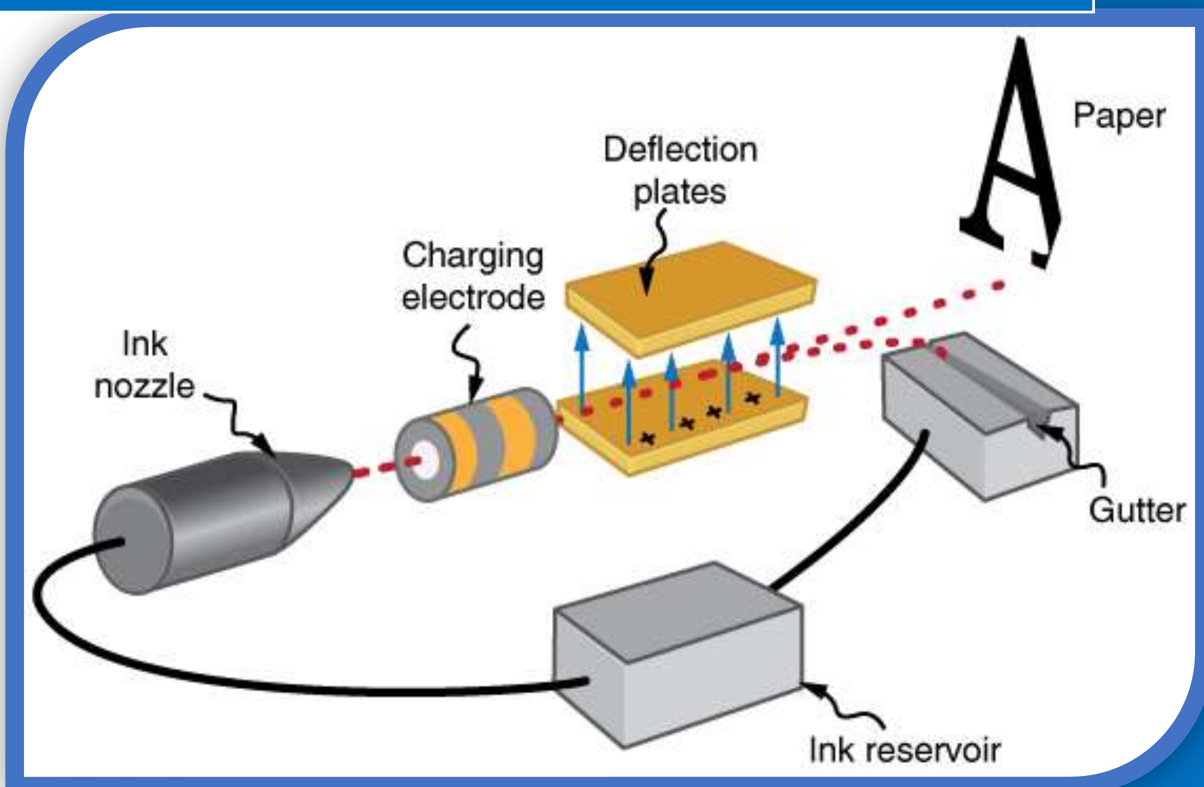
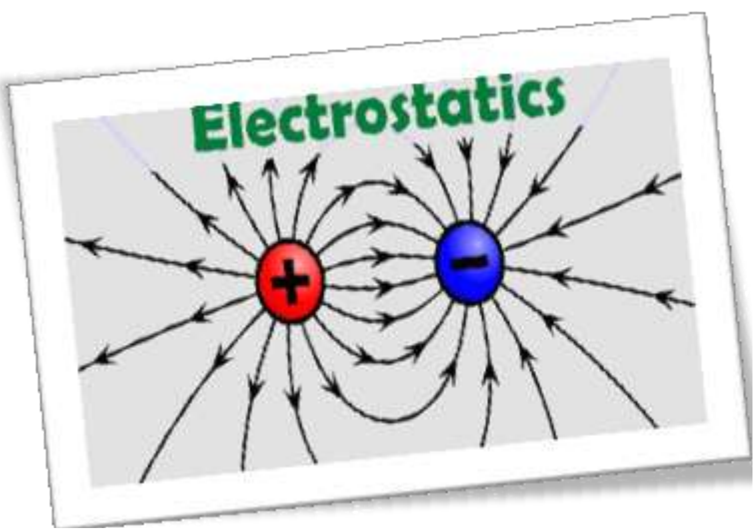
2020

ELECTROSTATICS II





TEACHERS OF PHYSICS
www.teachersofphysics.com

8/12/2020

1. State the SI unit of charge. (1mk)

- ✓ Coulomb or Ampere/second

2. **State three** properties of electric field lines. (3mk)

- ✓ Directed from positive charges and towards negative charges.
- ✓ Do not cross one another.
- ✓ Their density represent magnitude of electric field at a given point.
- ✓ They are perpendicular to the surface of the charge.

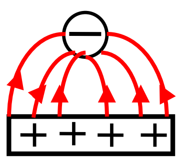
3. State one difference between a capacitor and a cell. (2mk)

- ✓ Capacitor stores electric charge while cell as a device to convert chemical energy to electrical energy.
- ✓ Capacitor is passive component of circuit while cell is an active component of circuit.
- ✓ Capacitor discharges instantly while cell runs for longer time.

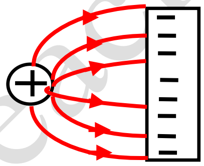
4. **Explain** how lighting a match box near the cap of a charged electroscope would cause the electroscope to discharge (2mks)

- ✓ Flame ionizes the air around the cap. The opposite charges to one on electroscope are attracted neutralizing the charges hence discharging.

5. Sketch the electrostatic field pattern due to the arrangement of the charges shown (1mk)

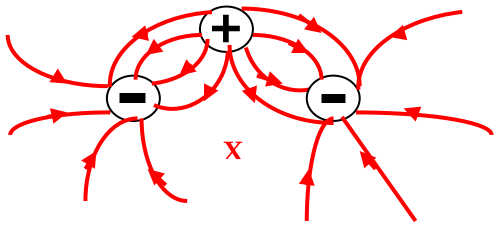


6. Figure below shows a positive charge near a plate carrying negative charge.

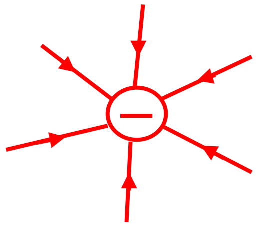


Draw the electric field between them. (2mks)

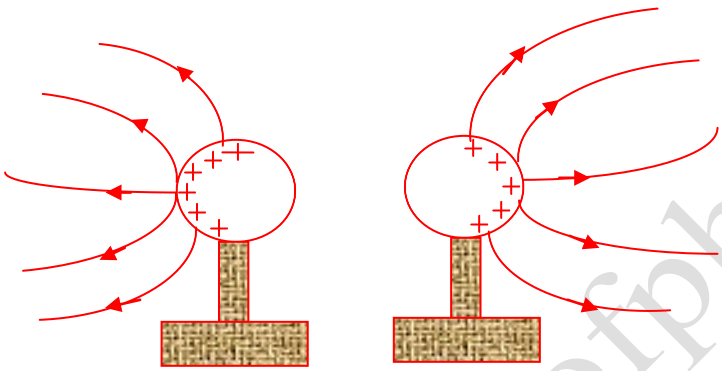
7. Draw the electric field pattern around the charges shown below. (2 mks)



8. Sketch an electric field pattern for an isolated negative charge. (1mk)



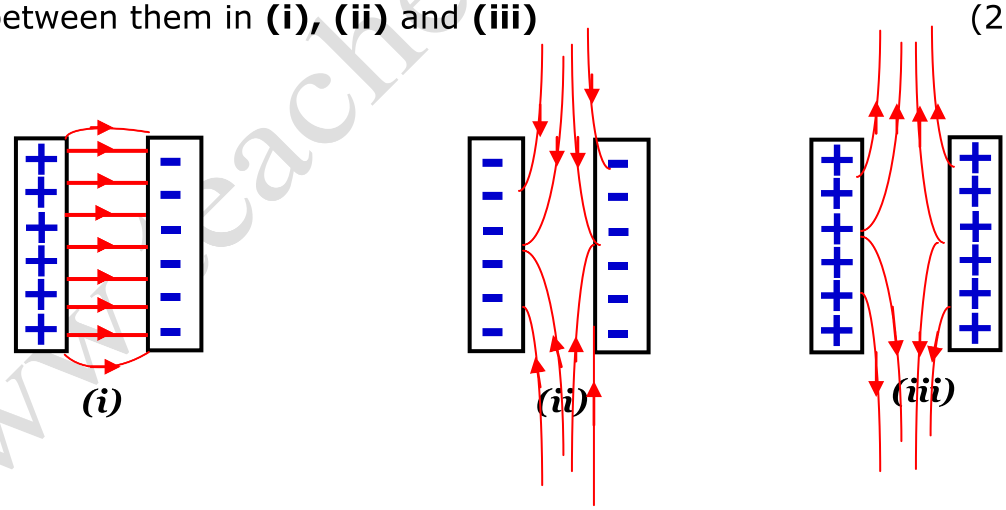
9. Two isolated and insulated spheres **A** and **B** carry the same positive charge. Sketch the electric lines of force of their field when placed close to each other but not touching some.



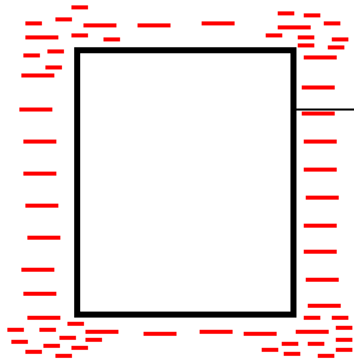
10. Explain why it is not advisable to shelter under a tree when it is raining. (1mk)

- ✓ Lighting tend to strike the tallest object in vicinity. Charges may spread out to the surrounding causing electrocution.

