UNITED ARAB EMIRATES
MINISTRY OF EDUCATION
الإمارات العربية المتحدة
وزارة التربية والتعليم

2021 - 2022

Final Review

Grade: 12 A

2021-2022 Trimester 1

Name: ______________________________

Class: ______________________________

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2021 - 2022

CH 1 - Electrostatics

Multiple-Choice Questions

1. Which one of the following statements *best* explains why tiny bits of paper are attracted to a charged rubber rod?

Paper is naturally a positive material.

Paper is naturally a negative material.

The paper becomes electrically polarized by induction.

Rubber and paper always attract each other.

The paper acquires a net positive charge by induction.

2. Five styrofoam balls are suspended from insulating threads. Several experiments are performed on the balls; and the following observations are made:

I. Ball A attracts B and A repels C.

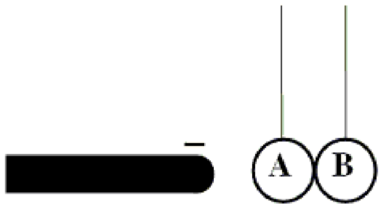
II. Ball D attracts B and D has no effect on E.

III. A negatively charged rod attracts both A and E.

What are the charges, *if any*, on *each* ball?

A	B	C	D	E
+	–	+	0	+
+	–	+	0	0
+	0	–	+	0
+	–	+	+	0
–	+	–	0	0

3. Two uncharged conducting spheres, **A** and **B**, are suspended from insulating threads so that they touch each other. While a negatively charged rod is held *near, but not touching* sphere **A**, someone moves ball B away from A. How will the spheres be charged, *if at all*?



Sphere **A**	*Sphere* **B**
0	+
0	0
+	–
–	+
–	0

4. Each of three objects has a net charge. Objects **A** and **B** attract one another. Objects **B** and **C** also attract one another, but objects **A** and **C** repel one another. Which one of the following table entries is a possible combination of the signs of the net charges on these three objects?

A	**B**	**C**
+	+	–
+	–	–
–	–	+
–	+	+
–	+	–

5. A conducting sphere has a net charge of -6.4×10^{-17} C. What is the approximate number of excess electrons on the sphere?

100
200
300
400
500

6. Complete the following statement: When an ebonite rod is rubbed with animal fur, the rod becomes negatively charged as

positive charges are transferred from the fur to the rod.
negative charges are transferred from the rod to the fur.
negative charges are created on the surface of the rod.
negative charges are transferred from the fur to the rod.
positive charges are transferred from the rod to the fur.

7. Complete the following statement: When a glass rod is rubbed with silk cloth, the rod becomes positively charged as

positive charges are transferred from the silk to the rod.

negative charges are transferred from the rod to the silk.

positive charges are created on the surface of the rod.

negative charges are transferred from the silk to the rod.

positive charges are transferred from the rod to the silk.

8. A charged conductor is brought near an uncharged insulator. Which one of the following statements is true?

Both objects will repel each other.

Both objects will attract each other.

Neither object exerts an electrical force on the other.

The objects will repel each other only if the conductor has a negative charge.

The objects will attract each other only if the conductor has a positive charge.

9. An aluminum nail has an excess charge of +3.2 μC. How many electrons must be added to the nail to make it electrically neutral?

2.0×10^{13}

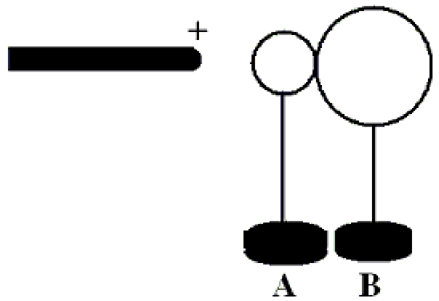
2.0×10^{19}

3.2×10^{16}

3.2×10^{6}

5.0×10^{-14}

10. Two uncharged, conducting spheres, **A** and **B**, are held at rest on insulating stands and are in contact. A positively charged rod is brought near sphere **A** as suggested in the figure. While the rod is in place, someone moves sphere **B** away from **A**. How will the spheres be charged, *if at all*?



Sphere **A**	*Sphere* **B**
positive	positive
negative	positive
zero	Zero
positive	negative
negative	negative

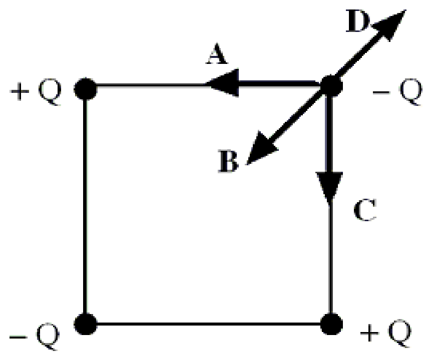
11. Consider three identical metal spheres, **A**, **B**, and **C**. Sphere **A** carries a charge of –2.0 μC; sphere **B** carries a charge of –6.0 μC; and sphere **C** carries a charge of +4.0 μC. Spheres **A** and **B** are touched together and then separated. Spheres **B** and **C** are then touched and separated. Does sphere **C** end up with an excess or a deficiency of electrons and how many electrons is it?

deficiency, 6×10^{13}
excess, 3×10^{13}
excess, 2×10^{13}
deficiency, 3×10^{12}
There is no excess or deficiency of electrons.

12. Two charged particles **A** and **B** are located near one another. Both the *magnitude* and *direction* of the force that particle **A** exerts on particle **B** is *independent* of

the sign of charge **B**.
the sign of charge **A**.
the distance between **A** and **B**.
the magnitude of the charge on **B**.
The magnitude and direction of the force are dependent on all of the above choices.

13. Four point charges, each of the same magnitude, with varying signs are arranged at the corners of a square as shown. Which of the arrows labeled **A**, **B**, **C**, and **D** gives the correct direction of the net force that acts on the charge at the upper right corner?



A
B
C
D
The net force on that charge is zero.

14. Two positive point charges Q and $2Q$ are separated by a distance R. If the charge Q experiences a force of magnitude F when the separation is R, what is the magnitude of the force on the charge $2Q$ when the separation is $2R$?

$F/4$
$F/2$
F
$2F$
$4F$

15. A charge Q exerts a 1.2 N force on another charge q. If the distance between the charges is doubled, what is the magnitude of the force exerted on Q by q?

0.30 N
0.60 N
2.4 N
3.6 N
4.8 N

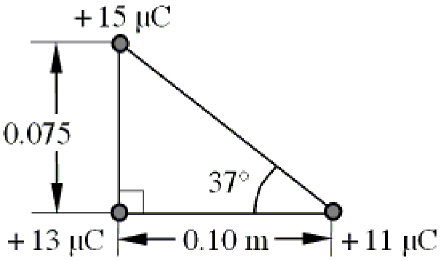
16. At what separation will two charges, each of magnitude 6.0 µC, exert a force of 0.70 N on each other?

1.1×10^{-5} m
0.23 m
0.48 m
0.68 m
1.4 m

17. One mole of a substance contains 6.02×10^{23} protons and an equal number of electrons. If the protons could somehow be separated from the electrons and placed in very small, individual containers separated by a million meters, what would be the magnitude of the electrostatic force exerted by one box on the other?

8.7×10^{3} N
9.5×10^{4} N
2.2×10^{5} N
8.4×10^{7} N
1.6×10^{8} N

18. Three charges are positioned as indicated in the figure. What are the horizontal and vertical components of the net force exerted on the +15 µC charge by the +11 µC and +13 µC charges?



horizontal	*vertical*
95 N	310 N
250 N	130 N
76 N	370 N
76 N	310 N
95 N	130 N

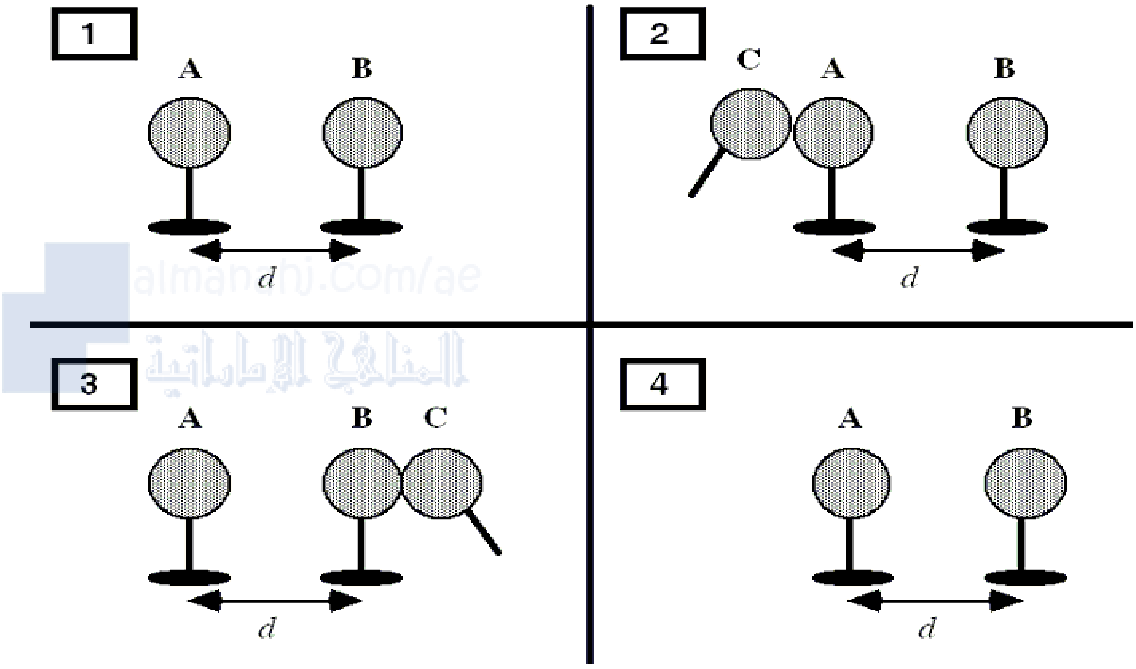
19. A –4.0-µC charge is located 0.45 m to the left of a +6.0-µC charge. What is the magnitude and direction of the electrostatic force on the positive charge?

2.2 N, to the right
2.2 N, to the left
1.1 N, to the right
1.1 N, to the left
4.4 N, to the right

20. Determine the ratio of the electrostatic force to the gravitational force between a proton and an electron, F_E/F_G. **Note**: $k = 8.99 \times 10^{9}$ N-m^2/C^2; $G = 6.672 \times 10^{-11}$ N-m^2/kg^2; $m_e = 9.109 \times 10^{-31}$ kg; and $m_p = 1.672 \times 10^{-27}$ kg.

1.24×10^{23}
2.52×10^{29}
1.15×10^{31}
2.26×10^{39}
1.42×10^{58}

21. In Frame **1**, two identical conducting spheres, **A** and **B**, carry equal amounts of excess charge that have the same sign. The spheres are separated by a distance *d*; and sphere **A** exerts an electrostatic force on sphere B that has a magnitude *F*. A third sphere, **C**, which is handled only by an insulating rod, is introduced in Frame **2**. Sphere **C** is identical to **A** and **B** except that it is *initially uncharged*. Sphere **C** is touched first to sphere **A**, in Frame **2**, and then to sphere **B**, in Frame **3**, and is finally removed in Frame **4**.



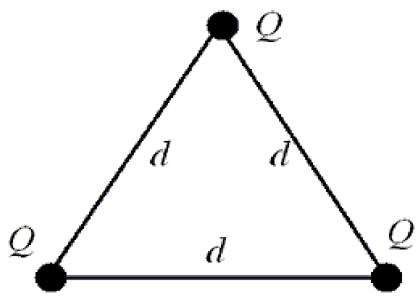
Determine the magnitude of the electrostatic force that sphere **A** exerts on sphere **B** in Frame **4**.

$F/2$ $F/3$

$3F/4$ $3F/8$

zero

22. Three identical point charges, *Q*, are placed at the vertices of an equilateral triangle as shown in the figure. The length of each side of the triangle is *d*. Determine the magnitude and direction of the total electrostatic force on the charge at the top of the triangle.

