

Capacitance

Question paper 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Capacitance
Sub Topic	
Paper Type	Theory
Booklet	Question paper 1

Time Allowed: 83 minutes

Score: /69

Percentage: /100

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 Three capacitors, each of capacitance $48\ \mu\text{F}$, are connected as shown in Fig. 6.1.

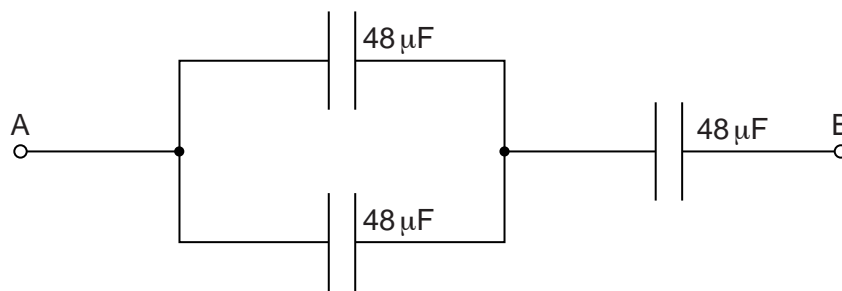


Fig. 6.1

(a) Calculate the total capacitance between points A and B.

capacitance = μF [2]

(b) The maximum safe potential difference that can be applied across any one capacitor is $6\ \text{V}$.

Determine the maximum safe potential difference that can be applied between points A and B.

potential difference = V [2]

- 2 An uncharged capacitor is connected in series with a battery, a switch and a resistor, as shown in Fig.6.1.

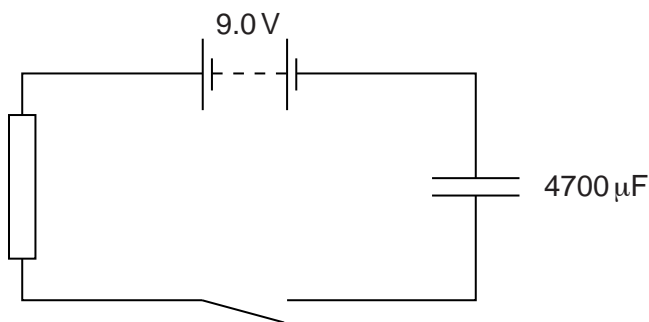


Fig. 6.1

The battery has e.m.f. 9.0V and negligible internal resistance. The capacitance of the capacitor is 4700 μF.

The switch is closed at time $t = 0$.

During the time interval $t = 0$ to $t = 4.0$ s, the charge passing through the resistor is 22 mC.

- (a) (i) Calculate the energy transfer in the battery during the time interval $t = 0$ to $t = 4.0$ s.

energy transfer = J [2]

- (ii) Determine, for the capacitor at time $t = 4.0$ s,

1. the potential difference V across the capacitor,

$V =$ V [2]

2. the energy stored in the capacitor.

energy = J [2]

(b) Suggest why your answers in (a)(i) and (a)(ii) part 2 are different.

.....
..... [1]

3 (a) State two functions of capacitors connected in electrical circuits.

1.
-
2.
-

[2]

(b) Three capacitors are connected in parallel to a power supply as shown in Fig. 4.1.

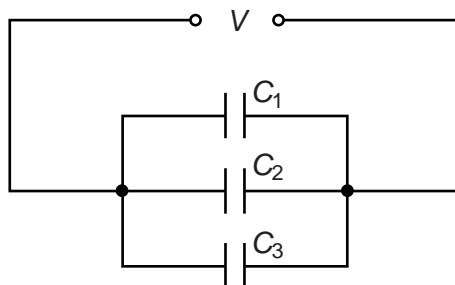


Fig. 4.1

The capacitors have capacitances C_1 , C_2 and C_3 . The power supply provides a potential difference V .

(i) Explain why the charge on the positive plate of each capacitor is different.

-
-
- [1]

(ii) Use your answer in (i) to show that the combined capacitance C of the three capacitors is given by the expression

$$C = C_1 + C_2 + C_3.$$

[2]

- (c)** A student has available three capacitors, each of capacitance $12\ \mu\text{F}$. Draw circuit diagrams, one in each case, to show how the student connects the three capacitors to provide a combined capacitance of

(i) $8\ \mu\text{F}$,

[1]

(ii) $18\ \mu\text{F}$.

[1]

4 (a) (i) Define *capacitance*.

.....
 [1]

(ii) A capacitor is made of two metal plates, insulated from one another, as shown in Fig. 5.1.

