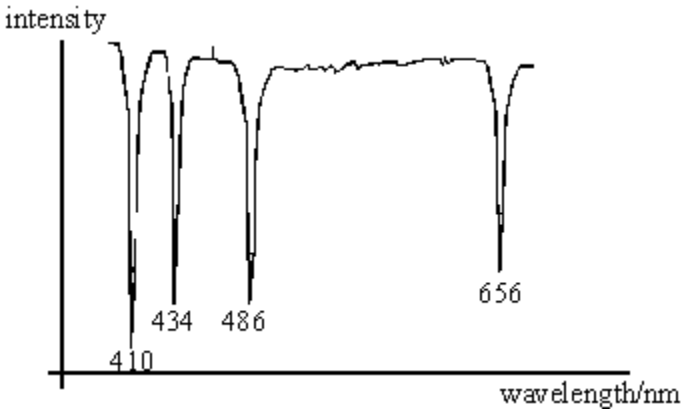
Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

(a) The graph shows part of the visible region of the spectrum of the star Vega.



The absorption lines are due to excited hydrogen atoms. The wavelength of each absorption is given in nm.

You may be awarded marks for the quality of the written communication provided in your answer.

(i) Explain how hydrogen atoms produce these absorption lines.

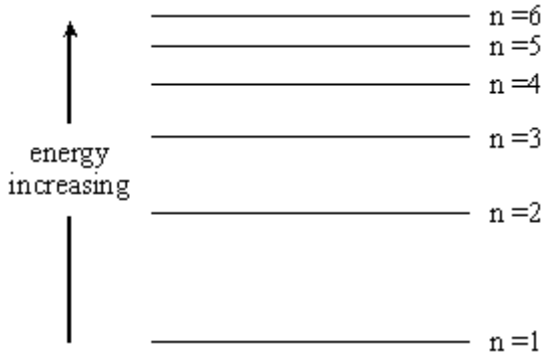
_____

_____

_____

_____

(ii) The diagram below shows the first six energy levels of a hydrogen atom. Draw an arrow to show the largest energy transition which produces an absorption line in the **visible** spectrum of Vega.



(iii) State the value of the wavelength corresponding to this transition.

_____

(iv) What is the name given to the series which gives rise to the visible region of the hydrogen spectrum?

_____

(v) For which spectral classes are these lines the dominant feature?

_____

(4)

(b) (i) The wavelength at maximum intensity in the spectrum of Vega has a value of 300 nm. Show that this corresponds to a value of about 10 000 K for the surface temperature of Vega.

_____

_____

_____

(ii) State the assumption made in your answer to (b)(i).

_____

(2)

(c) State the spectral class to which Vega belongs, giving a reason for your answer.

_____

_____

(1)

(Total 7 marks)

Q2.

(a) The original dish design of the Lovell Radio Telescope at Jodrell Bank used a 50 mm open wire mesh. Estimate the minimum wavelength detectable using this design.

_____

_____

(1)

(b) Before completion, the mesh was replaced by a solid metal surface of diameter 76 m capable of detecting radio signals as small as 60 mm wavelength. Calculate the resolving power of the telescope when detecting radiation of this wavelength.

_____

_____

_____

_____

(2)

(c) The Jodrell Bank Observatory also has a 13 m diameter radio telescope. State **two** advantages the telescope described in part (b) has over this smaller telescope when detecting radio waves of the same wavelength. Support each answer with a calculation.

advantage 1:

_____

_____

_____

_____

advantage 2:

_____

_____

_____

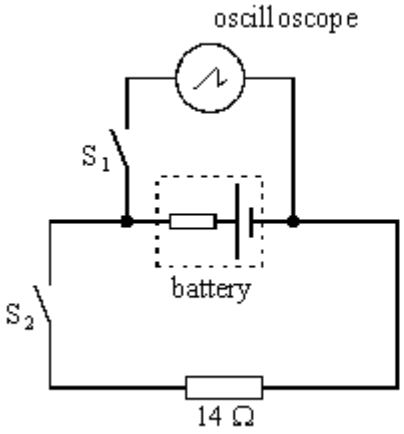
_____

(4)

(Total 7 marks)

Q3.

(a) The circuit shown in **Figure 1** may be used to determine the internal resistance of a battery. An oscilloscope is connected across the battery as shown. **Figure 2** represents the screen of the oscilloscope.



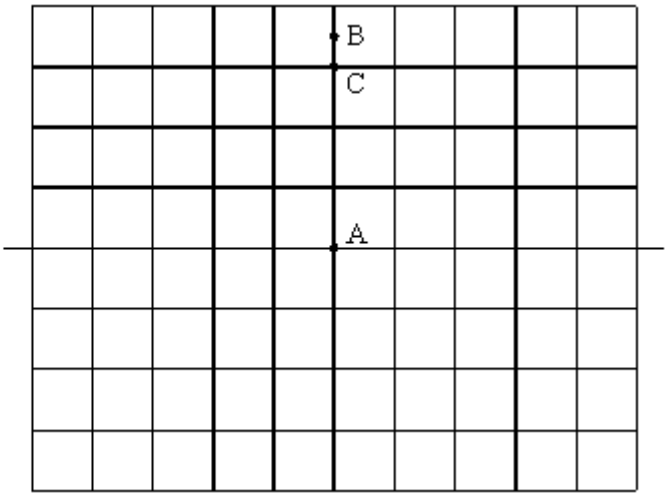


Figure 1 **Figure 2**

The time base of the oscilloscope is switched off throughout the experiment. Initially the switches S_1 and S_2 are both open. Under these conditions the spot on the oscilloscope screen is at A.

(i) Switch S_1 is now closed, with S_2 remaining open. The spot moves to B. State what the deflection AB represents.

_____

(ii) Switch S_1 is kept closed and S_2 is also closed. The spot moves to C. State what the

deflection AC represents.

_____

(iii) The vertical sensitivity of the oscilloscope is 0.50 V div^{-1}. Calculate the current through the 14 Ω resistor with both switches closed.

_____

_____

_____

(iv) Hence, calculate the internal resistance of the battery.

_____

_____

_____

(6)

(b) The oscilloscope is now connected to an alternating voltage source of rms value 3.5 V.

(i) Calculate the peak value of the alternating voltage.

_____

_____

(ii) Draw on **Figure 3** what you would expect to see on the oscilloscope screen, if the time base is still switched off and the voltage sensitivity is altered to 2.0 V div^{-1}.

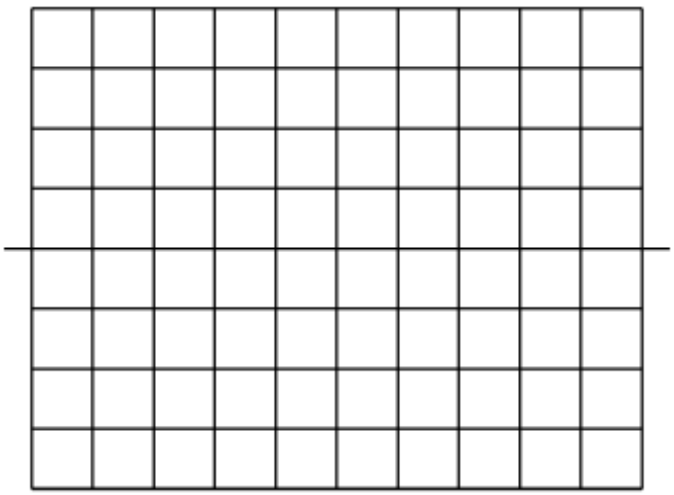


Figure 3

(3)

(Total 9 marks)