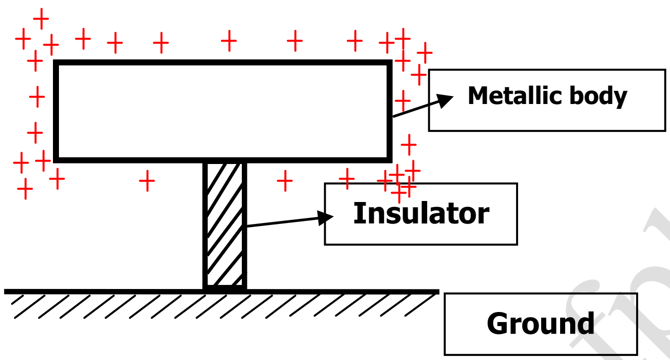
11. Figure below shows positive and negative charge carrying plates. Draw the electric field between them in **(i), (ii)** and **(iii)** (2mks)



12. The conductor shown in the figure below is charged negatively. Show the charge distribution.

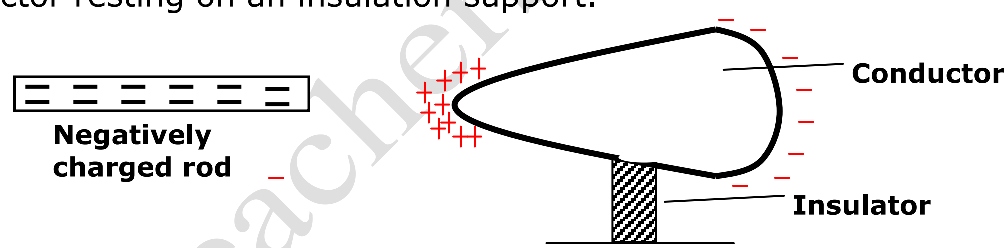


13. A metallic body shaped as shown is positively charged and insulated from the ground as shown.



On the figure show the charge distribution

14. The figure below shows a negatively charged rod placed near an uncharged conductor resting on an insulation support.



i) Show the charge distribution on the conductor. (1mk)

ii) State the effect

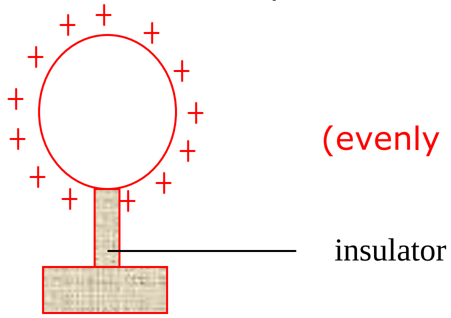
I) Of momentarily touching the conductor with a finger while the charged rod is still near the conductor. (1mk)

✓ The repelled negative charge flow to the ground, leaving the conductor positively charged.

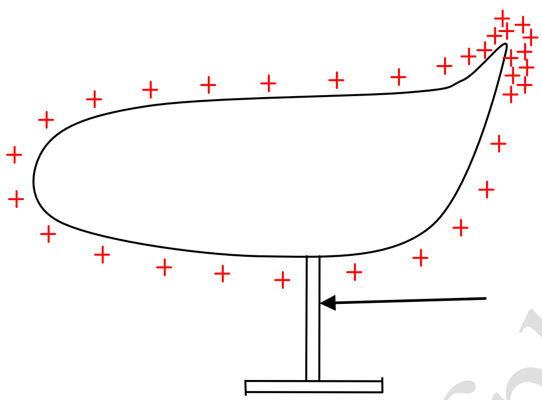
II) On the charge distribution of withdrawing the negatively charged rod after momentarily touching the conductor (1mk)

✓ Due to repulsion, the charges(positive) spreads on the conductor but the density is relatively high on sharp end.

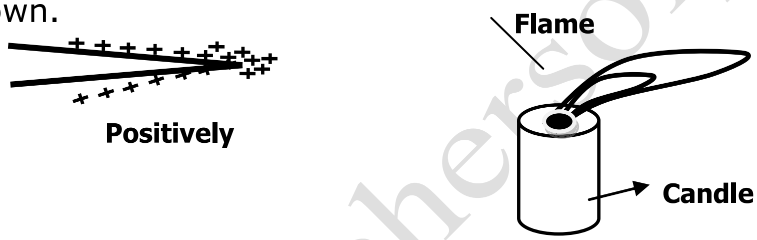
iii) In the space provided, sketch a diagram to show how the charge in ii (II) would have been distributed if the conductor was a sphere (1mk)



Show the charge distribution on the hollow conductor shown below if it is positively charged. (1mk)



15. A positively charged rod with appointed end is brought near a candle flame as shown.

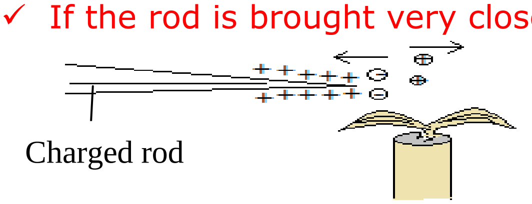


(i) State and explain the observation made.

- ✓ Candle flame is diverted as if being blown by wind.
- ✓ Reason – High density of charge at sharp edge ionize surrounding air producing positive and negative ions. The negative ions are attracted to the sharp point , while positive ions are repelled away towards the flame creating electric wind. Which blow the flame.

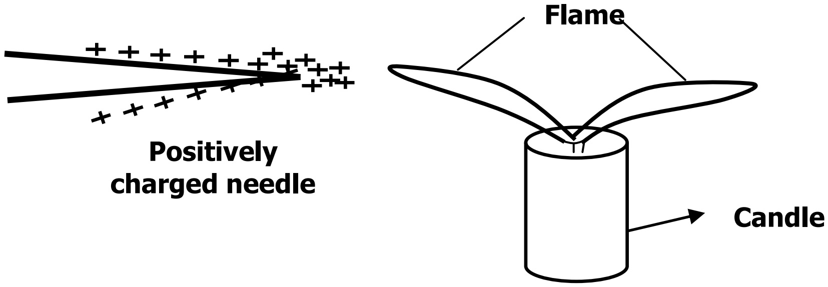
(ii) The rod is then brought very close to the flame. Use a diagram to explain what happen to the flame.

- ✓ If the rod is brought very close.



- ✓ The flame split in to two directions.
- ✓ The negative ions in the flame are attracted to the rod, diverting part of the flame towards it. At the same time, positive ions are repelled away diverting part of the flame away.

16. Figure below shows a highly charged needle bought near a candle flame



Explain why the flame burns in the direction shown (2mk)

- ✓ This is because the electric field will be cause by heavy drift of both negative and positive ions.

17. State the functions of the following features of a lighting arrestor.

i) Sharp spikes (1 Mk)

- ✓ To increase positive charge density

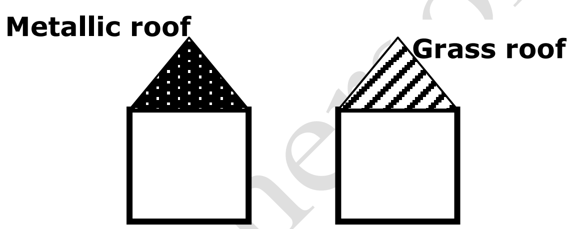
ii) Thick copper rod (1 Mk)

- ✓ Conduct negative charge (electrons) to the ground.

18. In the clothing and textile industries the machines experiences electrostatics forces at certain points. Suggests one method of reducing these forces.

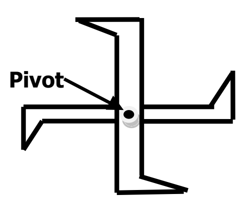
- ✓ By grounding the machines.

19. The fig shows sketches of two types of houses built in a lighting prone area. State with reason which house is safer to stay in during lighting and thunderstorms?



- ✓ Metal roofed house is safer.
- ✓ Metal easily conducts electrons to the ground while the grass roof can easily ignite as the lighting channels through on its way to ground.

20. A freely pivoted spike is charged to a high negative voltage in the air



Explain why the spikes move (2mks)

- ✓ Charge concentrate on the sharp edges. The repulsion due to similar charge cause rotation.

CAPACITANCE

1. Define capacitance of capacitor (1mk)

- ✓ Capacitance is the ratio of charge stored on the plate to the potential difference between the plate.

2. Define the volt. (1mk)

- ✓ A volt is the energy needed to move a unit charge from one point to another.

3. State and explain two factors affecting capacitance of parallel plate capacitor (4mks)

- ✓ **Area of overlap.**
  - ➢ Capacitance is directly proportional to the area of overlap.
- ✓ **Distance of separation.**
  - ➢ Capacitance is inversely proportional to the distance of separation.
- ✓ **Nature of the dielectric**.

4. One of the factors which affect the capacitance of a parallel plate capacitor is the area of overlap of the plates. Name **two** other factors. (2mks)

- ✓ Distance of separation.
- ✓ Nature of the dielectric materials.

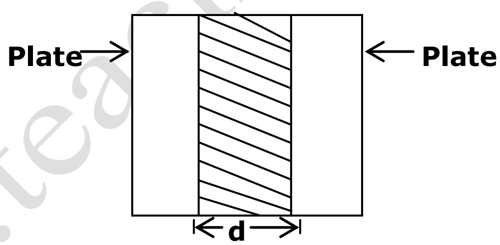
5. State a device where a variable air capacitor could be used.(1 mk)

- ✓ Radio tuners.
- ✓ Frequency mixers.
- ✓ Antenna impedance matching.

6. Explain briefly how a dielectric material affects the capacitance of parallel plate capacitor.

- ✓ Introduction of a dielectric material decreases the potential difference between the plates and hence increases the capacitance of the capacitor.

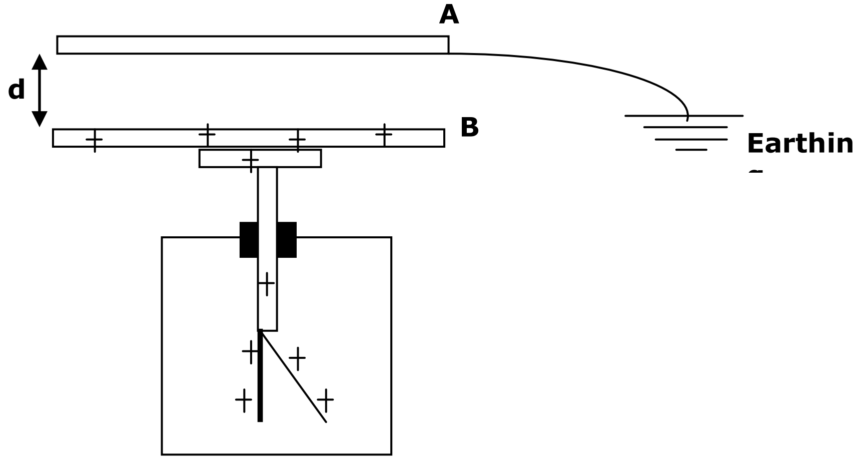
7. The two plates in figure 3 shows a capacitor with an insulator in between the plates.



