Rewarding Learning

ADVANCED
General Certificate of Education
2022

Centre Number

Candidate Number

Physics

Assessment Unit A2 3B

assessing

Practical Techniques
and Data Analysis

[APH32]

APH32

WEDNESDAY 11 MAY, MORNING

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all four** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 50.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question.
You may use an electronic calculator.

1 Hubble's law states that the recessional velocity of distant galaxies is directly proportional to the distance of the galaxy from the observer.

A plot of the recessional velocity and its distance from Earth is shown in **Fig. 1.1**.

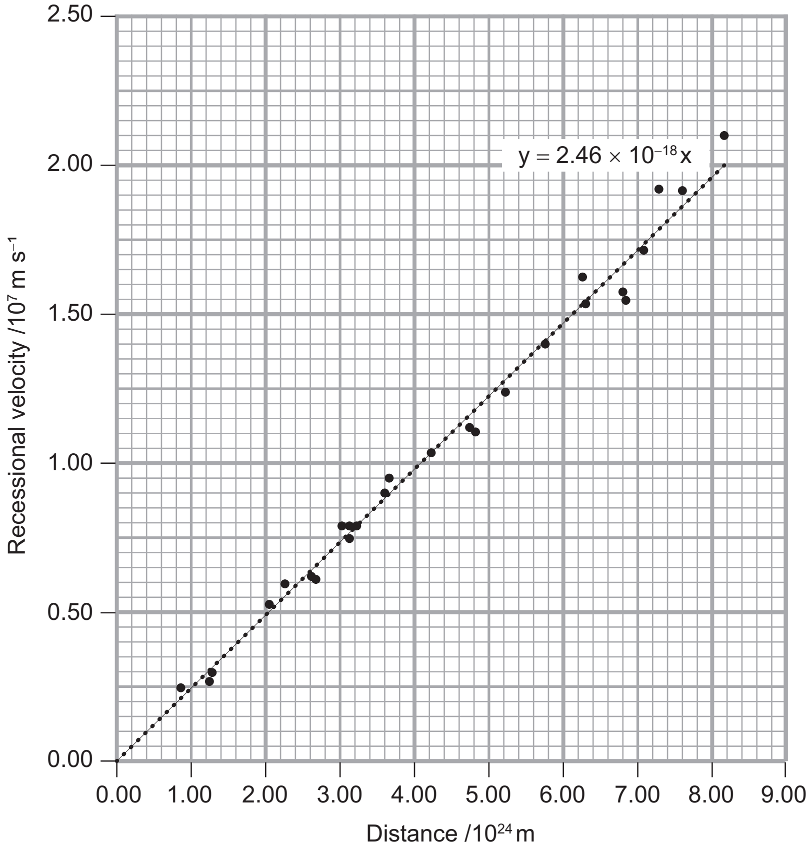

Fig. 1.1

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The age of the universe can be determined by calculating the reciprocal of the gradient.

(a) The equation for the straight line of best fit is given on the graph. Use this to calculate the age of the universe and state the unit.

age = ______________

unit = ______________ [2]

(b) **(i)** On **Fig. 1.1**, draw an extreme fit line that would allow you to estimate the maximum age of the universe. [2]

(ii) Use this extreme fit line to calculate the maximum age of the universe.

Maximum age = __________________ [3]

[Turn over

2 A student is provided with a tuning fork which has a frequency stated to be 440 Hz ± 5%. The student uses a cathode ray oscilloscope to determine the precise frequency of the tuning fork.

(a) (i) State the name of the other piece of equipment the student needs to allow the oscilloscope to display a sound wave.

______________________ [1]

(ii) **Fig. 2.1** shows the trace on the screen of the cathode ray oscilloscope immediately after the tuning fork has been struck. Which of the time-base settings shown on **Fig. 2.1** must the student be using?

time-base setting = __________________ [3]

(iii) The student has initially set the Y-sensitivity to 1 V cm^{-1}. State the value for the Y-sensitivity that the student should select to ensure the full extent of the wave remains on the screen but is as large as possible.

