Name of the Student:_____
Max. Marks : 16 Marks **Time : 16 Minutes**

Q1.

Centaurus A is the nearest example of an active galactic nucleus. Many astronomers believe a supermassive black hole at the centre of such a galaxy produces a quasar as it consumes the material of its nearby stars.

(a) Explain what is meant by the event horizon of a black hole.

_____

_____

_____

(1)

(b) (i) The mass of the black hole is 60 million times the mass of the Sun. Calculate the radius of its event horizon.

answer = _____m

(2)

(ii) Calculate the average density of the matter within its event horizon.

answer = _____kg m^{-3}

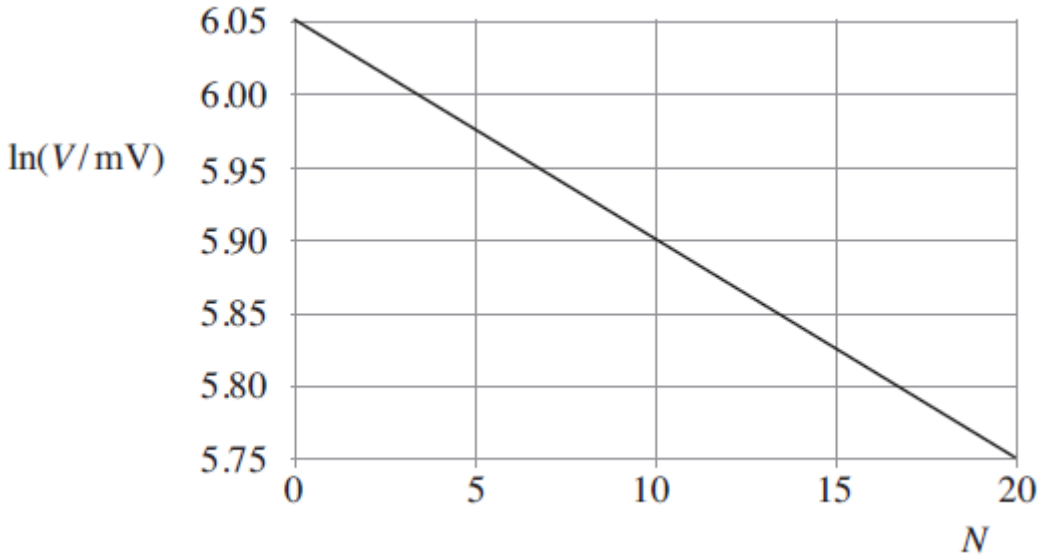
(2)

(Total 5 marks)

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Q2.

The voltage produced by a solar cell may be assumed to be proportional to the light intensity incident on it. A student uses a solar cell in an experiment to determine the half value thickness for glass i.e the thickness of glass that reduces the output voltage by half. The student uses a varying number N of microscope slides between a light source and the solar cell and measures the output voltage V for each value of N. The graph below was produced from the student's data.



Assuming that the output voltage of the solar cell is directly proportional to the light intensity incident upon it, the student intends to determine the half-value thickness of glass, ie the thickness of glass that would reduce the output voltage by half.

(a) Use the information provided in the student's graph to calculate $N_{0.5}$, the value of N equivalent to the half-value thickness of the glass.

_____

_____

_____

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_____

_____

_____

_____

(3)

(b) To determine the half-value thickness of the glass in mm, the student needs to make one additional measurement.

(i) Identify the measurement the student needs to make and explain how this is used to determine the half-value thickness of the glass.

_____

_____

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The student uses a micrometer screw gauge to make the additional measurement.

(ii) Identify **one** procedure that can be used to reduce the effect of random errors when making the measurement.

(iii) Identify **one** procedure that can be used to detect, and hence correct, for possible systematic errors in the measurements made with the micrometer screw gauge.

