6 **(a)** An X-ray spectrum from an X-ray machine is shown in Fig. 6.1

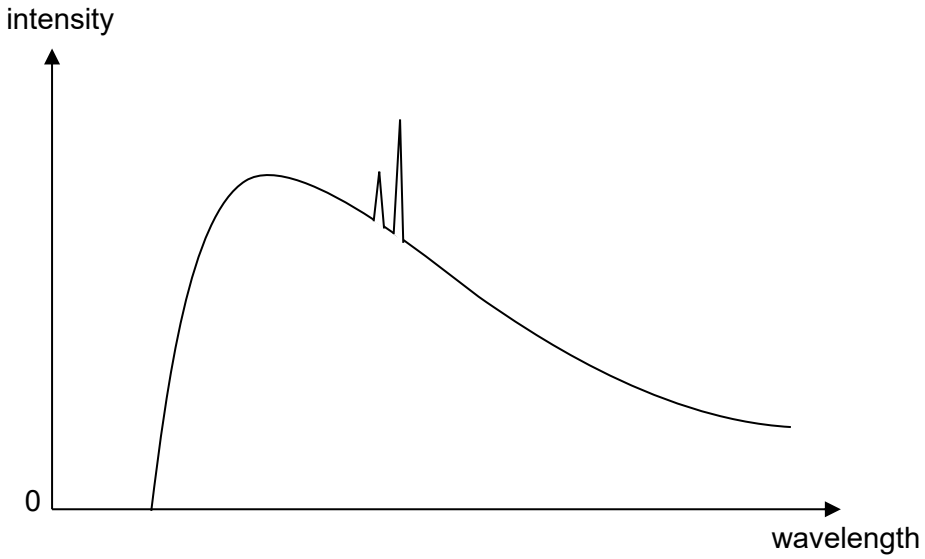

Fig. 6.1

(i) Explain why there is a minimum wavelength for the emitted X-rays.

……

……

……

……

…… [3]

(ii) The minimum wavelength of the spectrum in Fig. 6.1 is 0.068 nm. Calculate the accelerating voltage used in this X-ray machine to accelerate the electrons.

accelerating voltage = …… V [2]

(b) Fig. 6.2 shows some of the inner energy levels of the atom which is used in the metal target of the X-ray machine in part **(a)**.

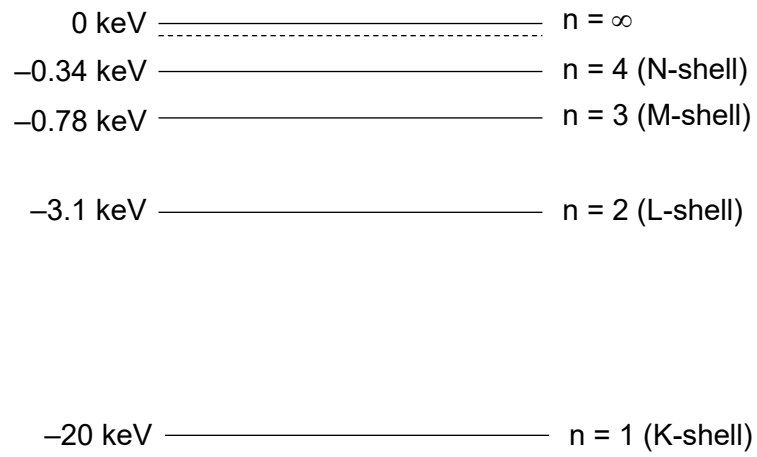

Fig. 6.2

(i) On Fig. 6.2, indicate with an arrow, the transition that gives rise to the K_α characteristic X-ray. [1]

(ii) Calculate the wavelength of the K_α characteristic X-ray for this metal target.

wavelength = ……..…… m [2]

(iii) Explain whether the K_α characteristic X-ray is produced in this X-ray machine.

……

……

……

……

……

…… [3]

(c) X-ray diffraction can be used to analyse the structure of long chains of molecules such as DNA molecules. Crystals consisting of these long chains of molecules act as diffraction grating for the X-ray. When X-ray is passed through the crystal, a diffraction pattern can be observed.

In one such analysis, X-rays of 0.11 nm passed through a crystal of DNA to produce a diffraction pattern.

(i) Estimate the order of magnitude of the spacing between the DNA molecules. Explain your answer.

……

……

…… [2]

(ii) Instead of X-ray, electron diffraction can sometimes be used instead to produce a diffraction pattern.

Calculate the momentum of the electrons which will produce the same diffraction pattern as the X-ray when passed through the same crystal of DNA.

momentum = …… N s [2]

Section B

Answer **one** question from this Section in the spaces provided.