

Test paper code

P1-16-06-09

CODE

A

1602

Capacitance

Time : 2 Hours

Maximum Marks : 130

Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose

A. General :

1. This booklet is your Question Paper containing **34 questions**. The booklet has **12 pages**.
2. The question paper CODE is printed on the right hand top corner of this sheet and on the back page of this booklet.
3. The question paper contains 3 blank pages for your rough work. No additional sheets will be provided for rough work.
4. Blank papers, clip boards, log tables, slide rules, calculators, cellular phones, pagers, electronic gadgets in any form are not allowed to be carried inside the examination hall.
5. Fill in the boxes provided below on this page and also write your Name and Registration No. in the space provided on the back page of this booklet.
6. The answer sheet, a machine-readable Objective Response Sheet (ORS), is provided separately.
7. DO NOT TEMPER WITH/MUTILATE THE ORS OR THIS BOOKLET.
8. Do not break the seal of the question paper booklet before being instructed to do by the invigilators.

C. Marking Scheme :

9. **Section I** contains 10 Questions with **single choice correct**. Every correctly answered question will be awarded **3 marks**, left unattempted will be awarded **0 marks** and incorrectly answered will be awarded **-1 marks**.
10. **Section II** contains 6 Questions with **one or more than one choice(s) correct**. Every correctly answered question will be awarded **4 marks**, left unattempted will be awarded **0 marks** and incorrectly answered will be awarded **-1 marks**.
11. **Section III** contains 4 Questions with **one or more than one choice(s) correct**. Every correctly answered question will be awarded **3 marks**, left unattempted will be awarded **0 marks** and incorrectly answered will be awarded **-1 marks**.
12. **Section IV** contains 2 group of 3 Questions each based on comprehension with **single choice correct**. Every correctly answered question will be awarded **4 marks**, left unattempted will be awarded **0 marks** and incorrectly answered will be awarded **-1 marks**.
13. **Section V** contains 2 Questions for matrix match. Every correct match will be awarded 2 marks, left unattempted will be awarded **0 marks**. There will be **no negative marking**.
14. **Section VI** contains 6 Subjective questions with single digit integer answer. Every correctly answered question will be awarded **4 marks**, left unattempted will be awarded **0 marks** and incorrectly answered will be awarded **-1 marks**.

K. Anwar

Name :

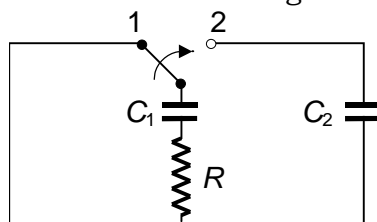
Reg. No. :

Signature of the Candidate

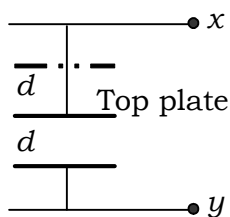
Signature of the Invigillator

3. An air filled parallel plate capacitor charged to potential V_1 is connected to an uncharged identical parallel plate capacitor with dielectric constant k . The common potential after connection is V_2 . The value of k
- (A) $\frac{V_1 + V_2}{V_1 - V_2}$ (B) $\frac{V_1}{V_1 - V_2}$
(C) $\frac{V_1 - V_2}{V_2}$ (D) $\frac{V_2}{V_1 - V_2}$
4. Two identical metal plates are given positive charges Q_1 and Q_2 ($<Q_1$) respectively. If they are now brought close together to form a parallel plate capacitor with capacitance C , the potential difference between them is
- (A) $\frac{(Q_1 + Q_2)}{2C}$ (B) $\frac{(Q_1 + Q_2)}{C}$
(C) $\frac{(Q_1 - Q_2)}{C}$ (D) $\frac{(Q_1 - Q_2)}{2C}$
5. A capacitor of capacitance $1 \mu\text{F}$ can withstand a maximum potential difference of 6 kV where as another capacitor of capacity $2 \mu\text{F}$ can store a maximum charge of 8 mC . Maximum potential the series combination of these two capacitors can withstand is
- (A) 2.4 kV (B) 5 kV
(C) 9 kV (D) 10 kV
-

9. A charged capacitor of capacitance C_1 is discharged through a resistor R . When the discharge current attains the value I_0 , the key is shifted from 1 to 2. Then the amount of heat liberated in the resistor starting from this moment is