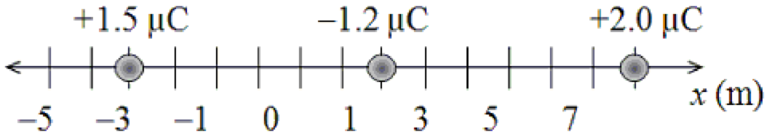


directed upward directed downward

directed upward directed downward

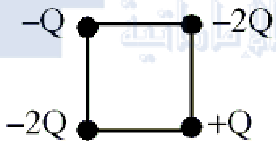
zero

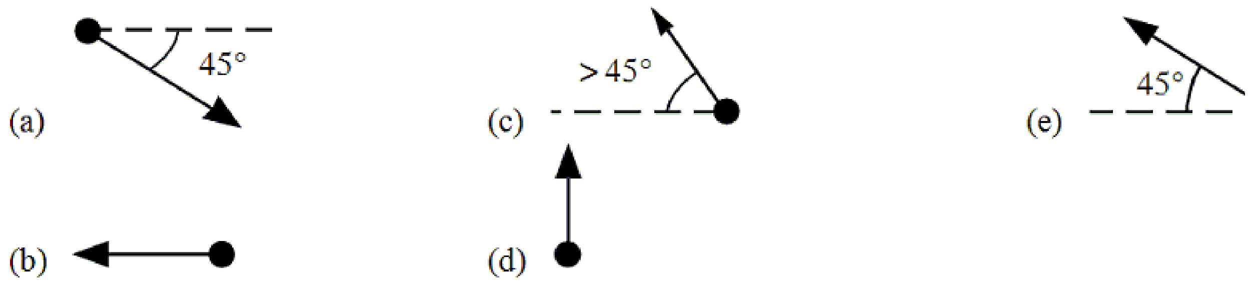
23. Three charges are located along the *x* axis as shown in the drawing. The mass of the –1.2 μC is 4.0×10^{-9} kg. Determine the magnitude and direction of the acceleration of the –1.2 μC charge when it is allowed to move if the other two charges remain fixed.



2×10^5 m/s^2, to the right
1×10^5 m/s^2, to the left
7×10^4 m/s^2, to the right
3×10^5 m/s^2, to the left
4×10^6 m/s^2, to the right

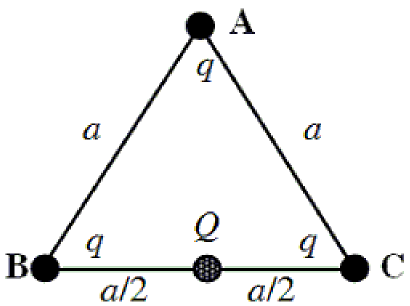
24. Four point charges are held fixed at the corners of a square as shown in the figure. Which of the five arrows shown below most accurately shows the direction of the net force on the charge –Q due to the presence of the three other charges?





a
b
c
d
e

25. The figure shows an equilateral triangle **ABC**. A positive point charge +*q* is located at each of the three vertices **A**, **B**, and **C**. Each side of the triangle is of length *a*. A point charge *Q* (that may be positive or negative) is placed at the mid-point between **B** and **C**.



Is it possible to choose the value of *Q* (*that is non-zero*) such that the force on *Q* is zero? Explain why or why not.

Yes, because the forces on *Q* are vectors and three vectors can add to zero.

No, because the forces on *Q* are vectors and three vectors can never add to zero.

Yes, because the electric force at the mid-point between **B** and **C** is zero whether a charge is placed there or not.

No, because the forces on *Q* due to the charges at **B** and **C** point in the same direction.

No, because a fourth charge would be needed to cancel the force on *Q* due to the charge at **A**.

26. Is it possible for two negative charges to attract each other?

Yes, they always attract.

Yes, they will attract if they are close enough.

Yes, they will attract if one carries a larger charge than the other.

No, they will never attract.

27. Is it possible for a positive and a negative charge to attract each other?

Yes, they always attract.

Yes, they will attract if they are close enough.

Yes, they will attract if one carries a larger charge than the other.

No, they will never attract.

28. A glass rod is rubbed with a piece of silk. During the process the glass rod acquires a positive charge and the silk

acquires a positive charge also.

acquires a negative charge.

remains neutral.

could either be positively charged or negatively charged. It depends on how hard the rod was rubbed.

29. A proton carries a

positive charge.

neutral charge.

negative charge.

variable charge.

30. An atom has more electrons than protons. The atom is

a positive ion

a negative ion

a superconductor

impossible

31. Materials in which the electrons are bound very tightly to the nuclei are referred to as

insulators.

conductors.

semiconductors.

superconductors.

32. Materials in which the electrons are bound very loosely to the nuclei and can move about freely within the material are referred to as

insulators. conductors.

semiconductors. superconductors.

33. A negatively charged rod is brought near one end of an uncharged metal bar. The end of the metal bar farthest from the charged rod will be charged

positive negative

neutral none of the given answers

34. Sphere A carries a net positive charge, and sphere B is neutral. They are placed near each other on an insulated table. Sphere B is briefly touched with a wire that is grounded. Which statement is correct?

Sphere B remains neutral

Sphere B is now positively charged

Sphere B is now negatively charged

The charge on sphere B cannot be determined without additional information

35. How can a negatively charged rod charge an electroscope positively?

by conduction by induction

by deduction It cannot

36. An originally neutral electroscope is briefly touched with a positively charged glass rod. The electroscope

remains neutral

becomes negatively charged

becomes positively charged

could become either positively or negatively charged, depending on the time of contact

37. An originally neutral electroscope is grounded briefly while a positively charged glass rod is held near it. After the glass rod is removed, the electroscope

remains neutral

is negatively charged

is positively charged

could be either positively or negatively charged, depending on how long the contact with ground lasted

38. A positive object touches a neutral electroscope, and the leaves separate. Then a negative object is brought near the electroscope, but does not touch it. What happens to the leaves?

They separate further

They move closer together

They are unaffected

cannot be determined without further information

39. A large negatively charged object is placed on an insulated table. A neutral metallic ball rolls straight toward the object, but stops before it touches it. A second neutral metallic ball rolls along the path followed by the first ball, strikes the first ball, and stops. The first ball rolls forward, but does not touch the negative object. At no time does either ball touch the negative object. What is the final charge on each ball?

The first ball is positive, and the second ball is negative

The first ball is negative, and the second ball is positive

Both balls remain neutral

Both balls are positive

40. Charge is

quantized

conserved

invariant

all of the given answers

41. What are the units of the Coulomb constant k, which appears in Coulomb's law?

$N.m/C$

N/C

$N^2.m/C^2$

$N.m^2/C^2$

42. Two charged objects are separated by a distance d. The first charge is larger in magnitude than the second charge

The first charge exerts a larger force on the second charge

The second charge exerts a larger force on the first charge

The charges exert forces on each other equal in magnitude and opposite in direction

The charges exert forces on each other equal in magnitude and pointing in the same direction

43. Sphere A carries a net charge and sphere B is neutral. They are placed near each other on an insulated table. Which statement best describes the electrostatic force between them?

There is no force between them since one is neutral

There is a force of repulsion between them

There is a force of attraction between them

The force is attractive if A is charged positively and repulsive if A is charged negatively

44. Two charged objects attract each other with a certain force. If the charges on both objects are doubled with no change in separation, the force between them

quadruples

doubles

halves

increases, but we can't say how much without knowing the distance between them

45. Two charges are separated by a distance d and exert mutual attractive forces of F on each other. If the charges are separated by a distance of d/3, what are the new mutual forces?

F/9 F/3

3F 9F

46. Two charged objects attract each other with a force F. What happens to the force between them if one charge is doubled, the other charge is tripled, and the separation distance between their centers is reduced to one-fourth its original value? The force is now equal to

16F 24F

(3/8)F 96F

47. An electron and a proton are separated by a distance of 1.0 m. What happens to the magnitude of the force on the proton if a second electron is placed next to the first electron?

It quadruples It doubles

It will not change It goes to zero

48. An electron and a proton are separated by a distance of 1.0 m. What happens to the magnitude of the force on the first electron if a second electron is placed next to the proton?

It doubles It does not change

It is reduced to half It becomes zero

49. An electron and a proton are separated by a distance of 1.0 m. What happens to the size of the force on the proton if the electron is moved 0.50 m closer to the proton?

It increases to 4 times its original value

It increases to 2 times its original value

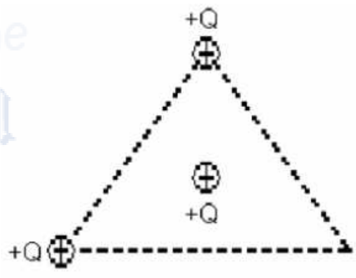
It decreases to one-half its original value

It decreases to one-fourth its original value

50. A point charge of +Q is placed at the center of a square. When a second point charge of -Q is placed at one of the square's corners, it is observed that an electrostatic force of 2.0 N acts on the positive charge at the square's center. Now, identical charges of -Q are placed at the other three corners of the square. What is the magnitude of the net electrostatic force acting on the positive charge at the center of the square?

zero
2.8 N
4.0 N
8.0 N

51. A point charge of +Q is placed at the centroid of an equilateral triangle. When a second charge of +Q is placed at one of the triangle's vertices, an electrostatic force of 4.0 N acts on it. What is the magnitude of the force that acts on the center charge due to a third charge of +Q placed at one of the other vertices?



zero
4.0 N
8.0 N
16 N

52. A coulomb is the same as:

an ampere/second
half an ampere·second^2
an ampere/meter^2
an ampere·second
a newton·meter^2

53. A kiloampere·hour is a unit of:

current
charge per time
power
charge
energy

54. The magnitude of the charge on an electron is approximately:

10^{23} C
10^{-23} C
10^{19} C
10^{-19} C
10^{9} C

55. The total negative charge on the electrons in 1 mol of helium (atomic number 2, molar mass 4) is:

4.8×10^4 C
9.6×10^4 C
1.9×10^5 C
3.8×10^5 C
7.7×10^5 C

56. The total negative charge on the electrons in 1 kg of helium (atomic number 2, molar mass 4) is:

48C
2.4×10^7 C
4.8×10^7 C
9.6×10^8 C
1.9×10^8 C

57. A wire carries a steady current of 2 A. The charge that passes a cross section in 2 s is:

3.2×10^{-19} C
6.4×10^{-19} C
1C
2C
4C

58. A wire contains a steady current of 2 A. The number of electrons that pass a cross section in 2 s is:

2
4
6.3×10^{18}
1.3×10^{19}
2.5×10^{19}

59. The charge on a glass rod that has been rubbed with silk is called positive:

by arbitrary convention
so that the proton charge will be positive
to conform to the conventions adopted for G and m in Newton's law of gravitation
because like charges repel
because glass is an insulator

60. To make an uncharged object have a negative charge we must:

add some atoms
remove some atoms
add some electrons
remove some electrons
write down a negative sign

61. To make an uncharged object have a positive charge:

remove some neutrons
add some neutrons
add some electrons
remove some electrons
heat it to cause a change of phase

62. When a hard rubber rod is given a negative charge by rubbing it with wool:

positive charges are transferred from rod to wool
negative charges are transferred from rod to wool
positive charges are transferred from wool to rod
negative charges are transferred from wool to rod
negative charges are created and stored on the rod

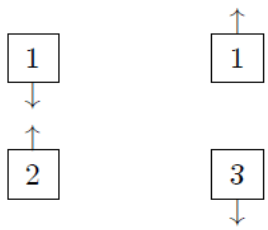
63. An electrical insulator is a material:

containing no electrons
through which electrons do not flow easily
that has more electrons than protons on its surface
cannot be a pure chemical element
must be a crystal

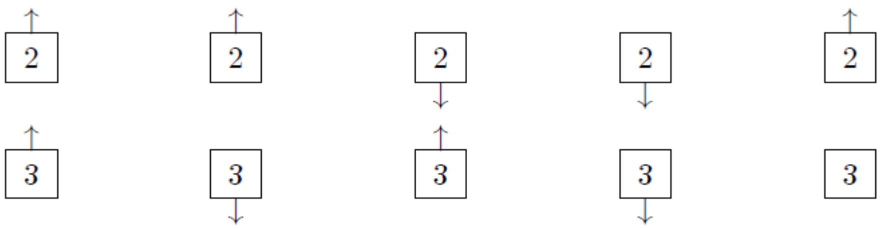
64. A conductor is distinguished from an insulator with the same number of atoms by the number of:

nearly free atoms
nearly free electrons
molecules
electrons
protons

65. The diagram shows two pairs of heavily charged plastic cubes. Cubes 1 and 2 attract e
other and cubes 1 and 3 repel each other.

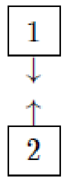


Which of the following illustrates the forces of cube 2 on cube 3 and cube 3 on cube 2?