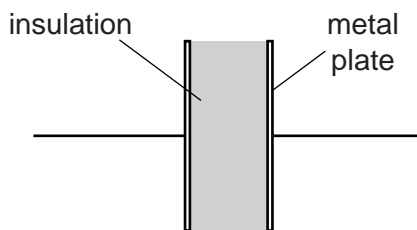


Fig. 5.1

Explain why the capacitor is said to store energy but not charge.

.....

 [4]

(b) Three uncharged capacitors X, Y and Z, each of capacitance $12\ \mu\text{F}$, are connected as shown in Fig. 5.2.

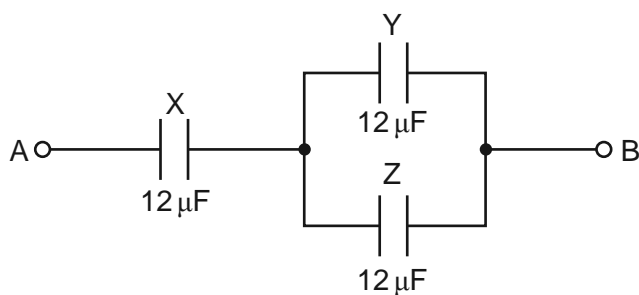


Fig. 5.2

A potential difference of 9.0V is applied between points A and B.

- (i) Calculate the combined capacitance of the capacitors X, Y and Z.

capacitance = μF [2]

- (ii) Explain why, when the potential difference of 9.0V is applied, the charge on one plate of capacitor X is $72\mu\text{C}$.

.....
.....
.....[2]

- (iii) Determine

1. the potential difference across capacitor X,

potential difference = V [1]

2. the charge on one plate of capacitor Y.

charge = μC [2]

5 (a) State two functions of capacitors in electrical circuits.

- 1.
 -
 - 2.
 -
- [2]

(b) Three uncharged capacitors of capacitance C_1 , C_2 and C_3 are connected in series, as shown in Fig. 4.1.

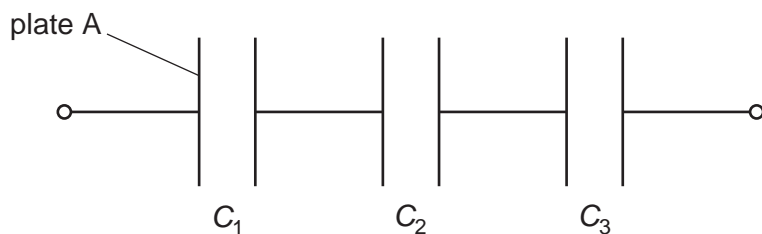


Fig. 4.1

A charge of $+Q$ is put on plate A of the capacitor of capacitance C_1 .

(i) State and explain the charges that will be observed on the other plates of the capacitors.
You may draw on Fig. 4.1 if you wish.

-
-
- [2]

(ii) Use your answer in (i) to derive an expression for the combined capacitance of the capacitors.

- (c) A capacitor of capacitance $12\ \mu\text{F}$ is charged using a battery of e.m.f. 9.0V , as shown in Fig. 4.2.

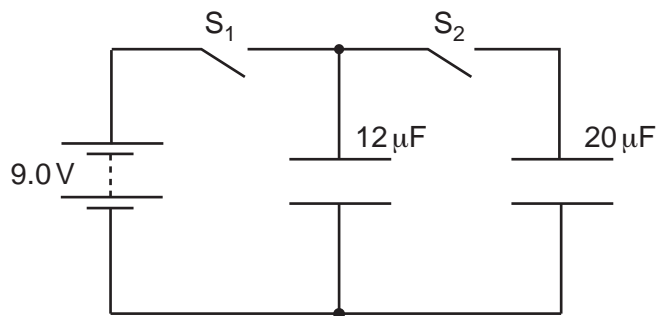


Fig. 4.2

Switch S_1 is closed and switch S_2 is open.

- (i) The capacitor is now disconnected from the battery by opening S_1 . Calculate the energy stored in the capacitor.

energy = J [2]

- (ii) The $12\ \mu\text{F}$ capacitor is now connected to an uncharged capacitor of capacitance $20\ \mu\text{F}$ by closing S_2 . Switch S_1 remains open. The total energy now stored in the two capacitors is $1.82 \times 10^{-4}\text{J}$.

Suggest why this value is different from your answer in (i).