- (A) $\frac{I_0^2 R^2 C_1 C_2}{4(C_1 + C_2)}$ (B) $\frac{I_0^2 R^2 C_1 C_2}{2(C_1 + C_2)}$
- (C) $\frac{I_0^2 R^2 C_1 C_2}{(C_1 + C_2)}$ (D) $\frac{2I_0^2 R^2 C_1 C_2}{(C_1 + C_2)}$
10. A parallel plate capacitor has a movable top plate that executes simple harmonic motion at frequency f . The displacement of the top plate varies such that the plate separation varies from d to $2d$. If V_0 is the voltage across the capacitor when the plates are at a constant separation d , then the voltage across X and Y varies as



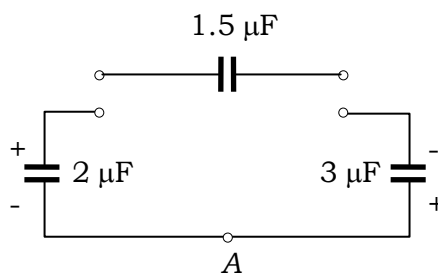
- (A) $V = \frac{V_0}{2} \left(1 - \frac{1}{2} \cos(2\pi ft) \right)$ (B) $V = \frac{V_0}{2} \left(3 - \frac{1}{2} \cos(2\pi ft) \right)$
- (C) $V = \frac{V_0}{2} \left(1 + \frac{1}{2} \cos(2\pi ft) \right)$ (D) $V = \frac{V_0}{2} \left(3 + \frac{1}{2} \cos(2\pi ft) \right)$

SECTION - II

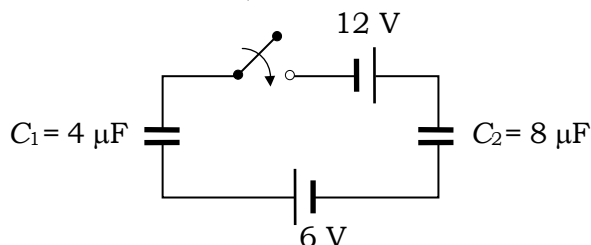
Multiple Correct Choice Type

This section contains 6 multiple choice questions numbered 11 to 16. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE or MORE** is/are correct.

11. Two capacitors of $2 \mu\text{F}$ and $3 \mu\text{F}$ are charged to 150 V and 120 V respectively. The plates of capacitor are connected as shown in the figure. A discharged capacitor of capacity $1.5 \mu\text{F}$ falls to the free ends of the wire. Then

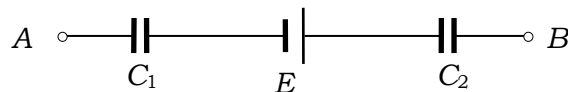


- (A) charge on the $1.5 \mu\text{F}$ capacitors is $180 \mu\text{C}$
 (B) charge on the $2 \mu\text{F}$ capacitor is $120 \mu\text{C}$
 (C) charge flows through A from right to left.
 (D) charge flows through A from left to right.
12. In the circuit shown initially C_1 , C_2 are uncharged. After closing the switch



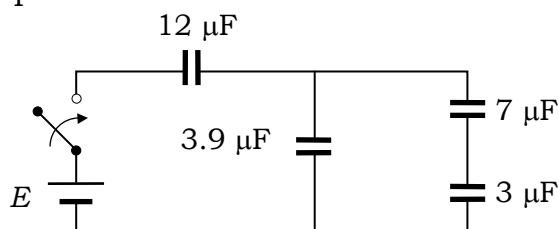
- (A) The charge on C_2 is greater than that on C_1
 (B) The charge on C_1 and C_2 are the same
 (C) The potential drops across C_1 and C_2 are the same
 (D) The potential drops across C_2 is greater than that across C_1

13. A circuit shown in the figure consists of a battery of emf 10 V and two capacitance C_1 and C_2 of capacitances $1.0 \mu\text{F}$ and $2.0 \mu\text{F}$ respectively. The potential difference $V_A - V_B$ is 5 V



