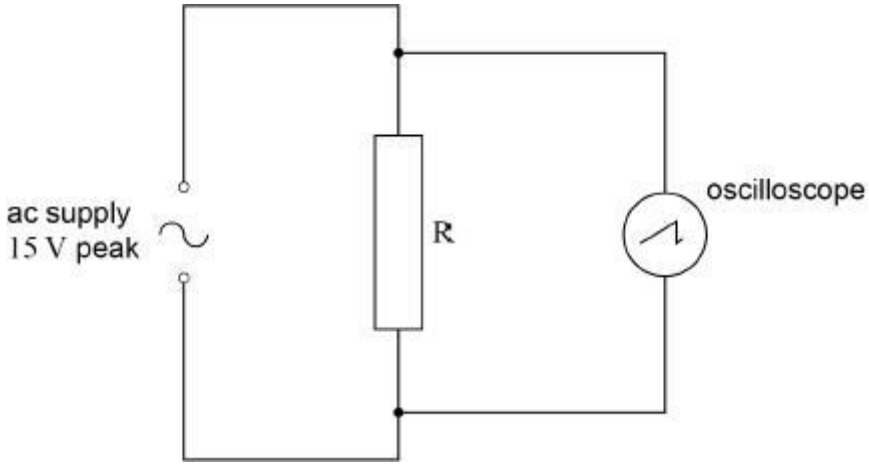
Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Q1.

Figure 1 shows an oscilloscope connected across resistor R which is in series with an ac supply. The supply provides a sinusoidal output of peak voltage 15 V.

Figure 1



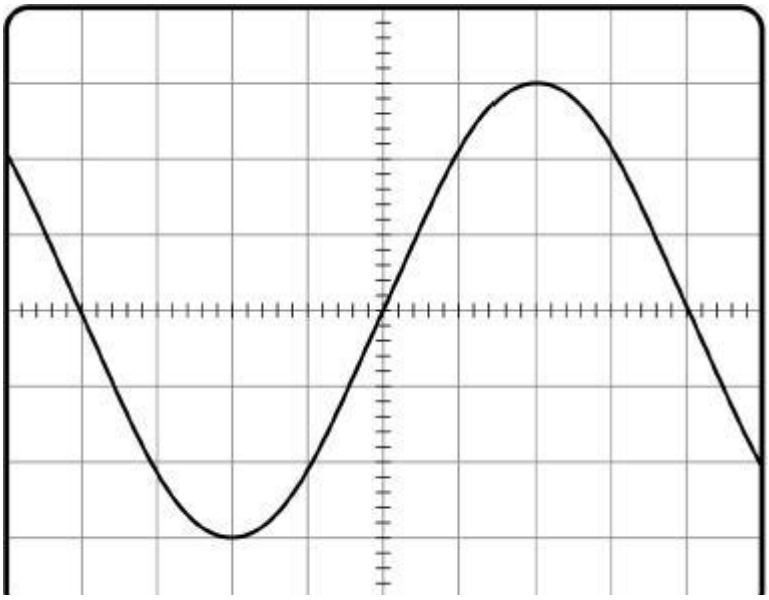
(a) Calculate the rms voltage of the supply.

rms voltage = _____ V

(1)

Figure 2 shows the trace of the waveform displayed on the oscilloscope.

Figure 2



(b) Determine the *y*-voltage gain of the oscilloscope used for **Figure 2**.

y-voltage gain = _____ V div^{-1}

(1)

(c) A dc supply gives the same rate of energy dissipation in R as the ac supply in **Figure 1**.

