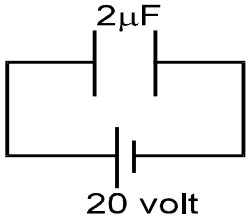
PHYSICS: **Max. Marks : 60**

SECTION – I

(MULTIPLE CORRECT CHOICE TYPE)

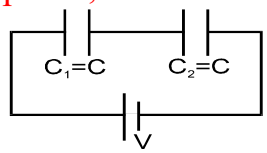
This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE is/ are correct**

1. In the figure a capacitor of capacitance 2μF is connected to a cell of emf 20 volt. The plates of the capacitor are drawn apart slowly to double the distance between them. The work done by the external agent on the plates is :



A) – 200 μJB) 200 μJ C) 400 μJ D) – 400 μJ

2. Two identical capacitor C_1 and C_2 are connected in series with a battery. They are fully charged. Now a dielectric slab is inserted between the plates of C_2. without touching the plates, then



A) Capacitance of C_2 increases

B) potential difference across C_1 increases

C) potential difference across C_1 decreases

D) Capacitance of C_2 decreases

3. An uncharged capacitor is connected in series with a resistor and a battery. The charging of the capacitor starts at t = 0. Choose the incorrect statement/s

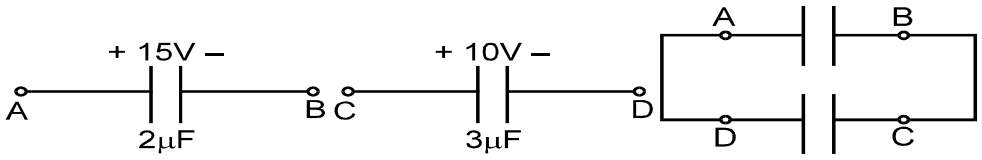
A) The rate at which energy stored in capacitor first increases then decreases

B) The rate at which energy stored in capacitor first decreases then increases

C) The rate at which energy stored in capacitor remains constant

D) The rate at which energy stored in capacitor continuously decreases

4. In the figure initial status of capacitance and their connection is shown. Which of the following is/are correct about this circuit :



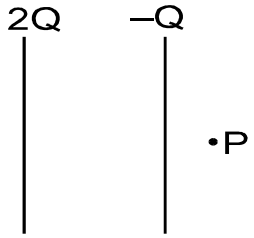
A) Final charge on each capacitor will be zero

B) Final total electrical energy of the capacitors will be zero

C) Total charge flown from A to D is 30μC

D) Total charge flown from A to D is – 30μC

5. In the figure shown the plates of a parallel plate capacitor have unequal charges. Its capacitance is 'C'. P is a point outside the capacitor and close to the plate of charge –Q. The distance between the plates is 'd'. Which of the following is/are correct.



A) A point charge at point 'P' will experience electric force due to capacitor

B) The potential difference between the plates will be $\frac{3Q}{2C}$

C) The energy stored in the electric field in the region between the plates is $\frac{9Q^2}{8C}$

D) The force on one plate due to the other plate is $\frac{Q^2}{2\pi \in_0 d^2}$

6. An uncharged parallel plate capacitor is connected to a battery. The electric field between the plates is 10V/m. Now a dielectric of dielectric constant 2 is inserted between the plates filling the entire space. Choose the incorrect statement/s

A) The electric field between the plates decreases by 5 V/m

B) The electric field between the plates now is 20 V/m

C) The electric field between the plates now is 10 V/m

D) none of these

7. 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. Which of the following is/are correct?

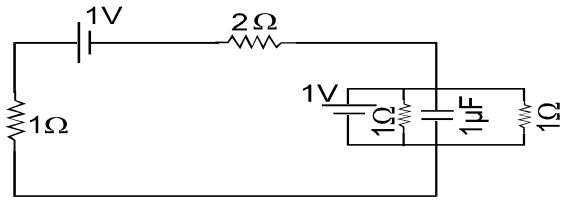
A) the energy stored in the capacitor will become K–fold

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

8. The charge on the capacitor in steady state cannot be:



A) 1 μc B) 2 μc C) 0 D) 0.5 μc

SECTION - II
(COMPREHENSION TYPE)

This section contains **4 groups of questions.** Each group has 2 multiple choice questions based on a paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE** is **correct.**

Paragraph for Questions 9 and 10

A small insect crawls in the direction of electron drift along bare copper wire that carries a current of 2.56 A. It travels with the drift speed of the electron in the wire of uniform cross section area $1mm^2$. Number of free electrons for copper = 8×10^{22}/cc & resistivity of copper = 1.6×10^{-8} Ωm.

