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| **••51** |

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The highest achievable resolving power of a microscope is limited only by the wavelength used; that is, the smallest item that can be distinguished has dimensions about equal to the wavelength. Suppose one wishes to “see” inside an atom. Assuming the atom to have a diameter of 100 pm, this means that one must be able to resolve a width of, say, 10 pm. (a) If an electron microscope is used, what minimum electron energy is required? (b) If a light microscope is used, what minimum photon energy is required? (c) Which microscope seems more practical? Why? |
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| **••52** | The existence of the atomic nucleus was discovered in 1911 by Ernest Rutherford, who properly interpreted some experiments in which a beam of alpha particles was scattered from a metal foil of atoms such as gold. (a) If the alpha particles had a kinetic energy of 7.5 MeV, what was their de Broglie wavelength? (b) Explain whether the wave nature of the incident alpha particles should have been taken into account in interpreting these experiments. The mass of an alpha particle is 4.00 u (atomic mass units), and its distance of closest approach to the nuclear center in these experiments was about 30 fm. (The wave nature of matter was not postulated until more than a decade after these crucial experiments were first performed.) |
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| **••53** |

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A nonrelativistic particle is moving three times as fast as an electron. The ratio of the de Broglie wavelength of the particle to that of the electron is 1.813 × 10-4. By calculating its mass, identify the particle. |
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51. (a) Setting  we solve for *K = E – mec*2:



(b) Using the value 



(c) The electron microscope is more suitable, as the required energy of the electrons is much less than that of the photons.

52. (a) Since  we may use the nonrelativistic formula  Using Eq. 38-43 (and noting that 1240 eV·nm = 1240 MeV·fm), we obtain



(b) Since  to a fairly good approximation, the wave nature of the ** particle does not need to be taken into consideration.

53. The wavelength associated with the unknown particle is



where *pp* is its momentum, *mp* is its mass, and *vp* is its speed. The classical relationship *pp = mpvp* was used. Similarly, the wavelength associated with the electron is *e* = *h*/(*meve*), where *me* is its mass and *ve* is its speed. The ratio of the wavelengths is

*p*/*e* = (*meve*)/(*mpvp*),

so



According to Appendix B, this is the mass of a neutron.