Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic: Fields And Their Consequences (Capacitance)

Name of the Student:____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

A capacitor of capacitance 63 pF is made from two parallel metal plates separated by an air gap. The capacitor is charged so that it stores a charge of 7.6×10^{-10} C; it is then isolated.

A sheet of mica of dielectric constant 6.0 is inserted between the plates so that it completely fills the space between them. The mica does not discharge the capacitor and does not change the separation of the plates.

(a) Explain what is meant by a dielectric constant of 6.0

____

____

____

____

(1)

(b) Mica is made up of polar molecules. As the mica is inserted, the capacitance of the capacitor changes.

Explain how the polar molecules cause this change in capacitance.

____

____

____

____

____

____

____

____

____

____

(3)

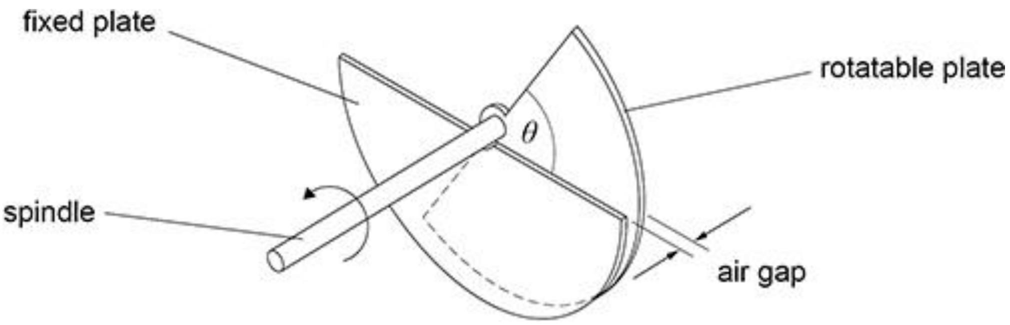
(c) Calculate the difference between the initial energy stored by the capacitor and the energy stored when the mica has been fully inserted.

energy difference = _______________ J

(3)

Figure 1 shows the structure of a variable capacitor used for measuring angular movement. The capacitor consists of two semicircular metal plates. These plates are parallel and are separated by an air gap.

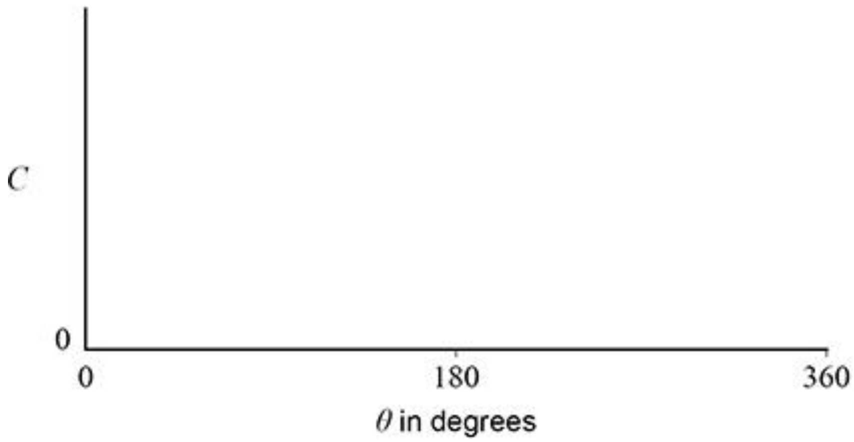
Figure 1



To vary the capacitance, one of the plates is rotated through an angle θ using the spindle. The other plate remains fixed.

(d) Sketch a graph on **Figure 2** to show how the capacitance C varies with θ as the spindle is turned through 360°.
When θ is 0°, the plates completely overlap.

Figure 2



(2)

(e) In one situation, the variable capacitor is too large for the available space.

The same maximum capacitance is required using plates that have half the diameter of the original capacitor.

Explain, with numerical detail, **two** ways in which this can be achieved.