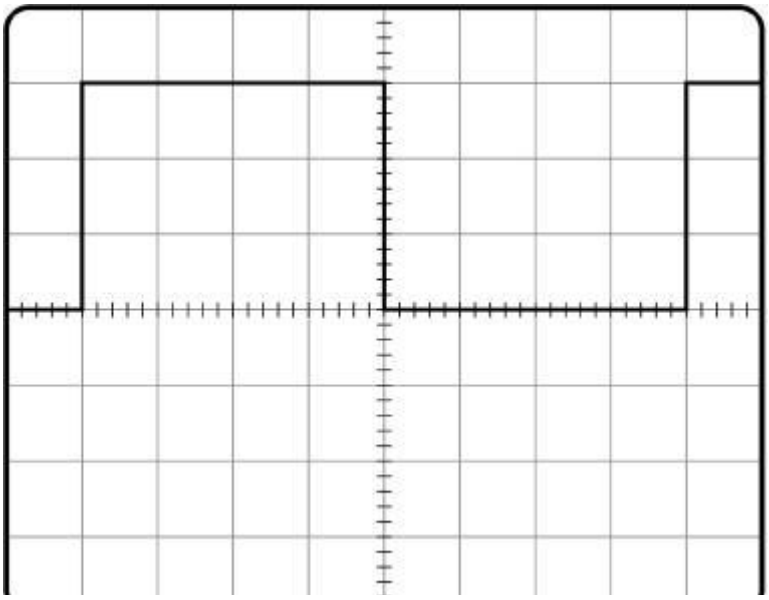
Draw the trace of the output of the dc supply on **Figure 2**.
The oscilloscope settings remain the same.

(1)

(d) The ac supply shown in **Figure 1** is replaced with a square-wave generator operating between 0 and +15 V.

Figure 3 shows the trace of the new waveform displayed on the oscilloscope. The time-base is set to 5.0×10^{-4} s div^{-1}.

Figure 3



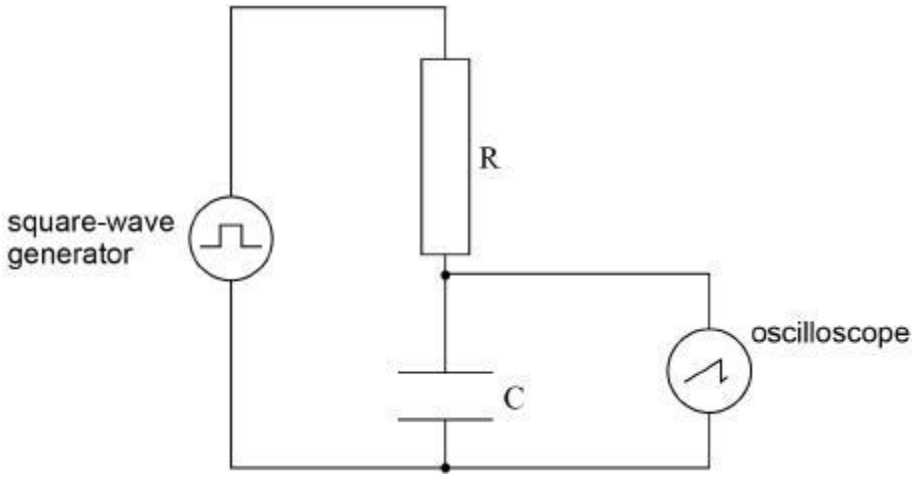
Calculate the frequency of the square waves.

frequency = _____ Hz

(1)

(e) **Figure 4** shows the arrangement with the square-wave generator connected to an RC circuit.
A capacitor C is placed in series with the resistor R.
The oscilloscope is connected across the capacitor C.

