BRAINYCHALKS

Institute for CBSE | JEE | NEET | OLYMPIAD

MONTHLY ASSESSMENT - I

Marks- 60 SUBJECT – PHYSICS Time – 2hr 15min

General Instructions

Read the following instructions very carefully and strictly follow them :

(i) This question paper contains 29 questions. All questions are compulsory.

(ii) This question paper comprises five Sections A, B, C, D .

(iii) Section A Questions no. 1 to 16 are MCQs of 1 mark each.

(iv) Section B Questions no. 17 to 19 are very short answer type questions, carrying 2 marks each. Answer to each question should not exceed 40 words.

(v) Section C Questions no. 20 to 25 are short answer type questions, carrying 3 marks each. Answer to each question should not exceed 60 words.

(vi) Section D Questions no. 26 to 29 are long answer type questions, carrying 5 marks each. Answer to each question should not exceed 120 words.

(vii) 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 has to be attempted.

(viii) In addition to this, separate instructions are given with each section and question, wherever necessary.

SECTION A $(16 \times 1 = 16)$

1. A negatively charged object X is repelled by another charged object Y. However an object Z is attracted to object Y. Which of the following is the most possibility for the object Z?
   (a) Positively charged only.
   (b) Negatively charged only.
   (c) Neutral or positively charged.
   (d) Neutral or negatively charged
2. When a negative charge (–Q) is brought near one face of a metal cube, the
   (a) cube becomes positively charged
   (b) cube becomes negatively charged
   (c) face near the charge becomes positively charged and the opposite face becomes negatively charged
   (d) face near the charge becomes negatively charged and the opposite face becomes positively charged
3. In an experiment three microscopic latex spheres are sprayed 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?

BRAINYCHALKS

(a) +5e, –4e, +5e
(b) +6e, +6e, –7e
(c) –4e, +3.5e, +5.5e
(d) +5e, –8e, +7e

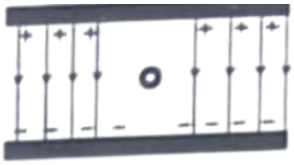
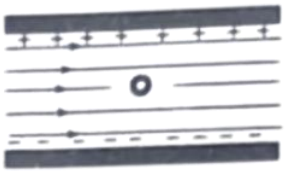
4. An object has charge of 1 C and gains 5.0×10^{18} electrons. The net charge on the object becomes
   (a) –0.80 C
   (b) +0.80 C
   (c) +1.80 C
   (d) +0.20 C
5. Three charges q, –q and q_0 are placed as shown in figure. The magnitude of the net force on the charge q_0 at point O is $k = 1/(4\pi\epsilon_0)$
   (a) 0
   (b) $2kqq_0 / a^2$
   (c) $\sqrt{2}\, kqq_0 / a^2$
   (d) $(1/\sqrt{2})\, kqq_0 / a^2$
6. 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) F/7
   (b) F/5
   (c) F/3
   (d) F/2
7. Two charged particles P and Q, having the same charge but different masses m_p and m_q, start from rest and travel equal distances in a uniform electric field **E** in time t_p and t_q respectively. Neglecting the effect of gravity, the ratio $\frac{t_p}{t_q}$ is:
   (a) $\frac{m_p}{m_q}$
   (b) $\frac{m_q}{m_p}$
   (c) $\sqrt{\frac{m_p}{m_q}}$
   (d) $\sqrt{\frac{m_q}{m_p}}$
8. The magnitude of the electric field due to a point charge object at a distance of 4.0 m is 9 N/C. From the same charged object the electric field of magnitude 16 N/C will be at a distance of
   (a) 1 m
   (b) 2 m
   (c) 3 m
   (d) 6 m
9. Assertion (A): A negative charge in an electric field moves along the direction of the electric field.
   Reason (R): On a negative charge a force acts in the direction of the electric field.