Y-sensitivity setting = ________________ [1]

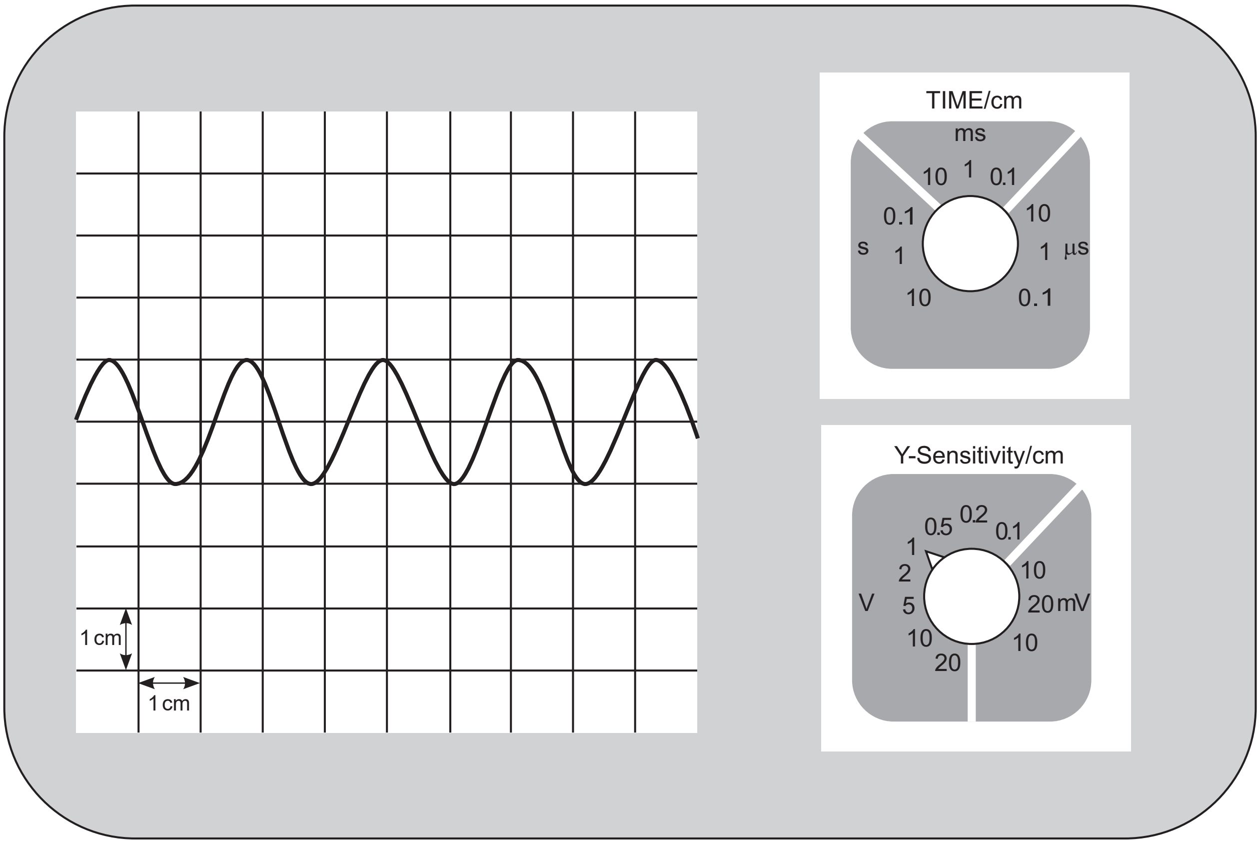

Fig. 2.1

(b) **Fig. 2.2** shows the display of the oscilloscope screen after the student has adjusted the Y-sensitivity setting. The time-base setting is unchanged.