The distance 'd cm' is reduced by half. Explain the effect on the capacitance of the capacitor. (1mk)

- ✓ The capacitance will double.

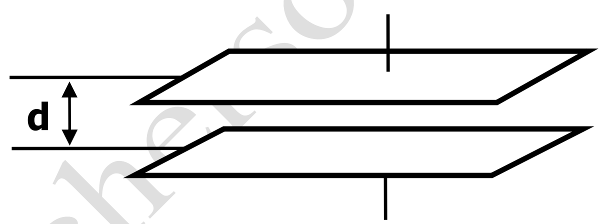
The figure below shows a charged electroscope and two aluminum plates A and B arranged as shown



State and explain the observations made on the leaf divergence when plate **A** is moved closer to **B.** (2mk)

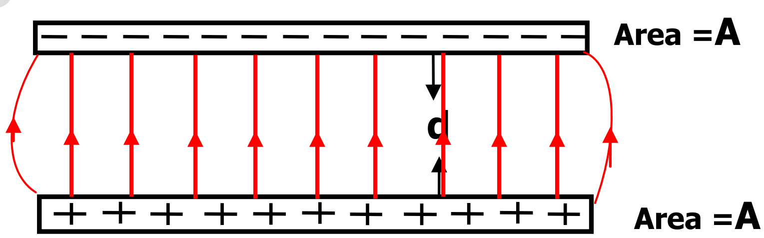
- ✓ Leaf divergence decreases / reduces.
- ✓ This is due to decrease in potential(V) between the plates since leaf divergence is a measure of the potential between the plates.

8. The figure below represents two parallel plates of a capacitor separated by a distance d. Each plate has an area of A square units. Suggest two adjustments that can be made so as to reduce the effective capacitance.



- ✓ Increase the distance of separation d.
- ✓ Reduce the area of overlap by sliding one of the plates sideways.

9. The figure shows the charged plates of a parallel plate capacitor where the distance d, is small.

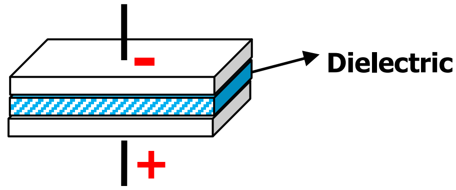


(i) Complete the diagram to show the electric field pattern in the space between the plates. (1 mk)

(ii) Without changing the distance **'d'** between the plates, suggest the method by which you could increase the capacitance of the capacitor. (1mk)

- ✓ Introducing a dielectric material between the plates.

10. The diagram shows a parallel plate capacitor with a dielectric material in between the plate.



State how each of the following quantities are affected when the dielectric material is pulled out of the parallel plates.

(i) The p.d across the plates. (1mk)

✓ P.d increases.

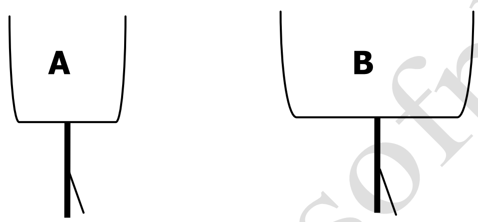
(ii) The charge on the plates. (1mk)

✓ Charge remains unchanged.

(iii) The capacitance of the system. (1mk)

✓ Capacitance decreases.

11. Two metal cans A and B of different sizes rest on two identical gold – leaf electroscopes as shown in figure. Each can is given exactly the same quantity of positive charge.



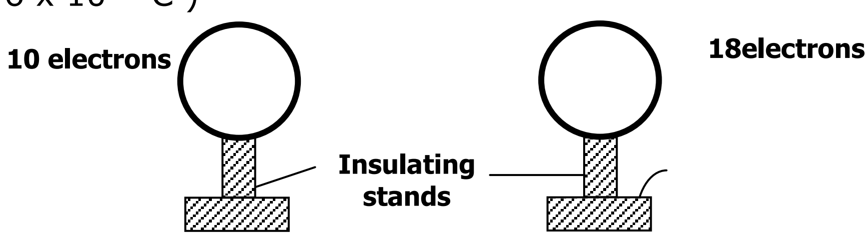
Show on the diagram the divergence on the leaves on each electroscope. Give a reason for your answer. 3mks

(A) Greater divergence (B) Smaller divergence

✓ Charges concentrate at sharp edges.

✓ Sharp edges at A are nearer the cap compared to B hence diversion of leaf at A is greater due to the greater charge density.

12. The two conducting balls shown in figure below are identical and contain the number of excess electrons indicated. The two balls are made to touch. How much charge in coulombs, will each have?
($e = 1.6 \times 10^{-19}$ C)



✓ Net charge on each ball$=\frac{18+10}{2}$

$=14$ electrons

$Q=ne$

$=14 \times (1.6 \times 10^{-19})C$

$=2.24 \times 10^{-18}C$

13. A $2\mu F$ capacitor is charged to a potential of 200V, the supply is disconnected. The capacitor is then connected to another uncharged capacitor. The p.d. across the parallel arrangement is 80V. Find the capacitance of the second capacitor.

$Q=CV$

$=2 \times 10^{-6}F \times 200\ V$

$=4 \times 10^{-4}\ C$

$C_1V_2+C_2V_2=4 \times 10^{-4}$

$2 \times 10^{-6} \times 80+C_2 \times 80=4 \times 10^{-4}$

$C_2=\frac{4\times10^{-4}-1.6\times10^{-4}}{80}$

$=\frac{2.4\times10^{-4}}{80}$

$=3.0 \times 10^{-6}$

$C_2=3.0\mu F$

14. A 10 μf capacitor is charged to a potential difference of 300V and isolated. It is then connected in parallel to a 5 μF capacitor. Find the resultant potential difference. (3mks)

$Q=CV$

$=10 \times 10^{-6}F \times 300\ V$

$=3.0 \times 10^{-3}\ C$

$C_1V_2+C_2V_2=3.0 \times 10^{-3}$

$(10 \times 10^{-6} +5 \times 10^{-6})\ V_2 =3 \times 10^{-3}$

$1.5 \times 10^{-5} \times V_2 =3 \times 10^{-3}$

$V_2=\frac{3\times10^{-4}}{1.5\times10^{-5}}$

$V_2=200V$

i) The energy stored before connection. (3mk)

$W=\frac{1}{2}QV$

$=\frac{1}{2} \times 3.0 \times 10^{-3} \times 300V$

$=0.45J$

ii) The energy in the two capacitors after connection. (3mk)

$W=\frac{1}{2}QV$

$W=\frac{1}{2}CV^2$

$W=\frac{1}{2} \times 10 \times 10^{-6} \times 200^2+\frac{1}{2} \times 5 \times 10^{-6} \times 200^2$

$=0.2+0.1$

$=0.3\ J$

15. A 5μF capacitor is charged to a p.d of 200v and isolated. It is then connected to another uncharged capacitor of 10μF. Calculate

i) The resultant p.d

$Q=CV$
$=5 \times 10^{-6} \times 200$
$=1.0\times10^{-3}C$
$C_1V+C_2V==1.0\times10^{-3}C$
$(5 \times 10^{-6} + 10 \times 10^{-6})V=1.0\times10^{-3}C$
$1.5 \times 10^{-5} \times V = 3 \times 10^{-3}$

$$V=\frac{1.0\times10^{-3}}{1.5\times10^{-5}}$$

$V=66.67V$

ii) The charge in each capacitor.

$Q_{c1}=CV$
$=5.0 \times 10^{-6} \times 66.67$
$=3.3335\times10^{-4}C$

$Q_{c2}=CV$
$=10.0 \times 10^{-6} \times 66.67$
$=6.667\times10^{-4}C$

16. Three capacitors of 1.5μF, 2.0 μF and 3.0 μF are connected in series to p.d. of 12V. Find;-

a) The combined capacitance.

✓ $$\frac{1}{Cs}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$$

✓ $$\frac{1}{Cs}=\frac{1}{1.5}+\frac{1}{2}+\frac{1}{3}$$

✓

✓ $$\frac{1}{Cs}=\frac{9}{6}$$

$Cs=0.667\,\mu F$

b) The total charge stored in the arrangement

$Q=CV$
$=0.667 \times 10^{-6} \times 12$
$=8.0004$ C
$=8.0$ C

c) The charge in each capacitor.

8.0 C (charge on each plate is the same)

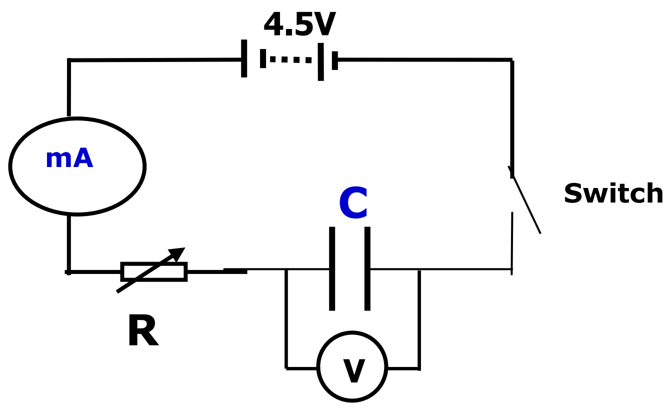
17. A capacitor of capacitance 10μf is charged by a battery to 5v.How much charge is stored in each plate (2mk)

$Q=CV$
$=10 \times 10^{-6} \times 5$
$=5.0 \times 10^{-5}C$

18. State two factors that affects the capacitance of a parallel plate capacitors. (2mk)

- ✓ Area of overlap.
- ✓ Distance of separation.
- ✓ Nature of the dielectric.

19. The figure below shows a capacitor **C** being charged.



(a) State what would be observed on the following when the switch is closed:

(i) The milliameter (1mk)

✓ Milliameter reading which is initially high gradually reduces to zero.

(ii) The voltmeter (1mk)

✓ Voltmeter reading increases from zero to 4.5V.

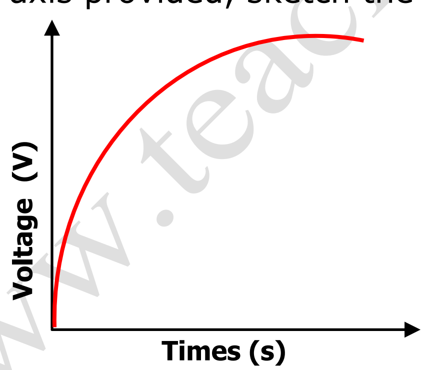
(b) Explain how the capacitor is charged. (3mk)

- ✓ Negative charges flow from negative terminal of the battery to the plate connected to it.
- ✓ At the same rate, negative charges flow from the other plate of the capacitor towards the positive terminal of the battery.
- ✓ Equal positive and negative charges appear on the plates.
- ✓ A potential difference is therefore set on the plates.

