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Class: XII
Subject: Physics
Topic: Electrostatics
Duration: 60 Min
Maximum Marks: 60

1. Let Q denote the charge on the plates of the capacitor of capacitance C. The dimensional formula for Q^2 / C is
   A. LMT^{-2}
   B. L^2M^2T
   C. $L^2M^2T^2$
   D. L^2MT^{-2}

   Ans. D

   Solution:

$$\text{Energy stored} = \frac{1}{2}\frac{q^2}{C}. \frac{q^2}{c} \text{ has the dimensions of energy.}$$

2. A charge of 10^{-10} C given to a sphere raises its potential from 1.5 V to 6.5 V. The radius of the sphere is
   A. 8.1 m
   B. 0.18 m
   C. 0.5 m
   D. 2.5 m

   Ans. B

   Solution:

$$V = \frac{q}{4\pi \in_o R} \quad 1.5 = \frac{q_1}{4\pi \in_o R}.................(1)$$

$$6.5 = \frac{q_2}{4\pi \in_o R}...............(2)$$

$$(2)-(1) \qquad 5 = (q_2 - q_1)\frac{1}{4\pi \in_o R}; R = \frac{10^{-10}}{4\pi \in_o \times 5} = \frac{9\times 10^9 \times 10^{-10}}{5} = 0.18m.$$

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B -147, Sector -6 Noida, UP - 201301,
www.askiitians.com
Email: info@askiitians.com
Tel: 1800-2000-838

3. A cylindrical capacitor has a length of 1 m and its inner cylinder has a radius of 5 cm. If the outer cylinder has a radius of 50 cm,then the capacitance is
   A. 10 pF
   B. 24 pF
   C. 16 pF
   D. 32 pF
   Ans. B
   Solution:

$$C = \frac{4\pi \in_o \ell}{2\times 2.303 \log(b/a)} = \frac{10^{-9}\times 1}{9\times 4.606\log(10)} = 0.024\times 10^{-9} = 24pF.$$

4. The energy stored per unit volume of a parallel plate air capacitor is 4.427 J/m3. If the potential difference between its plates is 1000 V, the distance between the plates is
   A. 2 mm
   B. 1 mm
   C. 0.6 mm
   D. 0.23 mm

   Ans.B
   Solution:

$$\text{Energy stored in capacitor} = \frac{1}{2}CV^2$$

$$\text{Energy stored / unit volum } e = \frac{1}{2}CV^2/\text{volume of air space} = \frac{1}{2}\frac{\in_0 A\times V^2}{d\times A.d}$$

$$\left[E' = \frac{1}{2}\frac{\in_0 V^2}{d^2}\right]$$

$$d = \sqrt{\frac{\in_0 V^2}{2E^1}} = \sqrt{\frac{8.85\times 10^{-12}\times 10^6}{2\times 4.427}} = \sqrt{10^{-6}} = 10^{-3}\, m.$$

5. Four charge of magnitude 2/3 nC, - 8/3 nC, and 2 nC and - 10/3 nC are placed at the corners A, B, C and D of a square of side 0.02 m. The potential at the centre is
   A. 1500
   B. $3000\sqrt{2}$ v
   C. $-1500\sqrt{2}$v
   D. -300$\sqrt{2}$ v

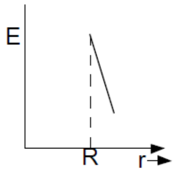
   Ans. C
   Solution:

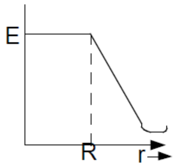
Potential at the centre = Algebraic sum of potentials due to charges at corners A B C & D.

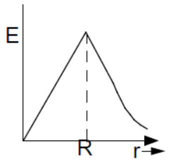
Distance from centre to the corner $d = 2\times10^{-2}\times\sqrt{2}$ m

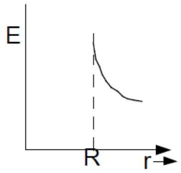
$$V = \frac{9\times10^{9}\times10^{-9}}{2\sqrt{2}\times10^{-2}}\left[\frac{2}{3}-\frac{8}{3}+2-\frac{10}{3}\right] = \frac{9}{2\sqrt{2}\times3\times10^{-2}}[-10] = \frac{-15\times10^{2}}{\sqrt{2}} = \frac{-1500}{\sqrt{2}}V$$

6. Which one of the following graphs represents the variation of electric field strength E with distance ‘r' from the centre of a uniformly charged non conducting sphere?

A. 

B. 

C. 

D. 