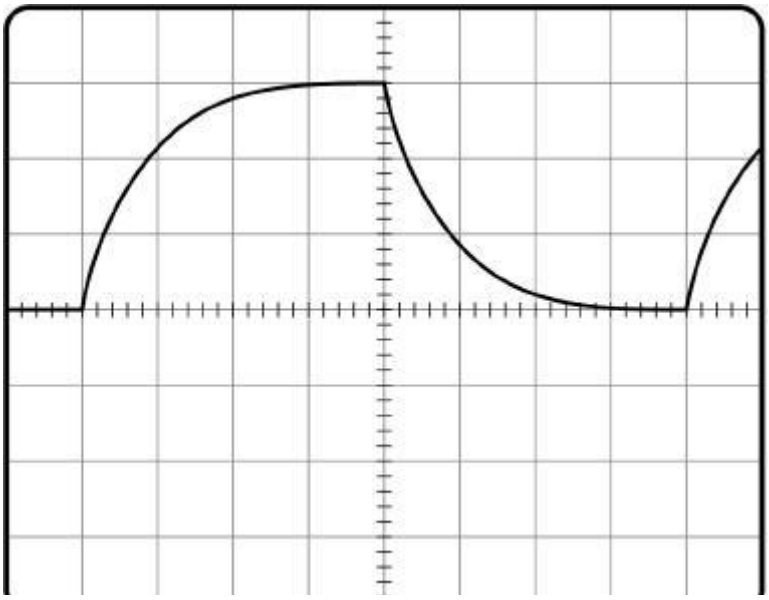
Figure 4



The capacitor charges and discharges.

Figure 5 shows the trace of the waveform displayed on the oscilloscope. The settings of the oscilloscope remain the same as in part (d).

Figure 5



Deduce the time constant for the RC circuit, explaining each step of your method.

time constant = _____ s

_____

_____

_____

_____

_____

_____

(3)

(f) State and explain a change to **one** control setting on the oscilloscope that would reduce the uncertainty in the value of the time constant.

_____

_____

_____

_____

_____

_____

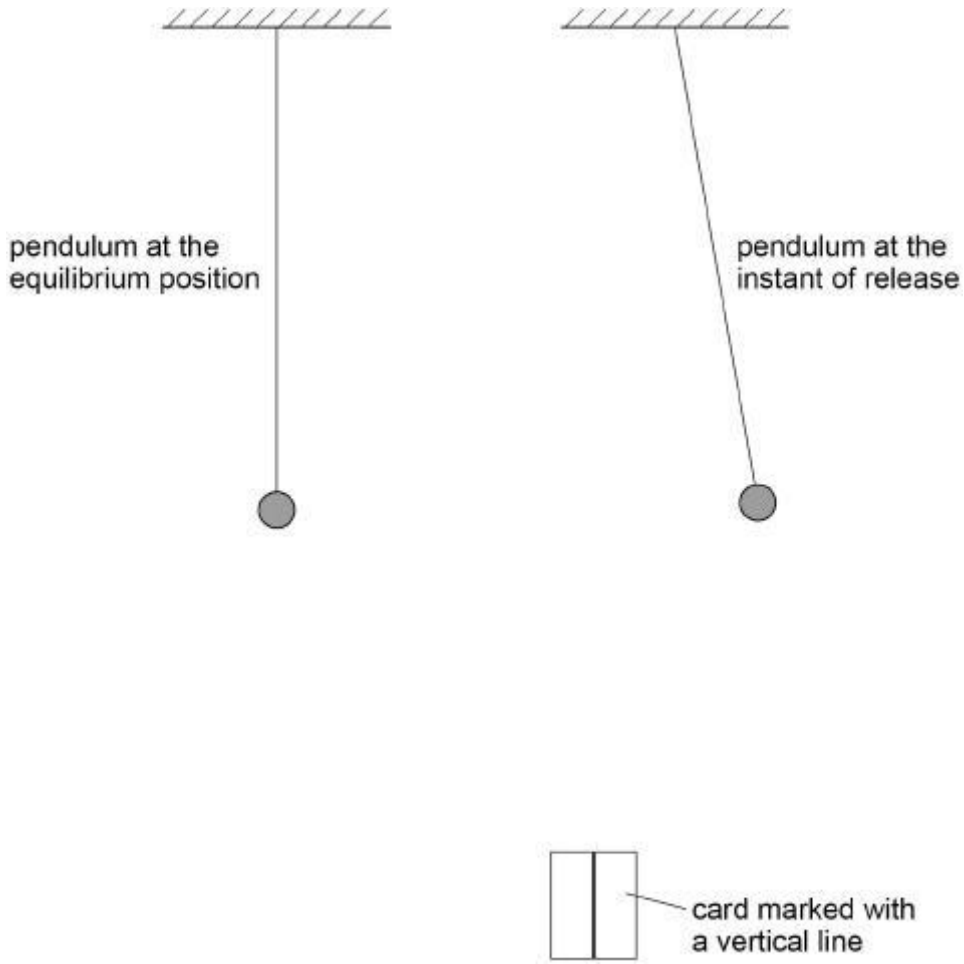
(2)
(Total 9 marks)