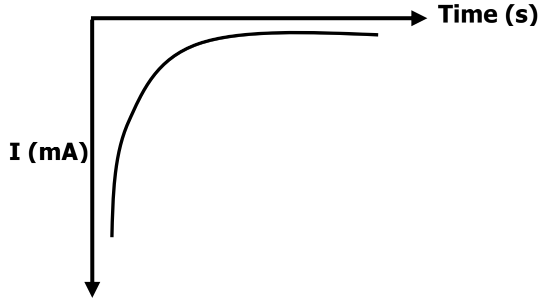
(c) State the purpose of the resistor **R**. (1mk)

✓ Used to create potential difference in the circuit causing the flow of current.

(d) On the axis provided, sketch the graph of voltage (V) against time (t) (1mk)



20. The graph shows the variation of current against time as the capacitor is being discharged

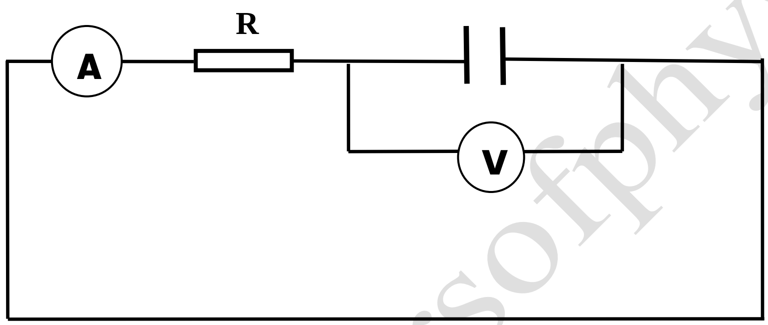


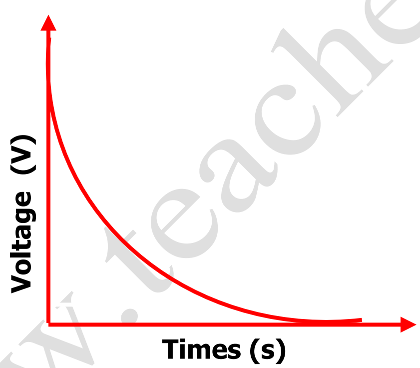
Explain the graph (1mk)

- ✓ During discharging, the charges flow in the opposite direction, to that of charging until positive charged on the positively charged plate are neutralized.
- ✓ This goes on for sometime until the charge on the plates is zero.

21. A capacitor was full charged to a potential of 40v. The capacitor is connected as shown in the figure 12 to discharge at load resistor R. Sketch a graph to show how the capacitor discharges with time

(2mks)





22. Two capacitors of capacitance **2μF** and **1μF** are connected in parallel. A p.d of 3V is applied across them. Find the energy stored in the combination. (2mk)

$C_p = C_1 + C_2$

$C_p = 2 + 1$

$= 3\ \mu F$

$E = \frac{1}{2}CV^2$

$= \frac{1}{2} \times 3 \times 10^{-6} \times 3^2$

$= 1.35 \times 10^{-5}$ J

23. Two capacitors of capacitance **4μF** and **8μF** are connected in (a) parallel and (b) series. Calculate the effective capacitance in each combination. (2mk)

(a) $C_p=C_1+C_2$

$C_p=4+8$

$=12\ \mu F$

(b) $C_s=\frac{C_1\times C_2}{C^1+C_2}$

$=\frac{8\times 4}{8+4}$

$=\frac{32}{12}$

$=2.667\ \mu F$

24. Two capacitors of xμF and 2μF are connected in parallel and the combination joined in series to a 5μF capacitor. The effective capacitance of the network is 2.5μF. Determine the value of x. (3mk)

$C_p=(x+2)\ \mu F$

$C_p=\frac{(x\times 2)\times 5}{x+2+5} \quad =2.5$

$5x+10=2.5(x+7)$

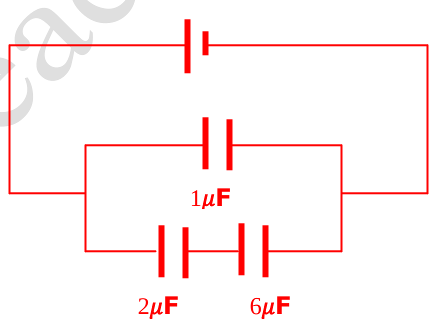
$5x+10=2.5x+17.5$

$2.5x=7.5$

$x=\frac{7.5}{2.5}$

$X=3.0\ \mu F$

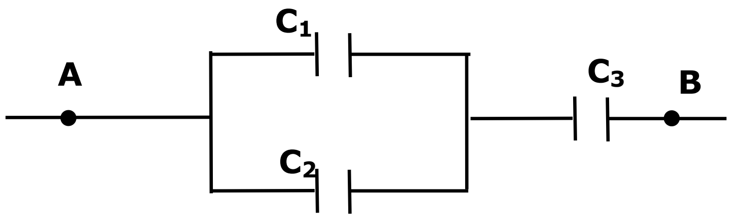
25. You are provided with **1μF, 2μF** and **6μF** capacitor. Arrange the three capacitors in series with a cell such that the total capacitance is **2.5μF** (2mk)



26. In the clothing and textile industries the machines experiences electrostatics forces at certain points. Suggests one method of reducing these forces.

- ✓ By earthing different parts of a textile to remove or neutralize the charges.

27. The Fig Shows part of a circuit containing three capacitors. Write an expression for C_T. The effective capacitance between A and B.

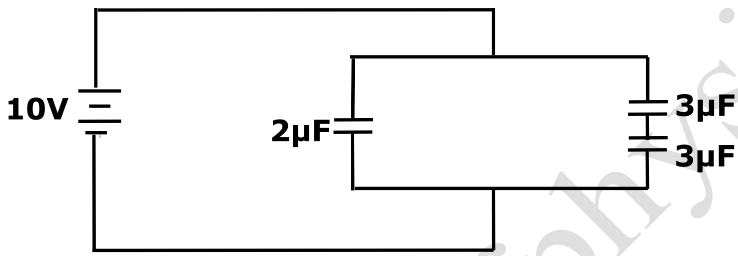


$C_T = C_1 + C_2$

$$C_T = \frac{C_T \times C_3}{C_T + C_3}$$

$$= \frac{C_1 + C_2)C_3}{C_1 + C_2C_3}$$

28. The fig. shows an arrangement of capacitors connected to a 10v. D.C supply determine:-



i) The charge stored in the 2μF capacitor

$Q = CV$

$= 2\times10^{-6}\times10$

$= 2.0\times10^{-5}$ C

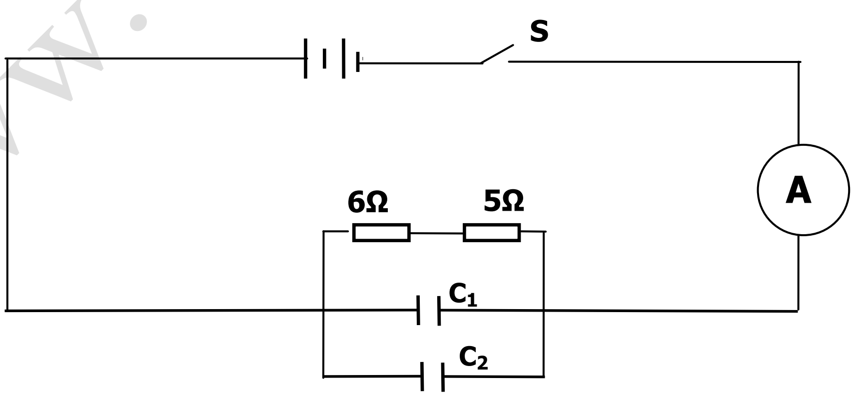
ii) The total capacitance of the arrangement

$$C_T = 2 + \frac{3\times3}{3+3}$$

$= 2 + 1.5$

$= 3.5\ \mu\mathbf{F}$

29. In the circuit diagram shown in Fig. 4 each cell has an e.m.f of 1.5 and internal resistance of 0.5Ω. The capacitance of each capacitor is 1.4μF.



When the switch s is closed determine the:

(i) Ammeter reading

$R_T = 2 \times 0.5 + 6 + 5$

$=12\ \Omega$

From ohm's law

$I=\frac{V}{R}$

$=\frac{3}{12}$

$=0.25A$

(ii) Charge on each capacitor

$V_R=IR$

$=0.25\times 11$

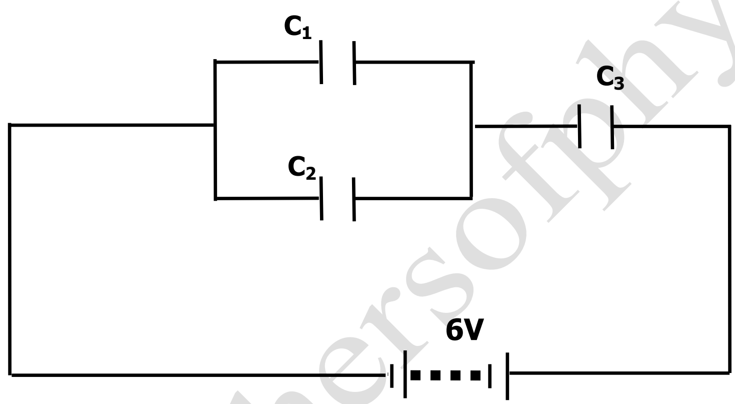
$=2.75$

$Q=CV$

$=1.4\times 10^{-6}\times 2.75$

$=3.85\times 10^{-6}$ C

30. In the circuit of the figure $C_1=2\ \mu F$, $C_2=C_3=0.5\ \mu F$ and E is a 6V battery. Calculate the total charge and p.d across C_1



