3 Hydrogen gas at low pressure can be made to emit photons in a discharge tube using a high voltage supply, as shown Fig. 3.1.

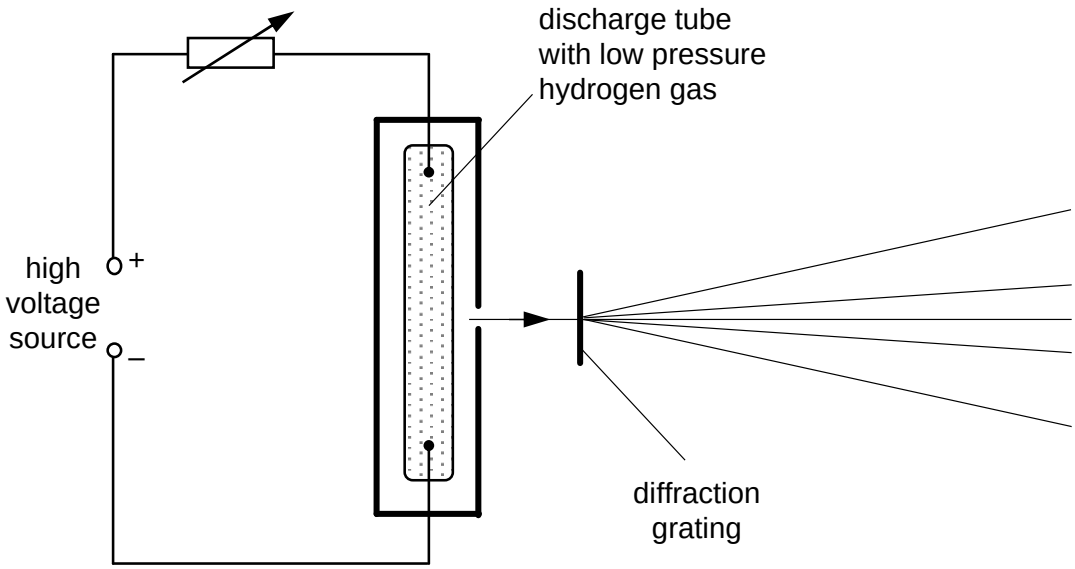

Fig. 3.1

The photons are incident normally on a diffraction grating and projected on a screen.

An emission line spectrum is observed.

(a) Explain what is meant by emission line spectrum.

……

…….. [1]

(b) Explain how the line spectrum of the hydrogen provides evidence for the existence of discrete energy levels in atoms.

……

……

……

……

……

…….. [3]

(c) Some electron energy levels in atomic hydrogen are illustrated in Fig. 3.2.

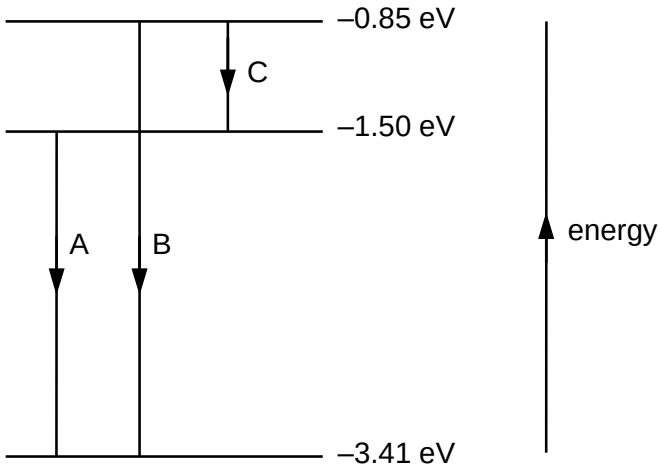

Fig. 3.2 (not to scale)

The electron transitions A and B cause light of visible wavelengths 654 nm and 488 nm to be emitted.

Explain why the third transition C in Fig. 3.2 cannot be observed.

……

……

……

…….. [3]

(d) The central maximum and the first order maxima of the two visible wavelengths from the hydrogen gas in **(c)** on the screen is shown in Fig. 3.3.

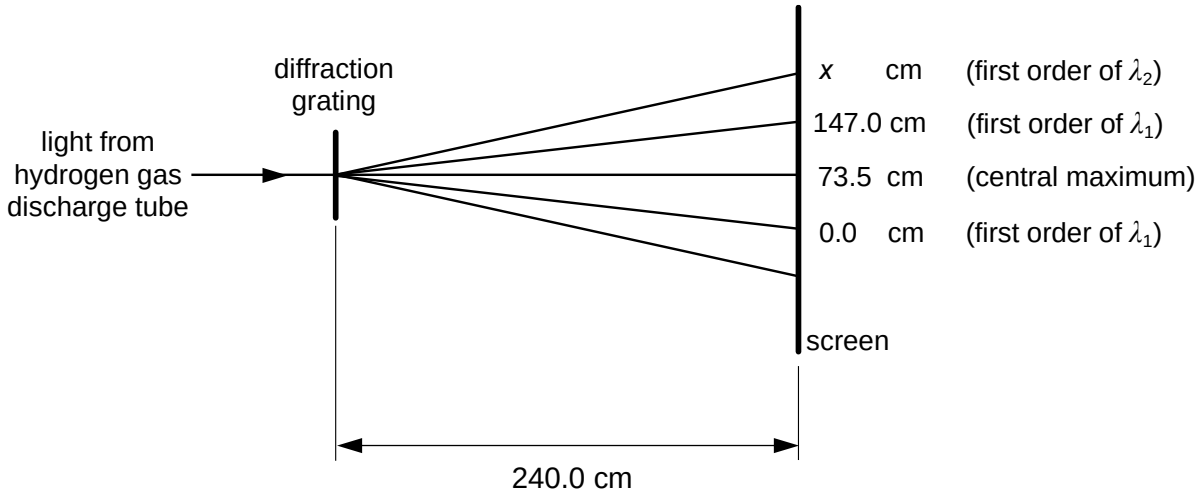

Fig. 3.3 (not to scale)

The screen is placed 240.0 cm from the diffraction grating.
The maxima positions on a scale on the screen is shown.

(i) Explain how the diffraction and the interference of light at the diffraction grating leads to the first order maxima for λ_1.

……

……

……

…… [3]

(ii) Determine the position x on the scale for λ_2.

x = …… cm [4]

[Total: 14]

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