Q8 $\boxed{\text{H}}$ We have $E_1 = 13.6$ eV. (See last paragraph of FT 1.7 in FT p.29, but note that the FT symbol E_1 is the negative of the same symbol used in the CMA question.) E_2 is found from $E_2 = h\nu = hc/\lambda$ where λ can be estimated as 0.71 Å from FT Fig.1-14. Hence

$$E_2 = \frac{6.626 \times 10^{-34} \times 2.998 \times 10^8}{0.71 \times 10^{-10}}\,\text{J} = 2.8 \times 10^{-15}\,\text{J}$$
$$= 17.5\,\text{keV}$$

(See also the calculation on FT p.38.) E_3 is given as $0.025\,\text{eV} = 4.0 \times 10^{-21}$ J. $E_4 = \frac{1}{2} \times 0.15 \times 40^2\,\text{J} = 120\,\text{J} = 7.5 \times 10^{20}$ eV. Finally, $E_5 = mc^2 = 9.109 \times 10^{-31} \times (2.998 \times 10^8)^2\,\text{J} = 8.19 \times 10^{-14}\,\text{J} = 511$ keV. The correct ordering is $E_4 > E_5 > E_2 > E_1 > E_3$ which is option H.

Q9 $\boxed{\text{A}}$ The reciprocal of the wavelength of the L_α line is given by FT Eq.1-25 on FT p.30 with $n_f = 2, n_i = 3$ (see Fig 1-16 on FT p35) and $Q = (Z - 7.5)e$ from FT p.38. The conversion to SI units is given at the bottom of page 9 of Unit 1. Then

$$\frac{1}{\lambda} = \frac{(8.988 \times 10^9)^2 \times 2\pi^2 \times 9.109 \times 10^{-31} \times (1.602 \times 10^{-19})^4}{2.998 \times 10^8 \times (6.626 \times 10^{-34})^3}(47 - 7.5)^2 \left(\frac{1}{2^2} - \frac{1}{3^2}\right)\text{m}^{-1}$$
$$= 2.377 \times 10^9\,\text{m}^{-1}$$
$$\therefore \lambda = 4.207 \times 10^{-10}\,\text{m}$$

Q10 $\boxed{\text{A}}$ The Bragg condition is $n\lambda = 2d\sin\theta$ where $n = 1, 2, 3\ldots$ (FT Eq.1-28). For 1st order, $n = 1$ and so the required distance is

$$d = \frac{\lambda}{2\sin\theta} = \frac{4.20 \times 10^{-10}}{2 \times \sin 30^\circ}\,\text{m} = 4.2 \times 10^{-10}\,\text{m}.$$

Q11 $\boxed{\text{D}}$ The given wave equation governs waves on an ideal string with wave speed v. A general solution is of the form given in Sec.2.3, namely Eq.19, of Unit 2.
All options but D are of the form $f(x + vt) + g(x - vt)$ or can be written in this form. Option D is $0.025L[\sin((x + 2\pi vt)/L) - \sin((x - 2\pi vt)/L)]$ which is not of the required form. (Note the trig. identity $\cos A \sin B = \frac{1}{2}[\sin(A + B) - \sin(A - B)]$ which is useful here.)

Q12 $\boxed{\text{C}}$ Only options B and C are pure travelling waves. Each is of the form $a\cos\theta + b\sin\theta = (a^2 + b^2)^{1/2}\sin(\theta + \delta)$ where $\tan\delta = a/b$. Thus the amplitude of option C is $(0.03^2 + (-0.04)^2)^{1/2}L = 0.05L$ as required. (The amplitude of option B is $0.05\sqrt{2}L$.)

Q13 $\boxed{\text{B}}$ Only options B and C are pure travelling waves. An expression for the phase of a sinusoidal travelling wave is $kx - \omega t + \phi = \frac{2\pi}{\lambda}x - \omega t + \phi$. (See Sec.2-2 of Unit 2.) Thus the wavelength of option B is L and that of option C is $2\pi L$.

Q14 $\boxed{\text{E}}$ Options D, E and F are all standing waves. Option D is not a solution of the given wave equation (see Q11) and so we must choose between E and F. The frequency ν is found by looking at the coefficient of t in the options. The coefficient is ω or $2\pi\nu$. See Sec.2.3 of Unit 2. Thus options E and F have frequencies v/L and $v/2L$ respectively. Only E is a standing wave solution of frequency v/L.

Q15 $\boxed{\text{F}}$ The nodes of a standing wave are points of zero displacement. Options E and F are the standing wave solutions. Putting $x = 0$ into these, only option F gives zero. Similarly only option F gives zero for $x = L$.