$C_T=C_1+C_2$

$=2+0.5$

$=2.5\ \mu F$

$C_T:C_3=2.5:0.5$

$=5:1$

$V_{CT}=\frac{1}{6}\times 6V$

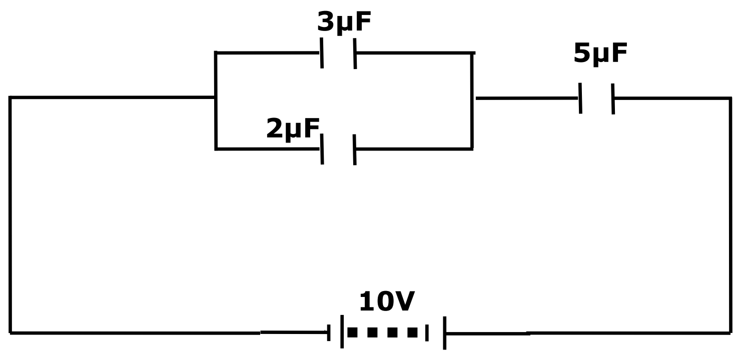
$=1$ V (inverse ratio of capacitance)

$Q_{c1}=C_1V$

$=2.0\times 10^{-6}\times 1$

$=2.0\times 10^{-6}$ C

31. Figure shows a circuit diagram with three capacitors.



(i) Determine the effective capacitance of the arrangement. (2mk)

$C_T=3+2$

$=5\ \mu F$

$C_T=\frac{5\times5}{5+5}$

$=\frac{25}{10}$

$=2.5\ \mu F$

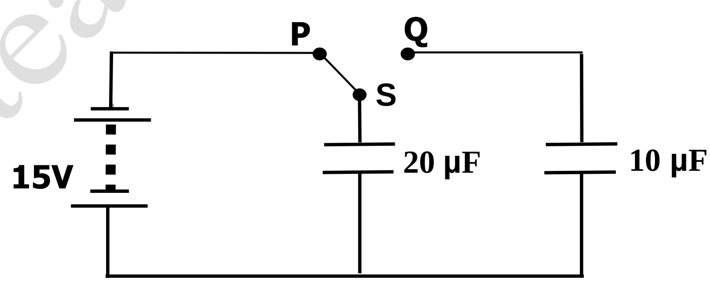
(ii) Find the energy stored in the combinations of capacitors. (3mk)

$W=\frac{1}{2}CV^2$

$=\frac{1}{2}\times2.5\times10^{-6}\times10^2$

$=1.25\times10^{-4}$ J

32. Fig represents a circuit which is used to charge a 20 μF capacitor by connecting it to a 15 V battery. Later the capacitor is connected to a 10 μF capacitor.



i) Switch S is first closed at position P so that the 20 μF capacitor charges. Find the maximum charge stored. (3 marks)

$Q=CV$

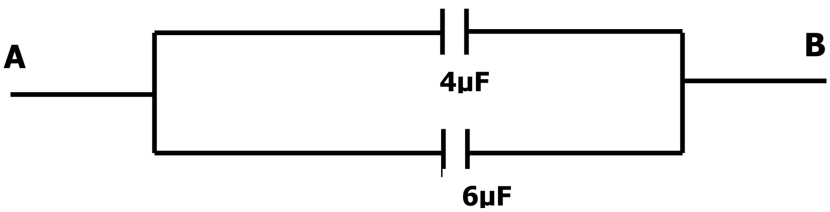
$=20\times10^{-6}\times15$

$=3.0\times10^{-4}$ C

ii) The switch S is now moved to Q. Determine the final potential difference, V across the capacitors. (3 marks)

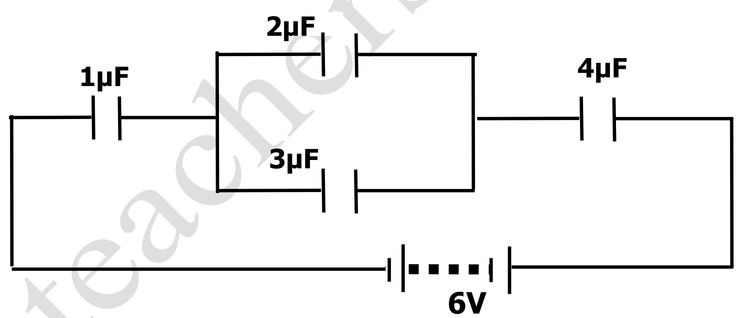
$C_1V+C_2V=3.0\times10^{-4}$
$(20\times10^{-6}+10^{-6})V=3.0\times10^{-4}$
$30\times10^{-6}\times V=3.0\times10^{-4}$
$V=\frac{3.0\times10^{-4}}{30\times10^{-6}}$
$V=10$ V

33. The figure below shows a part of a circuit containing two capacitors of **4μF** and **6μF** respectively.



$Q=CV$
$C=4+6$
$=10$ μF
$Q=10\times10^{-6}\times V$
$1.0\times10^{-6}=10\times10^{-6}\times V$
$V=\frac{1.0\times10^{-6}}{10\times10^{-6}}$
$=0.1$ V

34. Determine the p.d across AB given that the total charge in the capacitors is **0.000001C**. The figure below shows an arrangement of four capacitors connected to a 3.0 V power supply.



Calculate:
i. The effective capacitance (3mks)

$C_T=3+2$
$=5$ μF
$1/C_T=\frac{1}{1}+\frac{1}{5}+\frac{1}{4}$
$1/C_T=\frac{29}{20}$
$C_T=\frac{20}{29}$
$=0.6897$ μF

ii. The charge stored by the 3μF capacitor (3mks)

(Correction on power supply=6.0 V and not 3.0 V)

Q=CV

$=0.6897\times10^{-6}\times6$

$=4.1382\times10^{-6}$ C

$V_{CT}=Q/C$

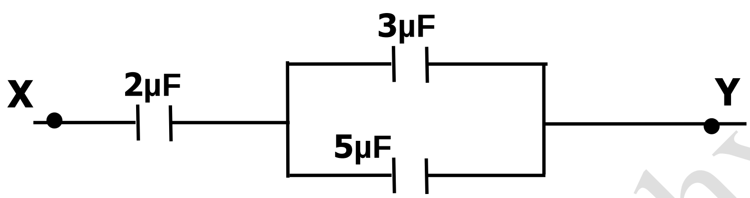
$=\frac{4.1382\times10^{-6}}{5\times10^{-6}}$

=0.8276 V

$Q=0.8276\times3\times10^{-6}$

$=2.483\times10^{-6}$ C

35. Fig shows a network of capacitors. Determine the charge stored in the 3μF capacitor when a battery of e.m.f. 4V is connected between point X and Y.(3 mk)



CT=3+5

=8 μF

$C_1:C_T=2:8$

=1:4

$V_{CT}=1/5\times4$ V

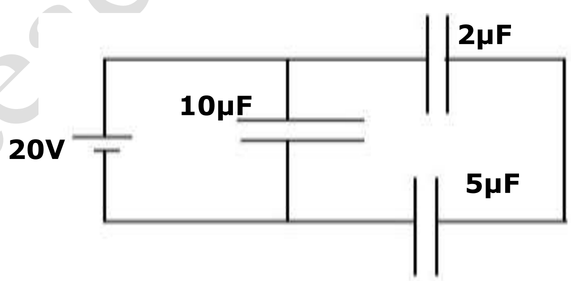
=0.8 V

Q=CV

$=3.0\times10^{-6}\times0.8$

$=2.4\times10^{-5}$ C

36. Figure shows arrangement of three capacities of 10μF, 2μF and 5μF.



Determine

(i) The effective capacitance. (3mk)

$C_S=\frac{2\times5}{2+5}$

$=\frac{10}{7}$

=1.429 μF

$C_T=10\mu F+1.429\ \mu F$

=11.429 μF

(ii) The charge on the **5μF** (3mk)

$Q_T = C_T V$

$= 11.429 \times 10\text{-}6 \times 20$

$= 2.2858 \times 10\text{-}6$ C

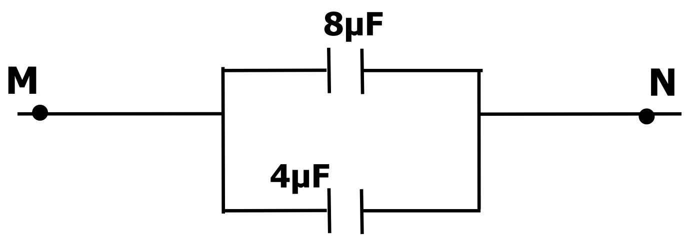
Charge on the 5μF capacitor.

$= (2.2858 \times 10^{-4}) - (10 \times 10^{-6} \times 20)$

$= (2.2858 \times 10^{-4}) - (2.0 \times 10^{-4})$

$= 2.858 \times 10^{-5}$ C

37. Figure below shows part of a circuit containing two capacitors of 4μF and 6μF respectively.



Determine the p.d across **MN** given that the total charge stored in the two capacitors is **4.5×10^{6}C** (3mks)

CT=8+4

$= 12$ μF

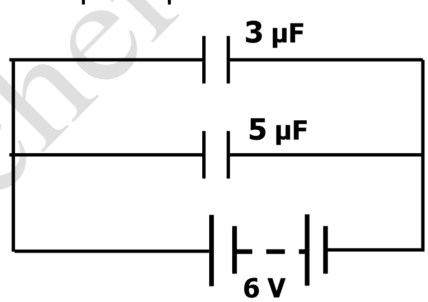
Q=CV

V=Q/C

$$= \frac{4.5 \times 10^{-6}}{12 \times 10^{-6}}$$

$= 0.375$ V

38. Fig below shows a 5μF and a 3μF capacitors connected to a 6V battery



Calculate the charge stored in the circuit (3mk)

$C_T = 3 + 5$

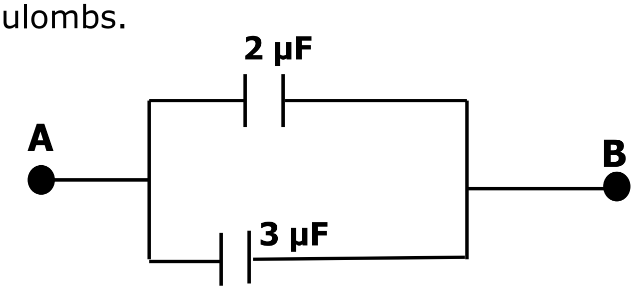
$= 8$ μF

$Q = C_T V$

$= 8 \times 10^{-6} \times 6$

$= 4.8 \times 10^{-5}$ C

39. The figure is a part of a circuit containing two capacitor of **2μF** and **3μF**, determine the potential difference across AB given that the total charge in the capacitors is **1 x 10^{-4}** coulombs. (3mk)