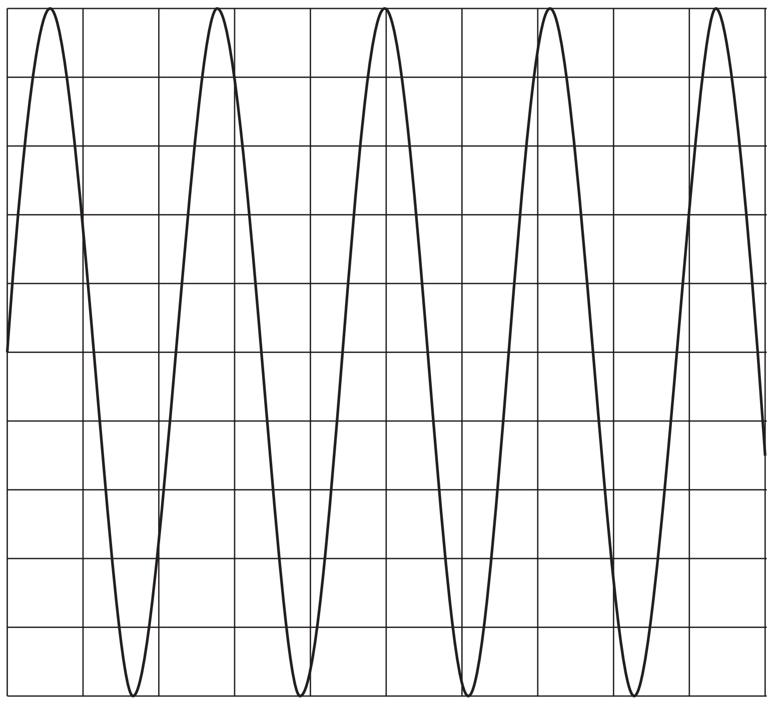

Fig 2.2

(i) Use **Fig. 2.2** to determine an **accurate** value for the time period of the wave.

Time period = ____________________ s [2]

(ii) State whether the frequency of the tuning fork falls within the range stated by the manufacturer. **Show calculations to support your conclusion.**

____

____

______________________________________ [3]

3 Warm water was poured into an empty beaker submerged in an ice bath. The temperature T of the water in the beaker was then measured by a student every 2 minutes as the temperature of the water decreased. The results the student recorded are shown in **Table 3.1**.

Table 3.1

Time / s	**T / °C**	**ln(T / °C)**
120	64	
240	50	
360	39	
480	30	
600	23	
720	18	

The temperature of the water T at time t is given by **Equation 3.1**.

$$T = T_o e^{-t/k}$$ **Equation 3.1**

where:

T_o is the initial temperature of the water in the beaker
k is a constant

(a) (i) Show that a graph of ln(T) against t is a straight line.

[3]

(ii) State how the value for the constant k could be determined from the graph.

____

____ [2]

(b) (i) Calculate the values for ln(T/°C) and insert them into the final column of **Table 3.1**. Record these values **to 2 decimal places**. [2]

(ii) Draw a graph of ln T against t on the grid of **Fig. 3.1**. Choose suitable scales for the axes, plot the points and draw the best fit line for the points. [5]

