7 **(a)** Explain what is meant by a *photon*.

.....

.....

..... [1]

(b) **(i)** Determine the maximum and minimum energy of photons spanning the visible spectrum.

maximum photon energy = ... eV

minimum photon energy = ... eV [1]

(ii) White light is passed through hydrogen gas. The emerging beam is passed through a diffraction grating.

Explain why there are dark lines observed in the resulting absorption spectrum despite all of the wavelengths that are absorbed are subsequently re-emitted.

.....

..... [1]

(iii) Fig. 7.1 shows some of the energy levels present in the hydrogen atom.

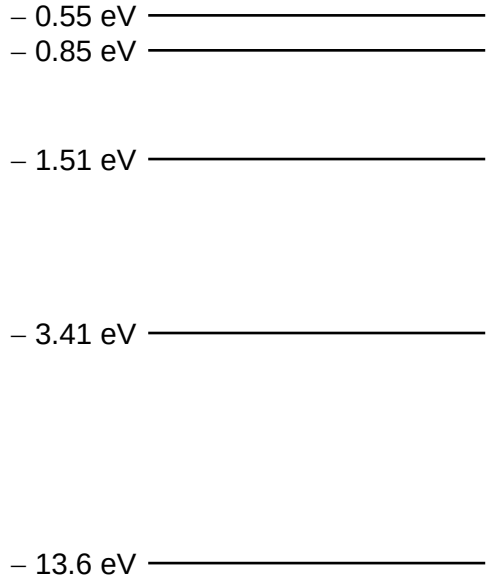

Fig. 7.1 (not to scale)

In Fig. 7.1, draw arrows to represent the electron promotion between energy levels that give rise to the dark lines observed in an absorption spectrum. [2]

(c) The hydrogen gas is now cooled to ground state.

(i) State and explain the changes, if any, to the resulting absorption spectrum.

.....

.....

.....

..... [2]

(ii) The white light source is switched off. An electron beam is accelerated from rest through potential difference V and made to pass through the cooled hydrogen gas. There are now three bright lines visible in the resulting emission spectrum.

1. Determine the minimum V for the above emission spectrum to occur.

minimum V = ... V [2]

2. Find the shortest wavelength of visible light emitted as part of the emission spectrum.

shortest wavelength = ... m [1]

[Total: 10]