Capacitance – 2021 A2

1. Nov/2021/Paper_41/No.6

(a) A capacitor consists of two parallel metal plates, separated by air, at a variable distance x apart, as shown in Fig. 6.1. The capacitance C is inversely proportional to x.

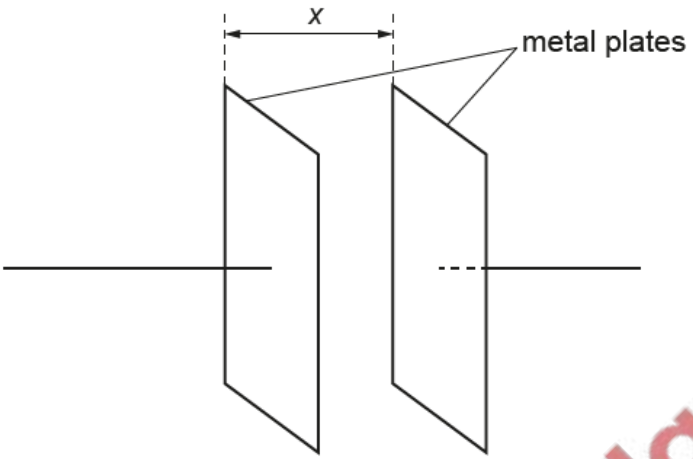

Fig. 6.1

The capacitor is charged by a supply so that there is a potential difference (p.d.) V between the plates.

State expressions, in terms of C and V, for the charge Q on one of the plates and for the energy E stored in the capacitor.

Q = ... E = ... [1]

(b) The charged capacitor in **(a)** is now disconnected from the supply. The plates of the capacitor are initially separated by distance L. They are then moved closer together by a distance D, as shown in Fig. 6.2.

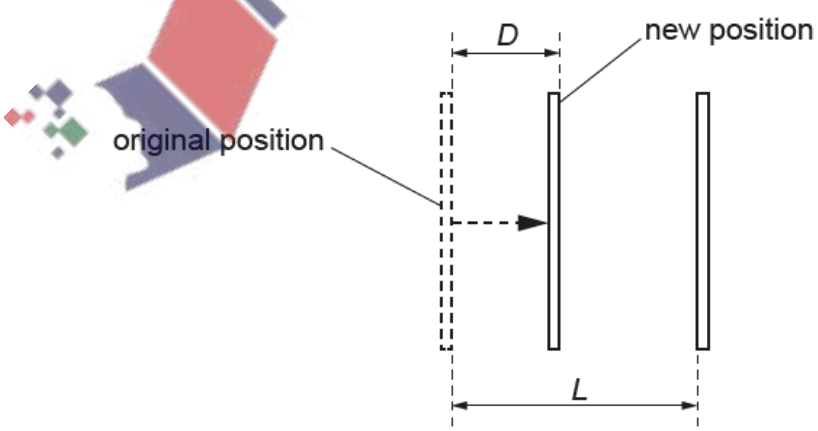

Fig. 6.2

State expressions, in terms of C, V, L and D, for:

(i) the new capacitance C_N

C_N = ... [1]

(ii) the new charge Q_N on one of the plates

Q_N = ... [1]

(iii) the new p.d. V_N between the plates.

V_N = ... [1]

(c) Explain whether reducing the separation of the plates in **(b)** results in an increase or decrease in the energy stored in the capacitor.

.....

.....

..... [1]

[Total: 5]

2. **(a)** State what is meant by the *capacitance* of a parallel plate capacitor.

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.....

..... [2]

(b) A capacitor of capacitance C is connected into the circuit shown in Fig. 7.1.

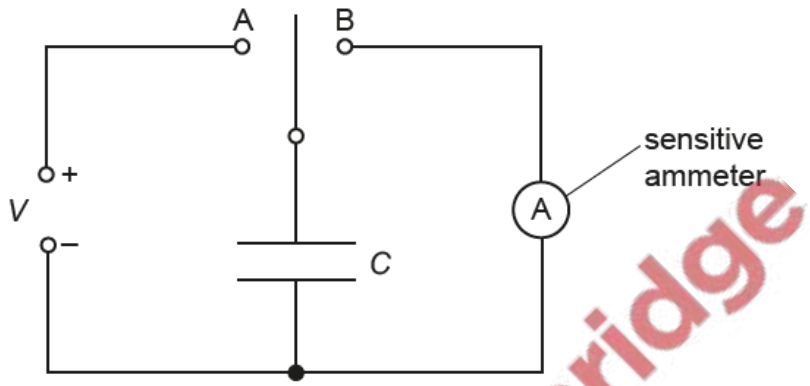

Fig. 7.1

When the two-way switch is in position A, the capacitor is charged so that the potential difference across it is V.
The switch moves to position B and the capacitor fully discharges through the sensitive ammeter.