9. What is order of the average time of collision for free electrons of copper?

A) 10^{-13} sec. B) 2.78×10^{-14} sec C) 10^{-11} sec. D) 10^{-8} sec.

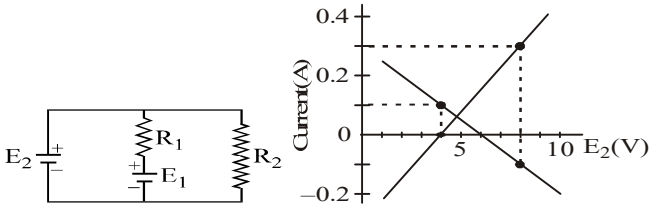
10. If the caterpillar starts from the point of zero potential at t = 0, it reaches a point of _____ potential after 10 sec.

A) 80 μV B) – 80 μV C) 160 μV D) – 160 μV

Paragraph for Questions 11 and 12

In the circuit shown, both batteries are ideal. EMF E_1 of battery 1 has a fixed value, but emf E_2 of battery 2 can be varied between 1 V and 10 V. The graph

gives the currents through the two batteries as a function of E_2, but are not marked as which plot corresponds to which battery. But for both plots, current is assumed to be negative when the direction of the current through the battery is opposite the direction of that battery's emf. (direction from negative to positive)



11. The value of emf E_1 is

A) 8 V B) 6 V C) 4 V D) 2 V

12. The resistance R_1 has value

A) 10 Ω B) 20 Ω C) 30 Ω D) 40 Ω

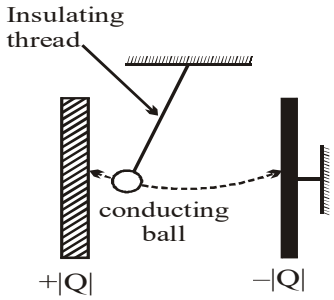
Paragraph for Questions 13 and 14

Experiments with a charged capacitor A capacitor and a Pendulum

We begin with an uncharged, isolated, parallel plate capacitor having its plates maintained at a fixed distance apart and with an isolated independent voltage source. By connecting the two plates of the uncharged capacitor momentarily to

the independent voltage source and then disconnecting the source, we are left with a charged and isolated capacitor. A small ball of cork , covered with a conducting foil, is suspended by an insulating thread between the two plates of the capacitor as a simple pendulum.

If the ball is initially at rest and is closer to the positive plate, it will be slightly attracted to that plate because of induction. On contact with the positive plate, some of the plate's positive charge is transferred to the ball by charge sharing. The positively charged ball then is repelled by the positive plate and attracted to the negative plate. Upon reaching the negative plate, the kinetic energy of the ball is completely converted into thermodynamic internal energy of the negative plate. The positive charge on the ball neutralizes some of the negative charge on the negative plate. The ball also then becomes negatively charged by charge sharing and subsequently is repelled by the negative plate and attracted back to the positive plate.



The process continues with the electric pendulum swinging back and forth between the two plates until essentially all of the charge on the capacitor is neutralized and the capacitor is discharged. We imagine positive charge transferred one way, negative charge the other way until the two plates are discharged. We observe that the force between the plates decreases with each swing of the pendulum, confirming our account of the neutralization or discharge of the two plates. Once discharged, the field between them is zero, they do not exert electric force on each other.

13. Consider the moment when the ball leaves the positive plate taking away a charge of 0.01μC, leaving a charge of 8.85μC on the positive plate. The tension in the string, when the ball reaches the lowest position for the first time is nearly. (Assume the distance between the plates is 1cm and length of the thread is 1m, area of the plates is $1m^2$ and mass of ball is 1mg and thread is symmetrically placed between the two plates). [$g=10m/s^2$)

A) 6×10^{-5} N B) 3×10^{-5} N C) 11×10^{-5} N D) 10^{-5} N

14. If the initial charge on the capacitor plates is 10μC, and the capacitance of the capacitor is 10μF, the total change in thermodynamics internal energy of the left plate is :

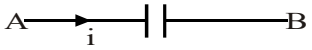
A) 5μJ B) 2.5μJ C) 10μJ D) 7.5μJ

Paragraph for Questions 15 and 16

15. Somewhere in a circuit is a resistor. A constant current is flowing in the direction as indicated in the figure. In going from A to B, we measure $\int_A^B \vec{E} \cdot d\vec{\ell}$. What do we find ?

