Alternating Current

Q1.   Domestic users in the United Kingdom are supplied with mains electricity at a *root mean square voltage* of 230V.

(a)   State what is meant by root mean square voltage.

....

....

....

(1)

(b)   (i)   Calculate the peak value of the supply voltage.

answer = ... V

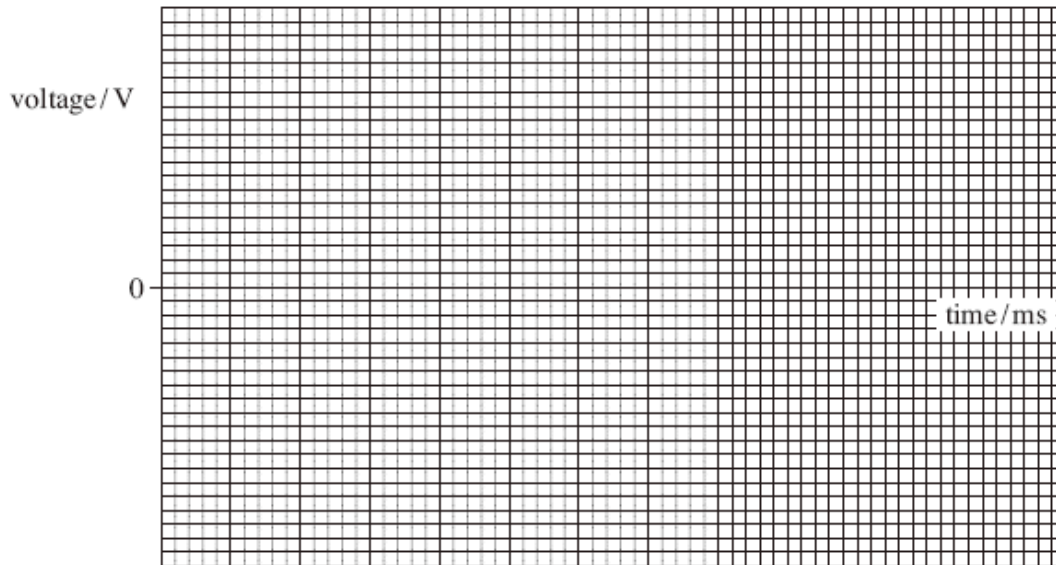**(2)**

(ii)   Calculate the average power dissipated in a lamp connected to the mains supply when the rms current is 0.26 A.

answer = ... W

(1)

(c)   The frequency of the voltage supply is 50 Hz. On the axes below draw the waveform of the supplied voltage labelling the axes with appropriate values.
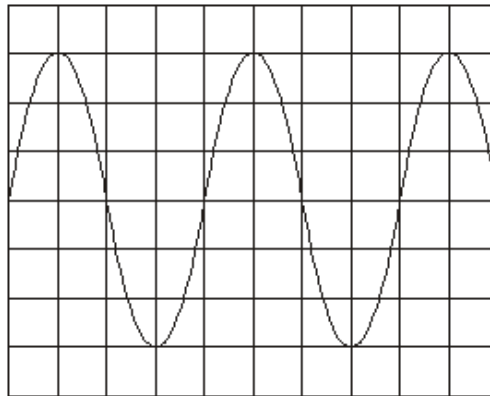
voltage/V

0

time/ms

(4)
(Total 8 marks)

Q2.   The circuit in **Figure 1** shows a sinusoidal ac source connected to two resistors, R_1 and R_2, which form a potential divider. Oscilloscope 1 is connected across the source and oscilloscope 2 is connected across R_2.

Figure 1
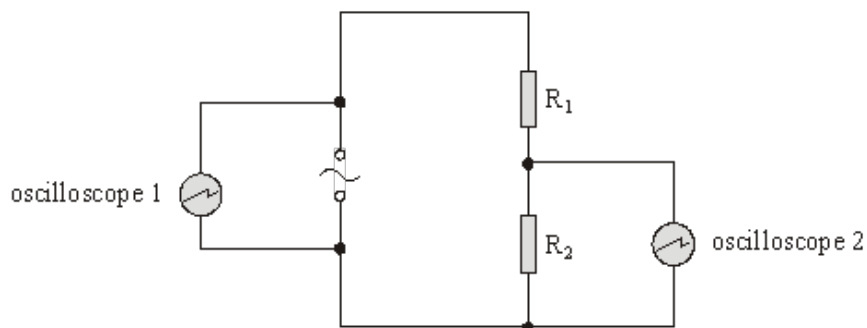
(a) **Figure 2** shows the trace obtained on the screen of oscilloscope 1. The time base of the oscilloscope is set at 10 m/s per division and the voltage sensitivity at 15 V per division.

