PHYSICS

Electric Charges and Fields

No. of Questions	Maximum Marks	Time
45	180	1 Hour

Speed TEST 15
Chapter-wise

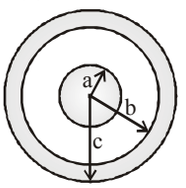
GENERAL INSTRUCTIONS

- This test contains 45 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solutions provided at the end of this book.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

1. The surface charge density of a thin charged disc of radius R is σ. The value of the electric field at the centre of the disc is $\frac{\sigma}{2\epsilon_0}$. With respect to the field at the centre, the electric field along the axis at a distance R from the centre of the disc reduces by

(a) 70.7% (b) 29.3% (c) 9.7% (d) 14.6%

2. A solid conducting sphere of radius a has a net positive charge 2Q. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere and has a net charge – Q. The surface charge density on the inner and outer surfaces of the spherical shell will be respectively



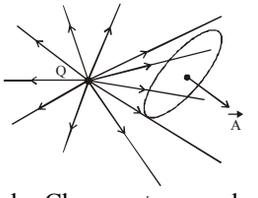
(a) $-\frac{2Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$ (b) $-\frac{Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

(c) $0, \frac{Q}{4\pi c^2}$ (d) $\frac{Q}{4\pi c^2}, 0$

3. Two equally charged, identical metal spheres A and B repel each other with a force 'F'. The spheres are kept fixed with a distance 'r' between them. A third identical, but uncharged sphere C is brought in contact with A and then placed at the mid point of the line joining A and B. The magnitude of the net electric force on C is

(a) F (b) $\frac{3F}{4}$ (c) $\frac{F}{2}$ (d) $\frac{F}{4}$

4. In the figure, the net electric flux through the area A is $\phi = \vec{E} \cdot \vec{A}$ when the system is in air. On immersing the system in water the net electric flux through the area



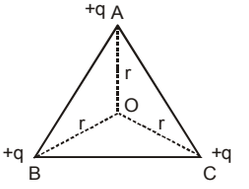
(a) becomes zero

(b) remains same

(c) increases

(d) decreases

5. ABC is an equilateral triangle. Charges +q are placed at each corner as shown in fig. The electric intensity at centre O will be



(a) $\frac{1}{4\pi\epsilon_o}\frac{q}{r}$

(b) $\frac{1}{4\pi\epsilon_o}\frac{q}{r^2}$

(c) $\frac{1}{4\pi\epsilon_o}\frac{3q}{r^2}$

(d) zero

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

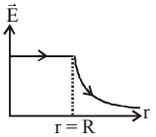
Space for Rough Work

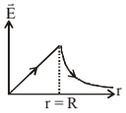
6. An electric dipole is placed in a uniform electric field. The dipole will experience
(a) a force that will displace it in the direction of the field
(b) a force that will displace it in a direction opposite to the field.
(c) a torque which will rotate it without displacement
(d) a torque which will rotate it and a force that will displace it

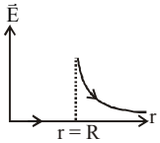
7. An uniform electric field E exists along positive x-axis. The work done in moving a charge 0.5 C through a distance 2 m along a direction making an angle 60° with x-axis is 10 J. Then the magnitude of electric field is

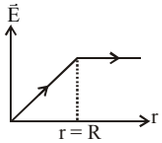
(a) $5\,Vm^{-1}$ (b) $2\,Vm^{-1}$ (c) $\sqrt{5}\ Vm^{-1}$ (d) $20\,Vm^{-1}$

8. Which one of the following graphs represents the variation of electric field with distance r from the centre of a charged spherical conductor of radius R?

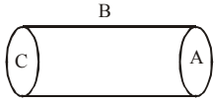
(a) 

(b) 

(c) 

(d) 

9. A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in units of voltmeter associated with the curved surface B, the flux linked with the plane surface A in units of voltmeter will be



(a) $\frac{q}{2\varepsilon_0}$ (b) $\frac{\phi}{3}$

(c) $\frac{q}{\varepsilon_0}-\phi$ (d) $\frac{1}{2}\left(\frac{q}{\varepsilon_0}-\phi\right)$

10. If E_a be the electric field strength of a short dipole at a point on its axial line and E_e that on the equatorial line at the same distance, then
(a) $E_e = 2E_a$ (b) $E_a = 2E_e$
(c) $E_a = E_e$ (d) None of the above

11. Three positive charges of equal value q are placed at vertices of an equilateral triangle. The resulting lines of force should be sketched as in

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

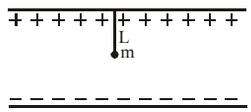
12. Three point charges Q_1, Q_2, Q_3 in the order are placed equally spaced along a straight line. Q_2 and Q_3 are equal in magnitude but opposite in sign. If the net force on Q_3 is zero. The value of Q_1 is