The switch moves repeatedly between A and B so that the capacitor charges and then discharges with frequency f.

(i) Show that the average current I in the ammeter is given by the expression

$$I = fCV.$$

[2]

(ii) For a potential difference V of 150 V and a frequency f of 60 Hz, the average current in the ammeter is 4.8 μA.

Calculate the capacitance, in pF, of the capacitor.

capacitance = ... pF [2]

(c) A second capacitor, having the same capacitance as the capacitor in **(b)**, is connected into the circuit of Fig. 7.1. The two capacitors are connected in series.

State and explain the new reading on the ammeter.

new reading = ... μA

.....

.....

..... [3]

[Total: 9]

3. June/2021/Paper_42/No.6

(a) Two flat metal plates are held a small distance apart by means of insulating pads, as shown in Fig. 6.1.

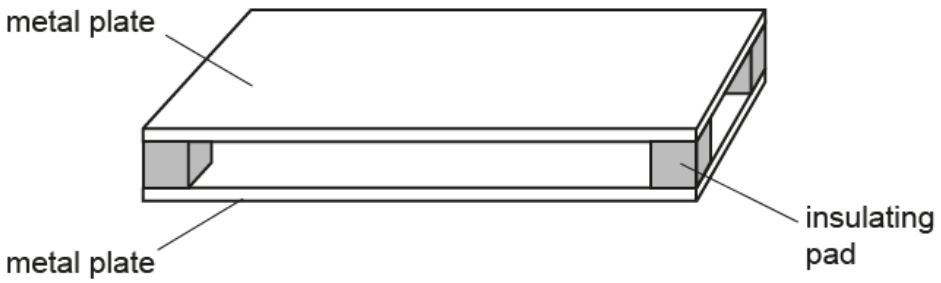

Fig. 6.1

Explain how the plates could act as a capacitor.

.....

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..... [2]

(b) The arrangement in Fig. 6.1 has capacitance *C*.
The arrangement is connected into the circuit of Fig. 6.2.

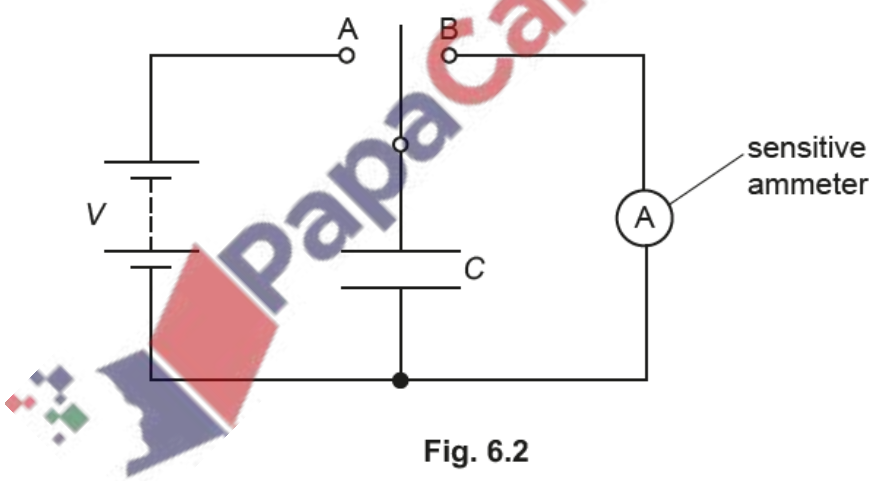

Fig. 6.2

When the two-way switch is moved to position A, the capacitor is charged so that the potential difference across it is *V*. When the switch moves to position B, the capacitor fully discharges through the sensitive ammeter.

The switch moves repeatedly between A and B so that the capacitor charges and then discharges with frequency *f*.

(i) Show that the average current I in the ammeter is given by

$$I = CVf.$$

[2]

(ii) For a potential difference V of 180 V and a frequency f of switching of 50 Hz, the average current I in the ammeter is 2.5 μA.

Calculate the capacitance, in pF, of the parallel plates.

capacitance = ... pF [2]

(c) A second capacitor is connected into the circuit of Fig. 6.2.
The two capacitors are connected in parallel.

State and explain the change, if any, in the average current in the ammeter.

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..... [2]

[Total: 8]