Q2.

A simple pendulum performs oscillations of period T in a vertical plane.

Figure 1 shows views of the pendulum at the equilibrium position and at the instant of release.
Figure 1 also shows a rectangular card marked with a vertical line.

Figure 1



(a) The card can be used as a fiducial mark to reduce uncertainty in the measurement of T.

Annotate **Figure 1** to show a suitable position for the fiducial mark. Explain why you chose this position.

_____

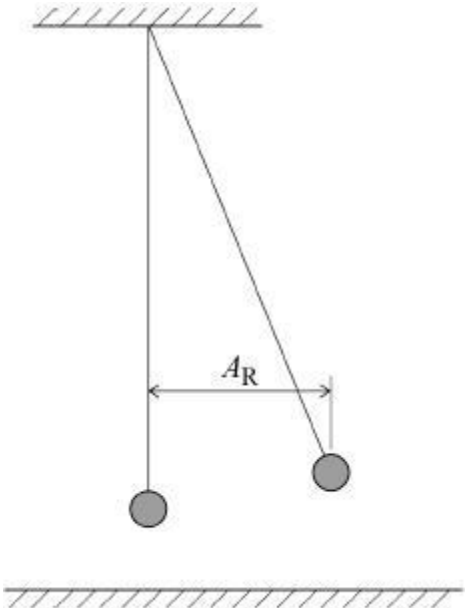
_____

_____

(2)

(b) The period of the pendulum is constant for small-amplitude oscillations.
Figure 2 shows an arrangement used to determine the maximum amplitude that can be considered to be small, by investigating how T varies with amplitude.