(a) $Q_1 = 4(Q_3)$ (b) $Q = 2(Q_3)$
(c) $Q_1 = \sqrt{2}(Q_3)$ (d) $Q_1 = |Q_3|$

13. Electric charge is uniformly distributed along a long straight wire of radius 1 mm. The charge per cm length of the wire is Q coulomb. Another cylindrical surface of radius 50 cm and length 1 m symmetrically encloses the wire. The total electric flux passing through the cylindrical surface is

(a) $\frac{Q}{\varepsilon_0}$ (b) $\frac{100Q}{\varepsilon_0}$ (c) $\frac{10Q}{\pi\varepsilon_0}$ (d) $\frac{100Q}{\pi\varepsilon_0}$

14. A small sphere carrying a charge 'q' is hanging in between two parallel plates by a string of length L. Time period of pendulum is T_0. When parallel plates are charged, the time period changes to T. The ratio T/T_0 is equal to



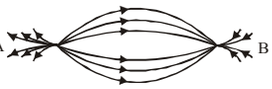
(a) $\left(\frac{g+\frac{qE}{m}}{g}\right)^{1/2}$ (b) $\left(\frac{g}{g+\frac{qE}{m}}\right)^{3/2}$
(c) $\left(\frac{g}{g+\frac{qE}{m}}\right)^{1/2}$ (d) $\left(\frac{g}{g+\frac{qE}{m}}\right)^{5/2}$

15. An electric dipole, consisting of two opposite charges of 2×10^{-6} C each separated by a distance 3 cm is placed in an electric field of 2×10^{5} N/C. Torque acting on the dipole is

(a) $12\times10^{-1}\,N-m$ (b) $12\times10^{-2}\,N-m$
(c) $12\times10^{-3}\,N-m$ (d) $12\times10^{-4}\,N-m$

16. The electric field in a certain region is acting radially outward and is given by E = Ar. A charge contained in a sphere of radius 'a' centred at the origin of the field, will be given by
(a) $A\,\varepsilon_0 a^2$ (b) $4\pi\varepsilon_0 Aa^3$ (c) $\varepsilon_0 Aa^3$ (d) $4\pi\varepsilon_0 Aa^2$

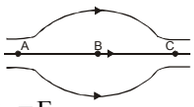
17. The spatial distribution of electric field due to charges (A, B) is shown in figure. Which one of the following statements is correct?



(a) A is +ve and B –ve, |A| > |B|
(b) A is –ve and B +ve, |A| = |B|
(c) Both are +ve but A > B
(d) Both are –ve but A > B

18. Point charges + 4q, –q and +4q are kept on the X-axis at points $x = 0$, $x = a$ and $x = 2a$ respectively.
(a) only – q is in stable equilibrium
(b) none of the charges is in equilibrium
(c) all the charges are in unstable equilibrium
(d) all the charges are in stable equilibrium.

19. Figure shows some of the electric field lines corresponding to an electric field. The figure suggests that



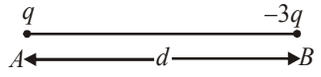
(a) $E_A > E_B > E_C$ (b) $E_A = E_B = E_C$
(c) $E_A = E_C > E_B$ (d) $E_A = E_C < E_B$

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	**7.** ⓐⓑⓒⓓ	**8.** ⓐⓑⓒⓓ	**9.** ⓐⓑⓒⓓ	**10.** ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	**12.** ⓐⓑⓒⓓ	**13.** ⓐⓑⓒⓓ	**14.** ⓐⓑⓒⓓ	**15.** ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	**17.** ⓐⓑⓒⓓ	**18.** ⓐⓑⓒⓓ	**19.** ⓐⓑⓒⓓ	

Space for Rough Work

20. For distance far away from centre of dipole the change in magnitude of electric field with change in distance from the centre of dipole is
(a) zero.
(b) same in equatorial plane as well as axis of dipole.
(c) more in case of equatorial plane of dipole as compared to axis of dipole.
(d) more in case of axis of dipole as compared to equatorial plane of dipole.

21. Two charge q and $-3q$ are placed fixed on x–axis separated by distance d. Where should a third charge $2q$ be placed such that it will not experience any force ?



