 m/s = 4.1938 × 10^5 m/s $\lambda_{5e^-} =$ 3.4689 Å

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Name Key B

Instructions: Open book & notes. Place answers in indicated spaces. Show all work. Use 4-5 significant figures.

Using the newly developed QuEG (**Qu**antum **E**lectron **G**lue) by Doc Ock, 8 resting electrons are glued together to create an octoelectron (8e-). Find the rest mass and charge of the octoelectron. Next, the octoelectron is accelerated by an electrostatic potential of 0.8 V in a vacuum chamber. Determine the kinetic energy (eV and J), momentum (kg•m/s), velocity (m/s), and de Broglie wavelength (Å) of the octoelectron.

$m_{8e^-} = 8 m_0 = 8(9.1093837 \times 10^{-31}\ kg) = \underline{7.2875 \times 10^{-30}\ kg}$

$q_{8e^-} = 8 e^- = 8(-1.602177 \times 10^{-19}\ C) = \underline{-1.2817 \times 10^{-18}\ C}$

$KE_{8e^-} = (8\ electrons)(0.8\ Volts) = \underline{6.4\ eV}$ $\xrightarrow{\times 1.6022 \times 10^{-19}\ J/eV}$

$= 8(+1.602177 \times 10^{-19}\ C)(0.8\ V) = \underline{1.0254 \times 10^{-18}\ J}$

$momentum_{8e^-} = \sqrt{2 m_{8e^-} KE_{8e^-}} = \sqrt{2(7.2875 \times 10^{-30}) 1.0254 \times 10^{-18}}$

$= m_{8e^-} v_{8e^-} = 7.2875 \times 10^{-30}(5.3048 \times 10^5) = \underline{3.8659 \times 10^{-24}\ kg\ m/s}$

$v_{8e^-} = \frac{p_{8e^-}}{m_{8e^-}} = \sqrt{\frac{2 KE_{8e^-}}{m_{8e^-}}} = \sqrt{\frac{2(1.0254 \times 10^{-18})}{7.2875 \times 10^{-30}}} = \underline{5.3048 \times 10^5\ m/s}$

(2.3) $\lambda_{8e^-} = h/p_{8e^-} = \frac{6.62607 \times 10^{-34}}{3.8659 \times 10^{-24}} = 1.714 \times 10^{-10}\ m$

$= \underline{1.714\ Å}$

$m_{8e^-} = \underline{7.2875 \times 10^{-30}\ kg}$ $q_{8e^-} = \underline{-1.2817 \times 10^{-18}\ C}$

$KE_{8e^-} = \underline{6.4\ eV} = \underline{1.0254 \times 10^{-18}\ J}$ $momentum_{8e^-} = \underline{3.8659 \times 10^{-24}\ kg\ m/s}$

$v_{8e^-} = \underline{530,484.1\ m/s}$ $\lambda_{8e^-} = \underline{1.714\ Å}$

$= 5.3048 \times 10^5\ m/s$