.....
 [1]

6 A capacitor consists of two metal plates separated by an insulator, as shown in Fig. 3.1.

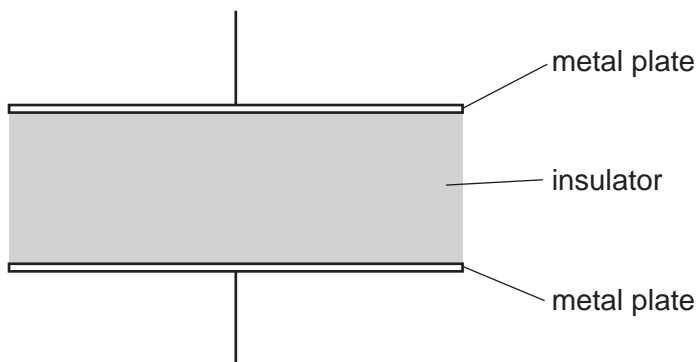


Fig. 3.1

The potential difference between the plates is V . The variation with V of the magnitude of the charge Q on one plate is shown in Fig. 3.2.

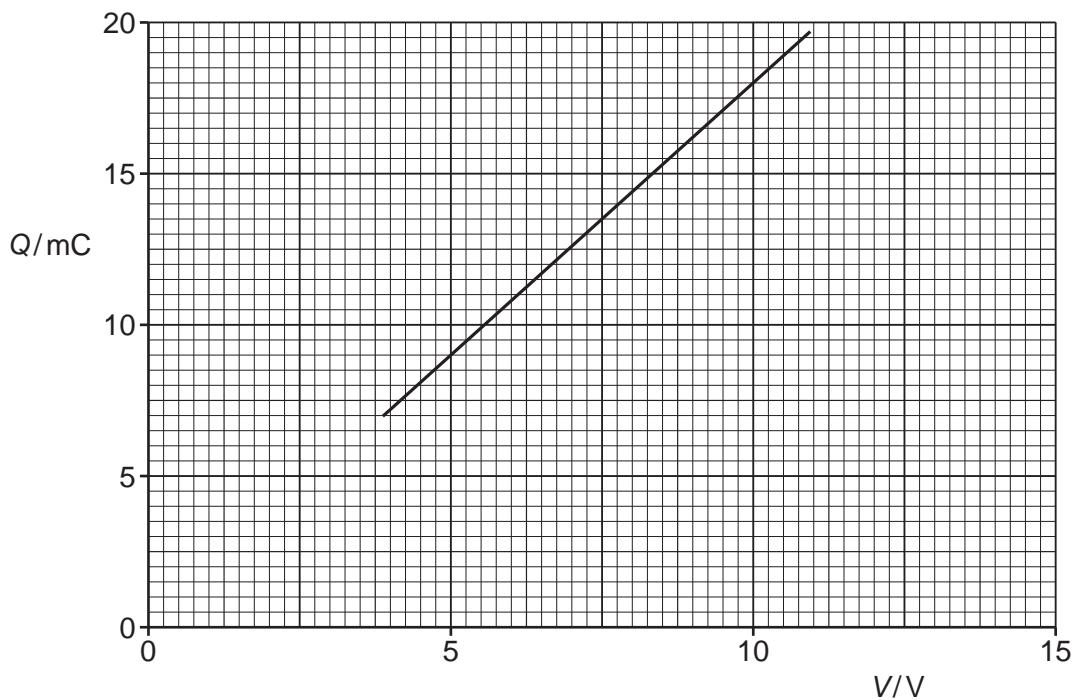


Fig. 3.2

(a) Explain why the capacitor stores energy but not charge.

.....

.....

.....

..... [3]

(b) Use Fig. 3.2 to determine

(i) the capacitance of the capacitor,

capacitance = μF [2]

(ii) the loss in energy stored in the capacitor when the potential difference V is reduced from 10.0V to 7.5V.

energy = mJ [2]

- (c) Three capacitors X, Y and Z, each of capacitance $10\mu\text{F}$, are connected as shown in Fig. 3.3.

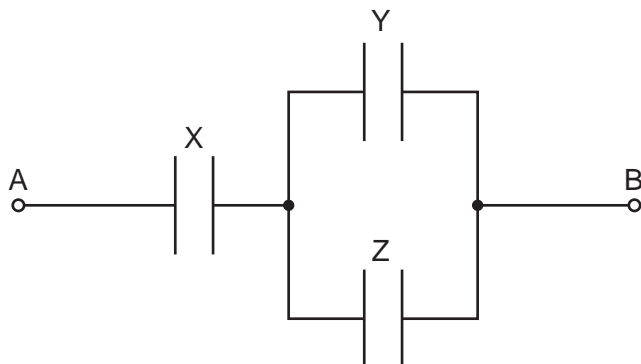


Fig. 3.3

Initially, the capacitors are uncharged.