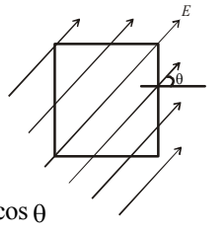
(a) $\frac{d-\sqrt{3}\,d}{2}$ (b) $\frac{d+\sqrt{3}\,d}{2}$ (c) $\frac{d+3d}{2}$ (d) $\frac{d-3d}{2}$

22. A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then Q/q equals:
(a) –1 (b) 1 (c) $-\frac{1}{\sqrt{2}}$ (d) $-2\sqrt{2}$

23. Identify the wrong statement in the following. Coulomb's law correctly describes the electric force that
(a) binds the electrons of an atom to its nucleus
(b) binds the protons and neutrons in the nucleus of an atom
(c) binds atoms together to form molecules
(d) binds atoms and molecules together to form solids

24. An oil drop of radius r and density ρ is held stationary in a uniform vertically upwards electric field 'E'. If ρ_0 (< ρ) is the density of air and e is quanta of charge, then the drop has–
(a) $\frac{4\pi r^3(\rho-\rho_0)g}{3eE}$ excess electrons
(b) $\frac{4\pi r^2(\rho-\rho_0)g}{eE}$ excess electrons
(c) deficiency of $\frac{4\pi r^3(\rho-\rho_0)g}{3eE}$ electrons
(d) deficiency of $\frac{4\pi r^2(\rho-\rho_0)g}{eE}$ electrons

25. A square surface of side L meter in the plane of the paper is placed in a uniform electric field E (volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in Figure. The electric flux linked to the surface, in units of volt. m, is



(a) EL^2 (b) $EL^2\cos\theta$
(c) $EL^2\sin\theta$ (d) zero

26. An electric dipole of moment $\vec{p}$ placed in a uniform electric field $\vec{E}$ has minimum potential energy when the angle between $\vec{P}$ and $\vec{E}$ is
(a) zero (b) $\frac{\pi}{2}$ (c) π (d) $\frac{3\pi}{2}$

27. Which of the following statements is incorrect?
(a) The charge q on a body is always given by q = ne, where n is any integer, positive or negative.
(b) By convention, the charge on an electron is taken to be negative.
(c) The fact that electric charge is always an integral multiple of e is termed as quantisation of charge.
(d) The quatisation of charge was experimentally demonstrated by Newton in 1912.

28. Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge of an electron)
(a) $\frac{4\pi\varepsilon_0 Fd^2}{e^2}$ (b) $\sqrt{\frac{4\pi\varepsilon_0 Fe^2}{d^2}}$
(c) $\sqrt{\frac{4\pi\varepsilon_0 Fd^2}{e^2}}$ (d) $\frac{4\pi\varepsilon_0 Fd^2}{q^2}$

29. Two small similar metal spheres A and B having charges 4q and – 4q, when placed at a certain distance apart, exert an electric force F on each other. When another identical uncharged sphere C, first touched with A then with B and then removed to infinity, the force of interaction between A and B for the same separation will be
(a) F/2 (b) F/8 (c) F/16 (d) F/32

30. The electric field intensity just sufficient to balance the earth's gravitational attraction on an electron will be: (given mass and charge of an electron respectively are 9.1×10^{-31}kg and 1.6×10^{-19}C .)
(a) -5.6×10^{-11} N/C (b) -4.8×10^{-15} N/C
(c) -1.6×10^{-19} N/C (d) -3.2×10^{-19} N/C

31. An electric dipole is placed at an angle of 30° with an electric field of intensity 2×10^5 NC^{-1}, It experiences a torque of 4 Nm. Calculate the charge on the dipole if the dipole length is 2 cm.
(a) 8mC (b) 4mC (c) 8mC (d) 2mC

32. A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. The kinetic energy attained by the particle after moving a distance y is
(a) qEy^2 (b) qE^2y (c) qEy (d) q^2Ey

33. There is an electric field E in x-direction. If the work done on moving a charge of 0.2 C through a distance of 2 m along a line making an angle 60° with x-axis is 4 J, then what is the value of E?
(a) 3 N/C (b) 4 N/C (c) 5 N/C (d) 20 N/C

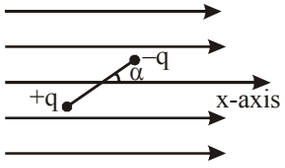
RESPONSE GRID					
	20. ⓐⓑⓒⓓ	**21.** ⓐⓑⓒⓓ	**22.** ⓐⓑⓒⓓ	**23.** ⓐⓑⓒⓓ	**24.** ⓐⓑⓒⓓ
	25. ⓐⓑⓒⓓ	**26.** ⓐⓑⓒⓓ	**27.** ⓐⓑⓒⓓ	**28.** ⓐⓑⓒⓓ	**29.** ⓐⓑⓒⓓ
	30. ⓐⓑⓒⓓ	**31.** ⓐⓑⓒⓓ	**32.** ⓐⓑⓒⓓ	**33.** ⓐⓑⓒⓓ	

Space for Rough Work

34. A surface has the area vector $\vec{A} = \left(2\hat{i} + 3\hat{j}\right)m^2$. The flux of an electric field through it if the field is $\vec{E} = 4\hat{i}\,\frac{V}{m}$:

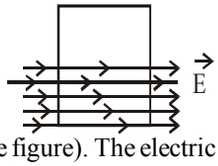
(a) 8V-m (b) 12V-m (c) 20V-m (d) zero

35. There exists a non!-uniform electric field along x-axis as shown in the figure below. The field increases at a uniform rate along +ve x-axis. A dipole is placed inside the field as shown. Which one of the following is correct for the dipole?



