Chapter 22: ELECTRIC FIELDS

1. An electric field is most directly related to:
   A. the momentum of a test charge
   B. the kinetic energy of a test charge
   C. the potential energy of a test charge
   D. the force acting on a test charge
   E. the charge carried by a test charge

   ans: D

2. As used in the definition of electric field, a "test charge":
   A. has zero charge
   B. has charge of magnitude 1 C
   C. has charge of magnitude 1.6×10^{-19} C
   D. must be an electron
   E. none of the above

   ans: E

3. Experimenter A uses a test charge q_0 and experimenter B uses a test charge $-2q_0$ to measure an electric field produced by stationary charges. A finds a field that is:
   A. the same in both magnitude and direction as the field found by B
   B. greater in magnitude than the field found by B
   C. less in magnitude than the field found by B
   D. opposite in direction to the field found by B
   E. either greater or less than the field found by B, depending on the accelerations of the test charges

   ans: A

4. The units of the electric field are:
   A. $\mathrm{N \cdot C^2}$
   B. C/N
   C. N
   D. N/C
   E. $\mathrm{C/m^2}$

   ans: D

5. The units of the electric field are:
   A. J/(C·m)
   B. J/C
   C. J·C
   D. J/m
   E. none of these

   ans: A

6. Electric field lines:
   A. are trajectories of a test charge
   B. are vectors in the direction of the electric field
   C. form closed loops
   D. cross each other in the region between two point charges
   E. are none of the above

   ans: E

7. Two thin spherical shells, one with radius R and the other with radius $2R$, surround an isolated charged point particle. The ratio of the number of field lines through the larger sphere to the number through the smaller is:
   A. 1
   B. 2
   C. 4
   D. 1/2
   E. 1/4

   ans: A

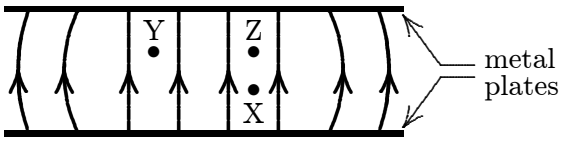
8. A certain physics textbook shows a region of space in which two electric field lines cross each other. We conclude that:
   A. at least two point charges are present
   B. an electrical conductor is present
   C. an insulator is present
   D. the field points in two directions at the same place
   E. the author made a mistake

   ans: E

9. Choose the correct statement concerning electric field lines:
   A. field lines may cross
   B. field lines are close together where the field is large
   C. field lines point away from a negatively charged particle
   D. a charged point particle released from rest moves along a field line
   E. none of these are correct

   ans: B

10. The diagram shows the electric field lines due to two charged parallel metal plates. We conclude that:



   A. the upper plate is positive and the lower plate is negative
   B. a proton at X would experience the same force if it were placed at Y
   C. a proton at X experiences a greater force than if it were placed at Z
   D. a proton at X experiences less force than if it were placed at Z
   E. an electron at X could have its weight balanced by the electrical force

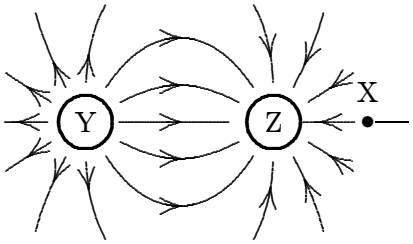
   ans: B

11. Let k denote $1/4\pi\epsilon_0$. The magnitude of the electric field at a distance r from an isolated point particle with charge q is:

A. kq/r
B. kr/q
C. kq/r^3
D. kq/r^2
E. kq^2/r^2

ans: D

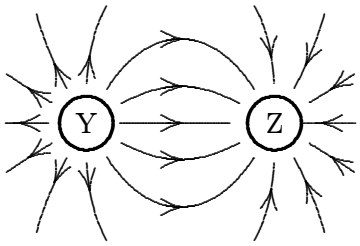
12. The diagram shows the electric field lines in a region of space containing two small charged spheres (Y and Z). Then:



A. Y is negative and Z is positive
B. the magnitude of the electric field is the same everywhere
C. the electric field is strongest midway between Y and Z
D. the electric field is not zero anywhere (except infinitely far from the spheres)
E. Y and Z must have the same sign

ans: D

13. The diagram shows the electric field lines in a region of space containing two small charged spheres (Y and Z). Then:



A. Y is negative and Z is positive
B. the magnitude of the electric field is the same everywhere
C. the electric field is strongest midway between Y and Z
D. Y is positive and Z is negative
E. Y and Z must have the same sign

ans: D

14. The electric field at a distance of 10 cm from an isolated point particle with a charge of 2×10^{-9} C is:

A. 1.8 N/C
B. 180 N/C
C. 18 N/C
D. 1800 N/C
E. none of these

ans: D

15. An isolated charged point particle produces an electric field with magnitude E at a point 2 m away from the charge. A point at which the field magnitude is $E/4$ is:

A. 1 m away from the particle
B. 0.5 m away from the particle
C. 2 m away from the particle
D. 4 m away from the particle
E. 8 m away from the particle

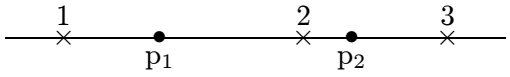
ans: D

16. An isolated charged point particle produces an electric field with magnitude E at a point 2 m away. At a point 1 m from the particle the magnitude of the field is:

A. E
B. $2E$
C. $4E$
D. $E/2$
E. $E/4$

ans: C

17. Two protons (p_1 and p_2) are on the x axis, as shown below. The directions of the electric field at points 1, 2, and 3, respectively, are:



A. $\longrightarrow, \longleftarrow, \longrightarrow$
B. $\longleftarrow, \longrightarrow, \longleftarrow$
C. $\longleftarrow, \longrightarrow, \longrightarrow$
D. $\longleftarrow, \longleftarrow, \longleftarrow$
E. $\longleftarrow, \longleftarrow, \longrightarrow$

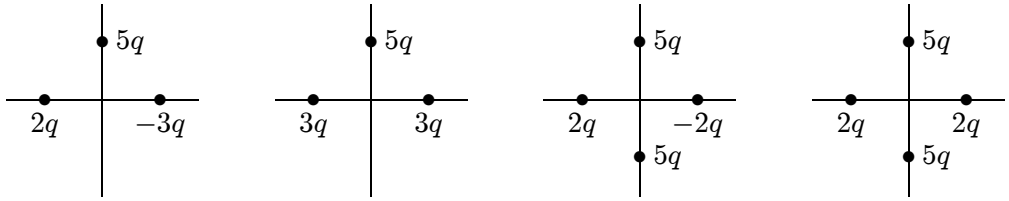
ans: E

18. Two point particles, with a charges of q_1 and q_2, are placed a distance r apart. The electric field is zero at a point P between the particles on the line segment connecting them. We conclude that:

A. q_1 and q_2 must have the same magnitude and sign
B. P must be midway between the particles
C. q_1 and q_2 must have the same sign but may have different magnitudes
D. q_1 and q_2 must have equal magnitudes and opposite signs
E. q_1 and q_2 must have opposite signs and may have different magnitudes

ans: C

19. The diagrams below depict four different charge distributions. The charge particles are all the same distance from the origin. The electric field at the origin:

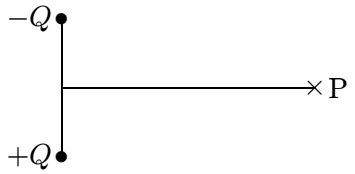


1 2 3 4

A. is greatest for situation 1
B. is greatest for situation 3
C. is zero for situation 4
D. is downward for situation 1
E. is downward for situation 3

ans: C

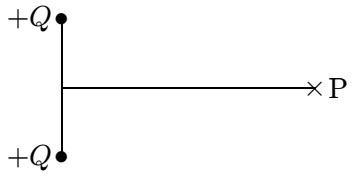
20. The diagram shows a particle with positive charge Q and a particle with negative charge $-Q$. The electric field at point P on the perpendicular bisector of the line joining them is:



A. ↑
B. ↓
C. →
D. ←
E. zero

ans: A

21. The diagram shows two identical particles, each with positive charge Q. The electric field at point P on the perpendicular bisector of the line joining them is:



A. $\uparrow$
B. $\downarrow$
C. $\rightarrow$
D. $\leftarrow$
E. zero

ans: C

22. Two point particles, one with charge $+8 \times 10^{-9}$ C and the other with charge -2×10^{-9} C, are separated by 4 m. The electric field in N/C midway between them is:

A. 9×10^{9}
B. $13,500$
C. $135,000$
D. 36×10^{-9}
E. 22.5

ans: E

23. Two charged point particles are located at two vertices of an equilateral triangle and the electric field is zero at the third vertex. We conclude:

A. the two particles have charges with opposite signs and the same magnitude
B. the two particles have charges with opposite signs and different magnitudes
C. the two particles have identical charges
D. the two particles have charges with the same sign but different magnitudes
E. at least one other charged particle is present

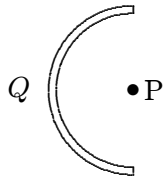
ans: E

24. Two point particles, with the same charge, are located at two vertices of an equilateral triangle. A third charged particle is placed so the electric field at the third vertex is zero. The third particle must:

A. be on the perpendicular bisector of the line joining the first two charges
B. be on the line joining the first two charges
C. have the same charge as the first two particles
D. have charge of the same magnitude as the first two charges but its charge may have a different sign
E. be at the center of the triangle

ans: A

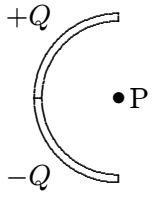
25. Positive charge Q is uniformly distributed on a semicircular rod. What is the direction of the electric field at point P, the center of the semicircle?