Figure 2

For the ac source, calculate

(i) the frequency,

....

....

(ii) the rms voltage.

....

....

....

(4)

(b) The resistors have the following values: R_1 = 450 Ω and R_2 = 90 Ω.
Calculate

(i) the rms current in the circuit,

....

(ii) the rms voltage across R_2.

....

(2)

(c)   Oscilloscope 2 is used to check the calculated value of the voltage across R_2. The screen of oscilloscope 2 is identical to that of oscilloscope 1 and both are set to the same time base. Oscilloscope 2 has the following range for voltage sensitivity: 1 V per div., 5 V per div., 10 V per div. and 15 V per div.
State which voltage sensitivity would give the most suitable trace. Explain the reasons for your choice.
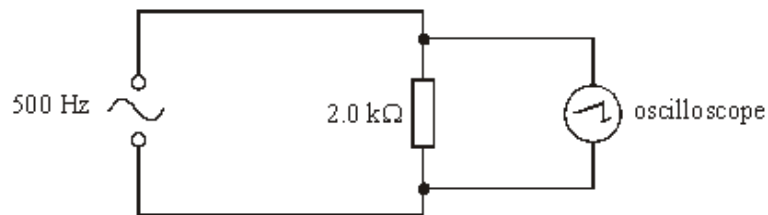
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(3)
(Total 9 marks)

Q3.   A sinusoidal alternating voltage source of frequency 500 Hz is connected to a resistor of resistance 2.0 kΩ and an oscilloscope, as shown in **Figure 1**.

Figure 1

(a)   The rms current through the resistor is 5.3 mA. Calculate the peak voltage across the resistor.

....

....

....

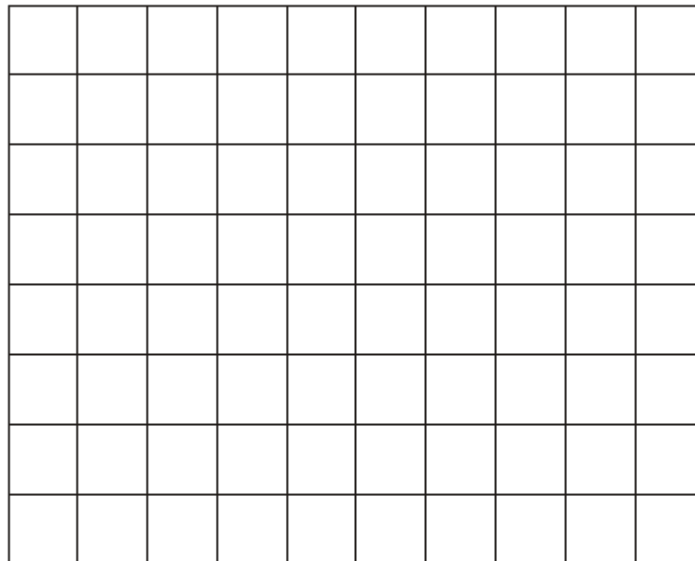**(2)**

(b)   The settings on the oscilloscope are

              timebase: 250 µs per division,
              voltage sensitivity: 5.0 V per division.

Draw on the grid, which represents the screen of the oscilloscope, the trace that would
be seen.

....

....

(4)
(Total 6 marks)

Q4.   An oscilloscope is connected to a sinusoidal ac source as shown in **Figure 1**.
The frequency and the voltage output of the ac source can be varied.
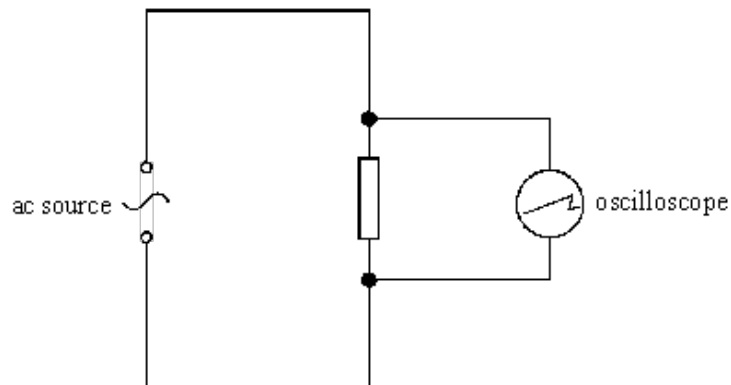
Figure 1

At a certain frequency the ac signal has an rms output of 7.1 V. **Figure 2** shows the trace obtained on the screen of the oscilloscope when one horizontal division corresponded to a time of 5.0 ms.

