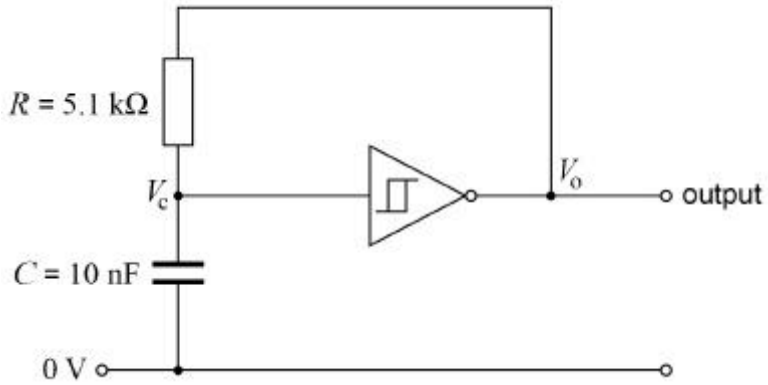
Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Q1.

(a) **Figure 1** shows an astable circuit based on a NOT logic gate. The symbol in the centre of the logic gate means that the output V_o changes at two different input values of V_c depending on whether the input voltage is rising or falling.

Figure 1



The pulse repetition frequency (PRF) for this particular circuit is given by:

$$\frac{1}{1.4\,RC}$$

Calculate the PRF in kHz

PRF = _____ kHz

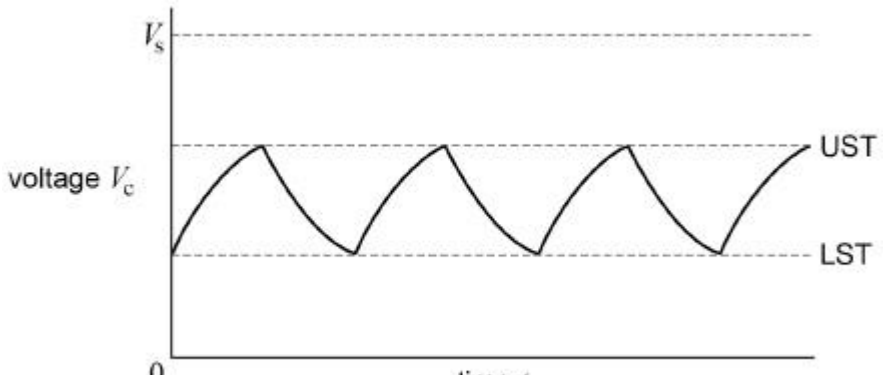
(1)

(b) The supply voltage to the NOT gate is V_s

- When V_c increases and reaches the upper switching threshold (UST), the output of the NOT gate will switch from V_s to 0 V
- When V_c decreases and reaches the lower switching threshold (LST), the output of the NOT gate will switch from 0 V to V_s

The graph in **Figure 2** shows V_c constantly changing as the capacitor charges and discharges.

Figure 2



Draw on **Figure 2** the output voltage V_o for the astable circuit.

(1)

(c) The circuit in **Figure 1** can be modified by the addition of a resistor to vary the PRF.

The astable is to be modified so that it produces a frequency 4 times that of the original.

Calculate the value of the resistor that should be added to the circuit and explain where in the circuit this additional resistor should be placed.