A. $\uparrow$
B. $\downarrow$
C. $\leftarrow$
D. $\rightarrow$
E. $\nearrow$

ans: D

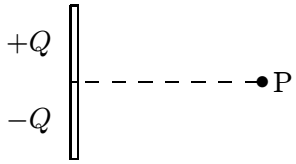
26. Positive charge $+Q$ is uniformly distributed on the upper half a semicircular rod and negative charge $-Q$ is uniformly distributed on the lower half. What is the direction of the electric field at point P, the center of the semicircle?



A. $\uparrow$
B. $\downarrow$
C. $\leftarrow$
D. $\rightarrow$
E. $\nearrow$

ans: B

27. Positive charge $+Q$ is uniformly distributed on the upper half a rod and negative charge $-Q$ is uniformly distributed on the lower half. What is the direction of the electric field at point P, on the perpendicular bisector of the rod?



A. $\uparrow$
B. $\downarrow$
C. $\leftarrow$
D. $\rightarrow$
E. $\nearrow$

ans: B

28. The electric field due to a uniform distribution of charge on a spherical shell is zero:
    A. everywhere
    B. nowhere
    C. only at the center of the shell
    D. only inside the shell
    E. only outside the shell

    ans: D

29. A charged particle is placed in an electric field that varies with location. No force is exerted on this charge:
    A. at locations where the electric field is zero
    B. at locations where the electric field strength is $1/(1.6 \times 10^{-19})\,\mathrm{N/C}$
    C. if the particle is moving along a field line
    D. if the particle is moving perpendicularly to a field line
    E. if the field is caused by an equal amount of positive and negative charge

    ans: A

30. The magnitude of the force of a 400-N/C electric field on a 0.02-C point charge is:
    A. $8.0\,\mathrm{N}$
    B. $8 \times 10^{-5}\,\mathrm{N}$
    C. $8 \times 10^{-3}\,\mathrm{N}$
    D. $0.08\,\mathrm{N}$
    E. $2 \times 10^{11}\,\mathrm{N}$

    ans: A

31. A 200-N/C electric field is in the positive x direction. The force on an electron in this field is:
    A. $200\,\mathrm{N}$ in the positive x direction
    B. $200\,\mathrm{N}$ in the negative x direction
    C. $3.2 \times 10^{-17}\,\mathrm{N}$ in the positive x direction
    D. $3.2 \times 10^{-17}\,\mathrm{N}$ in the negative x direction
    E. 0

    ans: D

32. An electron traveling north enters a region where the electric field is uniform and points north. The electron:
    A. speeds up
    B. slows down
    C. veers east
    D. veers west
    E. continues with the same speed in the same direction

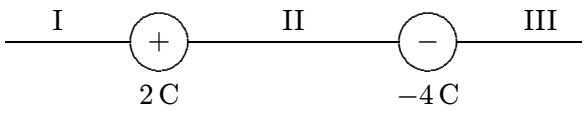
    ans: B

33. An electron traveling north enters a region where the electric field is uniform and points west. The electron:

A. speeds up
B. slows down
C. veers east
D. veers west
E. continues with the same speed in the same direction

ans: C

34. Two charged particles are arranged as shown. In which region could a third particle, with charge $+1\,\mathrm{C}$, be placed so that the net electrostatic force on it is zero?



A. I only
B. I and II only
C. lII only
D. I and III only
E. II only

ans: A

35. An electric dipole consists of a particle with a charge of $+6 \times 10^{-6}\,\mathrm{C}$ at the origin and a particle with a charge of $-6 \times 10^{-6}\,\mathrm{C}$ on the x axis at $x = 3 \times 10^{-3}\,\mathrm{m}$. Its dipole moment is:

A. $1.8 \times 10^{-8}\,\mathrm{C \cdot m}$, in the positive x direction
B. $1.8 \times 10^{-8}\,\mathrm{C \cdot m}$, in the negative x direction
C. 0 because the net charge is 0
D. $1.8 \times 10^{-8}\,\mathrm{C \cdot m}$, in the positive y direction
E. $1.8 \times 10^{-8}\,\mathrm{C \cdot m}$, in the negative y direction

ans: B

36. The force exerted by a uniform electric field on a dipole is:

A. parallel to the dipole moment
B. perpendicular to the dipole moment
C. parallel to the electric field
D. perpendicular to the electric field
E. none of the above

ans: E

37. An electric field exerts a torque on a dipole only if:

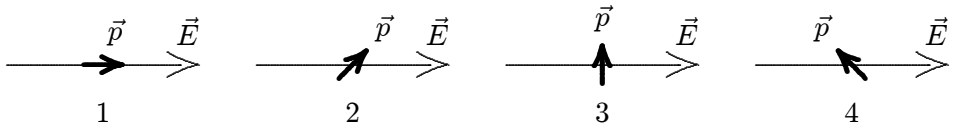
A. the field is parallel to the dipole moment
B. the field is not parallel to the dipole moment
C. the field is perpendicular to the dipole moment
D. the field is not perpendicular to the dipole moment
E. the field is uniform

ans: B

38. The torque exerted by an electric field on a dipole is:
    A. parallel to the field and perpendicular to the dipole moment
    B. parallel to both the field and dipole moment
    C. perpendicular to both the field and dipole moment
    D. parallel to the dipole moment and perpendicular to the field
    E. not related to the directions of the field and dipole moment

    ans: C

39. The diagrams show four possible orientations of an electric dipole in a uniform electric field $\vec{E}$. Rank them according to the magnitude of the torque exerted on the dipole by the field, least to greatest.



    A. 1, 2, 3, 4
    B. 4, 3, 2, 1
    C. 1, 2, 4, 3
    D. 3, 2 and 4 tie, then 1
    E. 1, 2 and 4 tie, then 3

    ans: E

40. A uniform electric field of 300 N/C makes an angle of 25° with the dipole moment of an electric dipole. If the torque exerted by the field has a magnitude of $2.5 \times 10^{-7}\,\mathrm{N \cdot m}$, the dipole moment must be:
    A. $8.3 \times 10^{-10}\,\mathrm{C \cdot m}$
    B. $9.2 \times 10^{-10}\,\mathrm{C \cdot m}$
    C. $2.0 \times 10^{-9}\,\mathrm{C \cdot m}$
    D. $8.3 \times 10^{-5}\,\mathrm{C \cdot m}$
    E. $1.8 \times 10^{-4}\,\mathrm{C \cdot m}$

    ans: C

41. When the dipole moment of a dipole in a uniform electric field rotates to become more nearly aligned with the field:
    A. the field does positive work and the potential energy increases
    B. the field does positive work and the potential energy decreases
    C. the field does negative work and the potential energy increases
    D. the field does negative work and the potential energy decreases
    E. the field does no work

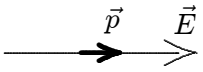
    ans: B

42. The dipole moment of a dipole in a 300-N/C electric field is initially perpendicular to the field, but it rotates so it is in the same direction as the field. If the moment has a magnitude of $2 \times 10^{-9}\,\mathrm{C \cdot m}$, the work done by the field is:

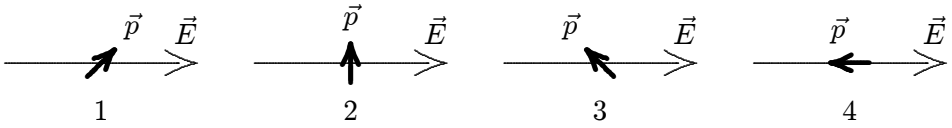
A. $-12 \times 10^{-7}\,\mathrm{J}$
B. $-6 \times 10^{-7}\,\mathrm{J}$
C. 0
D. $6 \times 10^{-7}\,\mathrm{J}$
E. $12 \times 10^{-7}\,\mathrm{J}$

ans: D

43. An electric dipole is oriented parallel to a uniform electric field, as shown.



It is rotated to one of the five orientations shown below. Rank the final orientations according to the change in the potential energy of the dipole-field system, most negative to most positive.



A. 1, 2, 3, 4
B. 4, 3, 2, 1
C. 1, 2, 4, 3
D. 3, 2 and 4 tie, then 1
E. 1, 2 and 4 tie, then 3

ans: A

44. The purpose of Milliken's oil drop experiment was to determine:

A. the mass of an electron
B. the charge of an electron
C. the ratio of charge to mass for an electron
D. the sign of the charge on an electron
E. viscosity

ans: B

45. A charged oil drop with a mass of $2 \times 10^{-4}\,\mathrm{kg}$ is held suspended by a downward electric field of $300\,\mathrm{N/C}$. The charge on the drop is:

A. $+1.5 \times 10^{-6}\,\mathrm{C}$
B. $-1.5 \times 10^{-6}\,\mathrm{C}$
C. $+6.5 \times 10^{-6}\,\mathrm{C}$
D. $-6.5 \times 10^{-6}\,\mathrm{C}$
E. 0

ans: D