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The Weavers Institute

TARGET: Class 12th CBSE Boards 2024-25

Physics (Electrostatics)

BATCH: 12th **DURATION: 1 HR 30 min** **MAX. MARKS: 35**

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

INSTRUCTIONS

Section A *– From question 1 to 6 are MCQs and 7-8 are assertion and reason based of 1 mark each.*
Section B *– Question no. 9-10 are Very Short Answer Type Questions, carrying 2 marks each.*
Answer to each question should not exceed 40 words.
Section C *contains Q.11 to Q.13 are Short Answer Type Questions, carrying 3 marks each.*
Answer to each question should not exceed 60 words
Section D *– Questions no 14 are case based questions with three sub questions and are of 4 marks each.*
Section-E *- Question no. 15-16 are long answer type questions, carrying 5 marks each.*
Answer to each question should not exceed 120 words
There is no overall choice in the question paper. However, an internal choice has been provided in few questions. Only one of the choices in such questions have to be attempted.
You may use the following values of physical constants where ever necessary

i. $c = 3 \times 10^8 m/s$
ii. $m_e = 9.1 \times 10^{-31}$ kg
iii. $e = 1.6 \times 10^{-19}$ C
iv. $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}
v. $h = 6.63 \times 10^{-34}$ Js
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$
vii. Avogadro's number = 6.023×10^{23} per gram mole

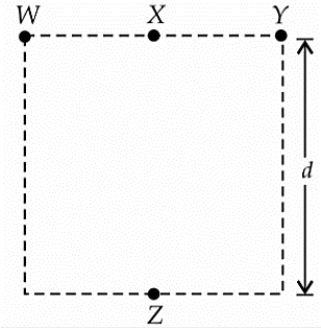
Section A

1. In an experiment three microscopic latex spheres are spread into a chamber and became charged with charges +3e, +5e and -3e respectively. All the three spheres came in contact simultaneously for a moment and got separated. Which one of the following are possible values for the final charge on the spheres?
   (A) +5e , -4e, +5e (B**) +6e, +6e , -7e** (C) -4e, +3.5e, +5.5e (D) +5e, -8e, +7e

2. An object has charge of 1 C and gains 5.0×10^{18} electrons. The net charge on the object becomes:
   (A) -0.80 C (B) +0.80 C (C) +1.80 C (D) **+0.20 C**

3. Four objects W, X, Y and Z, each with charge +q are held fixed at four points of a square of side d as shown in the figure. Objects X and Z are on the midpoints of the sides of the square. The

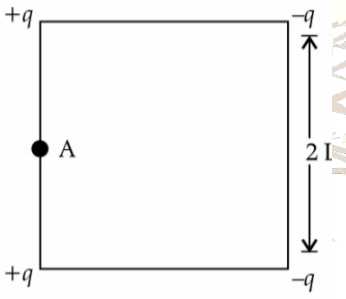
electrostatic force exerted by object W on object X is F. Then the magnitude of the force exerted by object W on Z is



(A) $\frac{F}{7}$ (B) $\frac{F}{5}$ (C) $\frac{F}{3}$ (D) $\frac{F}{2}$

4. A variable capacitor is connected to a 200 battery. If its capacitance is changed from 2μF to XμF the decrease in energy of the capacitor is
(A) **1μF** (B) 2μF (C) 3μF (D) 4μF

5. Four charges -q,-q, +q and +q are placed at the corners of a square of side 2 L is shown in figure. The electric potential at Point A midway between the two charges +q and +q is



(A) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$ (B) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$ (C) $\frac{1}{4\pi\varepsilon_0}\frac{q}{2L}\left(1-\frac{1}{\sqrt{5}}\right)$ (D) Zero

6. The capacitance of a parallel plate capacitor is 10μF. When a dielectric plate is introduced in between the plates, its potential becomes $\frac{1}{4}^{\text{th}}$ of its original value. What is the value of the dielectric constant of the plate introduced?
(A) 4 (B) 40 (C) 2.5 (D) none of the above

Both A and R are true and R is the correct explanation of A.
Both A and R are true but R is not the correct explanation of A.
A is true but R is false.
A is false but R is true.
Both A and R are false

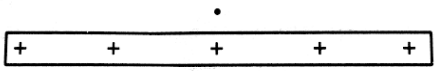
7. Assertion (A): A negative charge in an electric field moves opposite direction of the electric field.
Reason (R): On a negative charge a force acts in the opposite direction of the electric field.

8. Assertion (A) : If two spherical conductors of different radii have the same surface charge densities, then their electric field intensities will be equal.
Reason (R): Surface charge density $= \frac{Total\ charge}{area}$

Section B

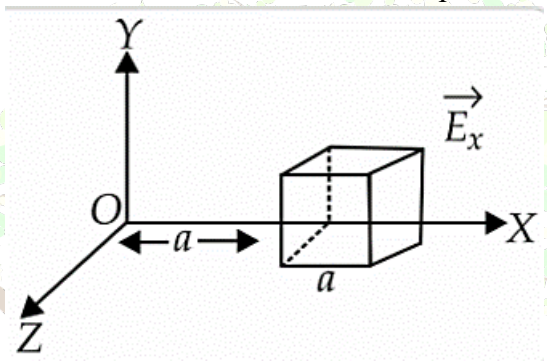
9. An infinitely long thin straight wire has a uniform linear charge density λ.
   (a) Obtain the expression for the electric field (E) at a point lying at a distance x from the wire, using Gauss' Law.
   (b) Show graphically the variation of this electric field E as a function of distance x from the wire.