Ans.C

7. The electric potential at any point x, y, z in metres is given by V = 4x2. The electric field at a point (1m, 0, 2m) is

A. + 4V/m

B. +8V/m

C. - 4V/m

D. - 8V/m

Ans.D

$$E = -\frac{dv}{dx} = -\frac{d}{dx}(4x^{2}) = -8x$$

$$\therefore E = -8\times1 = -8V/m$$

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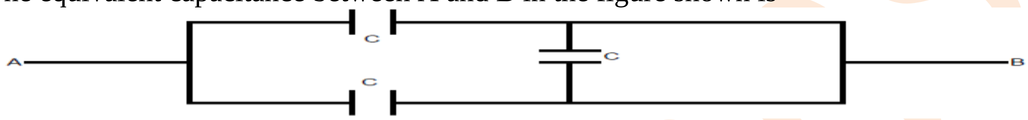
8. The electric potential at the surface of an atomic nucleus (Z = 50) of radius 9×10^{-15} m is
   A. 8×10^6 V
   B. 9V
   C. 9×10^5 V
   D. 80 V
   Ans. A
   Solution

$$V = \frac{1}{4\pi \in_o}\frac{q}{r} = \frac{1}{4\pi \in_o}.\frac{Ze}{r} = 9\times10^9 \times \frac{50\times1.6\times10^{-19}}{9\times10^{-15}} = 80.0\times10^5 = 8\times10^6 V$$

9. The equivalent capacitance between A and B in the figure shown is



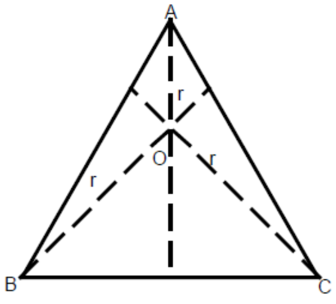
   A. C/2
   B. C
   C. 2C
   D. 2C/2

10. It requires 4J of work to move a charge of 20 C from point A to point B, separated by a distance of 0.2 m. The p.d. between the points A & B in volts is
   A. 16
   B. 80
   C. 5
   D. 0.2

   Ans. D
   Solution:

$$W = V.q \qquad V = \frac{W}{q} = \frac{4}{20} = 0.2\ V$$

11. Three charges +Q each are placed at A,B,C of equilateral triangle. At the circumcentre O, the electric field strength is



   A. Zero

B. $\dfrac{1}{4\pi\epsilon_o}\dfrac{3Q}{r^2}$

C. $\dfrac{1}{4\pi\epsilon_o}\dfrac{Q}{r^2}$

D. $\dfrac{1}{4\pi\epsilon_o}\dfrac{Q^2}{r^2}$

Ans. A
Solution:
For three E.I' s with an angk of 120_o each resultant is zero

12. A table tennis ball which has been covered with a conducting point is suspended by a light thread so that it hangs between two metal p.a.es. One plate is earthed, while other is attached to high voltage generator, the ball
A. hangs without moving
B. swings backward & forward hitting each plate in turn
C. is attracted to the high voltage plate and stays there
D. is repelled by earthed plate and stays there

Ans.B
Solution:
By induction the tennis ball gets -ve charge and gets attracted to the +ve plate and touches it.
Charges are then shared Like charges
repel and hence ball moves away & touches the earthed plate which gives its charge and goes to initial position & process repeats.

13. A parallel plate capacitor has plates of unequal area. The larger plate is connected to the positive terminal of the battery and smaller plate to -ve terminal. Let Q_+ and Q_- be the charges appearing on the positive and negative plates respectively
A. $Q_+ > Q$
B. $Q_+ = Q$
C. $Q_+ < Q$
D. None of these

Ans. B

14. A charged particle of mass 'm' and charge 'q' is released from rest in an electric field of constant magnitude E. The K.E. of the particle after a time 't' is
A. $2E^2t^2/mg$
B. $Eq^2m^2t^2$
C. $E^2q^2t^2/2m$
D. Eqm/t

Ans.C

Solution:

$$a = \frac{Eq}{m} \qquad v = u + at = 0 + \frac{Eq}{m} \times t$$

$$K.E. = \frac{1}{2}mv^2 \qquad = \frac{1}{2}m.\left(\frac{Eq}{m}.t\right)^2 = \frac{1}{2}\ \frac{E^2q^2t^2}{m}$$

15. An infinite number of charges of equal magnitude ‘q' nC but opposite sign are placed along x axis At x = 1, x = 2, x = 4, x = 8 ……… and so on. The electric potential at x = 0 due to these charges will be

