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- The diagram illustrates the absorption spectrum of cool hydrogen gas. On the left, two horizontal arrows represent "incident light" with "wavelengths 400 nm – 700 nm". These arrows point towards a central, irregularly shaped grey cloud labeled "Cool hydrogen gas". From the right side of the cloud, two horizontal arrows represent "emergent light". These arrows show a continuous spectrum with several distinct dark vertical lines (Fraunhofer absorption lines) of varying widths, indicating that specific wavelengths of light have been absorbed by the gas.

**(a)** The spectrum of light emerging from the cloud of cool hydrogen gas is viewed with a spectrometer. Explain why this spectrum contains 2 dark lines.

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[4]

- $$\frac{1}{\lambda_m} = R \left( \frac{1}{4} - \frac{1}{m^2} \right)$$

where  $R$  is a constant of value  $1.097 \times 10^7 \text{ m s}^{-1}$  and  $m$  is an integer taking the values 3, 4, 5... etc.

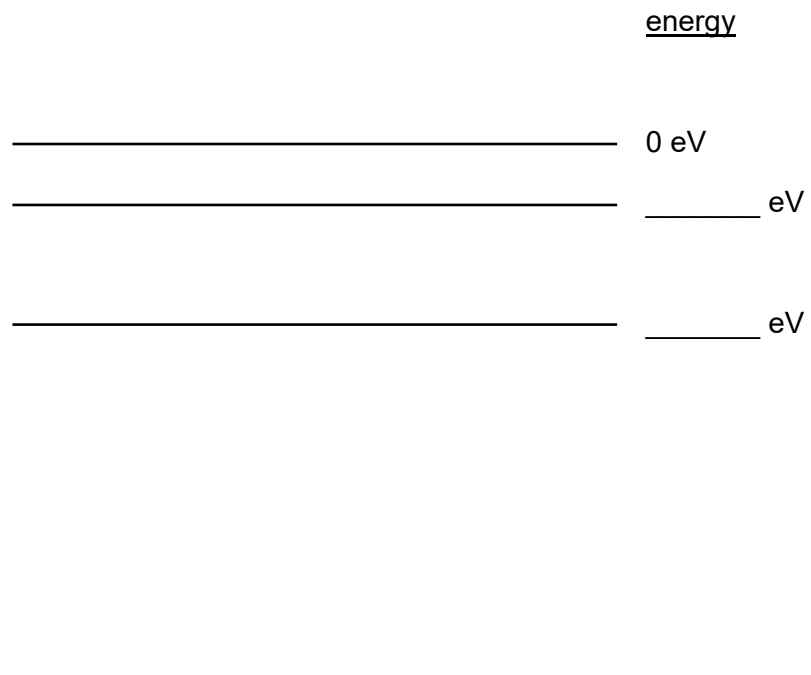
- (i) Calculate the value of the wavelength when  $m = 4$ .

wavelength = ..... m [2]

- (ii) Determine the minimum wavelength given by the equation.

minimum wavelength  
= ..... m [2]

- (iii) Some of the electron energy levels of the hydrogen atom in the gas are represented in Fig. 7.2.



**Fig. 7.2**

1. Use your answers from **(b)(i)** and **(b)(ii)** to determine the energy of the 3 other electron energy levels in Fig. 7.2. Write your answer in the blanks in Fig. 7.2.

[2]

2. On Fig. 7.2, draw, and label with D, the transitions giving rise to the 2 darks lines from **(a)**. [2]

[Total: 12]

## Section B

Answer **one** question from this Section in the spaces provided.