value of resistor = _____ kΩ

_____

_____

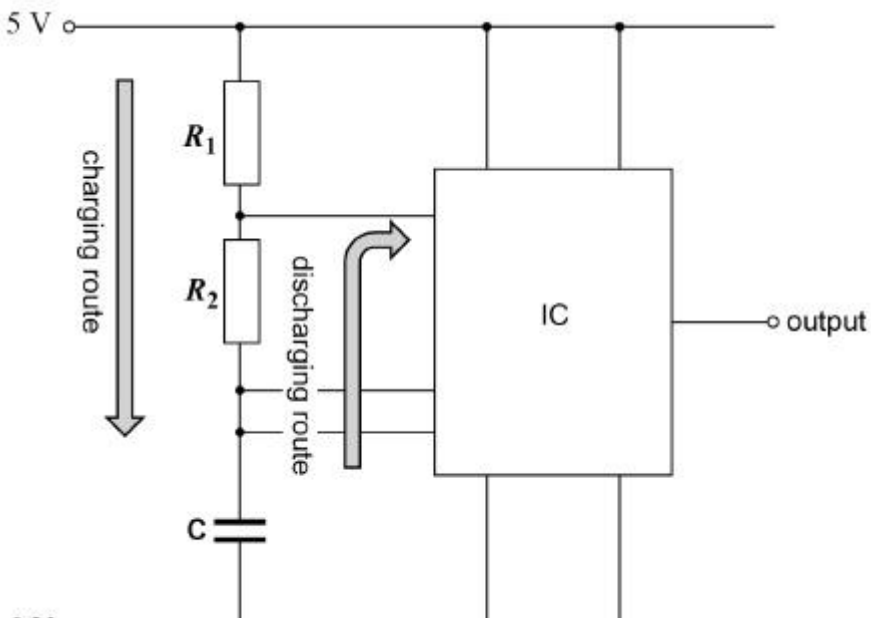
_____

_____

(2)

(d) In another astable, two resistors (R_1 and R_2) and a capacitor **C** form a timing chain to control the mark and space times for a square wave produced at the output of the integrated circuit (IC) shown in **Figure 3**.

Figure 3



The charging time for the capacitor **C** is: $t_C = 0.7 \times (R_1 + R_2) \times C$

The discharging time for the capacitor **C** is: $t_D = 0.7 \times R_2 \times C$

Calculate, in kΩ, values for $\boldsymbol{R_1}$ and $\boldsymbol{R_2}$ needed to produce a 5 kHz signal with 75% duty cycle given that the capacitor **C** has a value of 10 nF

$\boldsymbol{R_1}$ = _____ kΩ

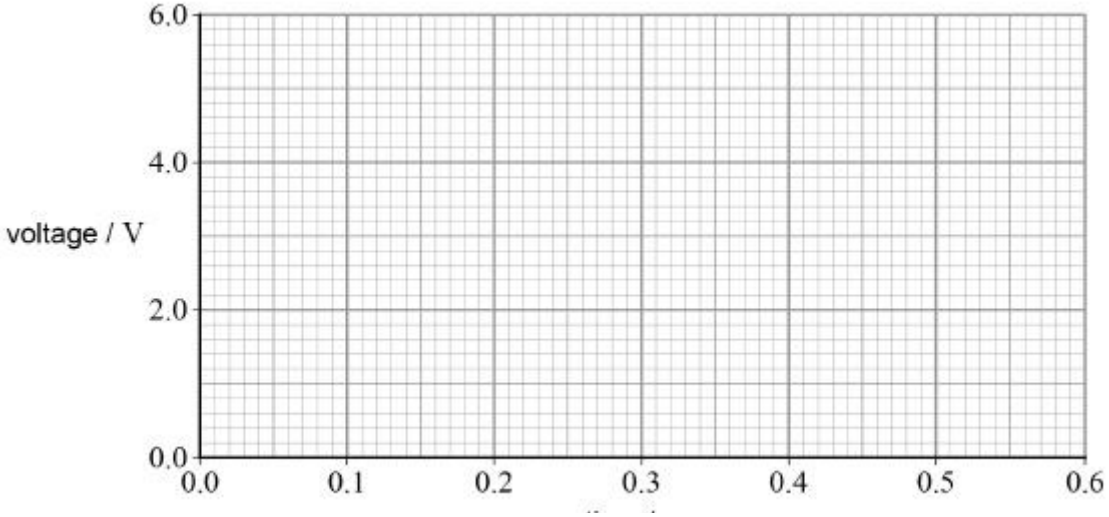
$\boldsymbol{R_2}$ = _____ kΩ

(2)

(e) The output of the IC in **Figure 3** is 5 V during the charging period and 0 V during the discharging period.