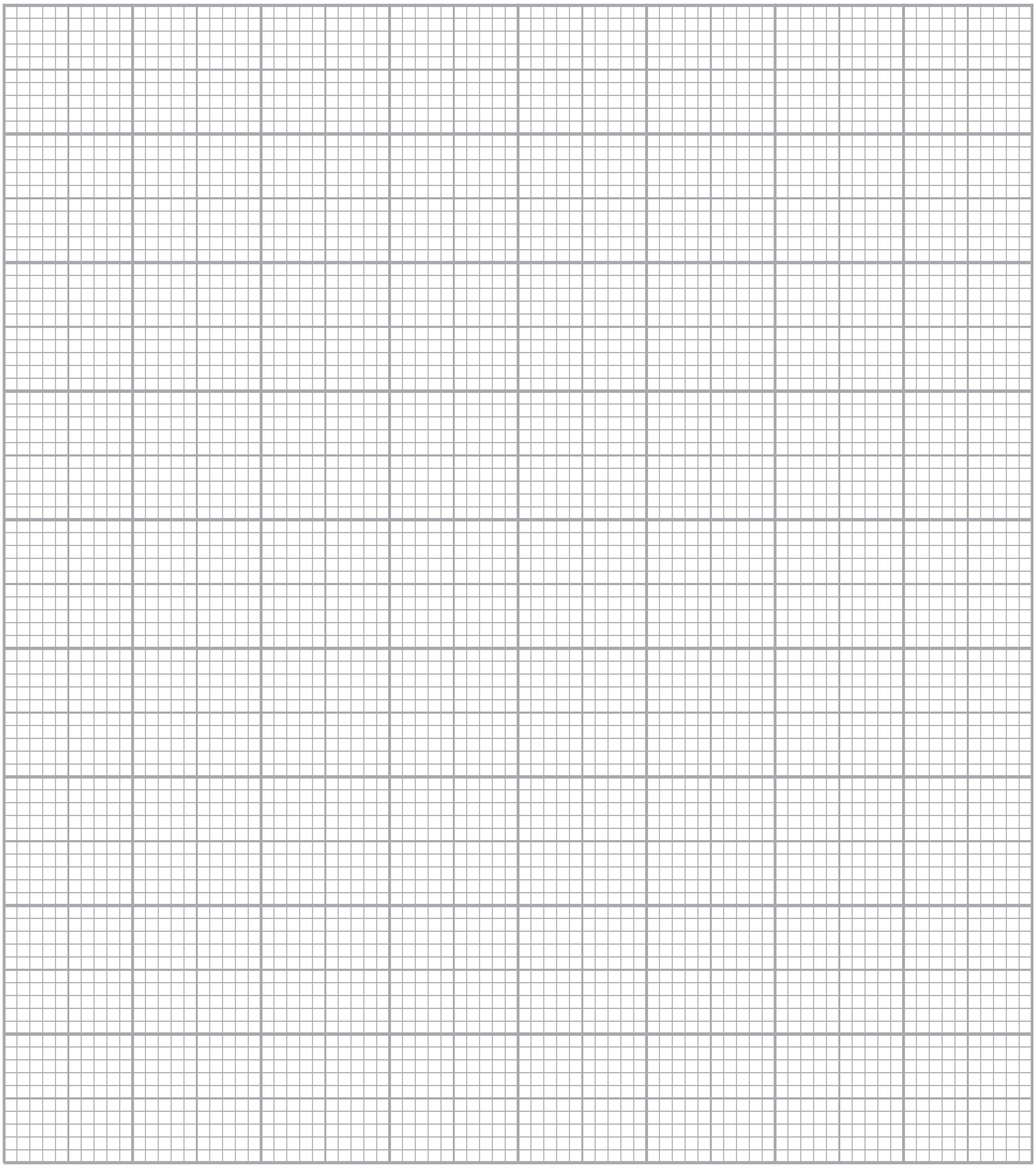

Fig. 3.1

(iii) Use your graph to find the initial temperature T_o of the water.

T_o = ____________ °C [3]

[Turn over

4 A student wishes to determine the resistivity of a metal wire whose length is greater than 50 cm and diameter is less than 1 cm.

(a) The student measured the potential difference across and the current through the wire using digital meters. The circuit is shown in **Fig. 4.1**.

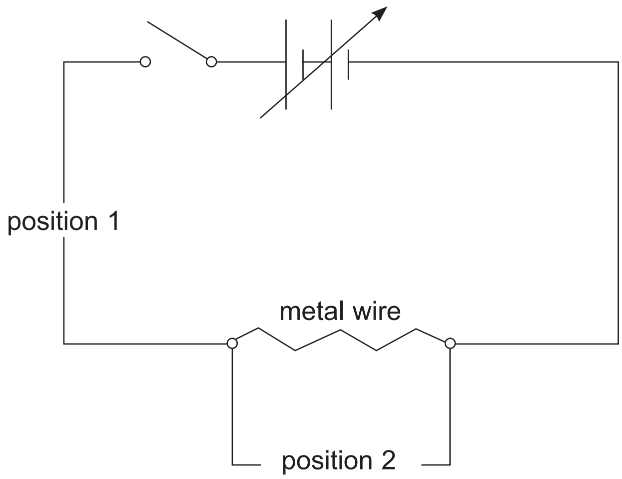

Fig. 4.1

(i) State the names of the measuring instruments that need to be placed in position 1 and position 2.

Position 1 ________________

Position 2 ________________ [2]

(ii) Explain why it is important to include a switch in this circuit.

____

____

____

____ [2]

(iii) State which instrument should be used to measure the following quantities and how, in addition to repeating and averaging, the instrument should be used for each reading to ensure it is as accurate as possible.

Quantity: Length of wire

Instrument: ____________________________

How to gain an accurate value:

____

____

____

____

Quantity: Diameter

Instrument: ____________________________

How to gain an accurate value:

____

____

____

____ [4]

(b) The resistance R of a wire of cross-section area A is given by **Equation 4.1**.

$$R = \rho\frac{L}{A}$$ **Equation 4.1**

(i) Using **Equation 4.1** as a starting point, show that the resistivity ρ is given by **Equation 4.2**.

$$\rho = \frac{\pi V d^2}{4LI}$$ **Equation 4.2**

where V is voltage, I is current, L is length and d is diameter.

[2]

(ii) The readings the student obtained are given in **Table 4.1**. State the absolute uncertainty and percentage uncertainty in each of the readings.

Table 4.1

Quantity	Reading	Absolute uncertainty	Percentage uncertainty
Voltage	0.41V		
Current	1.06 A		
Length	91.2 cm		
Diameter	2.64 mm		

[4]

(iii) Calculate the resistivity of the metal and the percentage uncertainty in the quantity.

ρ = ________________ Ω m ± ________ % [3]

(iv) Using your answer to part **(iii)**, calculate the absolute uncertainty in the resistivity.

Absolute uncertainty = ____________ Ω m [1]

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For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
Total Marks	

Examiner Number