10. A particle whose mass 5×10^{-6}g is held over a huge horizontal charge sheet with a density of $4 \times 10^{-6} \frac{C}{m^2}$. What charge should be applied to this particle such that it does not fall when released?



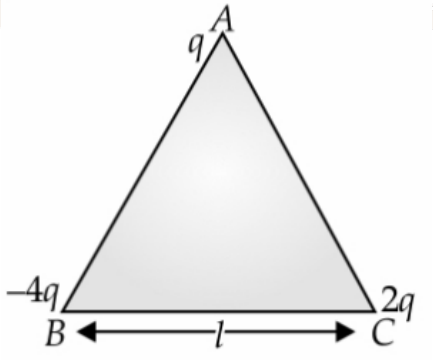
Section C

11. Define electric flux and write its SI unit. The electric field components in the figure shown are: [3]



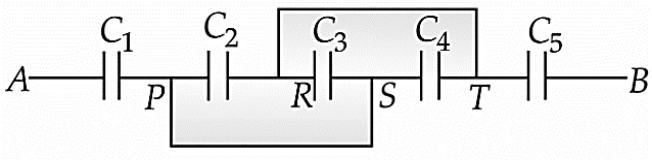
$E_x = ax\ E_y = 0, E_z = 0$ where $\alpha = \frac{100N}{C\ m}$. Calculate the charge within the cube, assuming a = 0.1
Ans 0.8854 pC

12. (i) Three-point charges q, -4q and 2q are placed at the vertices of an equilateral triangle ABC of side 'l' as shown in the figure. Obtain the expression for the magnitude of the resultant electric force acting on the charge q.



(ii) Find out the amount of the work done to separate the charges at infinite distance. [3]

13. (i) Find equivalent capacitance between A and B in the combination given below. Each capacitor is of 2 μF capacitance.



(ii) if a DC source of 7 V is connected across AB, how much charge is drawn from the source and what is the energy stored in the network? [3]

Section D

14. Read the given text and answer any four of the following questions on the basis of the same:

Super capacitor: Super capacitor is a high-capacity capacitor with a capacitance value much higher than normal capacitors but the lower voltage limits. Such capacitors and rechargeable batteries. In automobile, bus, train, crane, elevator such capacitor are used for regenerative banking, short term energy storage or burst-mode power delivery.

Super capacitors have many advantages over batteries: They are very low weight and generally don't contain harmful chemicals or toxic metal. They can be charged and discharged innumerable number of times without ever wearing out.

The disadvantage is that super capacitors aren't well-suited for long-term energy storage. The discharge rate of super capacitors is significantly higher than lithium-ion batteries; they can lose as much as 10-20% of their charge per day due to self-discharge.

Q1. Capacity of super capacitor is:

(A) Very low (B) Medium (C) **Very high** (D) may have any value.

Q2. Super capacitor makes a bridge between

(A) Electrolytic capacitor and rechargeable battery.

(B) Single use battery and electrolytic capacitor.

(C) Electrolytic capacitor and dynamo.

(D) Electrolytic and non-electrolytic capacitors.

Q3. Super capacitors can be charged and discharged:

(A) few numbers of times

(B) once only

(C) Several number of times but less than rechargeable batteries

(D) **Several number of times much more rechargeable batteries.**

Q4. Self-discharge rate of super capacitors:

(A) **10-20% of their chare per day** (B) 1-2% of their charge per day

(C) 0% of their charge per day (D) 100% of their charge per day

Q5: Super capacitors are used for

(A) degenerative braking (B) regenerative braking

(C) small appliances (D) long time charge storage.

Section E

15. (a) Use Gauss' Law to show that due to a uniformly charged spherical shell of radius R, the electric field at any point situated outside the shell at a distance r from its centre is equal to the electric field

at the same point, when the entire charge on the shell were concentrated at its centre. Also plot the graph showing the variation of electric field with r, for r$\leq R$ and r $\geq R$.
(b) Two-point charges of +1 μC and +4 μC are kept 30 cm apart. How far from the +1 μC charge on the line joining the two charges, will the net electric field be zero? [5]

16. (a) Three charges -q, Q and -q are placed at equal distances on a straight line. If the potential energy of the system of these charges is zero, then what is the ratio Q:q?
(b) (i) Obtain the expression for the electric field intensity due to a uniformly charged spherical shell of radius R at a point distant r from the centre of the shell outside it.
(ii) Draw a graph showing the variation of electric field intensity E with r, for r > R and r < R. [5]