A. 6 qnV
B. 6q V
C. 18 qV
D. 9 qV

Ans.B

Solution:

$$V = \frac{1}{4\pi \in_o} \times 10^{-9}\left[\frac{q}{1} - \frac{q}{2} + \frac{q}{4} - \frac{q}{8}\ldots\ldots\ldots\ldots\right] = 9q\left[\frac{1}{1} - \frac{1}{2} + \frac{1}{2^2} - \frac{1}{2^3}\ldots\ldots\ldots\right]$$

Term in the bracket is in G.P. of a = 1   r = -1/2

$$\therefore V = 9q \times \frac{1}{1+1/2} = 9q \times 2/3 = 6qV$$

16. Two identical capacitors each of capacitance C are charged to potentials V_1 & V_2 respectively. The negative ends of thecapacitors are connected together. When the positive ends are also connected the decrease in energy of the combined system is

A. $\frac{1}{4}C(V_1 - V_2)^2$

B. $\frac{1}{4}C(V_1 + V_2)^2$

C. $\frac{1}{4}C(V_1^2 - V_2^2)$

D. $4C(V_1^2 + V_2^2)$

Ans. A

Solution:

$$\text{Common potential } V = \frac{CV_1 + CV_2}{C + C} = \left(\frac{V_1 + V_2}{2}\right)\frac{1}{2}$$

$$\text{Loss} = \left(\frac{1}{2}CV_1^2 + \frac{1}{2}CV_2^2\right) - \frac{1}{2}(C + C)V^2 = \frac{1}{4}C(V_1 - V_2)^2$$

17. A 2 ìF capacitor is charged to 400 V. If its plates are joined through a resistance of 2 kÙ, then the heat produced in the resistor is
    A. 0.16 J
    B. 0.32 J
    C. 0.64 J
    D. 1.28 J

    Ans.A
    Solution:

$$\text{Heat produced} = \frac{1}{2}CV^2 = \frac{1}{2}\times 2\times(400)^2\times 10^{-6} = 0.16\text{ J.}$$

18. A and B are two parallel plate air capacitors. A has square plate of side 1 unit separated by a distance d. B has circular plates of radius 1 unit separated by the same distance d. Capacitances of A and B are in the ratio
    A. 22:7
    B. 7:22
    C. 10:1
    D. 1:10

    Ans. B
    Solution:

$$C\ \alpha\ A \quad \frac{C_1}{C_2} = \frac{A_1}{A_2} = \frac{1\times 1}{\pi\times 1^2} = \frac{7}{22} \Rightarrow 7:22.$$

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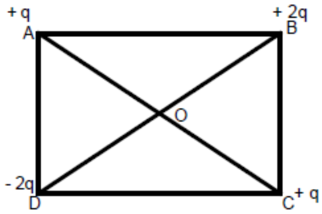
19. Three point charges 4 nC, 6 nC and 5 nC are placed at the corners A, B and C of a square ABCD. Find what charge must be placed at the corner D of the square so that the net potential at the centre of the square is zero



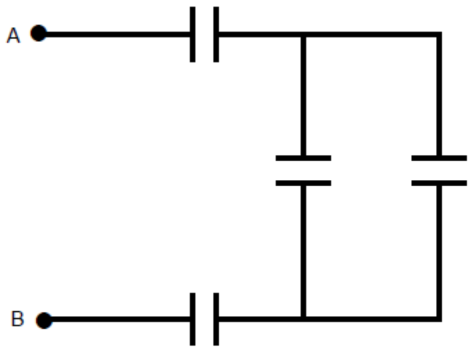
    A. -15 nC
    B. 15 nC
    C. 5 nC
    D. 3 nC

    Ans. A
    Solution:

$$O = \frac{1}{4\pi\in_o}\frac{4\times10^{-9}}{d} + \frac{6\times10^{-9}}{d} + \frac{5\times10^{-9}}{d} + \frac{q}{d}$$

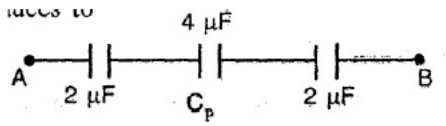
$$\frac{-q}{d} = \frac{15\times10^{-9}}{d} \qquad \therefore q = -15\ nC$$

20. The effective capacitance between the points A and B in the circuit shown (in ìF) is: (capacitance of each capacitor is 2 ìF)



A. 4/5
B. 3
C. 4
D. 2

Ans. A
Solution:
From the conditions



$$\therefore \frac{1}{C_{eff}} = \frac{1}{2} + \frac{1}{4} + \frac{1}{2} \Rightarrow C_{eff} = \frac{4}{5}\mu F.$$