- (A) charge on capacitor C_1 is equal to charge on capacitor C_2
 (B) Voltage across capacitor C_1 is 5 V.
 (C) Voltage across capacitor C_2 is 10 V
 (D) Energy stored in capacitor C_1 is two times the energy stored in capacitor C_2 .
14. The capacitance of a parallel plate capacitor is C when the region between the plate has air. This region is now filled with a dielectric slab of dielectric constant k . The capacitor is connected to a cell of emf E , and the slab is taken out
- (A) charge $(k-1)CE$ flows through the cell
 (B) energy $(k-1)E^2C$ is absorbed by the cell.
 (C) the energy stored in the capacitor is reduced by $(k-1)E^2C$
 (D) the external agent has to do $(k-1)E^2C$ amount of work to take the slab out.
-

15. Four capacitors and a battery are connected as shown. The potential drop across the $7\ \mu\text{F}$ capacitor is $6\ \text{V}$. Then the



- (A) potential difference across the $3\ \mu\text{F}$ capacitor is $10\ \text{V}$
 (B) charge on the $3\ \mu\text{F}$ capacitor is $42\ \mu\text{C}$
 (C) e.m.f. of the battery is $30\ \text{V}$
 (D) potential difference across the $12\ \mu\text{F}$ capacitor is $10\ \text{V}$.
16. The plates of a parallel plate capacitor with no dielectric are connected to a voltage source. Now a dielectric of dielectric constant k is inserted to fill the whole space between the plates with voltage source remaining connected to the capacitor.
- (A) the energy stored in the capacitor will become k -times
 (B) the electric field inside the capacitor will decrease to k -times
 (C) the force of attraction between the plates will increase to k^2 -times
 (D) the charge on the capacitor will increase to k -times

SECTION – III

Assertion – Reason Type

This section contains 4 questions numbered 17 to 20. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

17. STATEMENT-1

When a dielectric slab is partially inserted between the plates of an isolated charged parallel plate capacitor, it is attracted into the capacitor

because

STATEMENT-2

When dielectric is inserted the capacitance increases and the capacitor can hold more charge for same potential difference.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
- (B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1.
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

18. STATEMENT-1

When a capacitor is charged by a battery, both the plates receive charges equal in magnitude and opposite in sign, no matter sizes of plates are identical or not.

because

STATEMENT-2

The charge distribution on the plates of capacitor is in accordance with charge conservation principle.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
 - (B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1.
 - (C) Statement-1 is True, Statement-2 is False
 - (D) Statement-1 is False, Statement-2 is True
-

19. STATEMENT-1

A charged capacitor is disconnected from a battery. Now if its plates are separated further, the electric potential energy stored in capacitor increases.

because

STATEMENT-2

Energy stored in a capacitor is equal to the work done in charging it .

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
- (B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1.
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

20. STATEMENT-1

When two capacitors charged to different potentials are connected at both the terminals (either with similar polarities or with dissimilar polarities) there is a certain loss of energy.

because

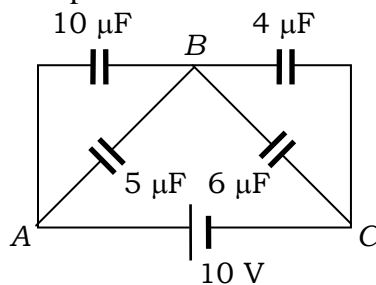
STATEMENT-2

In any spontaneous process there is always a net loss of energy of the system and movement of positive charge from higher potential to lower potential is an spontaneous process.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
 - (B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1.
 - (C) Statement-1 is True, Statement-2 is False
 - (D) Statement-1 is False, Statement-2 is True
-

Paragraph for Question Nos. 24 to 26

In the circuit shown in figure, four capacitors are connected to a battery.



- 24.** The equivalent capacitance of the circuit is
 (A) 25 μF (B) 6 μF
 (C) 8.4 μF (D) None of these
- 25.** The potential difference across the 6 μF capacitor is
 (A) 6 V (B) 5 V
 (C) 4 V (D) None of these
- 26.** The maximum energy is stored in the capacitor of
 (A) 10 μF (B) 6 μF
 (C) 5 μF (D) 4 μF
-

SECTION - V

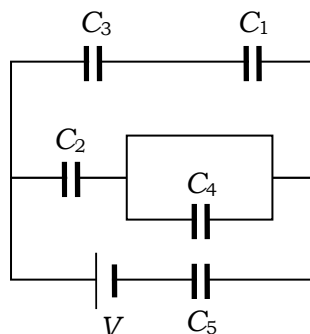
Matrix-Match Type

This section contains 2 questions, 27 and 28. Each question contains statement given in two columns which have to be matched. The statements in **Column I** are labeled (A, B, C and D) while the statements in **Column II** are labeled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II**. The appropriate bubbles corresponding to the answers to these questions have to be darkening of bubbles will look like the following.