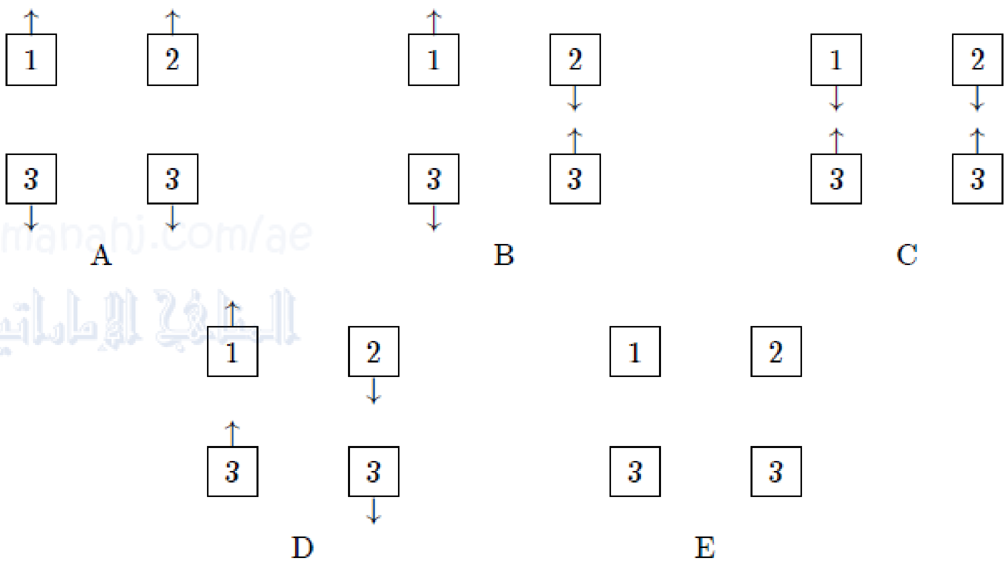


A B C D E

66. The diagram shows a pair of heavily charged plastic cubes that attract each other.



Cube 3 is a conductor and is uncharged. Which of the following illustrates the forces betwee cubes 1 and 3 and between cubes 2 and 3?



67. A neutral metal ball is suspended by a string. A positively charged insulating rod is placed
near the ball, which is observed to be attracted to the rod. This is because:

the ball becomes positively charged by induction

the ball becomes negatively charged by induction

the number of electrons in the ball is more than the number in the rod

the string is not a perfect insulator

there is a rearrangement of the electrons in the ball

68. A positively charged insulating rod is brought close to an object that is suspended by a string. If the object is attracted toward the rod we can conclude:

the object is positively charged

the object is negatively charged

the object is an insulator

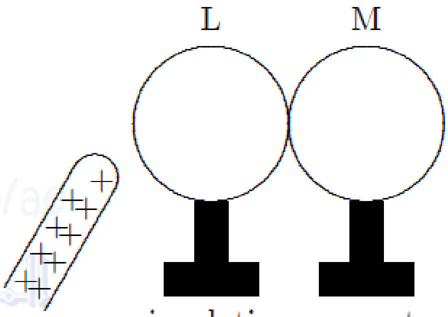
the object is a conductor

none of the above

69. A positively charged insulating rod is brought close to an object that is suspended by a string. If the object is repelled away from the rod we can conclude:

the object is positively charged
the object is negatively charged
the object is an insulator
the object is a conductor
none of the above

70. Two uncharged metal spheres, L and M, are in contact. A negatively charged rod is brought close to L, but not touching it, as shown. The two spheres are slightly separated and the rod is then withdrawn. As a result:



both spheres are neutral
both spheres are positive
both spheres are negative
L is negative and M is positive
L is positive and M is negative

71. A positively charged metal sphere A is brought into contact with an uncharged metal sphere B. As a result:

both spheres are positively charged
A is positively charged and B is neutral
A is positively charged and B is negatively charged
A is neutral and B is positively charged
A is neutral and B is negatively charged

72. The leaves of a positively charged electroscope diverge more when an object is brought near the knob of the electroscope. The object must be:

a conductor
an insulator
positively charged
negatively charged
uncharged

73. A negatively charged rubber rod is brought near the knob of a positively charged electroscope. The result is that:

the electroscope leaves will move farther apart
the rod will lose its charge
the electroscope leaves will tend to collapse
the electroscope will become discharged
nothing noticeable will happen

74. An electroscope is charged by induction using a glass rod that has been made positive by rubbing it with silk. The electroscope leaves:

gain electrons
gain protons
lose electrons
lose protons
gain an equal number of protons and electrons

75. Consider the following procedural steps:
1. ground an electroscope
2. remove the ground from the electroscope
3. touch a charged rod to the electroscope
4. bring a charged rod near, but not touching, the electroscope
5. remove the charged rod

To charge an electroscope by induction, use the sequence:

1, 4, 5, 2
4, 1, 2, 5
3, 1, 2, 5
4, 1, 5, 2
3, 5

76. A small object has charge Q. Charge q is removed from it and placed on a second small object. The two objects are placed 1m apart. For the force that each object exerts on the other to be a maximum. q should be:

2Q
Q
Q/2
Q/4
0

77. Two small charged objects attract each other with a force F when separated by a distance d. If the charge on each object is reduced to one-fourth of its original value and the distance between them is reduced to d/2 the force becomes:

F/16
F/8
F/4
F/2
F

78. Two identical conducting spheres A and B carry equal charge. They are separated by a distance much larger than their diameters. A third identical conducting sphere C is uncharged. Sphere C is first touched to A, then to B, and finally removed. As a result, the electrostatic force between A and B, which was originally F, becomes:

F/2
F/4
3F/8
F/16
0

79. Two particles, X and Y, are 4m apart. X has a charge of 2Q and Y has a charge of Q. The force of X on Y:

has twice the magnitude of the force of Y on X

has half the magnitude of the force of Y on X

has four times the magnitude of the force of Y on X

has one-fourth the magnitude of the force of Y on X

has the same magnitude as the force of Y on X

80. The units of $1/4\pi\epsilon_0$ are:

N^2C^2 | $N \cdot m/C$

$N^2 \cdot m^2/C^2$ | $N \cdot m^2/C^2$

m^2/C^2

81. A 5.0-C charge is 10m from a −2.0-C charge. The electrostatic force on the positive charge is:

9.0×10^8 N toward the negative charge

9.0×10^8 N away from the negative charge

9.0×10^9 N toward the negative charge

9.0×10^9 N away from the negative charge

none of these

82. Two identical charges, 2.0m apart, exert forces of magnitude 4.0N on each other. The value of either charge is:

1.8×10^{-9} C

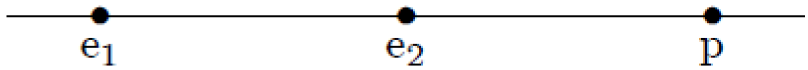
2.1×10^{-5} C

4.2×10^{-5} C

1.9×10^5 C

3.8×10^5 C

83. Two electrons (e1 and e2) and a proton (p) lie on a straight line, as shown. The directions of the force of e2 on e1, the force of p on e1, and the total force on e1, respectively, are:



−→, ←−, −→

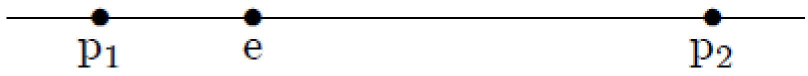
←−, −→, −→

−→, ←−, ←−

←−, −→, ←−

←−, ←−, ←−

84. Two protons (p1 and p2) and an electron (e) lie on a straight line, as shown. The directions of the force of p1 on e, the force of p2 on e, and the total force on e, respectively, are:



−→, ←−, −→

←−, −→, −→

−→, ←−, ←−

←−, −→, ←−

←−, ←−, ←−

85. Two particles have charges Q and −Q (equal magnitude and opposite sign). For a net force of zero to be exerted on a third charge it must be placed:

midway between Q and −Q

on the perpendicular bisector of the line joining Q and −Q, but not on that line itself

on the line joining Q and −Q, to the side of Q opposite −Q

on the line joining Q and −Q, to the side of −Q opposite Q

at none of these places (there is no place)

86. Particles 1, with charge q1, and 2, with charge q2, are on the x axis, with particle 1 at x = a, and particle 2 at x = −2a. For the net force on a third charged particle, at the origin, to be zero, q1 and q2 must be related by q2 =:

$2q_1$

$4q_1$

$-2q_1$

$-4q_1$

$-q_1/4$

87. Two particles A and B have identical charge Q. For a net force of zero to be exerted on a third charged particle it must be placed:

midway between A and B

on the perpendicular bisector of the line joining A and B but away from the line

on the line joining A and B, not between the particles

on the line joining A and B, closer to one of them than the other

at none of these places (there is no place)

88. A particle with charge 2-μC is placed at the origin, an identical particle, with the same charge, is placed 2m from the origin on the x axis, and a third identical particle, with the same charge, is placed 2m from the origin on the y axis. The magnitude of the force on the particle at the origin is:

9.0×10^{-3} N

6.4×10^{-3} N

1.3×10^{-2} N

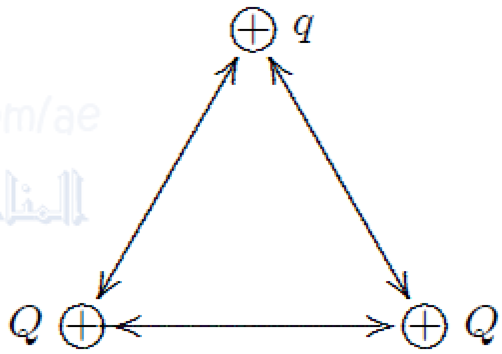
1.8×10^{-2} N

3.6×10^{-2} N

89. Charge Q is spread uniformly along the circumference of a circle of radius R. A point particle with charge q is placed at the center of this circle. The total force exerted on the particle can be calculated by Coulomb's law:

just use R for the distance
just use 2R for the distance
just use 2πR for the distance
the result of the calculation is zero
none of the above

90. Two particles, each with charge Q, and a third particle, with charge q, are placed at the vertices of an equilateral triangle as shown. The total force on the particle with charge q is:



parallel to the left side of the triangle
parallel to the right side of the triangle
parallel to the bottom side of the triangle
perpendicular to the bottom side of the triangle
perpendicular to the left side of the triangle

91. A particle with charge Q is on the y axis a distance a from the origin and a particle with charge q is on the x axis a distance d from the origin. The value of d for which the x component of the force on the second particle is the greatest is:

0
a
$\sqrt{2}a$
a/2
$a/\sqrt{2}$

92. In the Rutherford model of the hydrogen atom, a proton (mass M, charge Q) is the nucleus and an electron (mass m, charge q) moves around the proton in a circle of radius r. Let k denote the Coulomb force constant (1/4π€0) and G the universal gravitational constant. The ratio of the electrostatic force to the gravitational force between electron and proton is:

$kQq/GMmr^2$
GQq/kMm
kMm/GQq
GMm/kQq
kQq/GMm

93. A particle with a charge of 5×10^{-6} C and a mass of 20 g moves uniformly with a speed of 7m/s in a circular orbit around a stationary particle with a charge of -5×10^{-6} C. The radius of the orbit is:

0
0.23m
0.62m
1.6
4.4m

94. Charge is distributed uniformly on the surface of a spherical balloon (an insulator). A point particle with charge q is inside. The electrical force on the particle is greatest when:

it is near the inside surface of the balloon
it is at the center of the balloon
it is halfway between the balloon center and the inside surface
it is anywhere inside (the force is same everywhere and is not zero)
it is anywhere inside (the force is zero everywhere)

95. Charge is distributed on the surface of a spherical conducting shell. A point particle with charge q is inside. If polarization effects are negligible the electrical force on the particle is greatest when:

it is near the inside surface of the balloon
it is at the center of the balloon
it is halfway between the balloon center and the inside surface
it is anywhere inside (the force is same everywhere and is not zero)
it is anywhere inside (the force is zero everywhere)

96. Which one of these systems has the most negative charge?

2 electrons
3 electrons and 1 proton
5 electrons and 5 protons
N electrons and N-3 protons
1 electron

97. Two lightweight metal spheres are suspended near each other from insulating threads. One sphere has a net charge; the other sphere has no net charge. The spheres will:

Attract each other
Exert no net electrostatic force on each other
Repel each other
Doing any of these things depending on the sign of the charge on the one sphere

98. If an object is charged with a negative electrical charge, its charge can be equivalent to a charge:

+ 3 e
- 3 e
+ 1.6 e
- 1.6 e

99. The electric charge (+ 2 C) is equivalent to a charge:

- $1.25 \text{x}\ 10^{19}$ protons
- $1.25 \text{x}\ 10^{19}$ electrons
- 2 electrons
- 2 protons

Exercises

1. State the law of conservation of electric charge.

2. An object with ($-1.28\ n\,C$) net charge . What is The number of electrons it loses or acquires to become its charge (+ $2.00\ n\,C$)
Is the object lose or gain electrons ?

3. Two conductive and identical balls . one of them has (+ $7.90\ n\,C$) net charge and the other has (+ $1.50\ n\,C$) The two balls touched and then separated

➢ What charge both of them after touching ?
➢ Calculate the number of electrons that moved ?