$Q=CV$

$C_T=2+3$

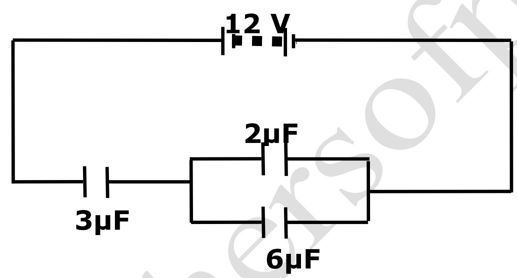
$=5\ \mu F$

$V=Q/C$

$=\frac{1\times10^{-4}}{5\times10^{-6}}$

$=20V$

40. Fig shows three capacitors of capacitance 3μF, 2μF, 6μF and 12V supply connected in a circuit.



Calculate:

(i) The total capacitance of the circuit. (2mks)

$C_P=2+6$

$=8\ \mu F$

$C_T=\frac{3\times8}{3+8}$

$=\frac{24}{11}$

$=2.182\ \mu F$

(ii) The charge stored in the circuit. (2mks)

$Q=CV$

$=2.182\times10^{-6}\times12$

$=2.6184\times10^{-5}\ C$

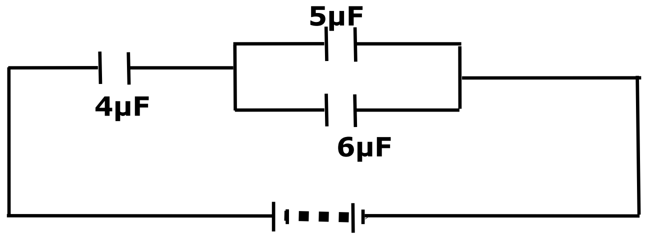
(iii) The potential difference across the 2μF capacitor. (2mks)

$V=Q/C$

$=\frac{2.6184\times10^{-5}}{8\times10^{-6}}$

$=3.273\ V$

41. The diagram below shows capacitors of **4μF**, **5μF** and **6μF** connected to 12V d.c supply



Find

ii The effective capacitance (3mks)

$C_P = 5+6$

$= 11\ \mu F$

$C_T = \frac{4\times11}{4+11}$

$= \frac{44}{15}$

$= 2.933\ \mu F$

ii The charge stored in the **6μF** capacitor (2mks)

$V_{CP} = 4/15\times12$

$= 3.2\ V$

$Q = CV$

$= 6\times10^{-6}\times3.2$

$= 1.92\times10^{-5}\ C$

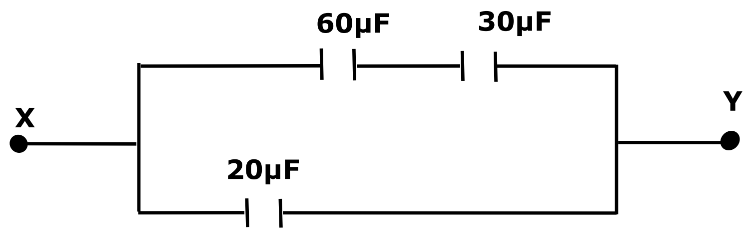
$C_S = \frac{4\times11}{4+11}$

$= \frac{44}{15}$

$= 2.933\ \mu F$

42. Calculate the effective capacitance of the capacitors shown across points X and Y.

(3mks)



$C_S = \frac{60 \times 30}{60+30}$

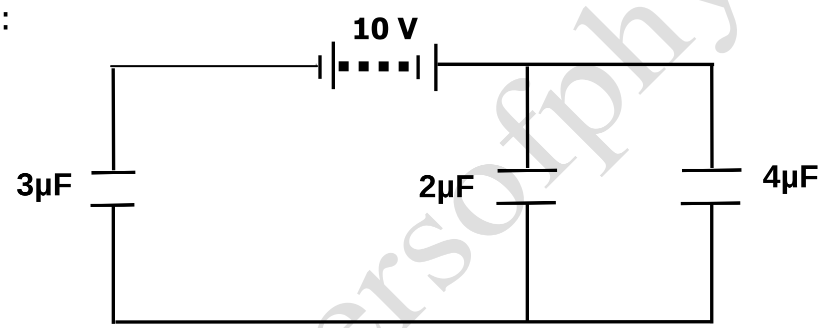
$= \frac{1800}{90}$

$= 20\ \mu F$

$C_T = 20\ \mu F + 20\ \mu F$

$= 40\ \mu F$

43. The fig shows an arrangement of capacitors connected to a 10V d.c supply. Determine:



(i) The charge stored in the 2μ F capacitor.

$C:C_P = 3:6$

$= 1:2$

$V_{CP} = 1/3 \times 10$

$= 3.333\ V$

Charge stored in 2 μF capacitor

$Q = CV$

$= 2 \times 10^{-6} \times 3.333$

$= 6.666 \times 10^{-6}\ C$

(ii) The total capacitance of the arrangement.

$C_P = 2+4$

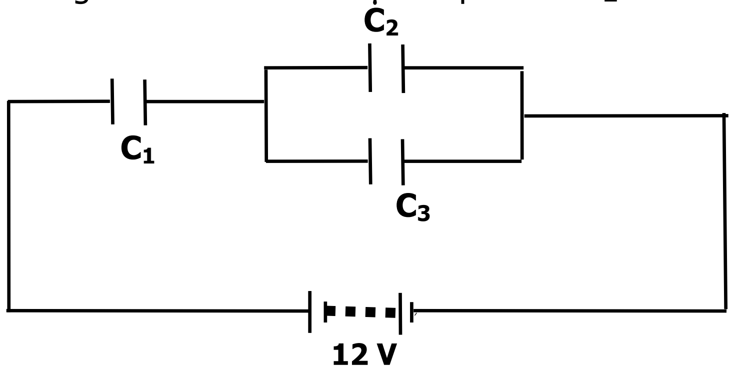
$= 6\ \mu F$

$C_T = \frac{6 \times 3}{6+3}$

$= \frac{18}{9}$

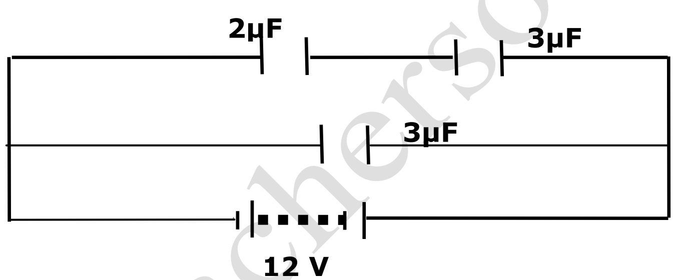
$= 2\ \mu F$

44. In the circuit below **C_1= 4 μF, C_2= 3μF** and **C_3 = 1μF**. Given that V= **12V**, calculate the charge stored on the **3μF** capacitor **C_2** 3 mks



$C_P = 3+1$
$= 4\ \mu F$
$C_1 : C_P = 4:4$
$= 1:1$
$Q = CV$
$V_4 = 1/2 \times 12V$
$= 6\ V$
$Q = 3\times10^{-6} \times 6$
$= 1.8\times10^{-5}\ C$

45. Three capacitors are 2μF and two 3μF capacitors are connected as shown below.



From the figure find the effective capacitance. (3mks)

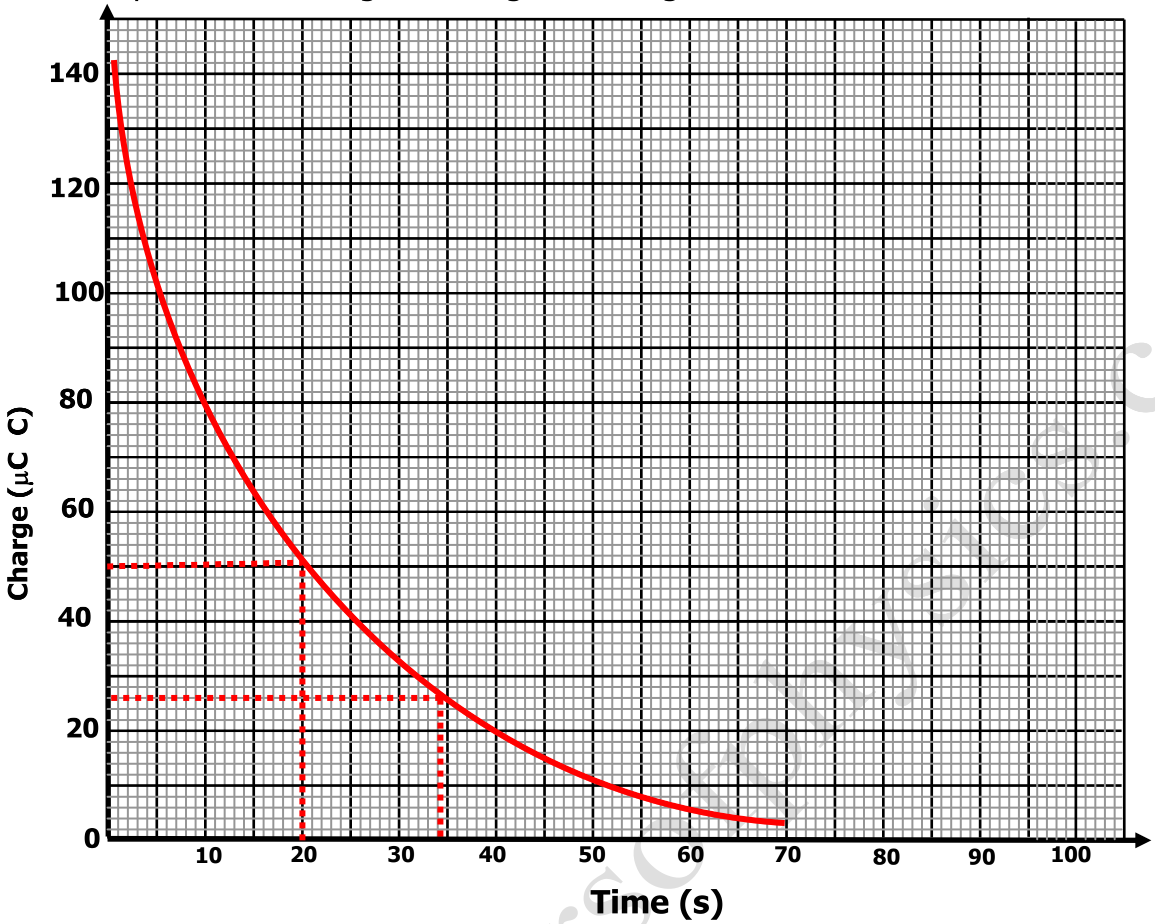
$$C_S = \frac{2\times3}{2+3}$$

$$= \frac{6}{5}$$

$= 1.2\ \mu F$

$C_T = 1.2+3$
$= 4.2\ \mu F$

46. a) The graph below shows the variation of charge and time when the capacitor is being discharged through a resistor.