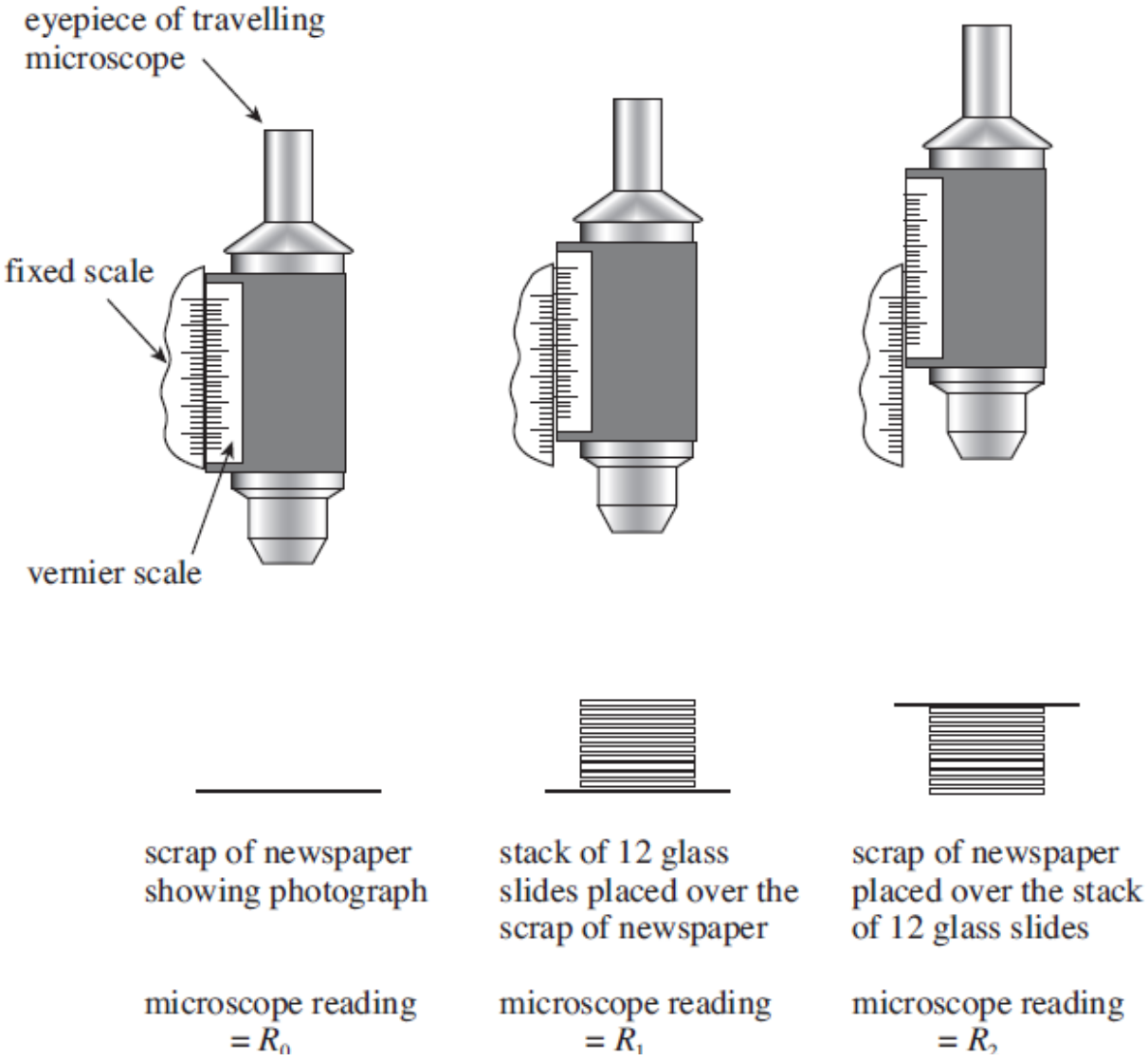
(3)

The student uses a travelling microscope to learn more about the properties of the glass slides.

The eyepiece of the microscope is arranged to move vertically up or down above a scrap of newspaper showing a photograph.
The photograph is composed of dots which are only clearly visible when viewed through the microscope. By adjusting the position of the microscope the student brings the dots into focus and then reads the position of the microscope, R_0, using the vernier scale.
The student then places a stack of 12 slides over the photograph and refocuses the microscope. She records the new reading, R_1.
Finally, she places the photograph on top of the slides, refocuses the microscope, and records the new reading R_2.

The sequence of operations is illustrated below.

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The readings made by the student are shown in the table below.

R_0/mm	R_1/mm	R_2/mm
2.74	**7.31**	**17.02**

(c) Assuming that the slides have identical dimensions, use the readings to determine the thickness of one glass microscope slide.

_____

_____

(1)

(d) Determine n, the refractive index of the glass, given by $n = \frac{R_2 - R_0}{R_2 - R_1}$.

_____

_____

(1)

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(e) The uncertainty in each of the readings R_0, R_1 and R_2, is 0.04 mm.

(i) State the uncertainty in $R_2 - R_0$.

_____

(ii) State the uncertainty in $R_2 - R_1$.

_____

(iii) Hence calculate the percentage uncertainty in n.

_____

_____

_____

_____

_____

_____

(3)

(Total 11 marks

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