4. Whichever is considered to be evidence that one object is charged . attracted to another object or repulsion ? Explain your answer

5. The rounded rod is charged to a small plastic balls drawn some balls for the rod then rushed away in different directions after touching the rod. Explain why?

....

....

....

....

....

CH 2 - Electric Fields and Gauss's Law

Multiple-Choice Questions

1. Which one of the following statements is true concerning the magnitude of the electric field at a point in space?

It is a measure of the total charge on the object.
It is a measure of the electric force on any charged object.
It is a measure of the ratio of the charge on an object to its mass.
It is a measure of the electric force per unit mass on a test charge.
It is a measure of the electric force per unit charge on a test charge.

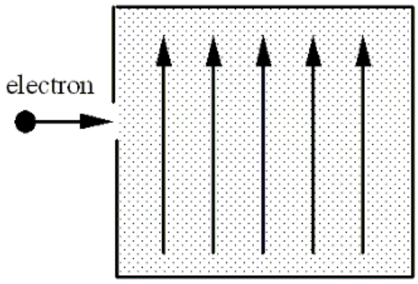
2. In the figure, point **A** is a distance *L* away from a point charge *Q*. Point **B** is a distance 4*L* away from *Q*. What is the ratio of the electric field at **B** to that at **A**, E_B/E_A?

1/16 1/9
1/4 1/3
This cannot be determined since neither the value of *Q* nor the length *L* is specified.

3. At which point (or points) is the electric field zero N/C for the two point charges shown on the *x* axis?

The electric field is never zero in the vicinity of these charges.
The electric field is zero somewhere on the *x* axis to the left of the +4*q* charge.
The electric field is zero somewhere on the *x* axis to the right of the –2*q* charge.
The electric field is zero somewhere on the *x* axis between the two charges, but this point is nearer to the –2*q* charge.
The electric field is zero at two points along the *x* axis; one such point is to the right of the –2*q* charge and the other is to the left of the +4*q* charge.

4. An electron traveling horizontally enters a region where a uniform electric field is directed upward. What is the direction of the force exerted on the electron once it has entered the field?

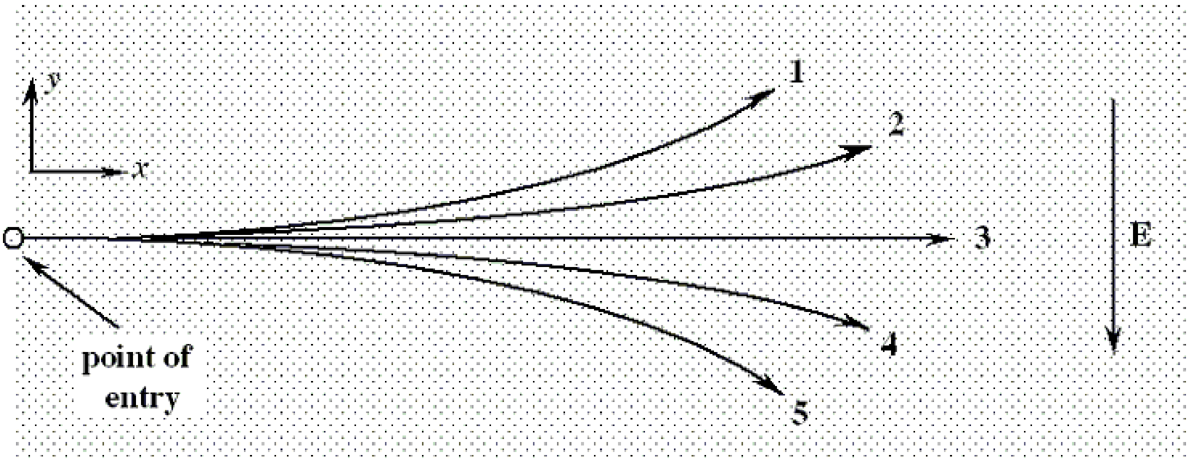


to the left
to the right
upward
downward
out of the page, toward the reader

5. Which one of the following statements is true concerning the strength of the electric field between two oppositely charged parallel plates?

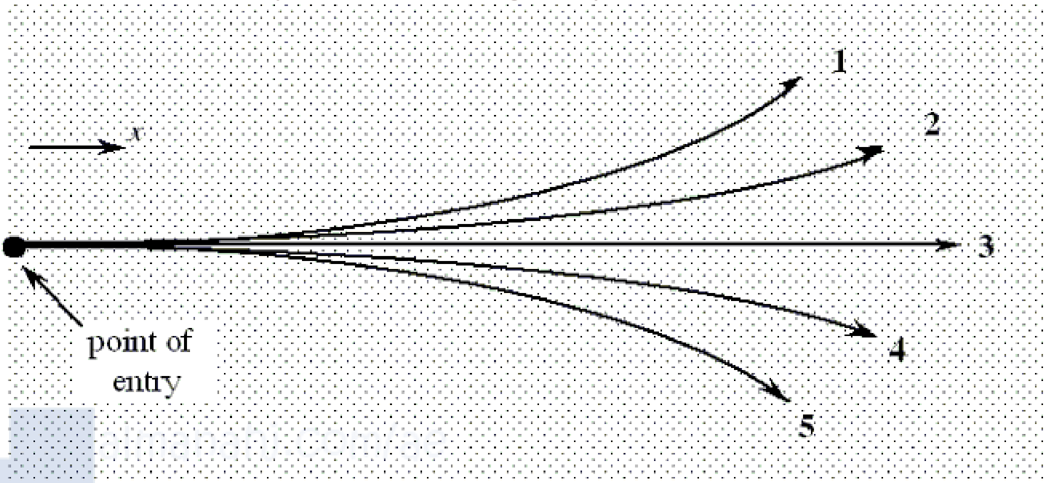
It is zero midway between the plates.
It is a maximum midway between the plates.
It is a maximum near the positively charged plate.
It is a maximum near the negatively charged plate.
It is constant between the plates except near the edges.

6. Two particles of the same mass carry charges +3*Q* and –2*Q*, respectively. They are shot into a region that contains a uniform electric field as shown. The particles have the same initial velocities in the positive *x* direction. The lines, numbered 1 through 5, indicate possible paths for the particles. If the electric field points in the negative *y* direction, what will be the resulting paths for these particles?



path **1** for +3*Q* and path **4** for –2*Q*
path **3** for +3*Q* and path **2** for –2*Q*
path **4** for +3*Q* and path **3** for –2*Q*
path **2** for +3Q and path **5** for –2Q
path **5** for +3Q and path **2** for –2Q

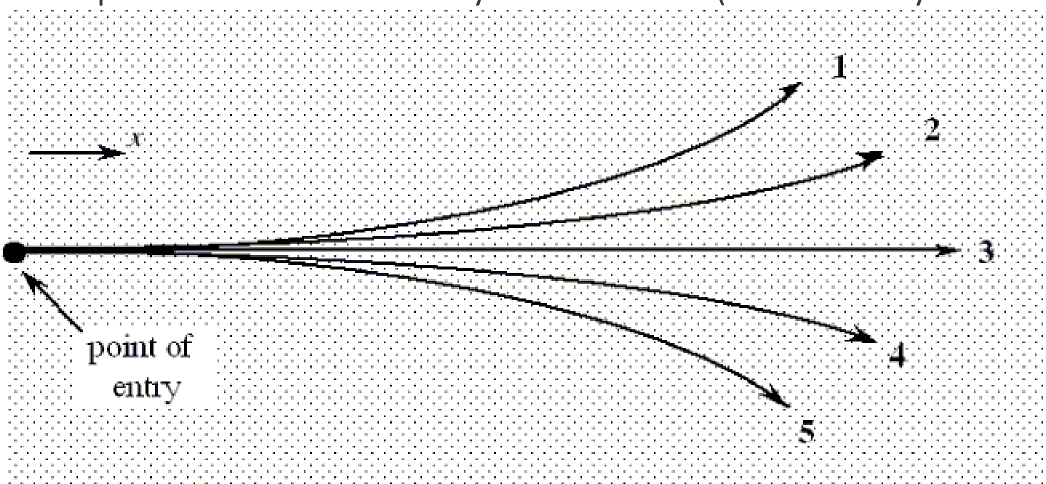
7. Five particles are shot from the left into a region that contains a uniform electric field. The numbered lines show the paths taken by the five particles. A negatively charged particle with a charge –3*Q* follows path **2** while it moves through this field. Do not consider any effects due to gravity.



In which direction does the electric field point?

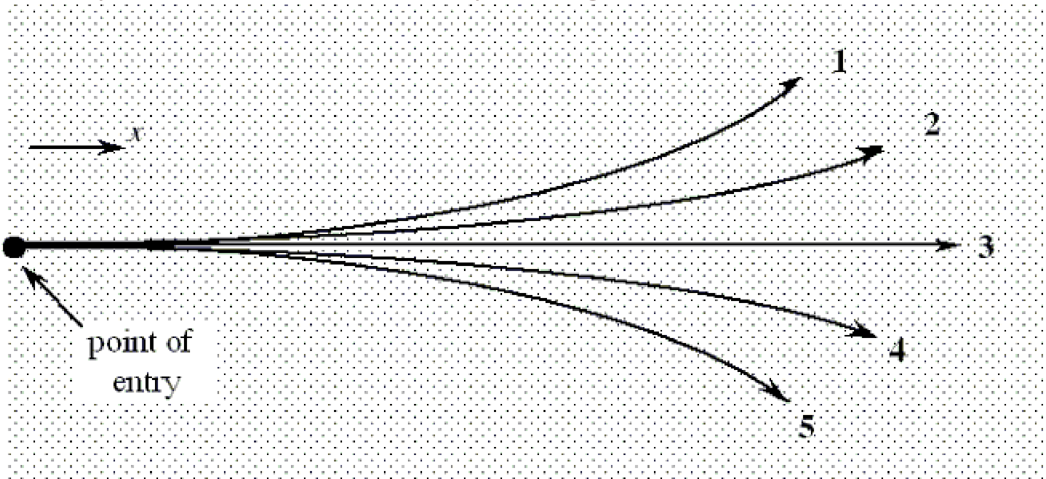
A) toward the top of the page
B) toward the left of the page
C) toward the right of the page
D) toward the bottom of the page
E) out of the page, toward the reader

8. Which path would be followed by a helium atom (an electrically neutral particle)?



A) path **1**
B) path **2**
C) path **3**
D) path **4**
E) path **5**

9. Which path would be followed by a charge +6Q?

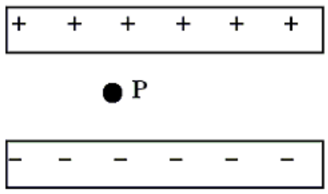


path **1**
path **2**
path **3**
path **4**
path **5**

10. What is the magnitude of the electric field due to a 6.0×10^{-9} C charge at a point located 0.025 m from the charge?

8.6×10^2 N/C
1.2×10^4 N/C
1.8×10^5 N/C
3.6×10^6 N/C
7.2×10^7 N/C

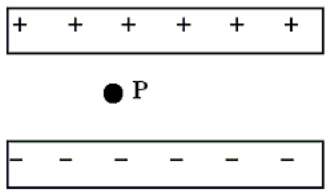
11. The figure shows a parallel plate capacitor. The surface charge density on each plate is 8.8×10^{-8} C/m^2. The point **P** is located 1.0×10^{-5} m away from the positive plate.



Which one of the following statements concerning the direction of the electric field between the plates is true?

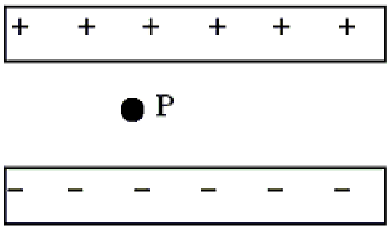
It points to the left.
It points to the right.
It points toward the negative plate.
It points toward the positive plate.
It points up out of the plane of the page.

12. What is the magnitude of the electric field at the point **P**?



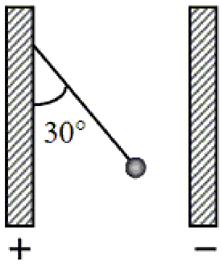
8.8 N/C
88 N/C
1.0×10^2 N/ C
8.8×10^2 N/C
9.9×10^3 N/C

13. If a $+2.0 \times 10^{-5}$ C point charge is placed at **P**, what is the force exerted on it?



0.2 N, toward the negative plate
0.2 N, toward the positive plate
5×10^{4} N, toward the positive plate
5×10^{4} N, toward the negative plate
5×10^{4} N, into the plane of the page

14. A small sphere of mass 2.5×10^{-5} kg carries a total charge of 6.0×10^{-8} C. The sphere hangs from a silk thread between two large parallel conducting plates. The excess charge on each plate is equal in magnitude, but opposite in sign. If the thread makes an angle of 30° with the positive plate as shown, what is the magnitude of the charge density on each plate?