Draw on **Figure 4** the wave pattern that represents this signal.

Figure 4



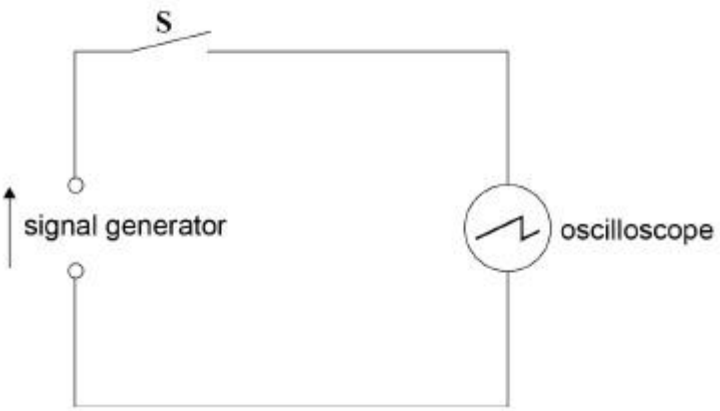
(2)

(Total 8 marks)

Q2.

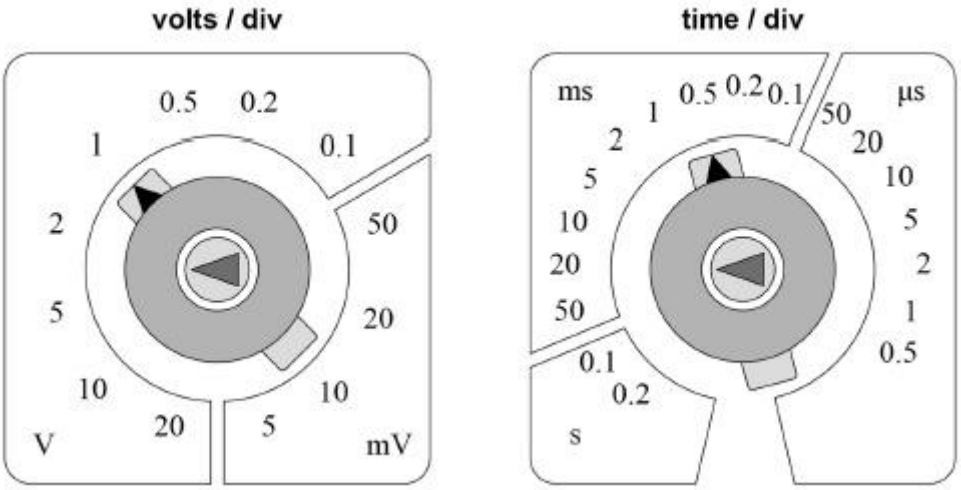
A signal generator is connected to an oscilloscope, as shown in **Figure 1**.

Figure 1



The Y-voltage gain and time-base settings of the oscilloscope are shown in **Figure 2**.

Figure 2



When switch **S** is open (off) the oscilloscope displays the waveform shown in **Figure 3**.

When **S** is closed (on) the oscilloscope displays the waveform shown in **Figure 4**.

(a) Determine the peak-to-peak voltage V of the waveform shown in **Figure 4**.