5.0 ms
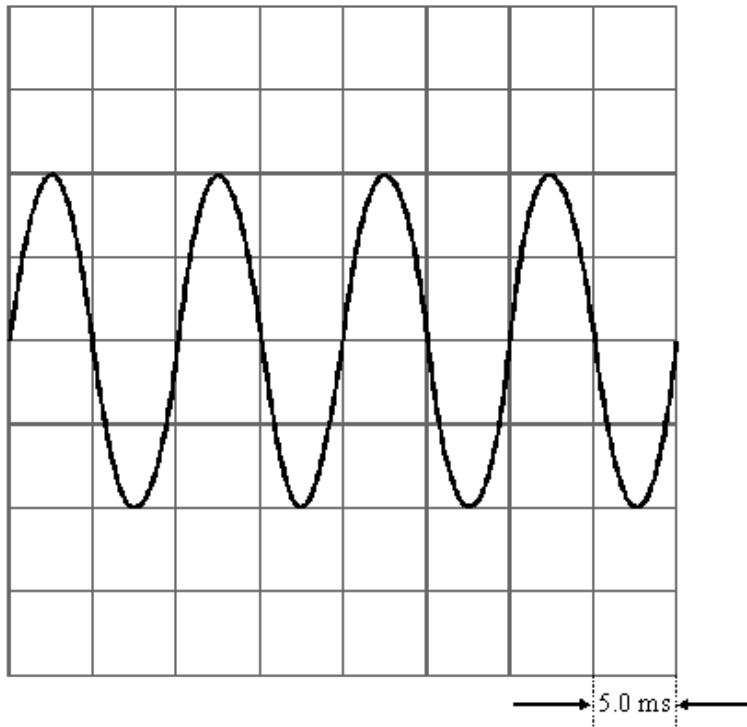
Figure 2

(a)   Calculate, for the signal shown in **Figure 2**,

   (i)   the peak voltage,

   ....

   (ii)   the frequency.

   ....

   ....

(3)

(b) The voltage output and frequency of the signal are now changed so that the peak voltage is 80 V and the frequency is 200 Hz.

State which **two** controls on the oscilloscope have to be altered so that **four** full cycles again appear on the screen but the peak to peak distance occupies the **full** screen.

Determine the values at which these two controls have to be set.

control 1: …..

value of the setting: ....

....

....

control 2: …..

value of setting: ....

....

....

(5)
(Total 8 marks)

Q5. The diagram below shows an ac waveform that is displayed on an oscilloscope screen.
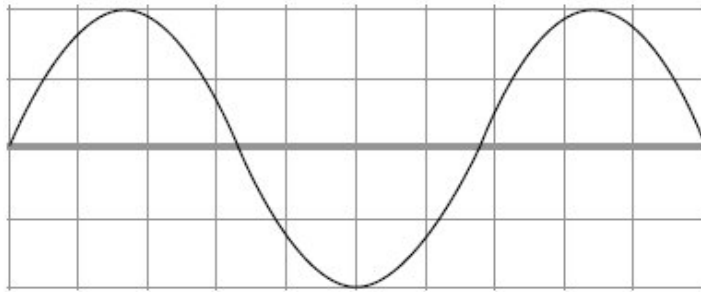
The time base of the oscilloscope is set at 1.5 ms per division and the y-gain at 1.5 V per division.

(a) For the ac waveform shown,

(i) Calculate the frequency

....

....

....

....

answer .... Hz

(3)

(ii)   Calculate the peak voltage

....

....

....

....

answer V

(2)

(iii)   the rms voltage

....

....

....

....

answer V

(2)

(b)   State and explain the effect on the oscilloscope trace if the time base is switched off.

....

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....

....

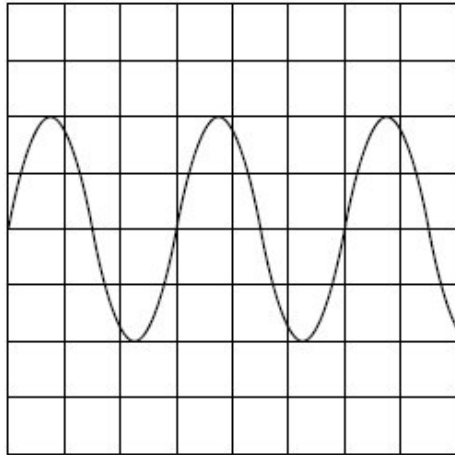...