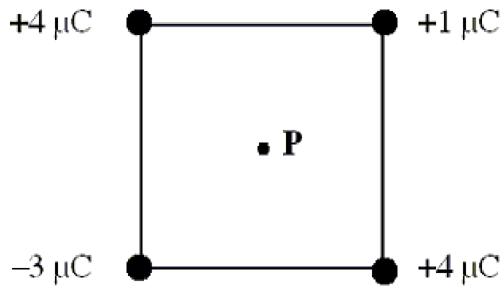


2.5×10^{-9} C/m^2
1.0×10^{-9} C/m^2
4.2×10^{-8} C/m^2
5.2×10^{-9} C/m^2
2.1×10^{-8} C/m^2

15. Complete the following statement: The magnitude of the electric field at a point in space does *not* depend upon

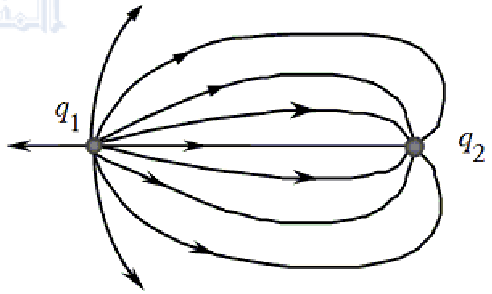
the distance from the charge causing the field.
the sign of the charge causing the field.
the magnitude of the charge causing the field.
the force that a unit positive charge will experience at that point.
the force that a unit negative charge will experience at that point.

16. Four point charges are placed at the corners of a square as shown in the figure. Each side of the square has length 2.0 m. Determine the magnitude of the electric field at the point **P**, the center of the square.



2.0×10^{-6} N/C
3.0×10^{-6} N/C
9.0×10^{3} N/C
1.8×10^{4} N/C
2.7×10^{4} N/C

17. The figure shows the electric field lines in the vicinity of two point charges. Which one of the following statements concerning this situation is true?



q_1 is negative and q_2 is positive.
The magnitude of the ratio (q_2/ q_1) is less than one.
Both q_1 and q_2 have the same sign of charge.
The magnitude of the electric field is the same everywhere.
The electric field is strongest midway between the charges.

18. Which one of the following statements is true concerning the electrostatic charge on a conductor?

The charge is uniformly distributed throughout the volume.
The charge is confined to the surface and is uniformly distributed.
Most of the charge is on the outer surface, but it is not uniformly distributed.
The charge is entirely on the surface and it is distributed according to the shape of the object.
The charge is dispersed throughout the volume of the object and distributed according to the object's shape.

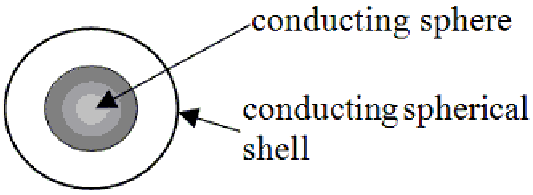
19. The magnitude of the electric field at a distance of two meters from a negative point charge is E. What is the magnitude of the electric field at the same location if the magnitude of the charge is doubled?

$E/4$
$E/2$
E
$2E$
$4E$

20. What is the magnitude and direction of the electric force on a –3.0 μC charge at a point where the electric field is 2800 N/C and is directed along the +*y* axis.

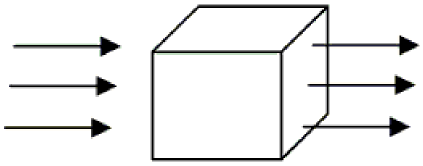
0.018 N, –*y* direction
0.012 N, +*y* direction
0.0084 N, –*y* direction
0.0056 N, +*y* direction
0.022 N, +*x* direction

21. A conducting sphere carries a net charge of +6 μC. The sphere is located at the center of a conducting spherical shell that carries a net charge of –2 μC. Determine the excess charge on the outer surface of the spherical shell.



–4 μC
+4 μC
–8 μC
+8 μC
+6 μC

22. A cubical Gaussian surface is placed in a uniform electric field as shown in the figure. The length of each edge of the cube is 1.0 m. The uniform electric field has a magnitude of 5.0×10^8 N/C and passes through the left and right sides of the cube perpendicular to the surface. What is the total electric flux that passes through the cubical Gaussian surface?



5.0×10^8 N×m^2/C
3.0×10^9 N×m^2/C
2.5×10^6 N×m^2/C
1.5×10^7 N×m^2/C
zero N×m^2/C

23. What is the electric flux passing through a Gaussian surface that surrounds a +0.075 C point charge?

8.5×10^9 N×m^2/C
6.8×10^8 N×m^2/C
1.3×10^7 N×m^2/C
4.9×10^6 N×m^2/C
7.2×10^5 N×m^2/C

24. A uniform electric field with a magnitude of 125 000 N/C passes through a rectangle with sides of 2.50 m and 5.00 m. The angle between the electric field vector and the vector normal to the rectangular plane is 65.0°. What is the electric flux through the rectangle?

1.56×10^6 N×m^2/C
6.60×10^5 N×m^2/C
1.42×10^5 N×m^2/C
5.49×10^4 N×m^2/C
4.23×10^4 N×m^2/C

25. A straight, copper wire has a length of 0.50 m and an excess charge of -1.0×10^{-5} C distributed uniformly along its length. Find the magnitude of the electric field at a point located 7.5×10^{-3} m from the midpoint of the wire.

1.9×10^{10} N/C
1.5×10^{6} N/C
6.1×10^{13} N/C
7.3×10^{8} N/C
4.8×10^{7} N/C

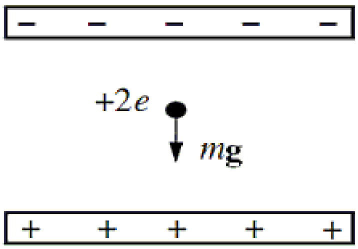
26. A total charge of -6.50 μC is uniformly distributed within a sphere that has a radius of 0.150 m. What is the magnitude and direction of the electric field at 0.300 m from the surface of the sphere?

2.89×10^{5} N/C, radially inward
6.49×10^{5} N/C, radially outward
4.69×10^{5} N/C, radially inward
9.38×10^{5} N/C, radially outward
1.30×10^{6} N/C, radially inward

27. A circular loop of wire with a diameter of 0.626 m is rotated in a uniform electric field to a position where the electric flux through the loop is a maximum. At this position, the electric flux is 7.50×10^{5} N×m^2/C. Determine the magnitude of the electric field.

8.88×10^{5} N/C
1.07×10^{6} N/C
2.44×10^{6} N/C
4.24×10^{6} N/C
6.00×10^{6} N/C

28. A helium nucleus is located between the plates of a parallel-plate capacitor as shown. The nucleus has a charge of +2e and a mass of 6.6×10^{-27} kg. What is the magnitude of the electric field such that the electric force exactly balances the weight of the helium nucleus so that it remains stationary?



4.0×10^{-7} N/C
6.6×10^{-26} N/C
2.0×10^{-7} N/C
5.0×10^{-3} N/C
1.4×10^{-8} N/C

29. Two identical conducting spheres carry charges of +5.0 mC and -1.0 mC, respectively. The centers of the spheres are initially separated by a distance *L*. The two spheres are brought together so that they are in contact. The spheres are then returned to their original separation *L*. What is the ratio of the magnitude of the electric force on either sphere *after* the spheres are touched to that *before* they were touched?

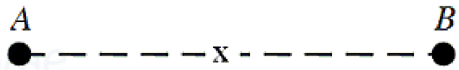
1/1
4/5
9/5
5/1
4/9

30. Two point charges, *A* and *B*, lie along a line separated by a distance *L*. The point **x** is the midpoint of their separation.

Which combination of charges would yield the greatest *repulsive* force between the charges?

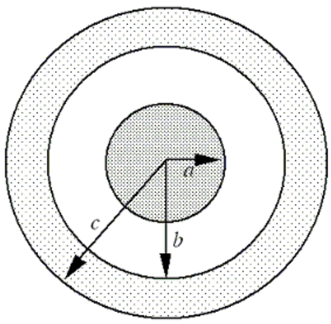
–2q and –4q
–1q and –4q
+1q and +7q
+1q and –3q
–2q and +4q

31. Which combination of charges will yield zero electric field at the point **x**?



+1q and –1q
+1q and –4q
+4q and +4q
+2q and –3q
–1q and +4q

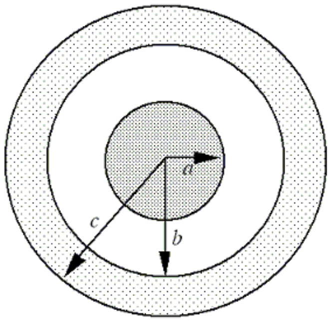
32. A solid, conducting sphere of radius *a* carries an excess charge of +6 μC. This sphere is located at the center of a hollow, conducting sphere with an inner radius of *b* and an outer radius of *c* as shown. The hollow sphere also carries a total excess charge of +6 μC.



Determine the excess charge on the *inner surface* of the outer sphere (a distance *b* from the center of the system).

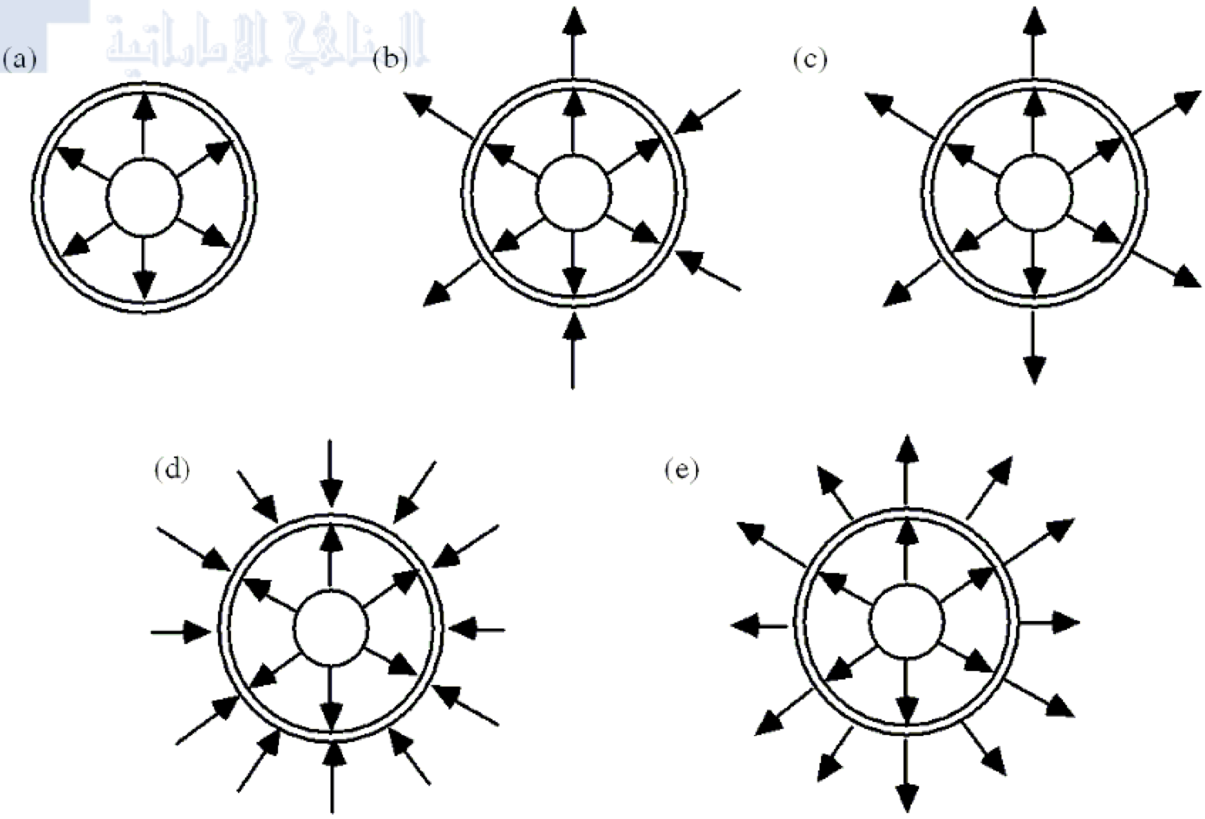
zero coulombs
+6 mC
–12 mC
–6 mC
+12 mC

33. Determine the excess charge on the *outer surface* of the outer sphere (a distance *c* from the center of the system).



zero coulombs
–6 mC
+6 mC
+12 mC
–12 mC

34. Which one of the following figures shows a qualitatively accurate sketch of the electric field lines in and around this system?



a
b
c
d
e

35. Which of the following is not a vector?
electric force
electric field
electric charge
electric line of force

36. At twice the distance from a point charge, the strength of the electric field
is four times its original value.
is twice its original value.
is one-half its original value.
is one-fourth its original value.