V = _____ V

(1)

(b) Determine the frequency f of the waveform shown in **Figure 4**.

f = _____ Hz

(2)

Figure 3

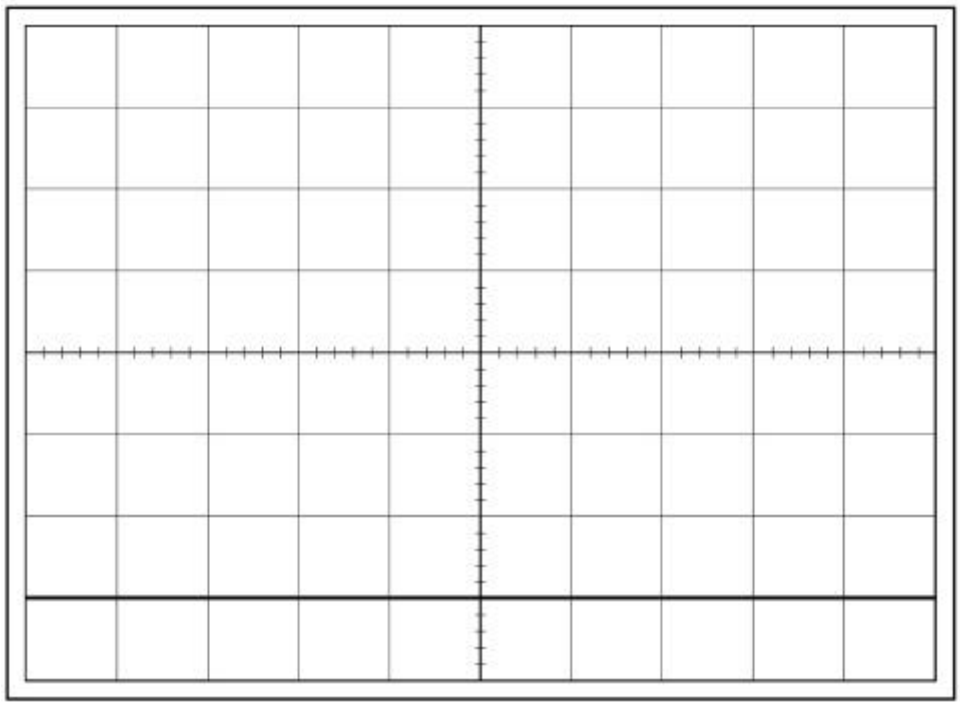
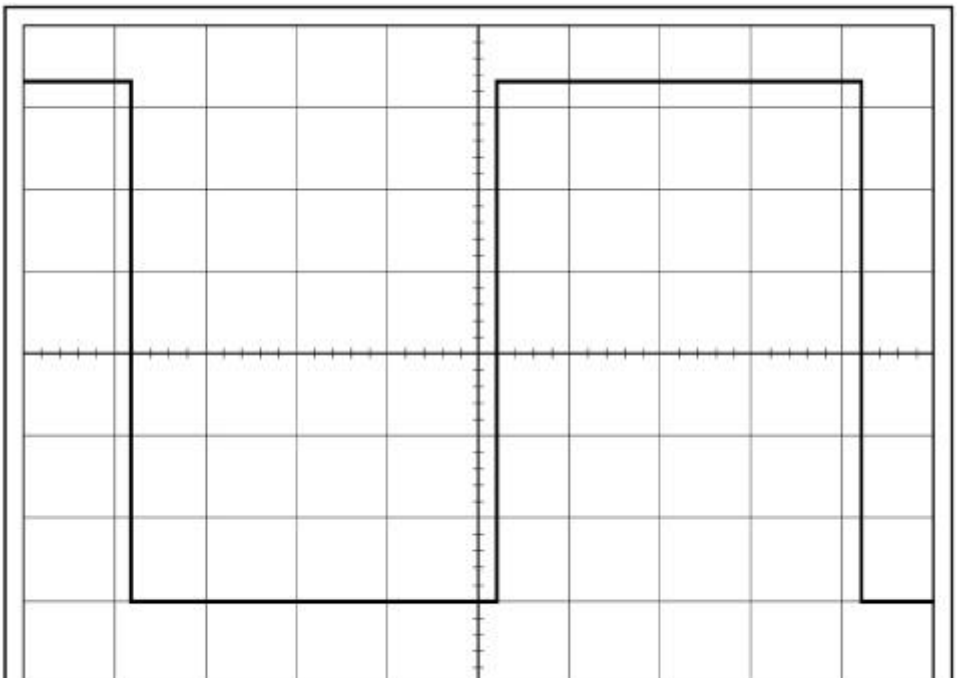
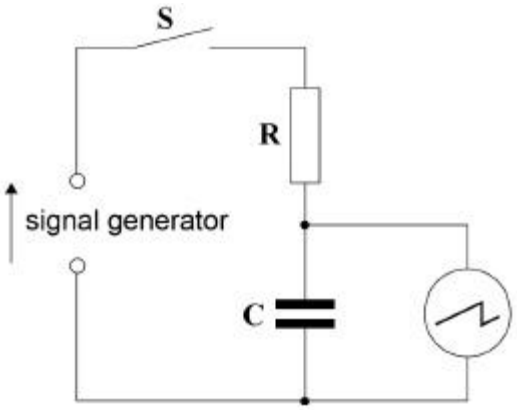