BRAINYCHALKS

(a) Both (A) and (R) are true and (R) is correct explanation of (A).
(b) Both (A) and (R) are true, and (R) is not correct explanation of (A).
(c) (A) is true, but (R) is false.
(d) (A) is false and (R) is also false

10. Which of the diagrams correctly represents the electric field between two charged plates if a neutral conductor is placed in between the plates?

(a) 
(b) 
(c) 
(d) 

11. The magnitude of electric field due to a point charge 2q, at distance r is E. Then the magnitude of electric field due to a uniformly charged thin spherical shell of radius R with total charge q at a distance $\frac{r}{2}(r \gg R)$ will be
(a) $\frac{E}{4}$
(b) 0
(c) 2E
(d) 4E

12. If the net electric flux through a closed surface is zero, then we can infer
(a) no net charge is enclosed by the surface
(b) uniform electric field exists within the surface
(c) electric potential varies from point to point inside the surface
(d) charge is present inside the surface

13. The electric flux through a closed Gaussian surface depends upon
(a) net charge enclosed and permittivity of the medium
(b) net charge enclosed, permittivity of the medium and the size of the Gaussian surface
(c) net charge enclosed only
(d) permittivity of the medium only

14. An electric dipole placed in a non-uniform electric field can experience
(a) a force but not a torque
(b) a torque but not a force
(c) always a force and a torque
(d) neither a force nor a torque

15. An electric dipole of length 2 cm is placed at an angle of 30° with an electric field 2×10^5 N/C. If the dipole experiences a torque of 8×10^{-3} N m, the magnitude of either charge of the dipole is

BRAINYCHALKS

(a) 4 μC
(b) 7 μC
(c) 8 mC
(d) 2 mC

16. A point charge situated at a distance 'r' from a short electric dipole on its axis experiences a force **F**. If the distance of the charge is '2r', the force on the charge will be

(a) $\frac{F}{16}$
(b) $\frac{F}{8}$
(c) $\frac{F}{4}$
(d) $\frac{F}{2}$

SECTION B

(Very Short Answer Type Questions) **(3 × 2 = 6)**

17. Derive the expression for the torque acting on an electric dipole, when it is held in a uniform electric field. Identify the orientation of the dipole in the electric field, in which it attains a stable equilibrium.

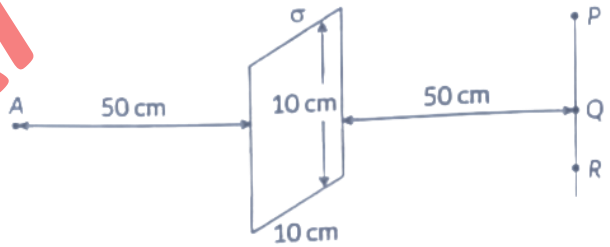
18. (a) Obtain the expression for the torque $\vec{\tau}$ experienced by an electric dipole of dipole moment $\vec{p}$ in a uniform electric field $\vec{E}$.
(b) What will happen if the field were not uniform?

19. An electric field along the x-axis is given by $\vec{E} = 100\hat{\imath}$ N/C for $x > 0$ and $\vec{E} = -100\hat{\imath}$ N/C for $x < 0$ A right circular cylinder of length 20 cm and radius 5 cm lies parallel to the x-axis, with its centre at the origin and one face at x = +10 cm, the other face at x = –10 cm. Calculate the net outward flux through the cylinder.

SECTION C

(Short Answer Type Questions) **(6 × 3 = 18)**

20. (a) A uniformly charged large plane sheet has charge density $\sigma = \left(\frac{1}{18\pi}\right) \times 10^{-15}$ C/m^2 Find the electric field at point A which is 50 cm from the sheet.



Consider a straight line with three points P, Q and R, placed 50 cm from the charged sheet on the right side as shown in the figure. At which of these points, does the magnitude of the electric field due to the sheet remain the same as that at point A and why?