37. Is it possible to have a zero electric field value between a negative and positive charge along the line joining the two charges?

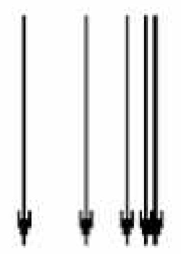
Yes, if the two charges are equal in magnitude.
Yes, regardless of the magnitude of the two charges.
No, a zero electric field cannot exist between the two charges.
cannot be determined without knowing the separation between the two charges

38. Is it possible to have a zero electric field value between two positive charges along the line joining the two charges?

Yes, if the two charges are equal in magnitude.
Yes, regardless of the magnitude of the two charges.
No, a zero electric field cannot exist between the two charges.
cannot be determined without knowing the separation between the two charges

39. Electric field lines near psitive point charges
circle clockwise.
circle counter-clockwise.
radiate inward.
radiate outward.

40. The electric field shown



increases to the right.
increases down.
decreases to the right.
decreases down.
is uniform.

41. Can electric field lines intersect in free space?

Yes, but only at the midpoint between two equal like charges.
Yes, but only at the midpoint between a positive and a negative charge.
Yes, but only at the centroid of an equilateral triangle with like charges at each corner.
No.

42. If a solid metal sphere and a hollow metal sphere of equal diameters are each given the same
charge, the electric field (E) midway between the center and the surface is

greater for the solid sphere than for the hollow sphere.
greater for the hollow sphere than for the solid sphere.
zero for both.
equal in magnitude for both, but one is opposite in direction from the other.

43. A solid block of metal in electrostatic equilibrium is placed in a uniform electric field. Give a statement concerning the electric field in the block's interior.

The interior field points in a direction opposite to the exterior field.
The interior field points in a direction that is at right angles to the exterior field.
The interior points in a direction that is parallel to the exterior field.
There is no electric field in the block's interior.

44. A cubic block of aluminum rests on a wooden table in a region where a uniform electric field is directed straight upward. What can be said concerning the charge on the block's top surface?

The top surface is charged positively
The top surface is charged negatively
The top surface is neutral
The top surface's charge cannot be determined without further information

45. If a conductor is in electrostatic equilibrium near an electric charge

the total charge on the conductor must be zero
the force between the conductor and the charge must be zero
the total electric field of the conductor must be zero
the electric field on the surface of the conductor is perpendicular to the surface

46. A positive point charge is enclosed in a hollow metallic sphere that is grounded. As compared to the case without the hollow sphere, the electric field at a point directly above the hollow sphere has

diminished to zero
diminished somewhat
increased somewhat
not changed

47. An atomic nucleus has a charge of +40e. What is the magnitude of the electric field at a distance of 1.0 m from the nucleus?

5.6×10^{-8} N/C
5.8×10^{-8} N/C
6.0×10^{-8} N/C
6.2×10^{-8} N/C

48. What are the magnitude and direction of the electric field at a distance of 1.50 m from a 50.0-nC charge?

20 N/C away from the charge
20 N/C toward the charge
200 N/C away from the charge
200 N/C toward the charge

49. A 5.0-C charge is 10 m from a small test charge. What is the magnitude of the electric field at the location of the test charge?

4.5×10^{6} N/C
4.5×10^{7} N/C
4.5×10^{8} N/C
4.5×10^{9} N/C

50. A 5.0-C charge is 10 m from a small test charge. What is the direction of the electric field?

toward the 5.0 C
away from the 5.0 C
perpendicular to a line joining the charges
none of the given answers

51. Two point charges each have a value of 3.0 C and are separated by a distance of 4.0 m. What is the electric field at a point midway between the two charges?

zero
9.0×10^{7} N/C
18×10^{7} N/C
4.5×10^{7} N/C

52. A 5.0-mC charge is placed at the 0 cm mark of a meter stick and a -4.0 mC charge is placed at the 50 cm mark. What is the electric field at the 30 cm mark?

4.0×10^{5} N/C
5.0×10^{5} N/C
9.0×10^{5} N/C
1.4×10^{6} N/C

53. A 5.0-mC charge is placed at the 0 cm mark of a meter stick and a -4.0 mC charge is placed at the 50 cm mark. At what point on a line joining the two charges is the electric field zero?

1.4 m from the 0 cm mark
2.9 m from the 0 cm mark
3.3 m from the 0 cm mark
4.7 m from the 0 cm mark

54. Two point charges of +3.0 mC and -7.0 mC are placed at x = 0 and x = 0.20 m. What is the
magnitude of the electric field at the point midway between them?

1.8 ¸ 10^6 N/C | 3.6 ¸ 10^6 N/C
4.5 ¸ 10^6 N/C | 9.0 ¸ 10^6 N/C

55. Three 3.0 mC charges are at the three corners of an square of side 0.50 m. The last corner is occupied by a -3.0 mC charge. Find the electric field at the center of the square.

2.2 ¸ 10^5 N/C | 4.3 ¸ 10^5 N/C
6.1 ¸ 10^5 N/C | 9.3 ¸ 10^5 N/C

56. Consider a square which is 1.0 m on a side. Charges are placed at the corners of the square as follows: +4.0 mC at (0, 0); +4.0 mC at (1, 1); +3.0 mC at (1, 0); -3.0 mC at (0, 1). What is the magnitude of the electric field at the square's center?

1.1 ¸ 10^5 N/C | 1.3 ¸ 10^5 N/C
1.5 ¸ 10^5 N/C | 1.7 ¸ 10^5 N/C

57. A force of 10 N acts on a charge of 5.0 mC when it is placed in a uniform electric field. What is the magnitude of this electric field?

50 MN/C | 2.0 MN/C
0.50 MN/C | 1000 MN/C

58. A particle with a charge of 4.0 mC has a mass of 5.0 ¸ 10-3 kg. What electric field directed upward will exactly balance the weight of the particle?

4.1 ¸ 10^2 N/C | 8.2 ¸ 10^2 N/C
1.2 ¸ 10^4 N/C | 5.1 ¸ 10^6 N/C

59. A Styrofoam ball of mass 0.120 g is placed in an electric field of 6000 N/C pointing downward.
What charge must be placed on the ball for it to be suspended?

-16.0 nC | -57.2 nC
-125 nC | -196 nC

60. A foam ball of mass 0.150 g carries a charge of -2.00 nC. The ball is placed inside a uniform electric field, and is suspended against the force of gravity. What are the magnitude and direction of the electric field?

573 kN/C down | 573 kN/C up
735 kN/C down | 735 kN/C up

61. A metal sphere of radius 10 cm carries a charge of +2.0 mC. What is the magnitude of the electric field 5.0 cm from the sphere's surface?

4.0×10^5 N/C
8.0×10^5 N/C
4.0×10^7 N/C
8.0×10^7 N/C

62. A metal sphere of radius 2.0 cm carries a charge of 3.0 mC. What is the electric field 6.0 cm from the center of the sphere?

4.2×10^6 N/C
5.7×10^6 N/C
7.5×10^6 N/C
9.3×10^6 N/C

63. An electric field is most directly related to:

the momentum of a test charge
the kinetic energy of a test charge
the potential energy of a test charge
the force acting on a test charge
the charge carried by a test charge

64. As used in the definition of electric field, a “test charge”:

has zero charge
has charge of magnitude 1C
has charge of magnitude 1.6×10^{-19} C
must be an electron
none of the above

65. Experimenter A uses a test charge q0 and experimenter B uses a test charge −2q0 to measure an electric field produced by stationary charges. A finds a field that is:

the same in both magnitude and direction as the field found by B
greater in magnitude than the field found by B
less in magnitude than the field found by B
opposite in direction to the field found by B
either greater or less than the field found by B, depending on the accelerations of the test charges

66. The units of the electric field are:

$N \cdot C^2$
C/N
N
N/C
C/m^2

67. The units of the electric field are:

J/(C·m)
J/C
J·C
J/m
none of these

68. Electric field lines:

are trajectories of a test charge
are vectors in the direction of the electric field
form closed loops
cross each other in the region between two-point charges
are none of the above

69. A certain physics textbook shows a region of space in which two electric field lines cross each other. We conclude that:

at least two-point charges are present
an electrical conductor is present
an insulator is present
the field points in two directions at the same place
the author made a mistake

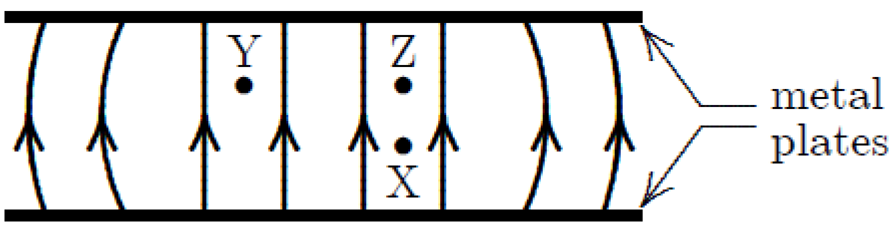
70. Two thin spherical shells, one with radius R and the other with radius 2R, surround an isolated charged point particle. The ratio of the number of field lines through the larger sphere to the number through the smaller is:

1
2
4
1/2
1/4

71. Choose the correct statement concerning electric field lines:

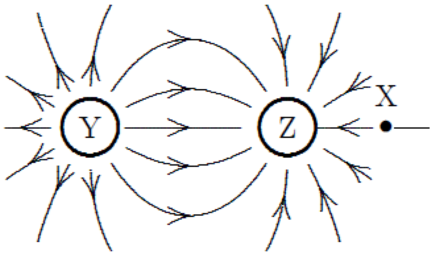
field lines may cross
field lines are close together where the field is large
field lines point away from a negatively charged particle
a charged point particle released from rest moves along a field line
none of these are correct

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



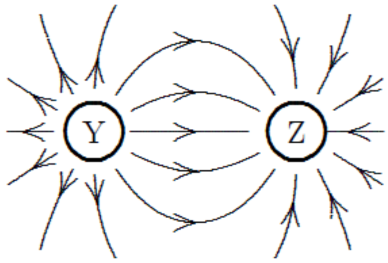
the upper plate is positive, and the lower plate is negative
a proton at X would experience the same force if it were placed at Y
a proton at X experiences a greater force than if it were placed at Z
a proton at X experiences less force than if it were placed at Z
an electron at X could have its weight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

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



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

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



Y is negative and Z is positive
the magnitude of the electric field is the same everywhere
the electric field is strongest midway between Y and Z
Y is positive and Z is negative
Y and Z must have the same sign

75. Let k denote 1/4π€₀ The magnitude of the electric field at a distance r from an isolated point particle with charge q is:

kq/r
kr/q
kq/r^3
kq/r^2
kq^2/r^2

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

1.8N/C
180N/C
18N/C
1800N/C
none of these

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

1m away from the particle
0.5m away from the particle
2m away from the particle
4m away from the particle
8m away from the particle

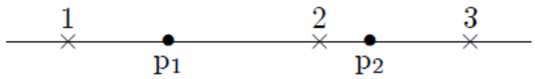
78. An isolated charged point particle produces an electric field with magnitude E at a point 2m away. At a point 1m from the particle the magnitude of the field is:

E
2E
4E
E/2
E/4

79. 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:

q_1 and q_2 must have the same magnitude and sign
P must be midway between the particles
q_1 and q_2 must have the same sign but may have different magnitudes
q_1 and q_2 must have equal magnitudes and opposite signs
q_1 and q_2 must have opposite signs and may have different magnitudes

80. 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:

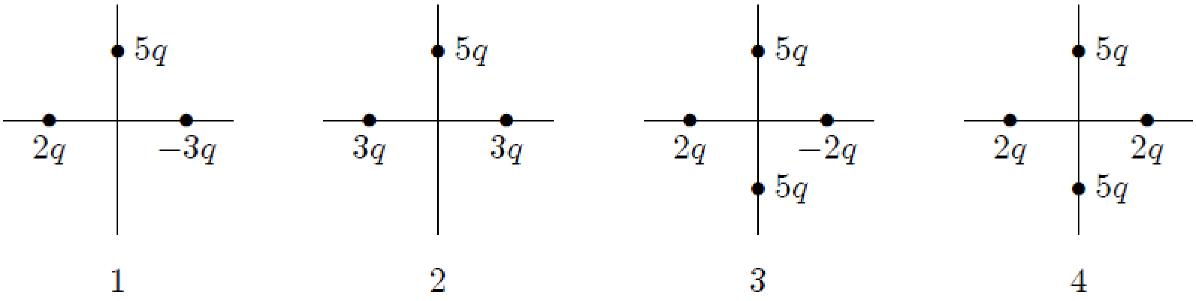


$\rightarrow, \leftarrow, \rightarrow$
$\leftarrow, \rightarrow, \leftarrow$
$\leftarrow, \rightarrow, \rightarrow$
$\leftarrow, \leftarrow, \leftarrow$
$\leftarrow, \leftarrow, \rightarrow$