A potential difference of 12V is applied between points A and B.

Determine the magnitude of the charge on one plate of capacitor X.

charge = μC [3]

7 (a) Define *capacitance*.

.....
..... [1]

(b) An isolated metal sphere has a radius r . When charged to a potential V , the charge on the sphere is q .
The charge may be considered to act as a point charge at the centre of the sphere.

(i) State an expression, in terms of r and q , for the potential V of the sphere.

..... [1]

(ii) This isolated sphere has capacitance. Use your answers in (a) and (b)(i) to show that the capacitance of the sphere is proportional to its radius.

[1]

(c) The sphere in (b) has a capacitance of 6.8 pF and is charged to a potential of 220 V.

Calculate

(i) the radius of the sphere,

radius = m [3]

(ii) the charge, in coulomb, on the sphere.

charge = C [1]

(d) A second uncharged metal sphere is brought up to the sphere in (c) so that they touch. The combined capacitance of the two spheres is 18pF.

Calculate

(i) the potential of the two spheres,

potential = V [1]

(ii) the change in the total energy stored on the spheres when they touch.

change = J [3]

8 (a) (i) State what is meant by *electric potential* at a point.

.....
.....
..... [2]

(ii) Define *capacitance*.

.....
..... [1]

(b) The variation of the potential V of an isolated metal sphere with charge Q on its surface is shown in Fig. 4.1.

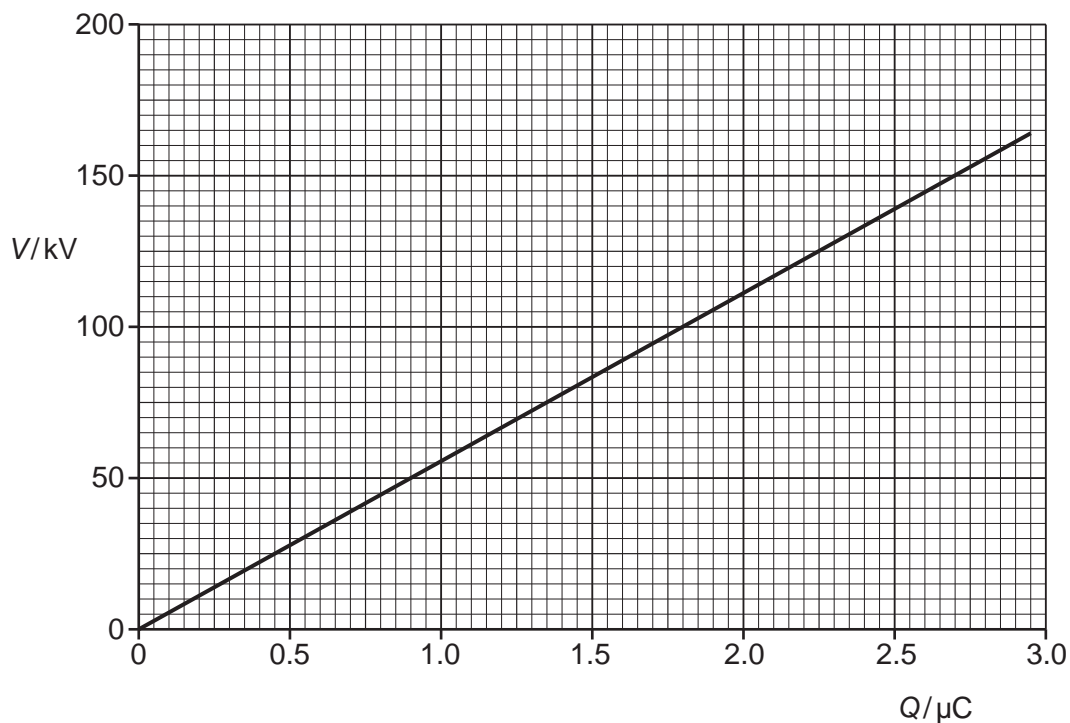


Fig. 4.1

An isolated metal sphere has capacitance. Use Fig. 4.1 to determine

- (i) the capacitance of the sphere,

capacitance = F [2]

- (ii) the electric potential energy stored on the sphere when charged to a potential of 150 kV.

energy = J [2]

- (c) A spark reduces the potential of the sphere from 150 kV to 75 kV. Calculate the energy lost from the sphere.

energy = J [2]