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 te
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

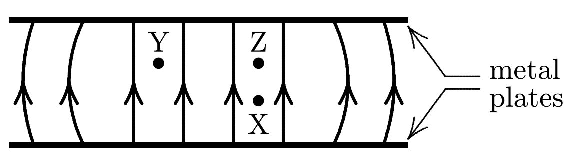
ans: E

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

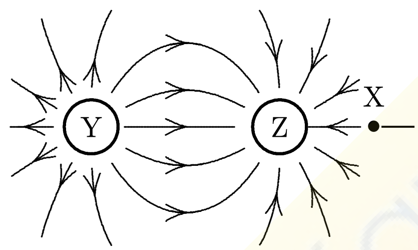
ans: B

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

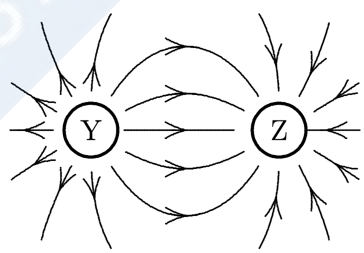
12. The diagram shows the electric field lines in a region of space containing two small charged spheres (Y and Z). Then:



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

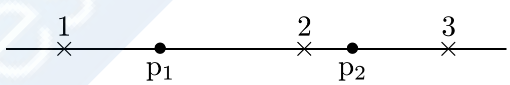
ans: D

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. $\longleftarrow, \longleftarrow, \longrightarrow$

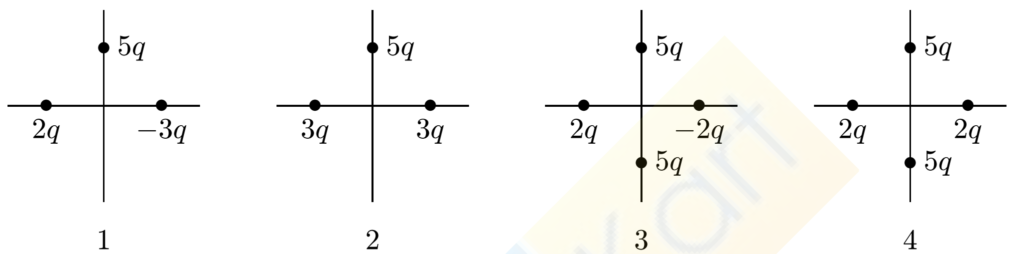
ans: E

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 betwe ude 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:



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

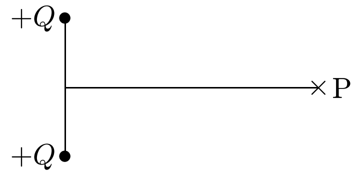
ans: C

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

ans: A

21. The diagram shows two identical particles, each with positive charge Q. The electric field at point P on the perpendicu



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

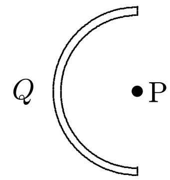
ans: E

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

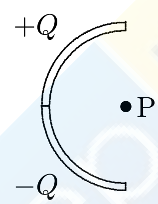
25. Positive charge Q is uniformlv distributed on a semicircular rod. What is the direction of the electric field at point P, th



A. ↑
B. ↓
C. ←
D. →
E. ↗

ans: D

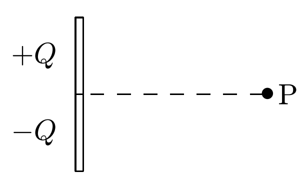
26. Positive charge $+Q$ is uniformly distributed on the upper half a semicircular rod and negative charge $-Q$ is uniformly distributed on the lower half. What is the direction of the electric field at point P, the center of the semicircle?



A. ↑
B. ↓
C. ←
D. →
E. ↗

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. ↑
B. ↓
C. ←
D. →
E. ↗

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

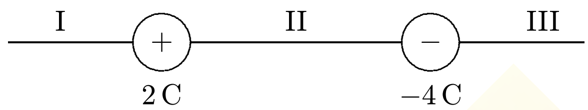
ans: B

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 C, be placed so that the net electrostatic force on it is zero?



