8 **(a)** When monochromatic light is shone on a clean metal surface, electrons are emitted from the surface due to the photoelectric effect.

(i) State what is meant by the threshold frequency of the metal.

……..

……..

…… [1]

(ii) Explain why the photoelectric effect is not observed below the threshold frequency.

……..

……..

……..

……..

……..

…… [2]

(b) Monochromatic light of wavelength 5.40×10^{-7} m is incident on a metal surface which has a work function of 1.40×10^{-19} J.

(i) Calculate the threshold frequency for the metal.

threshold frequency = …… Hz [2]

(ii) Calculate the energy of a single photon of this light.

energy of photon = …… J [2]

(iii) Calculate the maximum speed of the emitted electrons.

maximum speed = …… m s^{-1} [3]

(iv) Calculate the de Broglie wavelength of the fastest electrons.

de Broglie wavelength = …… nm [2]

(c) Fig. 8.1 below represents the energy levels of the four lowest states of the hydrogen atom.

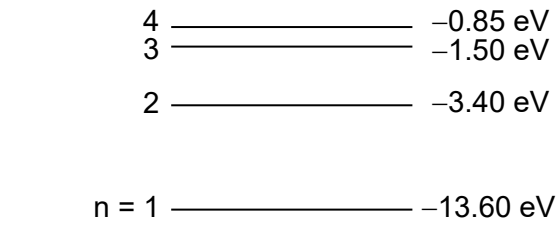

Fig. 8.1

(i) State what happens in the atom when line spectra are produced.

……..

……..

…… [1]

(ii) State the transition and determine the wavelength of one possible **visible** spectral line detected in the **emission** spectrum of atomic hydrogen, due to transitions between these states.

transition = level …… to ……

wavelength = …….. μm [3]

(d) Fig. 8.2 below represents a typical X-ray spectrum.

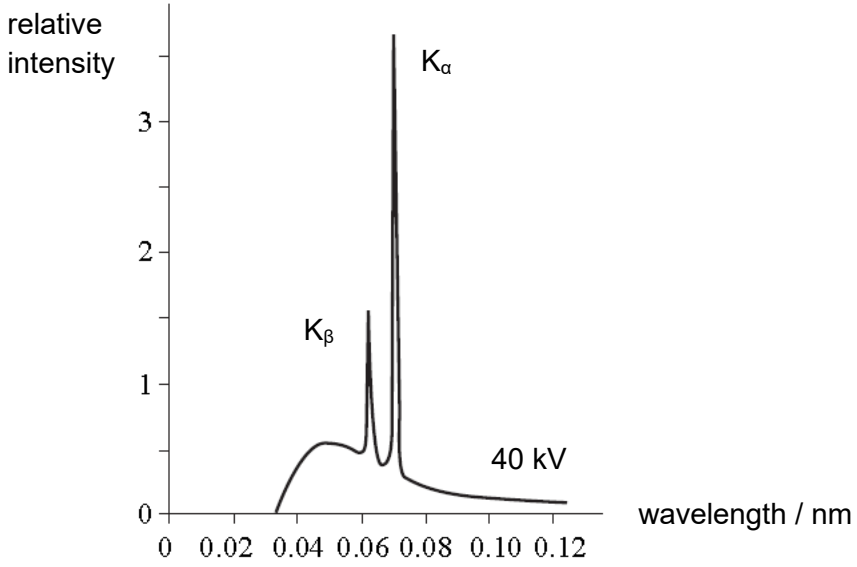

Fig. 8.2

(i) Distinguish between the mechanisms that produce **characteristic** X-ray spectra in Fig. 8.2 and the line spectra in part **(c)(i)**.

……..

……..

……..

……..

……..

…… [2]

(ii) Estimate the maximum velocity of the incoming electrons.

maximum velocity ≈ …… m s^{-1} [2]

END OF PAPER