BRAINYCHALKS

(b) Two small identical conducting spheres carrying charges 10 μC and –20 μC when separated by a distance r, experience a force F each. If they are brought in contact and then separated to a distance of r/2, what is the new force between them in terms of F?

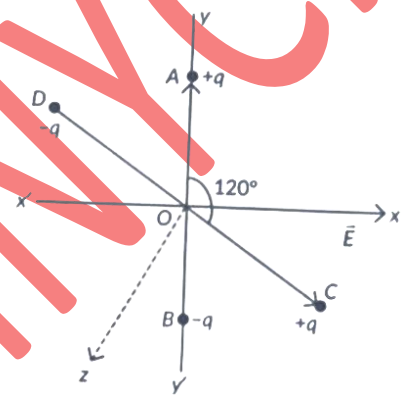
21. Two electric field lines cannot cross each other. Also, they cannot form closed loops. Give reason

22. A particle of charge 2 μC and mass 1.6 g is moving with a velocity 4 m s^{-1}. At t = 0 the particle enters in a region having an electric field $\vec{E} = 80\hat{\imath} + 60\hat{\jmath}$ (in N C^{-1})Find the velocity of the particle at t = 5 s.

23. Derive an expression for the electric field due to dipole of dipole moment **p** at a point on its perpendicular bisector.

24. Depict the orientation of the dipole in (a) stable, (b) unstable equilibrium in a uniform electric field.

25. Two small identical electric dipoles AB and CD, each of dipole moment **p**, are kept at an angle of 120° to each other in an external electric field **E** pointing along the x-axis as shown in the figure. Find the
(a) dipole moment of the arrangement, and
(b) magnitude and direction of the net torque acting on it.



SECTION D

(Long Answer Type Questions) **(4 × 5 = 20)**

26. An electric field is uniform and acts along +x direction in the region of positive x. It is also uniform with the same magnitude but acts in –x direction in the region of negative x. The value of the field is $E = 200$ N C^{-1} for $x > 0$and$E = -200$ N C^{-1} for $x < 0$. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x-axis so that one flat face is at $x = +10$cm and the other is at $x = -10$cm.

BRAINYCHALKS

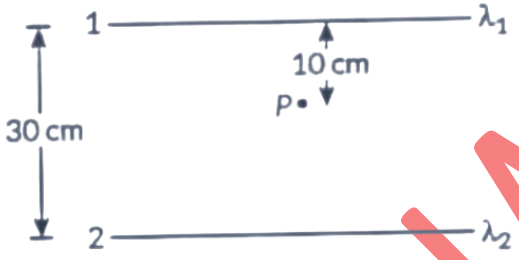
Find:

(i) The net outward flux through the cylinder.

(ii) The net charge present inside the cylinder.

27. (i) State Gauss's Law in electrostatics. Apply this to obtain the electric field $\vec{E}$ at a point near a uniformly charged infinite plane sheet.

(ii) Two long straight wires 1 and 2 are kept as shown in the figure. The linear charge density of the two wires are $\lambda_1 = 10\ \mu C/m$ and $\lambda_2 = -20\ \mu C/m$. Find the net force $\vec{F}$ experienced by an electron held at point P.



28. (i) A charge +Q is placed on a thin conducting spherical shell of radius R. Use Gauss's theorem to derive an expression for the electric field at a point lying

(i) inside and

(ii) outside the shell.

(ii) Show that the electric field for same charge density (σ) is twice in case of a conducting plate or surface than in a non-conducting sheet.

29. An electric dipole of dipole moment **p** consists of point charges +q and –q separated by a distance 2a apart. Deduce the expression for the electric field **E** due to the dipole at a distance x from the centre of the dipole on its axial line in terms of the dipole moment **p**. Hence show that in the limit $x \gg a$,

$$E \rightarrow \frac{2p}{4\pi\epsilon_0 x^3}$$

BRAINYCHAIKS