6 **(a)** The energy levels of a hypothetical one-electron atom are given by

$$E_n = -\frac{27.9}{n^2}\ \text{eV}$$

where $n = 1, 2, 3, \ldots$

(i) Describe how line spectra can be explained using the idea of discrete electron energy levels in isolated atoms.

....

....

....

....[2]

(ii) Explain why the energy of each energy level is negative.

....

....

....[1]

(iii) Calculate the energies of the four lowest energy levels and construct a clearly labelled energy level diagram in the space below.

[3]

(iv) If the atoms are in the ground state and are bombarded by electrons of kinetic energy 26.5 eV, determine the highest energy level that an atom can reach. Show your working clearly.

highest energy level = ... [2]

(v) Calculate the shortest wavelength of the photons emitted when the atoms subsequently de excites.

shortest wavelength = ...nm [2]

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(b) In a modern X-ray tube, electrons are accelerated through a large potential difference and the X-rays are produced when electrons strike a metal target embedded in a large piece of copper.

The emission spectrum of the metal when it is bombarded by a beam of fast-moving electrons is shown in Fig. 6.1.

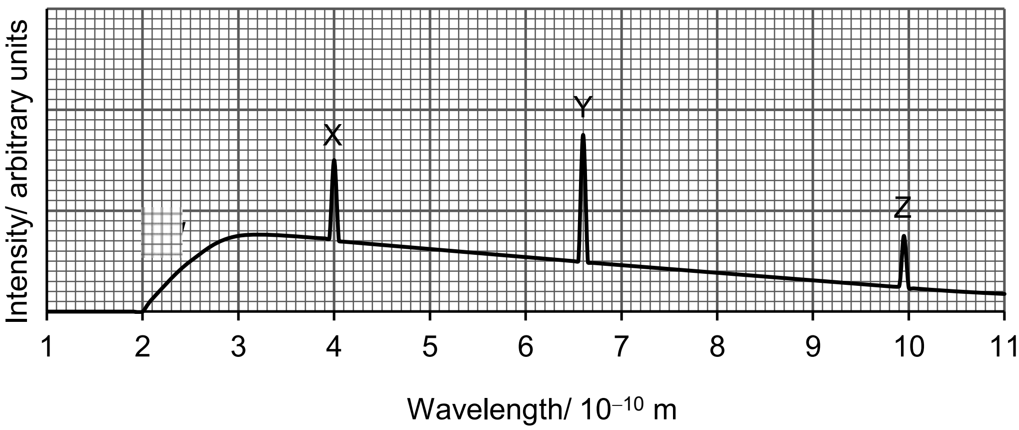

Fig. 6.1

(i) Calculate the accelerating potential of the X-ray tube.

accelerating potential = ... V [2]

(ii) Explain why there are sharp peaks X, Y and Z in the X –ray spectrum.

....

....

....

....[2]

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