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

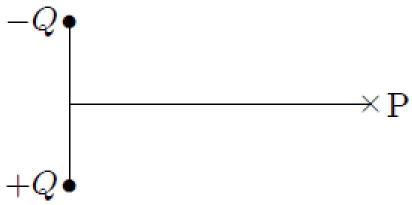
9×10^{9}
13, 500
135, 000
36×10^{-9}
22.5

82. 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:



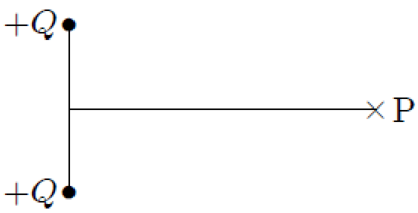
is greatest for situation 1
is greatest for situation 3
is zero for situation 4
is downward for situation 1
is downward for situation 3

83. 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:



↑
→
zero
↓
←

84. 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:

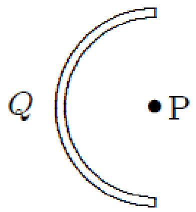


↑
→
zero
↓
←

85. 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:

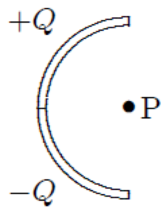
the two particles have charges with opposite signs and the same magnitude
the two particles have charges with opposite signs and different magnitudes
the two particles have identical charges
the two particles have charges with the same sign but different magnitudes
at least one other charged particle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

86. 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?



↑ ↓
← →
non

87. 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?

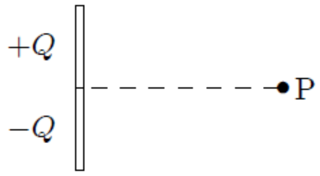


↑ ↓
← →
non

88. 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:

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

89. 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?



↑ ↓
← →
non

90. The electric field due to a uniform distribution of charge on a spherical shell is zero:

everywhere
nowhere
only at the center of the shell
only inside the shell
only outside the shell

91. The magnitude of the force of a 400-N/C electric field on a 0.02-C point charge is:

8.0N
8×10^{-5} N
8×10^{-3} N
0.08N
2×10^{11} N

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

speeds up
slows down
veers east
veers west
continues with the same speed in the same direction

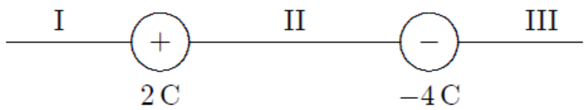
93. An electron traveling north enters a region where the electric field is uniform and points west. The electron:

speeds up
slows down
veers east
veers west
continues with the same speed in the same direction

94. A charged particle is placed in an electric field that varies with location. No force is exerted on this charge:

at locations where the electric field is zero
at locations where the electric field strength is $1/(1.6 \times 10^{-19})$N/C
if the particle is moving along a field line
if the particle is moving perpendicularly to a field line
if the field is caused by an equal amount of positive and negative charge

95. 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?



I only
III only
II only
I and II only
I and III only

96. A 200-N/C electric field is in the positive x direction. The force on an electron in this field is:

200N in the positive x direction
200N in the negative x direction
3.2×10^{-17} N in the positive x direction
3.2×10^{-17} N in the negative x direction
0

97. An electric dipole consists of a particle with a charge of $+6\times10^{-6}$ 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:

1.8×10^{-8} C · m, in the positive x direction
1.8×10^{-8} C · m, in the negative x direction
0 because the net charge is 0
1.8×10^{-8} C · m, in the positive y direction
1.8×10^{-8} C · m, in the negative y direction

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

parallel to the dipole moment
perpendicular to the dipole moment
parallel to the electric field
perpendicular to the electric field
none of the above

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

$+1.5 \times 10^{-6}$ C
$+6.5 \times 10^{-6}$ C
0
-1.5×10^{-6} C
-6.5×10^{-6} C

CH 3 - Electric Potential

Multiple-Choice Questions

1. Which one of the following statements is true concerning the work done by an external force in moving an electron at constant speed between two points in an electrostatic field?
   - The work done is always zero joules
   - The work done is always positive
   - The work done only depends on the speed of the electron
   - The work done depends on the total distance covered
   - The work done depends only on the displacement of the electron

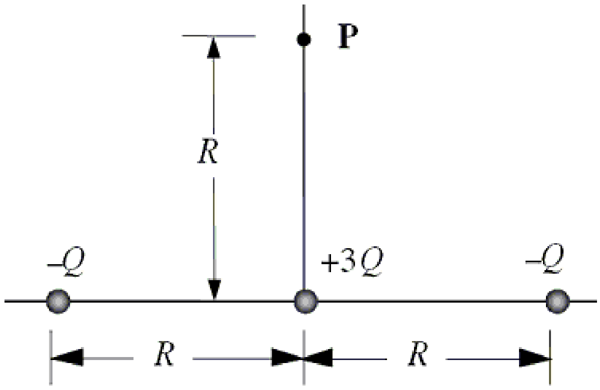
2. Complete the following statement: The *electron volt* is a unit of
   - energy
   - electric field strength
   - electric force
   - electric potential difference
   - electric power

3. The electric potential at a certain point is space is 12 V. What is the electric potential energy of a -3.0 μC charge placed at that point?
   - +4 mJ
   - -4 mJ
   - +36 mJ
   - -36 mJ
   - zero μJ

4. A completely ionized beryllium atom (net charge = +4*e*) is accelerated through a potential difference of 6.0 V. What is the increase in kinetic energy of the atom?
   - zero eV
   - 0.67 eV
   - 4.0 eV
   - 6.0 eV
   - 24 eV

5. If the work required to move a +0.25 C charge from point **A** to point **B** is +175 J, what is the potential difference between the two points?
   - zero volts
   - 44 V
   - 88 V
   - 350 V
   - 700 V

6. Three-point charges -Q, -Q, and +3Q are arranged along a line as shown in the sketch.



What is the electric potential at the point **P**?

+kQ/R

-2kQ/R

-1.6kQ/R

+1.6kQ/R

+4.4kQ/R

7. Which one of the following statements best explains why it is possible to define an *electrostatic potential* in a region of space that contains an *electrostatic field*?

Work must be done to bring two positive charges closer together

Like charges repel one another and unlike charges attract one another

A positive charge will gain kinetic energy as it approaches a negative charge

The work required to bring two charges together is independent of the path taken

A negative charge will gain kinetic energy as it moves away from another negative charge

8. 12Two positive point charges are separated by a distance R. If the distance between the charges is reduced to R/2, what happens to the total electric potential energy of the system?

The total electric potential energy is doubled

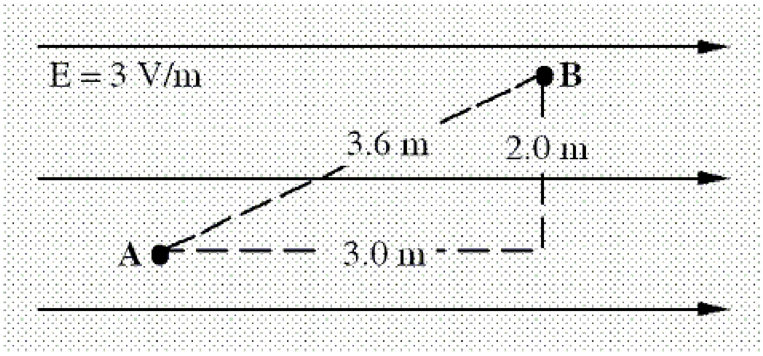
The total electric potential energy remains the same

The total electric potential energy increases by a factor of 4

The total electric potential energy is reduced to one-half of its original value

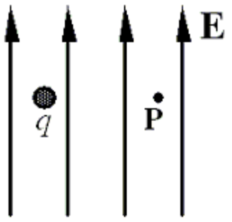
The total electric potential energy is reduced to one-fourth of its original value

9. A +1.0 μC point charge is moved from point **A** to **B** in the uniform electric field as shown. Which one of the following statements is necessarily true concerning the potential energy of the point charge?



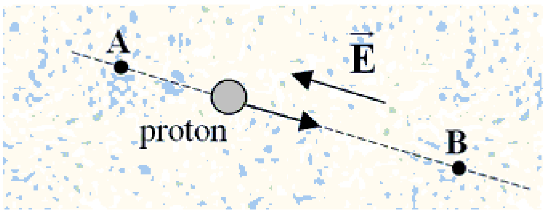
The potential energy increases by 6.0×10^{-6} J
The potential energy decreases by 6.0×10^{-6} J
The potential energy decreases by 9.0×10^{-6} J
The potential energy increases by 10.8×10^{-6} J
The potential energy decreases by 10.8×10^{-6} J

10. A charge q = -6.0 µC is moved 0.25 m horizontally to point **P** in a region where an electric field is 250 V/m directed vertically, as shown. What is the change in the electric potential energy of the charge?



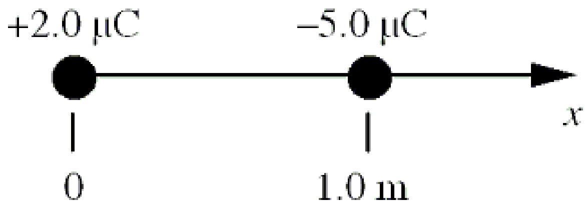
-2.4×10^{-5} J
zero joules
$+2.4 \times 10^{-5}$ J
-1.5×10^{-4} J
$+1.5 \times 10^{-4}$ J

11. A proton moves in a constant electric field $\vec{E}$ from point A to point B. The magnitude of the electric field is 6.4×10^{4} N/C; and it is directed as shown in the drawing, the direction opposite to the motion of the proton. If the distance from point A to point B is 0.50 m, what is the change in the proton's electric potential energy, $EPE_A - EPE_B$?



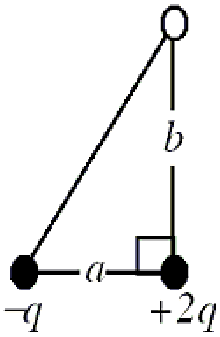
-2.4×10^{-15} J
$+1.2 \times 10^{-15}$ J
-1.8×10^{-15} J
-3.2×10^{-15} J
-5.1×10^{-15} J

12. Two-point charges are arranged along the *x* axis as shown in the figure. At which of the following values of *x* is the electric potential equal to zero?
Note: At infinity, the electric potential is zero.



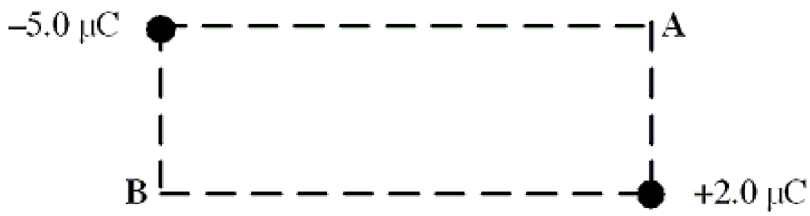
+0.05 m
+0.29 m
+0.40 m
+0.54 m
+0.71 m

13. Two-point charges are located at two of the vertices of a right triangle, as shown in the figure. If a third charge -*q* is brought from infinity and placed at the third vertex, what will its electric potential energy be? Use the following values: $a = 0.35$ m; $b = 0.65$ m, and $q = 3.0 \times 10^{-6}$ C.



-1.7 J
-0.14 J
-0.028 J
+0.85 J
+1.7 J

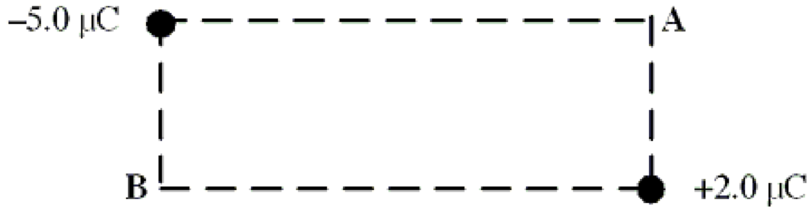
14. Two-point charges are held at the corners of a rectangle as shown in the figure. The lengths of sides of the rectangle are 0.050 m and 0.150 m. Assume that the electric potential is defined to be zero at infinity.