Figure 2

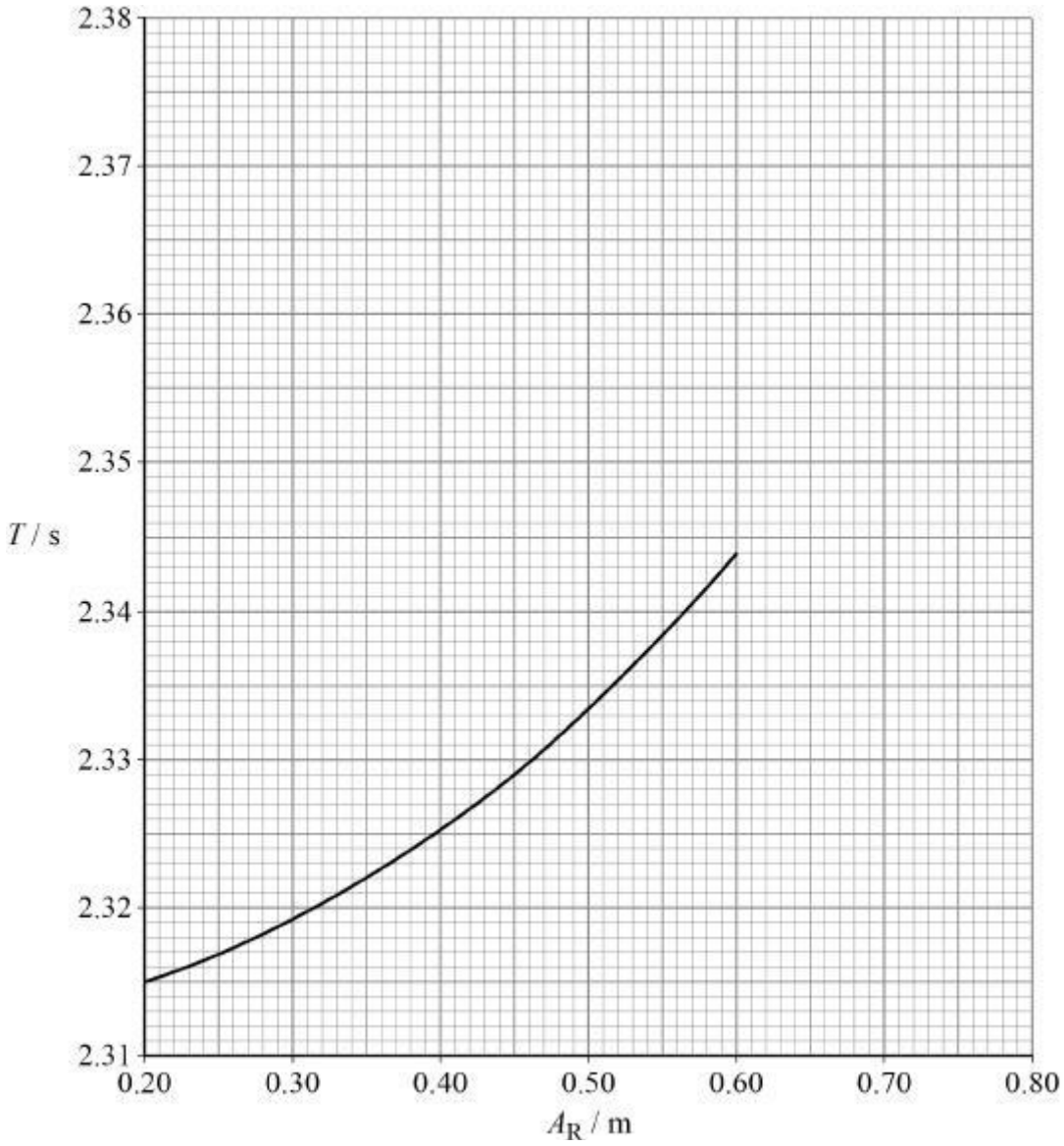


Describe a suitable procedure to determine A_R, the amplitude of the pendulum as it is released. You may add detail to **Figure 2** to illustrate your answer.

(2)

(c) **Figure 3** shows some of the results of the experiment.

Figure 3



Estimate, using **Figure 3**, the expected percentage increase in T when A_R increases from 0.35 m to 0.70 m.
Show your working.

percentage increase = _____ %

(3)

In another experiment the pendulum is released from a fixed amplitude.
The amplitudes A_n of successive oscillations are recorded, where n = 1, 2, 3, 4, 5... .

Table 1 shows six sets of readings for the amplitude A_5.

Table 1

A_5 / m	0.217	0.247	0.225	0.223	0.218	0.224

(d) Determine the result that should be recorded for A_5.

Go on to calculate the percentage uncertainty in this result.

A_5 = _____ m

percentage uncertainty = _____ %

(3)

(e) **Table 2** shows results for A_n and the corresponding value of ln(A_n / m) for certain values of n.