1 ____

____

____

____

2 ____

____

____

____

____

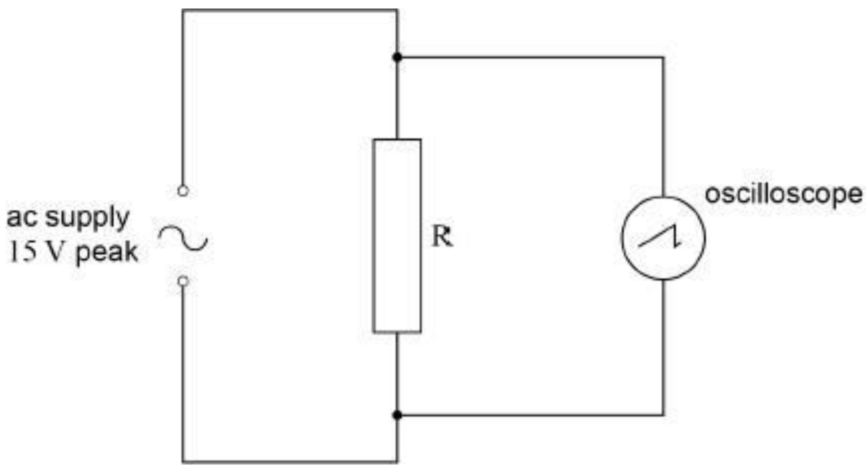
(3)

(Total 12 marks)

Q2.

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



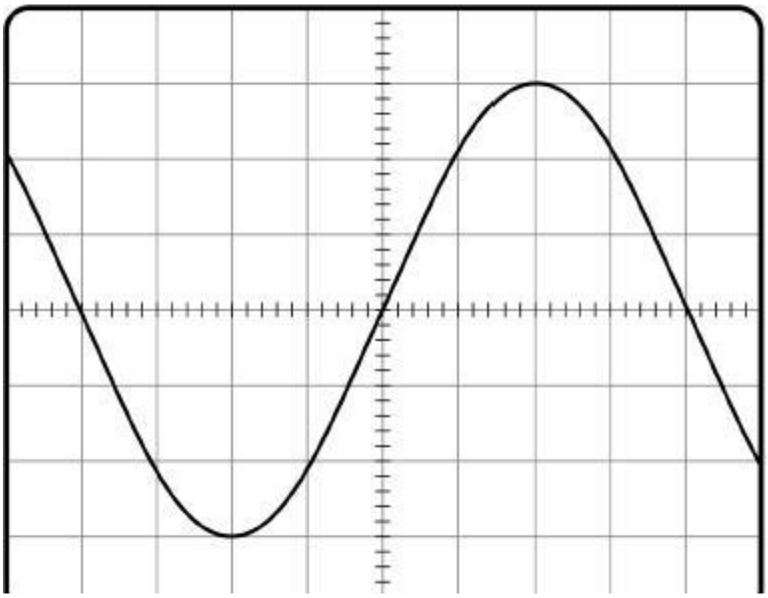
(a) Calculate the rms voltage of the supply.

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**.

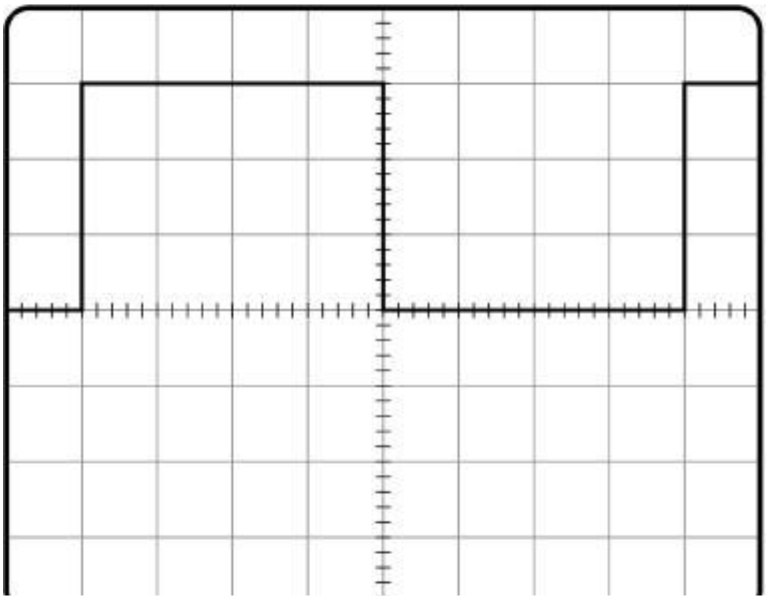
Draw the trace of the output of the dc supply on **Figure 2**.
The oscilloscope settings remain the same.