(2)
(Total 9 marks)

Q6.   An alternating current (ac) source is connected to a resistor to form a complete circuit. The trace obtained on an oscilloscope connected across the resistor is shown in the diagram below.

The oscilloscope settings are: Y gain 5.0 V per division

time base 2.0 ms per division.

(i)   Calculate the peak voltage of the ac source.

answer = ... V

(1)

(ii)   Calculate the rms voltage.

answer = ... V

(1)

(iii)   Calculate the time period of the ac signal.

answer = ... ms

(1)

(iv)   Calculate the frequency of the ac signal.

answer = ... Hz

(2)
(Total 5 marks)
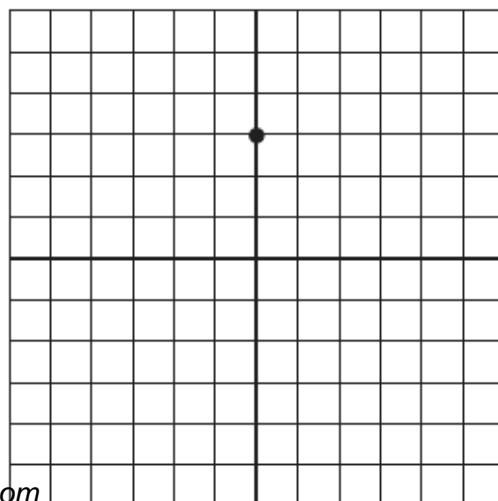
Q7.   An oscilloscope is used to investigate various voltage sources. In order to do this a voltage source is connected to the y-input and the time base is switched off. **Figure 1** below shows the screen of the oscilloscope when the y-input is not connected to a voltage source.

Figure 1
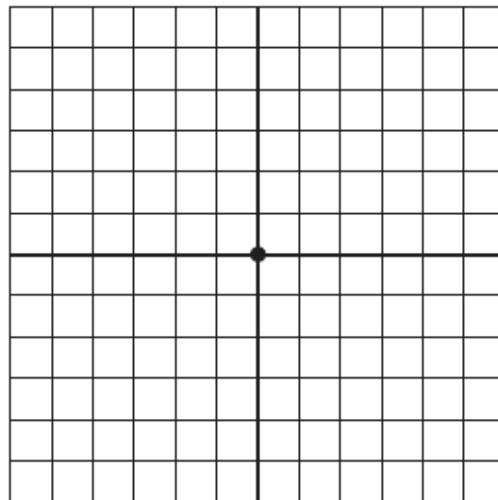
Figure 2 shows the screen when a 1.5V cell is connected to the y-input.

Figure 2

(a)   On the grid below show the appearance of the screen if the y-input is connected to a 2.5V dc supply.
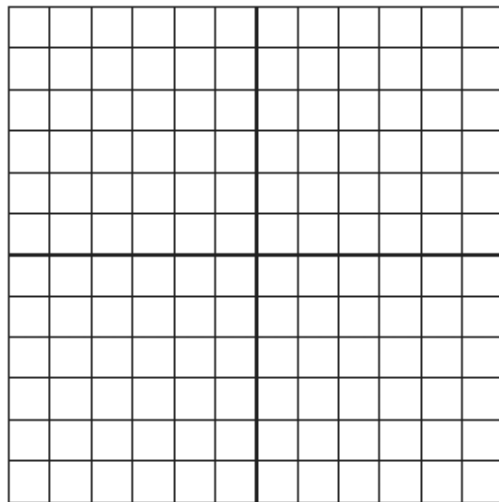
(1)

(b)   The y-input is now connected to a sinusoidal ac voltage supply and the screen is shown in **Figure 3**.

Figure 3
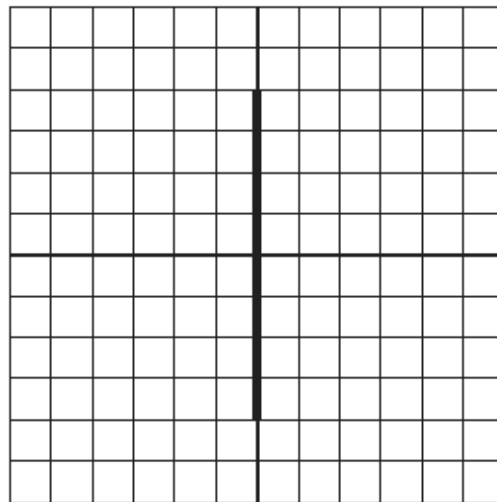
(i)   Explain why a vertical line is now seen on the screen.

....

....

....

....

....

....