From the graph, determine:

(i) the quantity of charge at t = 34 seconds. 1mk

=27 μC

(ii) the amount of current flowing when the time is 20 seconds.(3mks)

Q=51 μC

Q=It

I=Q/t

$= \dfrac{51 \times 10^{-6}}{20}$

$= 2.55 \times 10^{-6}$ A

(iii) the initial charge. 1mk

=140 μC or 1.4×10^{-4} C

b) State two factors affecting capacitance. 2mks

- ✓ Area of overlap.
- ✓ Distance of separation.
- ✓ Nature of dielectric material.

b) Two resistors 6Ω and 3Ω in parallel are connected in series to a 4Ω resistor and a cell of e.m.f 1.5v, and negligible internal resistance. Calculate:

(i) the equivalent resistance of the circuit. 3mks

$$R_p=\frac{R_1 \times R_2}{R_1+R_2}$$

$$=\frac{6\times3}{6+3}$$

$$=\frac{18}{9}$$

$=2\ \Omega$

$R_T=2+4$

$=6\ \Omega$

(ii) the current through each resistor. 3mks

Total current

$$I_T=\frac{1.5\ V}{6\ \Omega}$$

$=0.25$ A

p.d through 4Ω resistor

$=0.25\text{A}\times4\Omega$

$=1.0$ V

$I_{4\Omega}=0.25\text{A}$

$$I_{6\Omega}=\frac{0.5\ V}{6\ \Omega} \quad =0.0833\ \text{A}$$

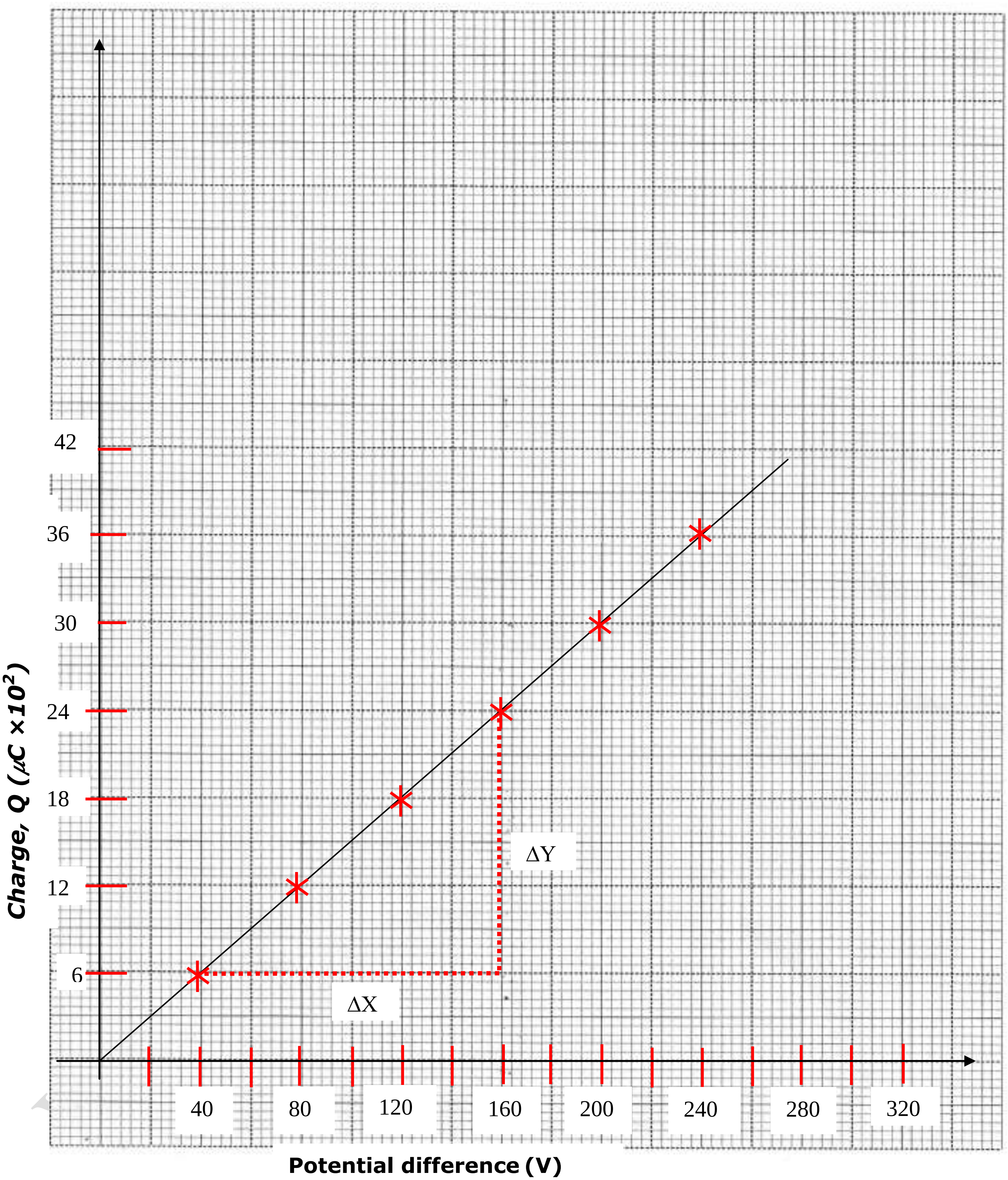
$$I_{3\Omega}=\frac{0.5\ V}{3\ \Omega} \quad =0.1667\ \text{A}$$

47. A form III girl carried out an experiment to investigate the relationship between the p.d across the plates and the charge stored. The following were the results.

P.d(v)	**40**	**80**	**120**	**160**	**200**	**240**
Capacitance (μF)	**15**	**15**	**15**	**15**	**15**	**15**
Charge, Q (μ C)	**600**	**1200**	**1800**	**2400**	**3000**	**3600**

i) Fill the column for the charge stored. (1mk)

ii) On the grid provided, plot a graph of charge stored against p.d across the plates. (4mks)



iii) Use the graph to determine the energy stored in the capacitor.(3mks)

$$\text{Slope}=\frac{\Delta Q}{\Delta V}$$
$$=\frac{2400\times10^{-6}-600\times10^{-6}}{160-40}$$
$$=\frac{1.8\times10^{-3}}{120}$$
$=1.5\times10^{-5}$ F or 15 μF

$W=1/2CV^2$ or $W=1/2QV$ (Area under the graph)

$=1/2\times3600\times10^{-6}\times240$

$=0.432$ J

Or

$W=1/2CV2$

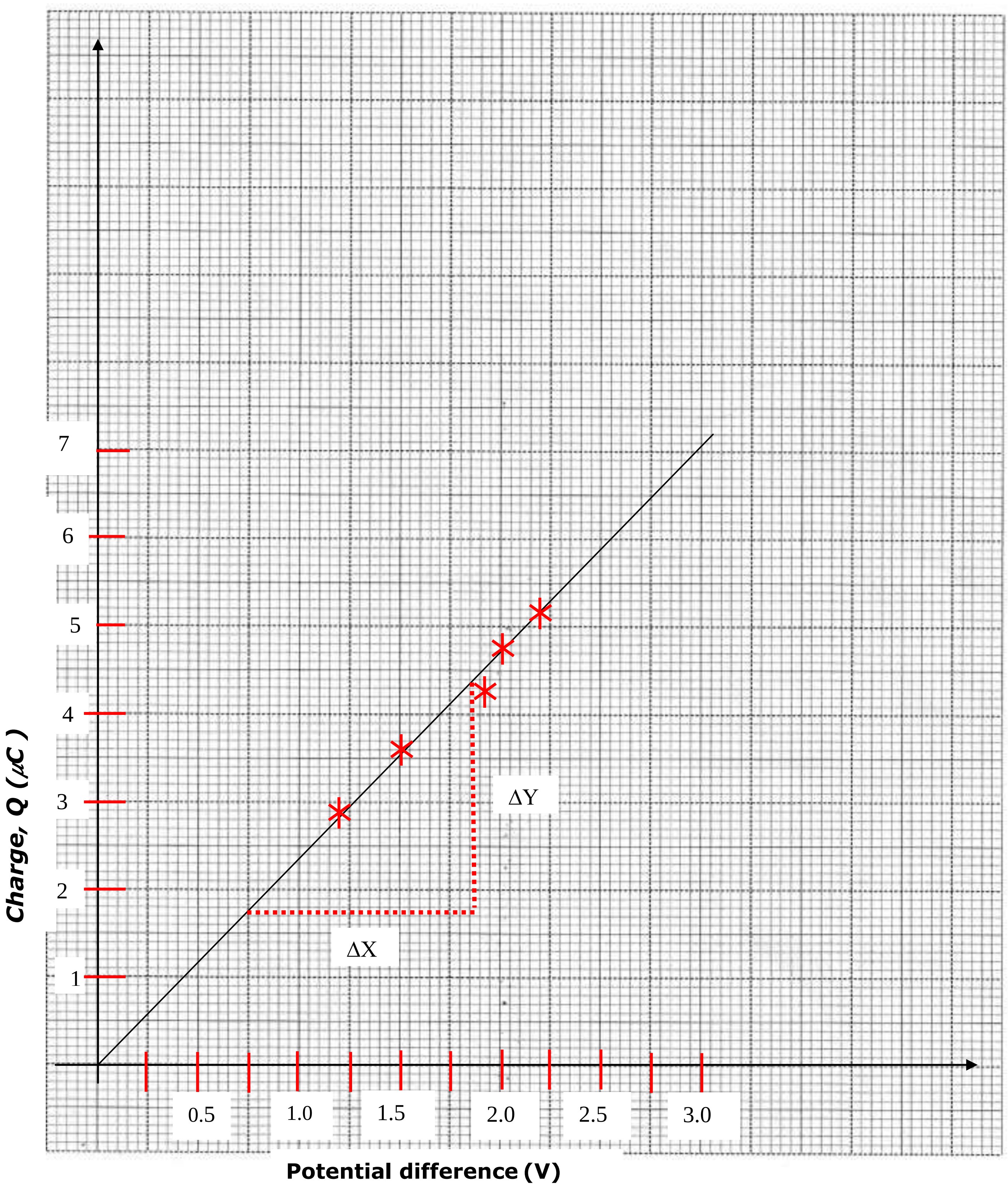
$=1/2\times15\times10^{-6}\times240^2$

$=0.432$ J

48. In A capacitor was connected in a circuit and charged until it was full. The Potential difference (Pd) across it was measured using a voltmeter. The corresponding values of the charge stored was calculated and tabulated in the table below.