(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



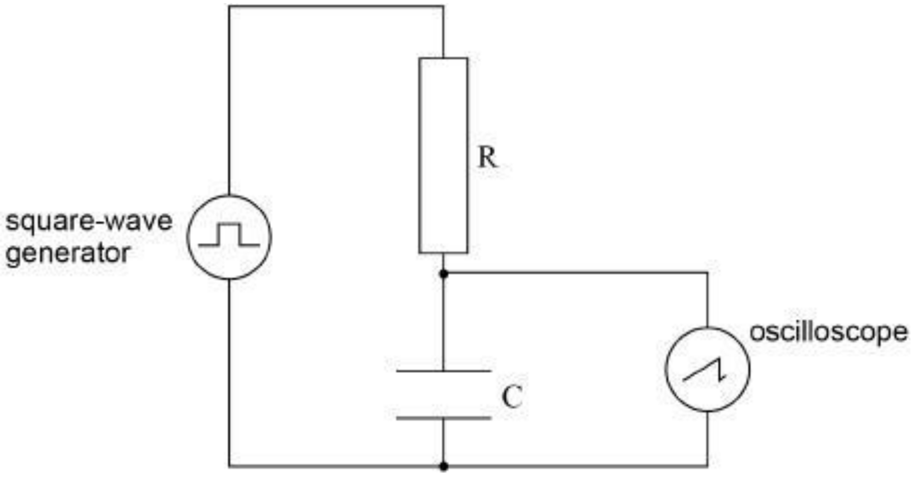
Calculate the frequency of the square waves.

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.

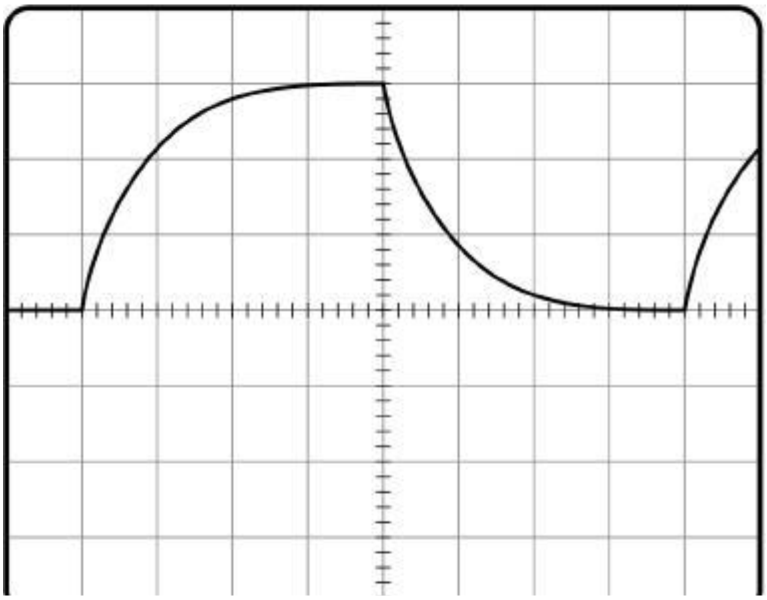
Figure 4



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)