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

ans: A

35. An electric dipole consists of a particle with a charge of $+6 \times 10^{-6}$ C at the origin and a particle with a charge of -6×10^{-6} C on the x axis at $x = 3 \times 10^{-3}$ 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

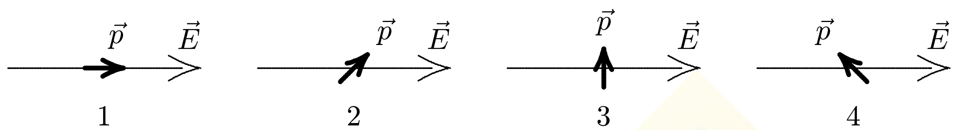
ans: B

38. The torque exerted by an electric field on a dipole is:

A. parallel to the field an
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

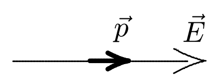
ans: B

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 t [illegible] e of $2 \times 10^{-9}\,\mathrm{C\cdot m}$, the work done by the field is:

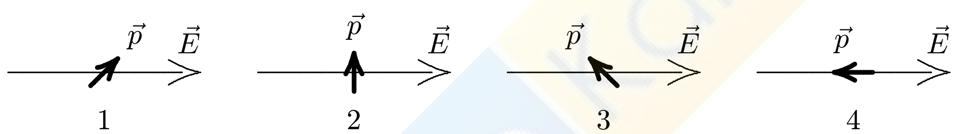
A. -12×10^{-7} J
B. -6×10^{-7} J
C. 0
D. 6×10^{-7} J
E. 12×10^{-7} J

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 2×10^{-4} kg is held suspended by a downward electric field of 300 N/C. The charge on the drop is:

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

ans: D

Chapter 23: GAUSS' LAW

1. A total charge of $6.3 \times 10^{-\text{[illegible]}}$ C is distributed uniformly throughout a 2.7-cm radius sphere. The volume charge density is:
   A. $3.7 \times 10^{-7}\,\mathrm{C/m^3}$
   B. $6.9 \times 10^{-6}\,\mathrm{C/m^3}$
   C. $6.9 \times 10^{-6}\,\mathrm{C/m^2}$
   D. $2.5 \times 10^{-4}\,\mathrm{C/m^3}$
   E. $7.6 \times 10^{-4}\,\mathrm{C/m^3}$
   ans: E

2. Charge is placed on the surface of a 2.7-cm radius isolated conducting sphere. The surface charge density is uniform and has the value $6.9 \times 10^{-6}\,\mathrm{C/m^2}$. The total charge on the sphere is:
   A. $5.6 \times 10^{-10}\,\mathrm{C}$
   B. $2.1 \times 10^{-8}\,\mathrm{C}$
   C. $4.7 \times 10^{-8}\,\mathrm{C}$
   D. $6.3 \times 10^{-8}\,\mathrm{C}$
   E. $9.5 \times 10^{-3}\,\mathrm{C}$
   ans: D

3. A spherical shell has an inner radius of 3.7 cm and an outer radius of 4.5 cm. If charge is distributed uniformly throughout the shell with a volume density of $6.1 \times 10^{-4}\,\mathrm{C/m^3}$ the total charge is:
   A. $1.0 \times 10^{-7}\,\mathrm{C}$
   B. $1.3 \times 10^{-7}\,\mathrm{C}$
   C. $2.0 \times 10^{-7}\,\mathrm{C}$
   D. $2.3 \times 10^{-7}\,\mathrm{C}$
   E. $4.0 \times 10^{-7}\,\mathrm{C}$
   ans: A

4. A cylinder has a radius of 2.1 cm and a length of 8.8 cm. Total charge 6.1×10^{-7} C is distributed uniformly throughout. The volume charge density is:
   A. $5.3 \times 10^{-5}\,\mathrm{C/m^3}$
   B. $5.3 \times 10^{-5}\,\mathrm{C/m^2}$
   C. $8.5 \times 10^{-4}\,\mathrm{C/m^3}$
   D. $5.0 \times 10^{-3}\,\mathrm{C/m^3}$
   E. $6.3 \times 10^{-2}\,\mathrm{C/m^3}$
   ans: D

5. When a piece of paper is held with one face perpendicular to a uniform electric field the flux through it is $25\,\mathrm{N\cdot m^2/C}$ flux through it is:

A. 0
B. $12\,\mathrm{N\cdot m^2/C}$
C. $21\,\mathrm{N\cdot m^2/C}$
D. $23\,\mathrm{N\cdot m^2/C}$
E. $25\,\mathrm{N\cdot m^2/C}$

ans: D

6. The flux of the electric field $(24\,\mathrm{N/C})\,\hat{\mathrm{i}} + (30\,\mathrm{N/C})\,\hat{\mathrm{j}} + (16\,\mathrm{N/C})\,\hat{\mathrm{k}}$ through a $2.0\,\mathrm{m^2}$ portion of the yz plane is:

A. $32\,\mathrm{N\cdot m^2/C}$
B. $34\,\mathrm{N\cdot m^2/C}$
C. $42\,\mathrm{N\cdot m^2/C}$
D. $48\,\mathrm{N\cdot m^2/C}$
E. $60\,\mathrm{N\cdot m^2/C}$

ans: D

7. Consider Gauss's law: $\oint \vec{E}\cdot d\vec{A} = q/\epsilon_0$. Which of the following is true?

A. $\vec{E}$ must be the electric field due to the enclosed charge
B. If $q = 0$, then $\vec{E} = 0$ everywhere on the Gaussian surface
C. If the three particles inside have charges of $+q$, $+q$, and $-2q$, then the integral is zero
D. on the surface $\vec{E}$ is everywhere parallel to $d\vec{A}$
E. If a charge is placed outside the surface, then it cannot affect $\vec{E}$ at any point on the surface

ans: C

8. A charged point particle is placed at the center of a spherical Gaussian surface. The electric flux Φ_E is changed if:

A. the sphere is replaced by a cube of the same volume
B. the sphere is replaced by a cube of one-tenth the volume
C. the point charge is moved off center (but still inside the original sphere)
D. the point charge is moved to just outside the sphere
E. a second point charge is placed just outside the sphere

ans: D

9. Choose the INCORRECT statement:

A. Gauss' law can be derived from Coulomb's law
B. Gauss' law states that the net number of lines crossing any closed surface in an outward direction is proportional to the net charge enclosed within the surface
C. Coulomb's law can be derived from Gauss' law and symmetry
D. Gauss' law applies to a closed surface of any shape
E. According to Gauss' law, if a closed surface encloses no charge, then the electric field must vanish everywhere on the surface

ans: E

10. The outer surface of the cardboard center of a paper towel roll:

A. is a possible Gaussian
B. cannot be a Gaussian surface because it encloses no charge
C. cannot be a Gaussian surface since it is an insulator
D. cannot be a Gaussian surface because it is not a closed surface
E. none of the above

ans: D

11. A physics instructor in an anteroom charges an electrostatic generator to 25 μC, then carries it into the lecture hall. The net electric flux in $N \cdot m^2/C$ through the lecture hall walls is:

A. 0
B. 25×10^{-6}
C. 2.2×10^{5}
D. 2.8×10^{6}
E. can not tell unless the lecture hall dimensions are given

ans: D

12. A point particle with charge q is placed inside the cube but not at its center. The electric flux through any one side of the cube:

A. is zero
B. is q/ϵ_0
C. is $q/4\epsilon_0$
D. is $q/6\epsilon_0$
E. cannot be computed using Gauss' law

ans: E

13. A particle with charge 5.0-μC is placed at the corner of a cube. The total electric flux in $N \cdot m^2/C$ through all sides of the cube is:

A. 0
B. 7.1×10^{4}
C. 9.4×10^{4}
D. 1.4×10^{5}
E. 5.6×10^{5}

ans: E

14. A point particle with charge q is at the center of a Gaussian surface in the form of a cube. The electric flux through any one face of the cube is:

A. q/ϵ_0
B. $q/4\pi\epsilon_0$
C. $q/3\epsilon_0$
D. $q/6\epsilon_0$
E. $q/12\epsilon_0$

ans: D

15. The table below gives the electric flux in $N \cdot m^2/C$ through the ends and round surfaces of four Gaussian surfaces in the fc ide, from the most negative to the most positive.

