9 (a) State:

(i) **two** pieces of evidence provided by the photoelectric effect for the particulate nature of electromagnetic radiation

1. .....

.....

2. .....

..... [2]

(ii) how a line emission spectrum may be explained on the basis of the existence of discrete electron energy levels in atoms.

.....

.....

.....

.....

..... [3]

(b) Some electron energy levels in an isolated atom are shown in Fig. 9.1.

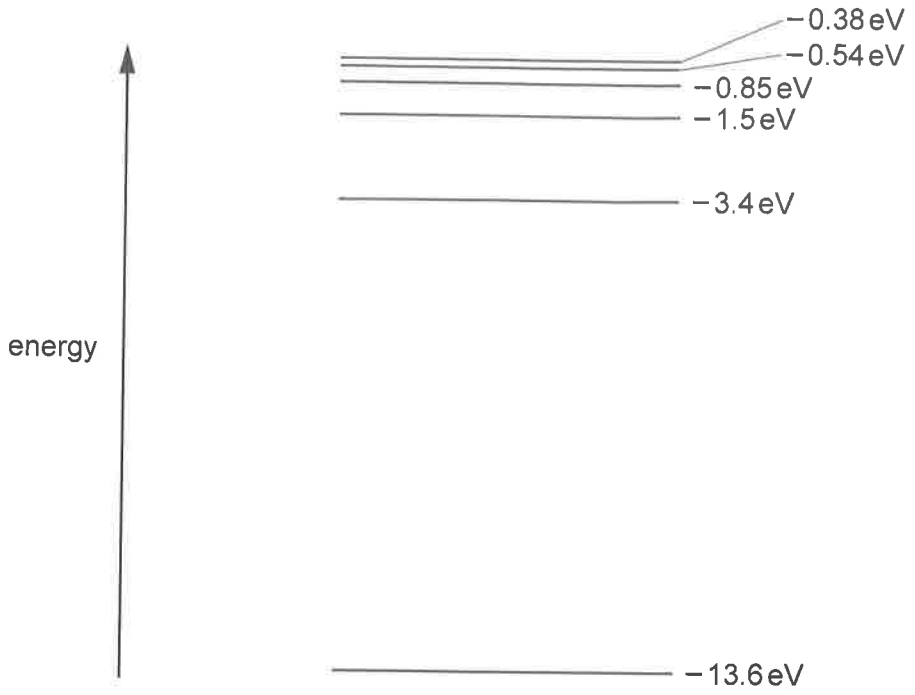

Fig. 9.1

In the visible section of the spectrum of electromagnetic radiation, purple light has the shortest wavelength.

(i) Calculate the energy, in eV, of a photon of purple light of wavelength 340×10^{-9} m.

energy = ... eV [3]

(ii) By reference to your answer in **(b)(i)**, explain why a visible line spectrum does **not** result from electrons de-exciting to the −13.6 eV energy level.

.....

.....

..... [2]

(c) The isotope beryllium-7 ($^{7}_{4}$Be) is radioactive with a half-life of 53 days. A beryllium-7 nucleus decays by the emission of a γ-ray photon of energy 0.48 MeV.
Initially, the total mass of undecayed beryllium-7 in a radioactive sample is 5.7×10^{-12} kg.

(i) Determine the probability of decay of a beryllium-7 nucleus in a time of 1.0 day.

probability = ... [1]

(ii) Calculate the number of undecayed beryllium-7 nuclei in the sample after 120 days.

number = ... [3]

(iii) State why, although the beryllium-7 is radioactive, the number of beryllium-7 nuclei in the sample does **not** change.

.....

..... [2]

(d) The beryllium-7 nuclei in **(c)** may be considered to be stationary before the emission of the γ-ray photons.

Determine the recoil speed of a beryllium-7 nucleus due to the emission of a γ-ray photon.

speed = ... $m\,s^{-1}$ [4]

[Total: 20]