A) a positive value
B) a negative value
C) zero
D) we do not have enough information to answer

16. Somewhere in a circuit is a parallel plate capacitor. A current is flowing in the direction as indicated in the figure, and this current is increasing. In going from A to B through the gap between the two plates of the capacitor, we again measure the integral as mentioned above. What do we find ?



A) a positive value
B) a negative value
C) zero
D) we do not have enough information to answer

SECTION – III
(MATRIX MATCH TYPE)

This section contains **4 multiple choice questions.** Each question has matching lists. The codes for the lists have choices (A), (B), (C), and (D) out of which **ONLY ONE** is correct.

17. A resistor of resistance R is connected to a cell of internal resistance 5 ohm.

In column-I range of R (in ohm) is given and In column-II power consumed by it is given.

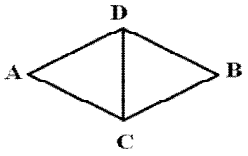
Column-I	**Column-II**
a) 1 to 2	p) Increases continuously
b) 1 to 3	q) decreases continuously
c) 3 to 7	r) first Increases then decreases
d) 6 to 10	s) first decreases then Increases

Choose the correct matching from the following

A) a-q;b-p;c-s;d-r B) a-r;b-q;c-s;d-p

C) a-p;b-p;c-s;d-r D) a-p;b-p;c-r;d-q

18. A uniform wire of resistance R is stretched uniformly n times & then cut to form five identical wires. These wires are arranged as shown in fig.



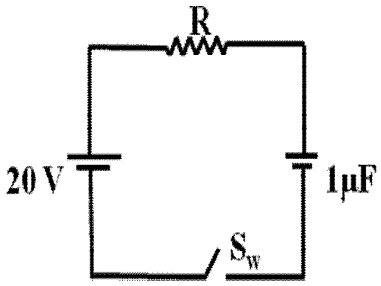
Column-I	Column-II
a) Effective resistance b/w A & B	p) $\frac{n^2R}{5}$
b) Effective resistance b/w B & C	q) $\frac{n^2R}{8}$
c) Effective resistance b/w C & D	r) $\frac{n^2R}{10}$
d) Effective resistance b/w D & A	s) $\frac{8n^2R}{5}$

Choose the correct matching from the following

A) a-p;b-p;c-p;d-p B) a-p;b-q;c-r;d-q

C) a-q;b-q;c-q;d-q D) a-p;b-p;c-r;d-q

19. Figure shows an uncharged capacitor connected in series with resistor R and ideal battery. At t=0 switch is closed and is observed that when charge on the capacitor is X% of maximum value then the current in the circuit is 1A. Column-I contains different values of X and Column-II contains resistance.



Column-I	**Column-II**
a) 75%	p) 18 ohm
b) 50%	q) 05 ohm
c) 25%	r) 10 ohm
d) 10%	s) 15 ohm

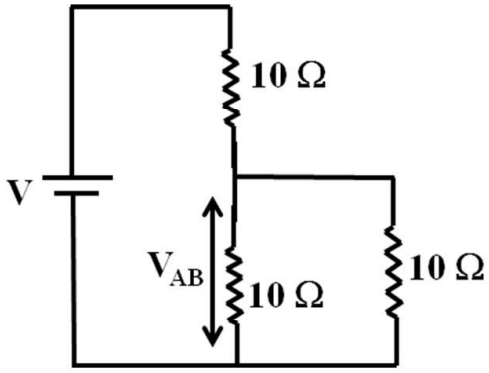
Choose the correct matching from the following

A) a-p;b-q;c-p;d-r B) a-p;b-q;c-s;d-r

C) a-q;b-r;c-s;d-p D) a-p;b-q;c-r;d-s

20. An ideal cell of emf V volt is connected across 3 resistance of 10ohm each.

Column-I contains different values of V and column-II contains V_{AB} (in volt)



Column-I	**Column-II**
a) 120	p) 10
b) 90	q) 20
c) 60	r) 30
d) 30	s) 40

Choose the correct matching from the following

A) a-s;b-r;c-q;d-p B) a-p;b-q;c-r;d-s

C) a-q;b-r;c-s;d-p D) a-q;b-r;c-s;d-s