	left end	right end	rounded surface
cylinder 1:	$+2 \times 10^{-9}$	$+4 \times 10^{-9}$	-6×10^{-9}
cylinder 2:	$+3 \times 10^{-9}$	-2×10^{-9}	$+6 \times 10^{-9}$
cylinder 3:	-2×10^{-9}	-5×10^{-9}	$+3 \times 10^{-9}$
cylinder 4:	$+2 \times 10^{-9}$	-5×10^{-9}	-3×10^{-9}

A. 1, 2, 3, 4
B. 4, 3, 2, 1
C. 3, 4, 2, 1
D. 3, 1, 4, 2
E. 4, 3, 1, 2
ans: E

16. A conducting sphere of radius 0.01 m has a charge of 1.0×10^{-9} C deposited on it. The magnitude of the electric field in N/C just outside the surface of the sphere is:
A. 0
B. 450
C. 900
D. 4500
E. 90,000
ans: C

17. A round wastepaper basket with a 0.15-m radius opening is in a uniform electric field of 300 N/C, perpendicular to the opening. The total flux through the sides and bottom, in $N \cdot m^2$ C, is:
A. 0
B. 4.2
C. 21
D. 280
E. can not tell without knowing the areas of the sides and bottom
ans: C

18. 10 C of charge are placed on a spherical conducting shell. A particle with a charge of −3 C is placed at the center of the cavity. The net charge on the inner surface of the shell is:
A. −7 C
B. −3 C
C. 0 C
D. +3 C
E. +7 C
ans: D

19. 10 C of charge are placed on a spherical conducting shell. A particle with a charge of −3 C is placed at the center of the

A. −7 C
B. −3 C
C. 0 C
D. +3 C
E. +7 C

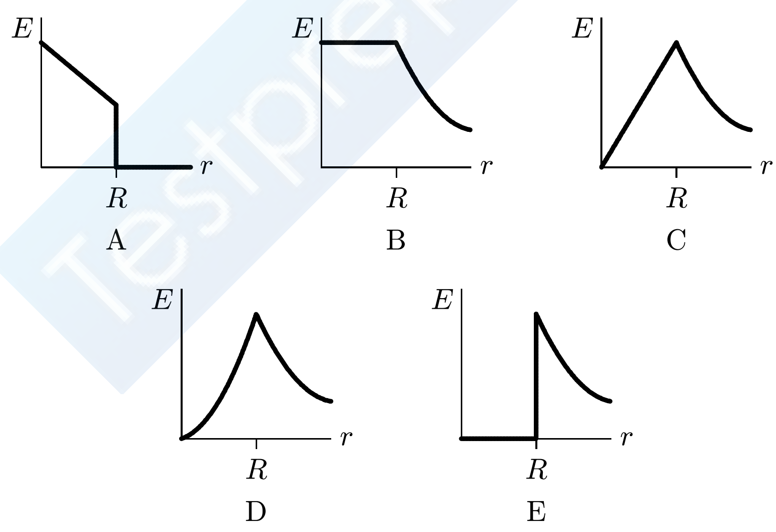
ans: E

20. A 30-N/C uniform electric field points perpendicularly toward the left face of a large neutral conducting sheet. The surface charge density in C/m^2 on the left and right faces, respectively, are:

A. $-2.7 \times 10^{-9}\,C/m^2$; $+2.7 \times 10^{-9}\,C/m^2$
B. $+2.7 \times 10^{-9}\,C/m^2$; $-2.7 \times 10^{-9}\,C/m^2$
C. $-5.3 \times 10^{-9}\,C/m^2$; $+5.3 \times 10^{-9}\,C/m^2$
D. $+5.3 \times 10^{-9}\,C/m^2$; $-5.3 \times 10^{-9}\,C/m^2$
E. 0; 0