Table 2

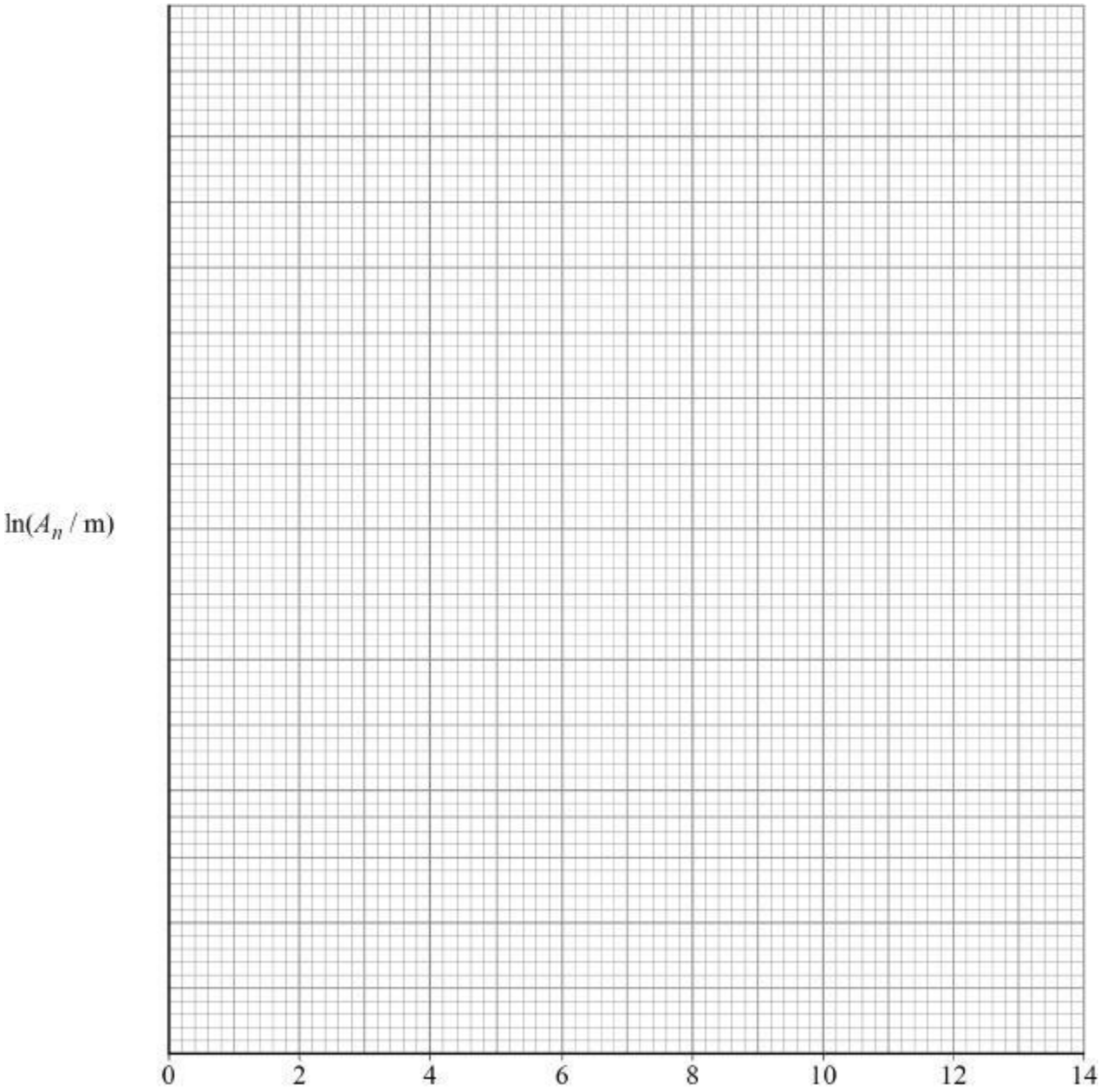
n	A_n / m	ln(A_n / m)
2	0.238	−1.435
4	0.225	
7	0.212	−1.551
10	0.194	−1.640
13	0.183	−1.698

Complete **Table 2**.

(1)

(f) Plot on **Figure 4** a graph of ln(A_n / m) against n.

Figure 4



(g) It can be shown that

$$A_n = A_0\,\delta^{-n}$$

where A_0 is the amplitude of release of the pendulum
δ is a constant called the damping factor.

Explain how to find δ from your graph.
You are **not** required to determine δ.

_____

_____

_____

(2)

(Total 15 marks)