Figure 4



(c) **Figure 5** shows the signal generator connected in series with a resistor **R** and a capacitor **C**.

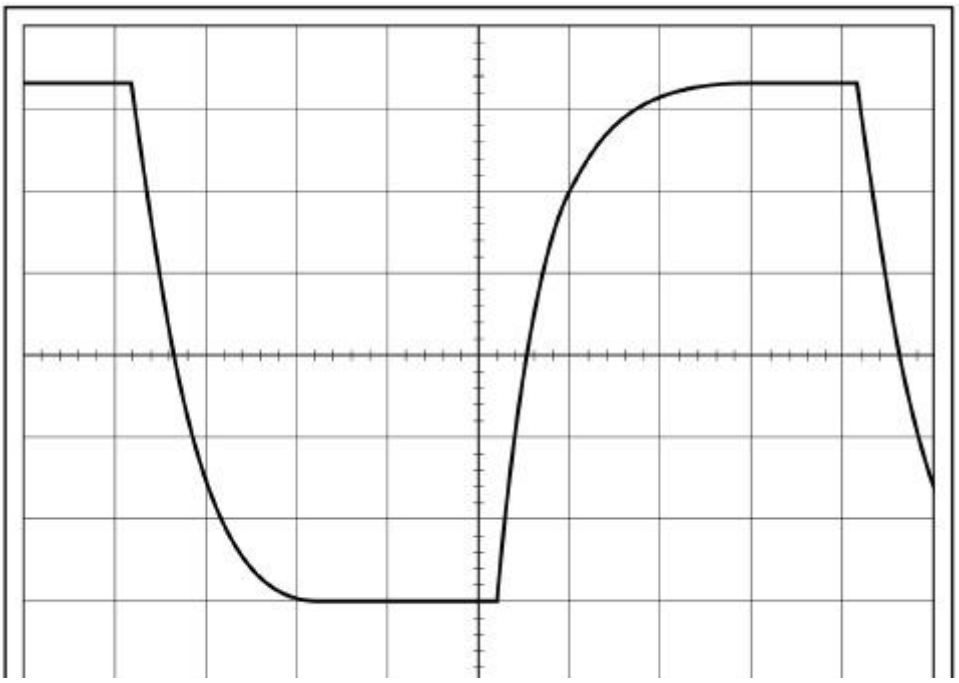
Figure 5



The oscilloscope is connected across the capacitor.
The Y-voltage gain and time-base settings are still the same as shown in **Figure 2**.

When **S** is closed (on) the oscilloscope displays the waveform shown in **Figure 6**.

Figure 6



Determine the time constant of the circuit in **Figure 5**.

time constant = _____ s

(2)

(d) A student suggests that setting the time-base to 0.2 ms division^{-1} might reduce uncertainty in the determination of the time constant.

State and explain any possible advantage or disadvantage in making this suggested adjustment.