Pd across the Capacitor (V)	**1.2**	**1.5**	**1.8**	**2.0**	**2.2**
Charge stored (μC)	**2.88**	**3.60**	**4.32**	**4.80**	**5.28**

a) Plot a graph of the charge stored against the Pd. (5 marks)



b) Using the graph, determine:

i) The capacitance of the capacitor. (3 marks)

Capacitance=slope

$$\text{Slope}=\frac{\Delta Q}{\Delta V}$$

$$=\frac{4.2\times10^{-6}-1.8\times10^{-6}}{1.75-0.75}$$

$$=\frac{2.4\times10^{-6}}{1.0}$$

$=2.4\times10^{-6}$ F

ii) The energy stored by the capacitor. (2 marks)

W=1/2QV (Area under the graph)

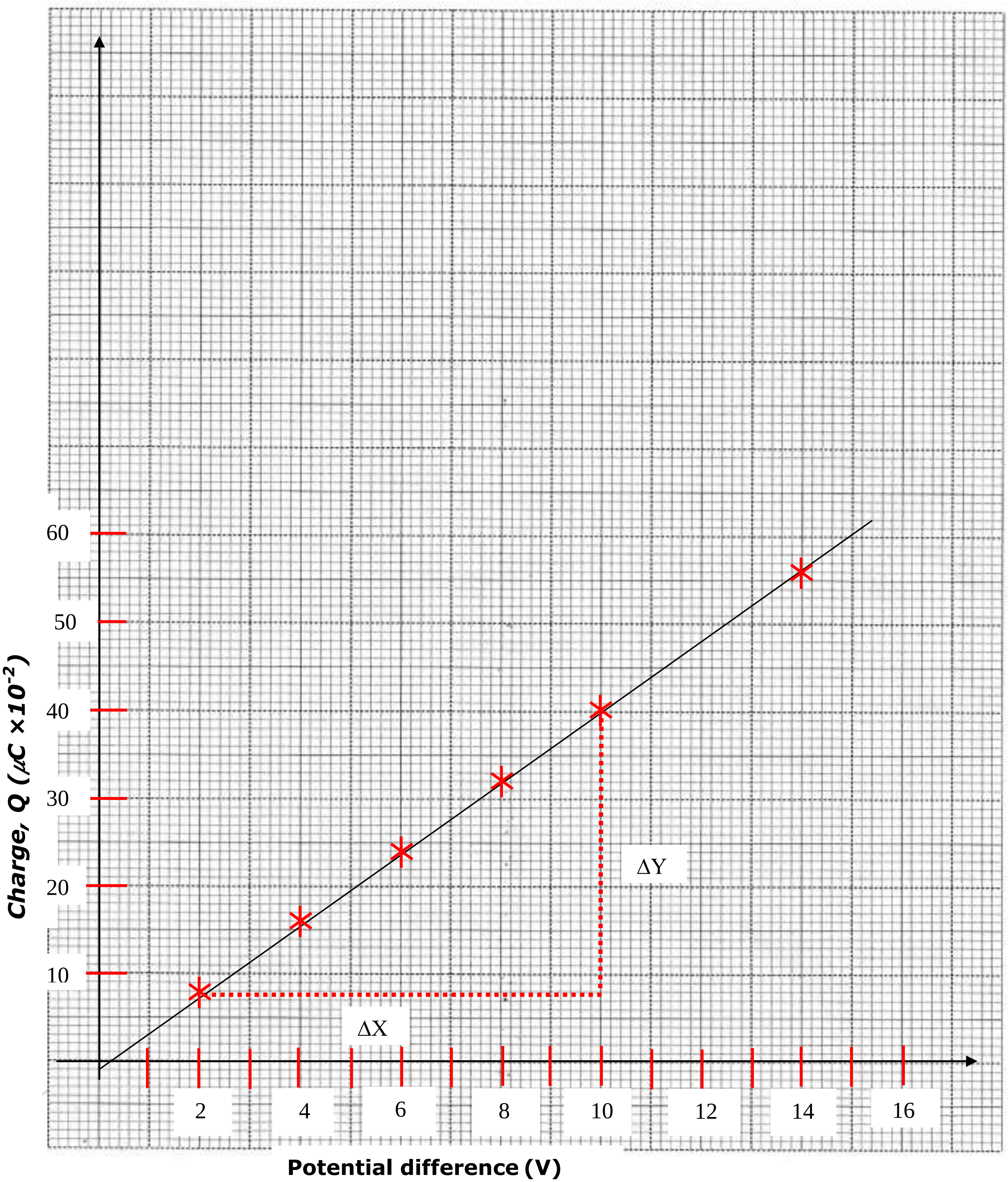
$=1/2\times5.3\times10^{-6}\times2.2$

$=5.83\times10^{-6}$ J

49. In an experiment to study the variation of charge stored on capacitor and the potential difference across it, the following results were obtained.

Charge Q (μC)	**0.08**	**0.16**	**0.24**	**0.32**	**0.40**	**0.56**
P.d (V)	**2.0**	**4.0**	**6.0**	**8.0**	**10.0**	**14.0**

Plot a graph of charge **Q**. against p.d



Use your graph to determine:-

a) Capacitance of the capacitor.

Capacitance=slope

$\text{Slope}=\frac{\Delta Q}{\Delta V}$

$=\frac{0.40-0.08}{10.0-2.0}$

$=\frac{0.32}{8.0}$

$=0.04\ \mu F$

b) Energy stored in the capacitor when the p.d across its plate is 10V.

Energy

W=1/2QV (Area under the graph)

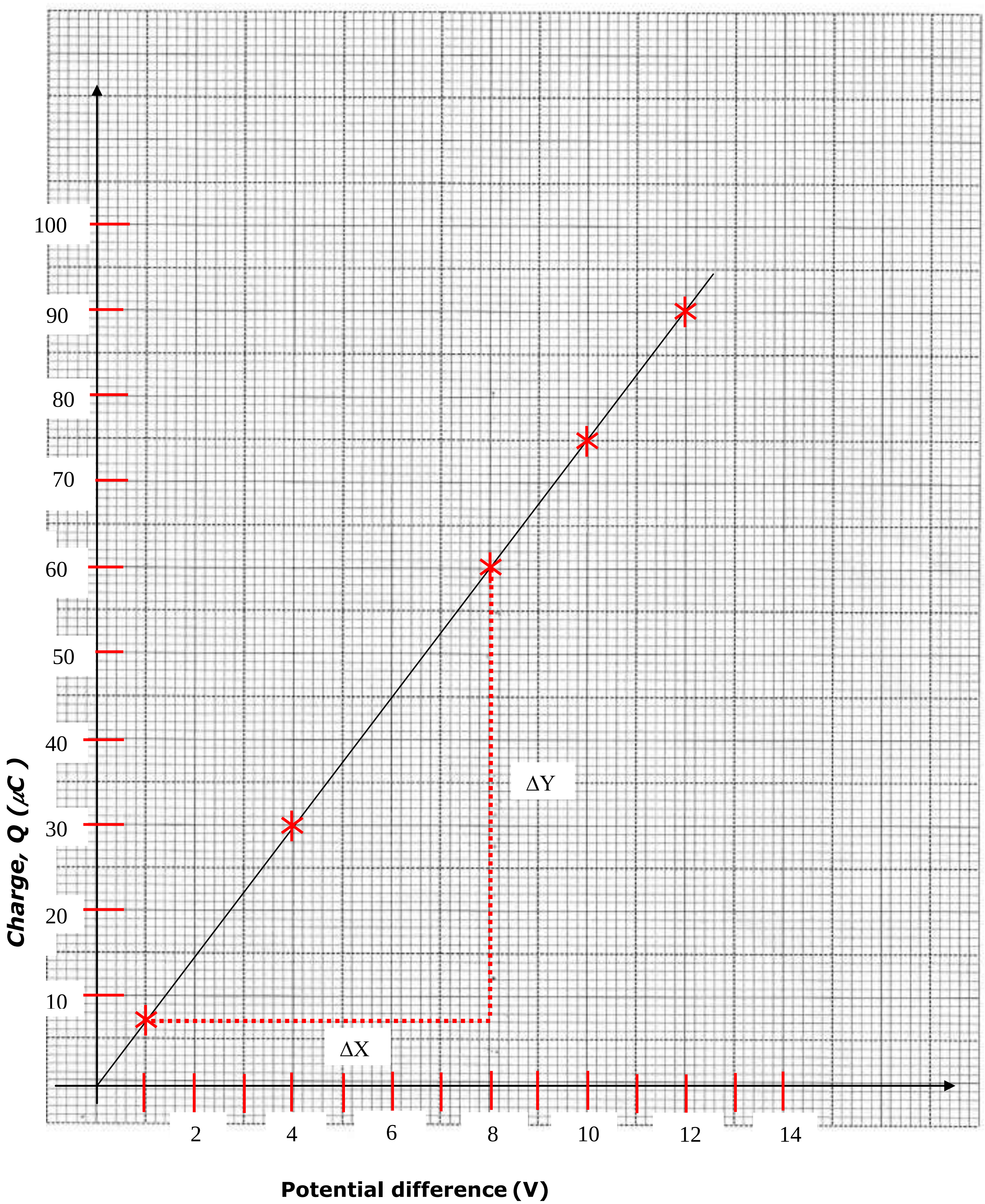
$=1/2\times0.4\times10^{-6}\times10$

$=2.0\times10^{-6}$ J

50. In an experiment with capacitor the charge stored was measured for different values of charging potential difference and the following results were obtained.

Charge stored (μ C)	**7.5**	**30**	**60**	**75**	**90**
Potential difference (V)	**1.0**	**4.0**	**8.0**	**10.0**	**12.0**

(i) Plot a graph of charge stored (y-axis) against potential difference on the grid provided. (4 mk)



(ii) Use the graph to d e capacitor. (2 mk)

Capacitance, C=slope

$$C=\frac{\Delta Q}{\Delta V}$$

$$=\frac{60-7.5}{8.0-1.0}$$

$$=\frac{52.5}{7.0}$$

$=7.5\times10^{-6}$ F or 7.5 μF