(a) Dipole moves along positive x-axis and undergoes a clockwise rotation
(b) Dipole moves along negative x-axis and undergoes a clockwise rotation
(c) Dipole moves along positive x-axis and undergoes a anticlockwise rotation
(d) Dipole moves along negative x-axis and undergoes a anticlockwise rotation

36. A square surface of side L metres is in the plane of the paper. A uniform electric field $\vec{E}$ (volt /m), also in the plane of the paper, is limited only to the lower half of the square surface (see figure). The electric flux in SI units associated with the surface is



(a) $EL^2/2$ (b) zero (c) EL^2 (d) $EL^2/(2\varepsilon_0)$

37. Among two discs A and B, first have radius 10 cm and charge 10^{-6} μC and second have radius 30 cm and charge 10^{-5} C. When they are touched, charge on both q_A and q_B respectively will, be

(a) q_A =2.75 μC, q_B =3.15 μC

(b) q_A =1.09 μC, q_B =1.53 μC

(c) $q_A = q_B$ =5.5 μC (d) None of these

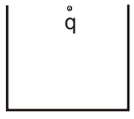
38. The total electric flux emanating from a closed surface enclosing an α-particle (e-electronic charge) is

(a) $\frac{2e}{\varepsilon_0}$ (b) $\frac{e}{\varepsilon_0}$ (c) $e\varepsilon_0$ (d) $\frac{\varepsilon_0 e}{4}$

39. Which of the following is a wrong statement?

(a) The charge of an isolated system is conserved
(b) It is not possible to create or destroy charged particles
(c) It is possible to create or destroy charged particles
(d) It is not possible to create or destroy net charge

40. A charge q is placed at the centre of the open end of a cylindrical vessel. The flux of the electric field through the surface of the vessel is



(a) zero (b) q/ε_o

(c) $q/2\varepsilon_o$ (d) $2q/\varepsilon_o$

41. If the electric flux entering and leaving a closed surface are 6×10^6 and 9×10^6 S.I. units respectively, then the charge inside the surface of permittivity of free space ε_0 is

(a) $\varepsilon_0 \times 10^6$ (b) $-\varepsilon_0 \times 10^6$
(c) $-2\varepsilon_0 \times 10^6$ (d) $3\varepsilon_0 \times 10^6$

42. Two particle of equal mass m and charge q are placed at a distance of 16 cm. They do not experience any force. The value of $\frac{q}{m}$ is

(a) 1 (b) $\sqrt{\frac{\pi\varepsilon_0}{G}}$ (c) $\sqrt{\frac{G}{4\pi\varepsilon_0}}$ (d) $\sqrt{4\pi\varepsilon_0 G}$

43. A rod of length 2.4 *m* and radius 4.6 *mm* carries a negative charge of 4.2×10^{-7} C spread uniformly over it surface. The electric field near the mid–point of the rod, at a point on its surface is

(a) -8.6×10^5 N C^{-1} (b) 8.6×10^4 N C^{-1}
(c) -6.7×10^5 N C^{-1} (d) 6.7×10^4 N C^{-1}

44. A hollow insulated conduction sphere is given a positive charge of 10 μC. What will be the electric field at the centre of the sphere if its radius is 2 m?

(a) Zero (b) 5 μCm^{-2}
(c) 20 μCm^{-2} (d) 8 μCm^{-2}

45. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will

(a) increase four times (b) be reduced to half
(c) remain the same (d) be doubled

RESPONSE GRID					
	34. ⓐⓑⓒⓓ	**35.** ⓐⓑⓒⓓ	**36.** ⓐⓑⓒⓓ	**37.** ⓐⓑⓒⓓ	**38.** ⓐⓑⓒⓓ
	39. ⓐⓑⓒⓓ	**40.** ⓐⓑⓒⓓ	**41.** ⓐⓑⓒⓓ	**42.** ⓐⓑⓒⓓ	**43.** ⓐⓑⓒⓓ
	44. ⓐⓑⓒⓓ	**45.** ⓐⓑⓒⓓ			

PHYSICS CHAPTERWISE SPEED TEST-15			
Total Questions	45	Total Marks	180
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	50	Qualifying Score	70
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work