If the correct matches are A – p, s and t, B – q and r, C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following.

	p	q	r	s	t
A	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
B	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
C	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>

27. Match the statements about the following figure where capacity of each capacitor is C , in **Column I** with statements in **Column II** and indicate your answer by darkening bubbles in the 4×5 matrix given in the ORS.



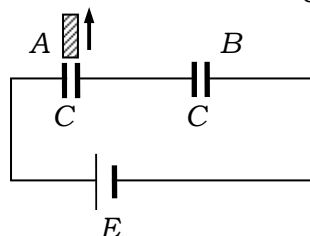
Column I

- (A) There is maximum potential difference across
- (B) There is zero potential difference across
- (C) Potential difference will be same across
- (D) Charge circulated by battery is the sum of charges appearing on

Column II

- (p) C_1
- (q) C_2
- (r) C_3
- (s) C_4
- (t) C_5

28. A dielectric slab of dielectric constant k is being removed from capacitor A as shown in figure. The capacitance of the two capacitors is C each and emf of the cell is E . Match the statements in **Column I** with statements in **Column II** and indicate your answer by darkening bubbles in the 4×5 matrix given in the ORS.



Column I

- (A) The capacitance of A
- (B) The energy stored in B
- (C) The potential difference across A
- (D) Charge on A

Column II

- (p) May increase or decrease
- (q) Will increase
- (r) Will decrease
- (s) Will remain same
- (t) Can not be determined

SECTION - VI

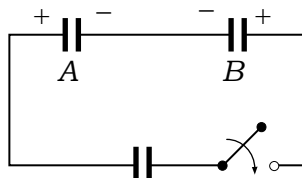
Integer Answer Type

This section contains 6 questions numbered 29 to 34. The answer to each of the questions is a single digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following:

	X	Y	Z	W
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

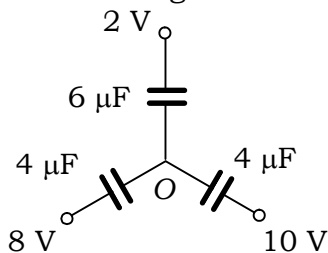
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29. A dielectric slab of thickness $\frac{d}{2}$ is inserted between the plates of a charged and isolated parallel plate capacitor with plate separation d . The potential difference across capacitor is found V . Now the dielectric slab is removed and the plate separation is reduced to $\left(\frac{3}{8}\right)d$. The potential difference now becomes $\frac{V}{2}$. The dielectric constant of the slab is.
-

- 30.** A capacitor A of $6 \mu\text{F}$ charged to a potential difference 16 V and another capacitor B of $8 \mu\text{F}$ charged to 24 V . Now these two capacitors are connected to an uncharged capacitor of capacity $\frac{24}{7} \mu\text{F}$ as shown. Find the final potential different across the uncharged capacitor.

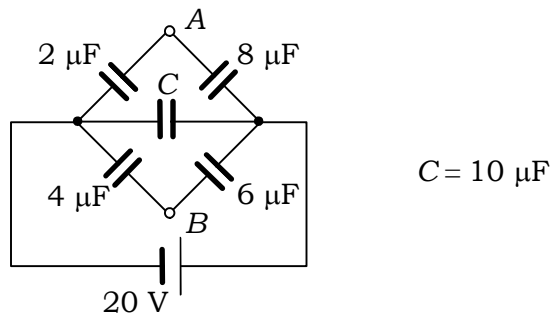


- 31.** Two spheres of radii R and $3R$ are charged to same charge density σ . When the two spheres are connected through a conductor the amount of charge transferred from one to the other sphere is $\eta\pi R^2\sigma$ where η is.
-

32. Find the potential of the point O in the given circuit.



33. The potential difference between points A and B in the capacitance network shown here is



34. The capacitance of a parallel plate capacitor is C_0 . A slab of material of dielectric constant 3 has the same area as the plates of the parallel capacitor but has a thickness $\frac{3}{4}d$, where d is the separation of plates. If the slab is inserted between the plates, then the capacitance becomes ηC_0 where η is.