16/19

D7 Quantum Calculations

D7.1 Complete the questions in the table:

Frequency of light /Hz	Wavelength of light /nm	Photon energy /J	Photon energy /eV
6.0×10^{14}			(a)
	(b)		1.5
	(c)		2.5
	500		(d)
	1013		(e)
2.0×10^{15}			(f)

D7.2 A laser diode requires 3.2 V across it to make it work. This means that its photons will have an energy of 3.2 eV. Calculate the wavelength of the light emitted.

D7.3 When an electron annihilates a positron, two photons are produced, each with an energy of 511 keV. Calculate the photon frequency.

Caution - when working with particles, do not use $c = f\lambda$. Question D7.9(b) shows you why.

Complete the questions in the table:

	Wavelength /nm	Particle	Momentum /kg m s^{-1}	Kinetic energy /eV
D7.4	3.0	Electron	(a)	(b)
D7.5	3.0	Neutron	(a)	(b)
D7.6	(a)	Electron ($\beta-$)	(b)	10^5

D7.7 a) Calculate the momentum of an electron if its kinetic energy is 10 keV.

b) An electron's wavelength is 3.0×10^{-7} m. What is its momentum?

D7.8 The tandem electrostatic accelerator can accelerate carbon-12 nuclei to a kinetic energy of 60 MeV. How fast are they going? Assume $m = 12 \times m_{\text{neutron}}$.

D7.9 An electron is travelling at 2.0×10^{6} m s^{-1}.

a) Calculate its momentum and its kinetic energy. Now use the momentum to calculate its wavelength and use the energy to calculate its frequency.

b) Use $c = f\lambda$ to 'calculate' the speed of the electron using the frequency and wavelength. (Extension - what do you notice? Can you spot what has caused this oddity?)