_____

_____

_____

_____

_____

_____

_____

_____

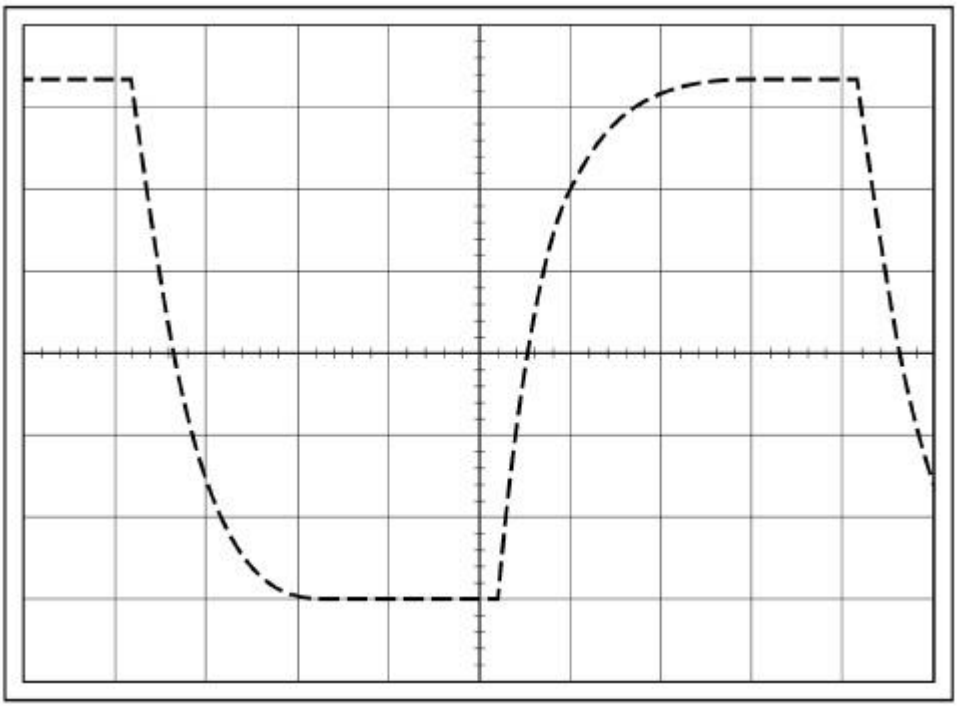
(3)

(e) The student connects an identical resistor in parallel with **R** and uses the oscilloscope to display the waveform across **C**.

Draw on **Figure 7** the waveform you expect the student to see.

The waveform of **Figure 6** is shown as a dashed line to help you show how the waveform changes.

Figure 7



Explain the change in the waveform.

_____

_____

_____

_____

_____

_____

(2)

(f) **Figure 8a** is a graph of voltage against time showing the output of the signal generator. **Figure 8b** shows the voltage across **C** during the same time interval.

The student interchanges the positions of **R** and **C** and connects the oscilloscope across **R**.

Complete **Figure 8c** to draw the voltage across R during the time interval.