(2)

(ii)   Calculate the peak-to-peak voltage of the ac supply.

answer = ... V

(2)

(iii)   Calculate the root mean square voltage of the supply.

answer = ... V

(2)
(Total 7 marks)

Q8.   An oscilloscope is connected to an alternating voltage source of rms value 4.2 V at a frequency of 2.5 kHz.

(a)   Calculate the peak-to-peak alternating voltage.

peak-to-peak voltage = ...

(2)

(b) **Figure 1** represents the screen of the oscilloscope.

Figure 1
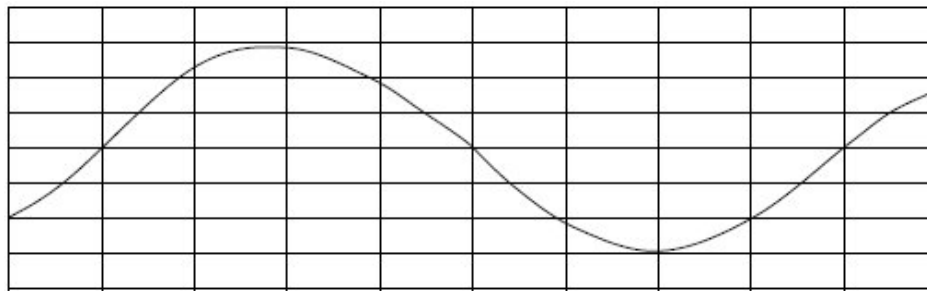
Determine

(i) the voltage sensitivity of the oscilloscope,

voltage sensitivity = ...

(ii) the time base setting of the oscilloscope.

time base setting = ...

(3)

(c) The time base of the oscilloscope is switched off and the voltage sensitivity is set to 0.5 V div⁻¹. The oscilloscope is connected across a 1.75 V battery of internal resistance 3.5 Ω which is connected to a 10 Ω resistor as shown in **Figure 2**. **Figure 3** represents the screen of the oscilloscope which shows the spot when registering zero volts.

Figure 2
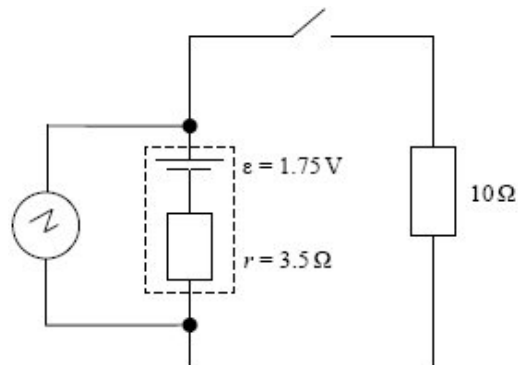
Figure 3
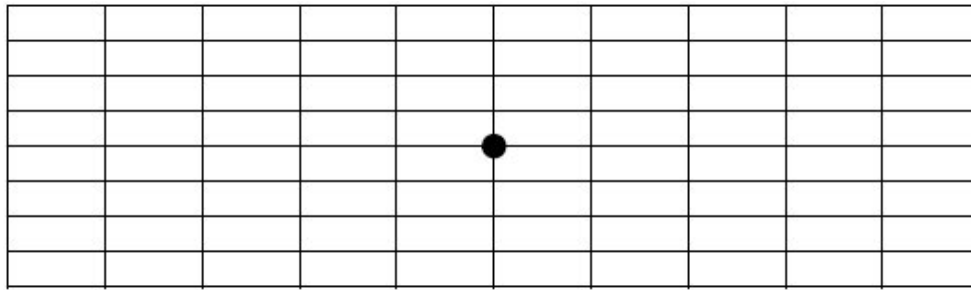
(i)   Draw a spot on **Figure 3** showing the appearance on the screen when the switch is open. Label this spot O.

(ii)   When the switch is closed determine the current flowing through the 10 Ω resistor.

current = ...

(iii)   Draw a spot on **Figure 3** showing the appearance on the screen when the switch is closed. Label this spot C.

(5)
(Total 10 marks)

Q9. (a) An alternating current supply provides an output voltage of 12 V rms at a frequency of 50 Hz. Describe how you would use an oscilloscope to check the accuracy of the rms output voltage and the frequency of the supply.

The quality of your written communication will be assessed in your answer.

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(6)

(b) The power supply in part (a) is connected to a 12 V 24 W lamp.

(i) Calculate the rms current in the lamp.

answer = ... A

(1)

(ii)   Calculate the peak current in the lamp.

answer = ... A

(1)

(iii)   Calculate the peak power of the lamp.

answer = ... W

(2)
(Total 10 marks)