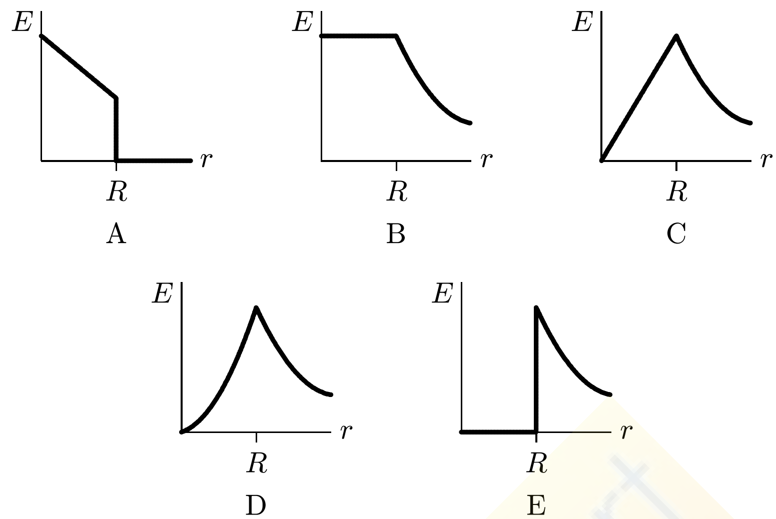
ans: A

21. A solid insulating sphere of radius R contains positive charge that is distributed with a volume charge density that does not depend on angle but does increase with distance from the sphere center. Which of the graphs below might give the magnitude E of the electric field as a function of the distance r from the center of the sphere?



ans: D

22. Which of the following graphs represents the magnitude of the electric field as a function of the distance from the cent



ans: E

23. Charge Q is distributed uniformly throughout an insulating sphere of radius R. The magnitude of the electric field at a point $R/2$ from the center is:

A. $Q/4\pi\epsilon_0 R^2$
B. $Q/\pi\epsilon_0 R^2$
C. $3Q/4\pi\epsilon_0 R^2$
D. $Q/8\pi\epsilon_0 R^2$
E. none of these

ans: D

24. Positive charge Q is distributed uniformly throughout an insulating sphere of radius R, centered at the origin. A particle with positive charge Q is placed at $x = 2R$ on the x axis. The magnitude of the electric field at $x = R/2$ on the x axis is:

A. $Q/4\pi\epsilon_0 R^2$
B. $Q/8\pi\epsilon_0 R^2$
C. $Q/72\pi\epsilon_0 R^2$
D. $17Q/72\pi\epsilon_0 R^2$
E. none of these

ans: C

25. Charge Q is distributed uniformly throughout a spherical insulating shell. The net electric flux in $\mathrm{N \cdot m^2/C}$ through the inner surface of the shell is:

A. 0
B. Q/ϵ_0
C. $2Q/\epsilon_0$
D. $Q/4\pi\epsilon_0$
E. $Q/2\pi\epsilon_0$

ans: A

26. Charge Q is distributed uniformly throughout a spherical insulating shell. The net electric flux in $N \cdot m^2/C$ through the c

A. 0
B. Q/ϵ_0
C. $2Q/\epsilon_0$
D. $Q/4\epsilon_0$
E. $Q/2\pi\epsilon_0$

ans: B

27. A 3.5-cm radius hemisphere contains a total charge of 6.6×10^{-7} C. The flux through the rounded portion of the surface is $9.8 \times 10^4 \, N \cdot m^2/C$. The flux through the flat base is:

A. 0
B. $+2.3 \times 10^4 \, N \cdot m^2/C$
C. $-2.3 \times 10^4 \, N \cdot m^2/C$
D. $-9.8 \times 10^4 \, N \cdot m^2/C$
E. $+9.8 \times 10^4 \, N \cdot m^2/C$

ans: C

28. Charge is distributed uniformly along a long straight wire. The electric field 2 cm from the wire is 20 N/C. The electric field 4 cm from the wire is:

A. 120 N/C
B. 80 N/C
C. 40 N/C
D. 10 N/C
E. 5 N/C

ans: D

29. Positive charge Q is placed on a conducting spherical shell with inner radius R_1 and outer radius R_2. A particle with charge q is placed at the center of the cavity. The magnitude of the electric field at a point in the cavity, a distance r from the center, is:

A. zero
B. $Q/4\pi\epsilon_0 R_1^2$
C. $q/4\pi\epsilon_0 r^2$
D. $(q+Q)/4\pi\epsilon_0 r^2$
E. $(q+Q)/4\pi\epsilon_0(R_1^2 - r^2)$

ans: C

30. Positive charge Q is placed on a conducting spherical shell with inner radius R_1 and outer radius R_2. A point charge q is placed at the center of the cavity. The magnitude of the electric field at a point outside the shell, a distance r from the center, is:

A. zero
B. $Q/4\pi\epsilon_0 r^2$
C. $q/4\pi\epsilon_0 r^2$
D. $(q+Q)/4\pi\epsilon_0 r^2$
E. $(q+Q)/4\pi\epsilon_0(R_1^2 - r^2)$

ans: D

31. Positive charge Q is placed on a conducting spherical shell with inner radius R_1 and outer radius R_2. A point charge [illegible] tric field produced by the charge on the inner surface at a point in the interior of the conductor, a distance r from the center, is:

A. 0
B. $Q/4v\pi\epsilon_0 R_1^2$
C. $Q/4\pi\epsilon_0 R_2^2$
D. $q/4\pi\epsilon_0 r^2$
E. $Q/4\pi\epsilon_0 r^2$

ans: D

32. A long line of charge with λ_ℓ charge per unit length runs along the cylindrical axis of a cylindrical shell which carries a charge per unit length of λ_c. The charge per unit length on the inner and outer surfaces of the shell, respectively are:

A. λ_ℓ and λ_c
B. $-\lambda_\ell$ and $\lambda_c + \lambda_\ell$
C. $-\lambda_\ell$ and $\lambda_c - \lambda_c$
D. $\lambda_\ell + \lambda_c$ and $\lambda_c - \lambda_\ell$
E. $\lambda_\ell - \lambda_c$ and $\lambda_c + \lambda_\ell$

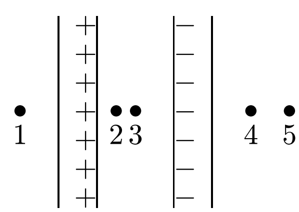
ans: B

33. Charge is distributed uniformly on the surface of a large flat plate. The electric field 2 cm from the plate is 30 N/C. The electric field 4 cm from the plate is:

A. 120 N/C
B. 80 N/C
C. 30 N/C
D. 15 N/C
E. 7.5 N/C

ans: C

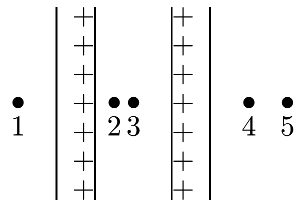
34. Two large insulating parallel plates carry charge of equal magnitude, one positive and the other negative, that is distributed uniformly over their inner surfaces. Rank the points 1 through 5 according to the magnitude of the electric field at the points, least to greatest.



A. 1, 2, 3, 4, 5
B. 2, then 1, 3, and 4 tied, then 5
C. 1, 4, and 5 tie, then 2 and 3 tie
D. 2 and 3 tie, then 1 and 4 tie, then 5
E. 2 and 3 tie, then 1, 4, and 5 tie

ans: C

35. Two large parallel plates carry positive charge of equal magnitude that is distributed uniformly over their inner surfaces. R [illegible] tric field at the points, least to greatest.



A. 1, 2, 3, 4, 5
B. 5, 4, 3, 2, 1
C. 1, 4, and 5 tie, then 2 and 3 tie
D. 2 and 3 tie, then 1 and 4 tie, then 5
E. 2 and 3 tie, then 1, 4, and 5 tie

ans: E

36. A particle with charge Q is placed outside a large neutral conducting sheet. At any point in the interior of the sheet the electric field produced by charges on the surface is directed:

A. toward the surface
B. away from the surface
C. toward Q
D. away from Q
E. none of the above

ans: C

37. A hollow conductor is positively charged. A small uncharged metal ball is lowered by a silk thread through a small opening in the top of the conductor and allowed to touch its inner surface. After the ball is removed, it will have:

A. a positive charge
B. a negative charge
C. no appreciable charge
D. a charge whose sign depends on what part of the inner surface it touched
E. a charge whose sign depends on where the small hole is located in the conductor

ans: C

38. A spherical conducting shell has charge Q. A particle with charge q is placed at the center of the cavity. The charge on the inner surface of the shell and the charge on the outer surface of the shell, respectively, are:

A. 0, Q
B. q, $Q - q$
C. Q, 0
D. $-q$, $Q + q$
E. $-q$, 0

ans: D