Figure 8a

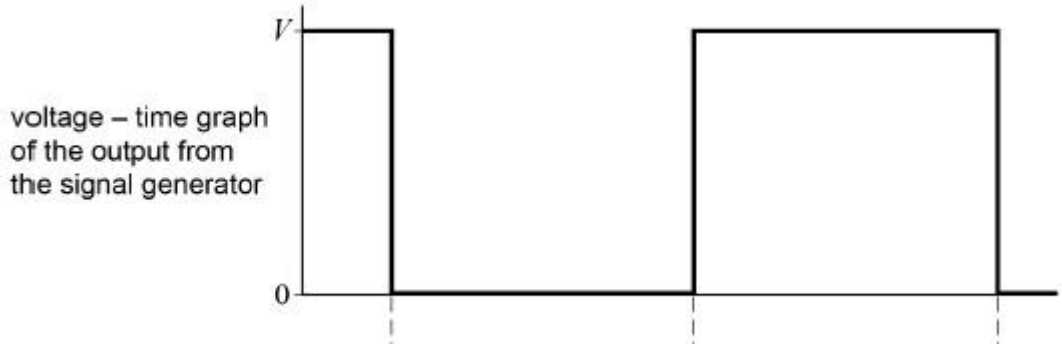


Figure 8b

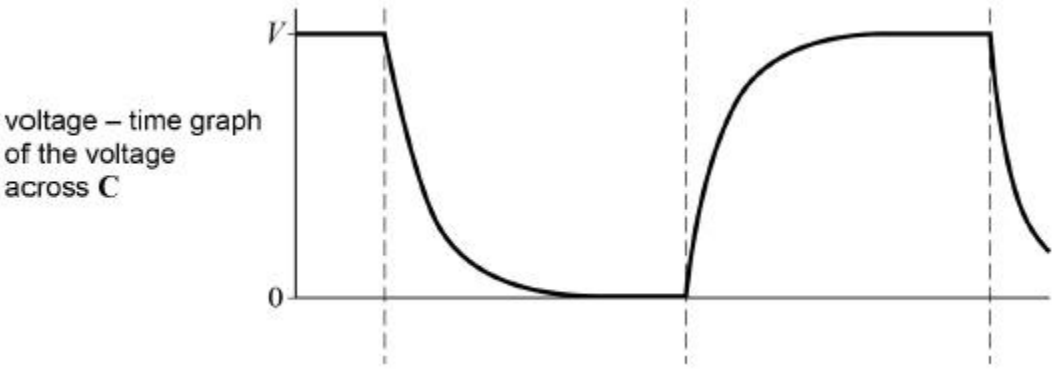
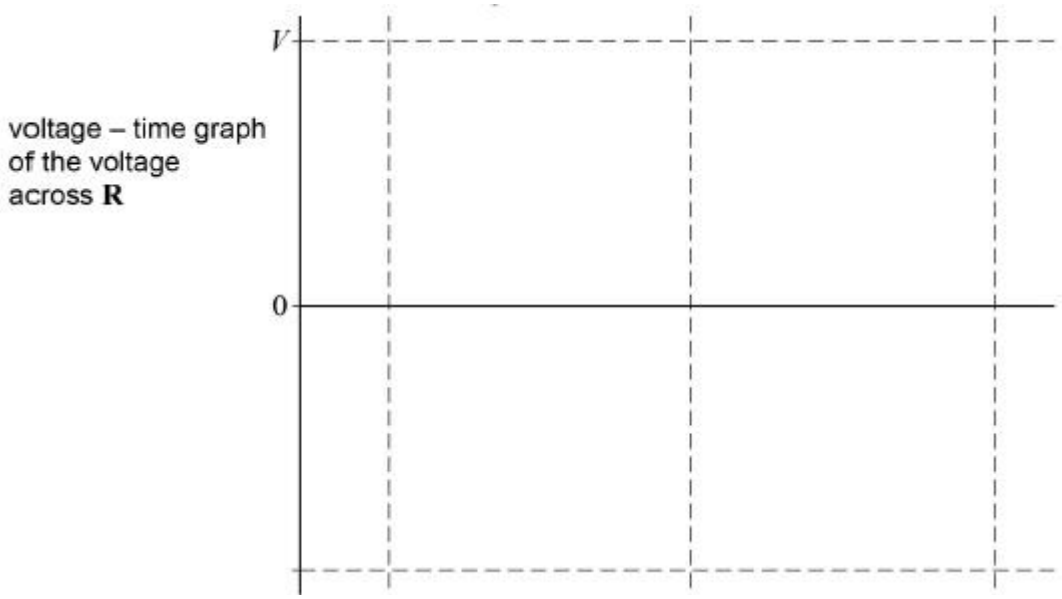


Figure 8c



(2)

(g) State and explain what changes, if any, the student needs to make to the settings of the oscilloscope so the waveform across **R** is fully displayed.

_____

_____

_____

_____

_____

_____

_____

_____

(2)

(Total 14 marks)