Determine the electric potential at corner **A**.

$+6.0 \times 10^4$ V
-2.4×10^5 V
$+4.6 \times 10^5$ V
-7.8×10^5 V
zero volts

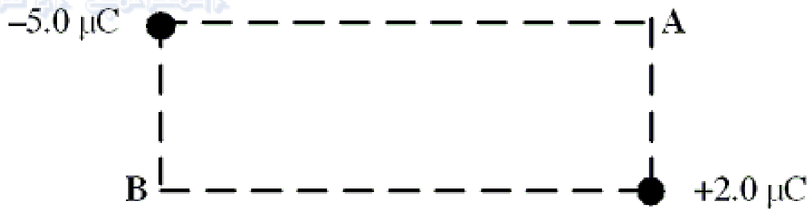
15. Two-point charges are held at the corners of a rectangle as shown in the figure. The lengths of sides of the rectangle are 0.050 m and 0.150 m. Assume that the electric potential is defined to be zero at infinity.



What is the potential difference, $V_B - V_A$, between corners **A** and **B**?

- -8.4×10^5 V
- -7.8×10^5 V
- -7.2×10^5 V
- -6.0×10^5 V
- zero volts

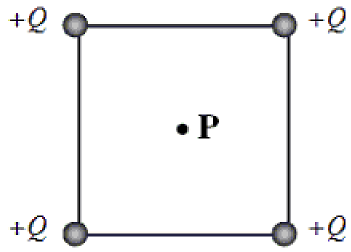
16. Two-point charges are held at the corners of a rectangle as shown in the figure. The lengths of sides of the rectangle are 0.050 m and 0.150 m. Assume that the electric potential is defined to be zero at infinity.



What is the electric potential energy of a +3.0 μC charge placed at corner **A**?

- 0.10 J
- 0.18 J
- 2.3 J
- 3.6 J
- zero joules

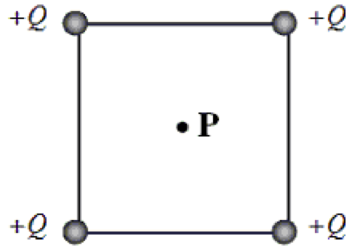
17. Four-point charges are individually brought from infinity and placed at the corners of a square as shown in the figure. Each charge has the identical value $+Q$. The length of the diagonal of the square is $2a$.



What is the magnitude of the electric field at **P**, the center of the square?

- kQ/a^2
- $2kQ/a^2$
- $4kQ/a^2$
- $kQ/4a^2$
- zero V/m

18. Four-point charges are individually brought from infinity and placed at the corners of a square as shown in the figure. Each charge has the identical value $+Q$. The length of the diagonal of the square is $2a$.



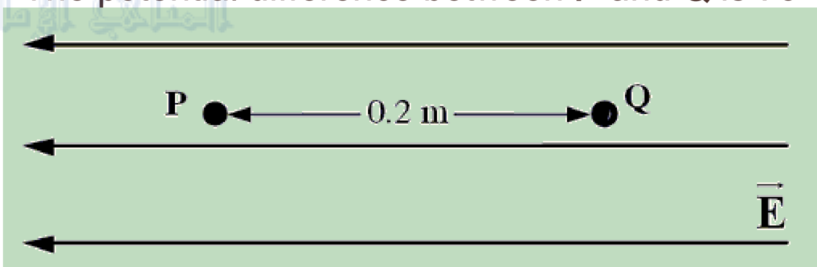
What is the electric potential at **P**, the center of the square?

kQ/a $2kQ/a$

$4kQ/a$ $kQ/4a$

zero volts

19. **P** and **Q** are points within a uniform electric field that are separated by 0.2 m as shown. The potential difference between **P** and **Q** is 75 V.



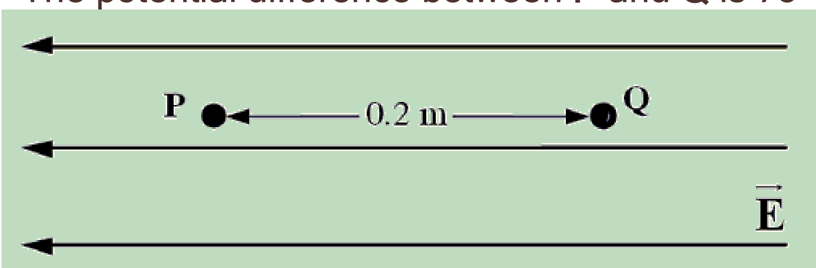
Determine the magnitude of this electric field

15 V/m 75 V/m

375 V/m 750 V/m

1100 V/m

20. **P** and **Q** are points within a uniform electric field that are separated by 0.2 m as shown. The potential difference between **P** and **Q** is 75 V.



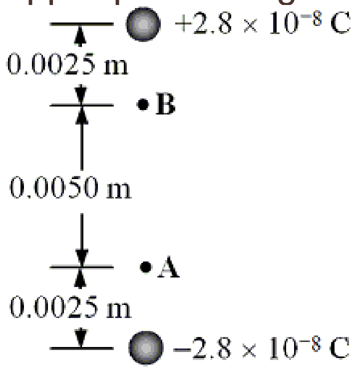
How much work is required to move a +150 μC point charge from **P** to **Q**?

0.023 J 0.056 J

75 J 140 J

2800 J

21. Two-point charges are separated by 1.00×10^{-2} m. One charge is -2.8×10^{-8} C; and the other is $+2.8 \times 10^{-8}$ C. The points **A** and **B** are located 2.5×10^{-3} m from the lower- and upper-point charges as shown.



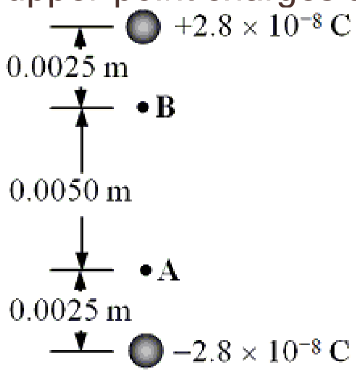
If an electron, which has a charge of 1.60×10^{-19} C, is moved from rest at A to rest at B, what is the change in electric potential energy of the electron?

$+4.3 \times 10^{-15}$ J $+5.4 \times 10^{-15}$ J

-2.1×10^{-14} J -3.2×10^{-14} J

zero joules

22. Two-point charges are separated by 1.00×10^{-2} m. One charge is -2.8×10^{-8} C; and the other is $+2.8 \times 10^{-8}$ C. The points **A** and **B** are located 2.5×10^{-3} m from the lower- and upper-point charges as shown.



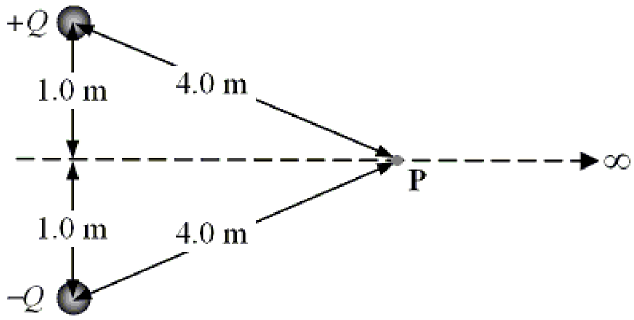
If a proton, which has a charge of $+1.60 \times 10^{-19}$ C, is moved from rest at **A** to rest at **B**, what is change in electrical potential energy of the proton?

$+2.1 \times 10^{-14}$ J $+3.2 \times 10^{-14}$ J

-4.3×10^{-15} J -5.4×10^{-15} J

zero joules

23. Two charges of opposite sign and equal magnitude $Q = 0.82$ C are held 2.0 m apart as shown in the figure.



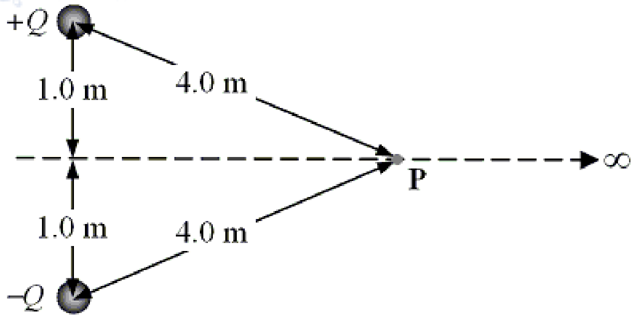
Determine the magnitude of the electric field at the point **P**.

2.8×10^{8} V/m 4.4×10^{8} V/m

5.6×10^{8} V/m 9.2×10^{8} V/m

zero V/m

24. Two charges of opposite sign and equal magnitude $Q = 0.82$ C are held 2.0 m apart as shown in the figure.



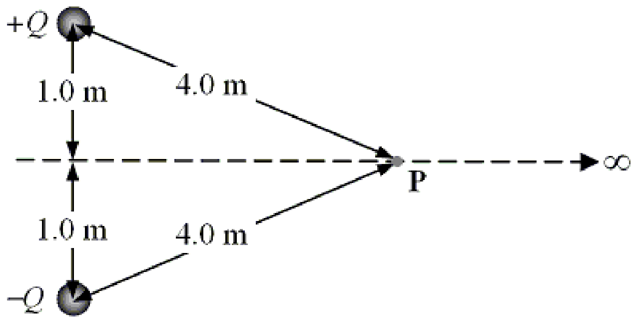
Determine the electric potential at the point **P**

1.1×10^{9} V 2.2×10^{9} V

4.5×10^{9} V 9.0×10^{9} V

zero volts

25. Two charges of opposite sign and equal magnitude $Q = 0.82$ C are held 2.0 m apart as shown in the figure.



How much work is required to move a 1.0 C charge from infinity to the point **P**?

zero joules 2.2×10^{9} J

4.5×10^{9} J 9.0×10^{9} J

infinity

26. Which one of the following statements concerning electrostatic situations is false?

E is zero everywhere inside a conductor

Equipotential surfaces are always perpendicular to **E**

Zero work is needed to move a charge along an equipotential surface

If *V* is constant throughout a *region of space,* then *E* must be zero in that region

No force component acts along the path of a charge as it is moved along an equipotential surface

27. Which one of the following statements best describes the equipotential surfaces surrounding a point charge?

The equipotential surfaces are planes extending radially outward from the charge

The equipotential surfaces are curved planes surrounding the charge, but only one passes through the charge

The equipotential surfaces are concentric cubes with the charge at the center

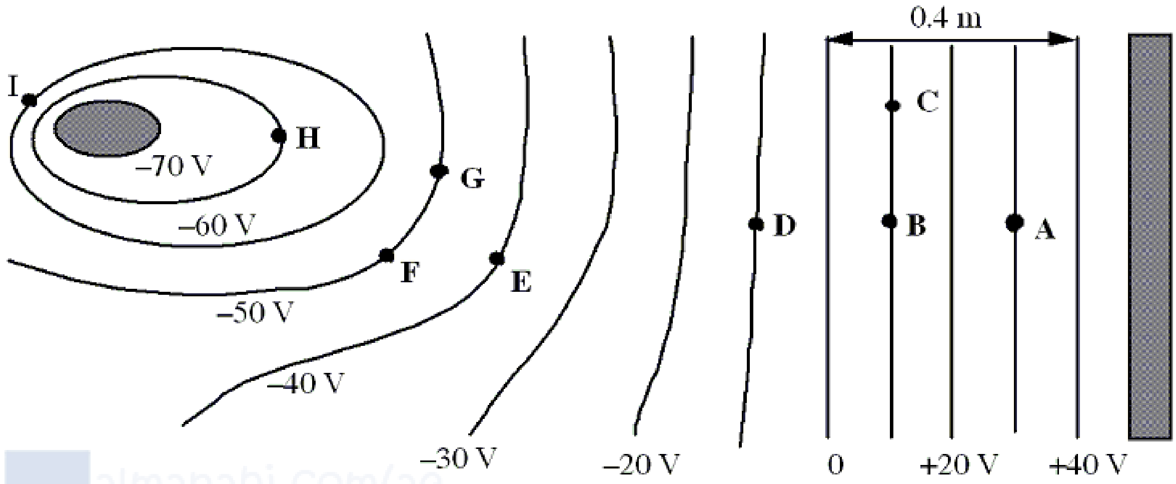
The equipotential surfaces are concentric spheres with the charge at the center

The equipotential surfaces are concentric cylinders with the charge on the axis at the center

28. A charge is located at the center of sphere A (radius R_A = 0.0010 m), which is in the center of sphere B (radius R_B = 0.0012 m). Spheres A and B are both equipotential surfaces. What is the ratio V_A/V_B of the potentials of these surfaces?

0.42 0.83
1.2 1.4
2.4

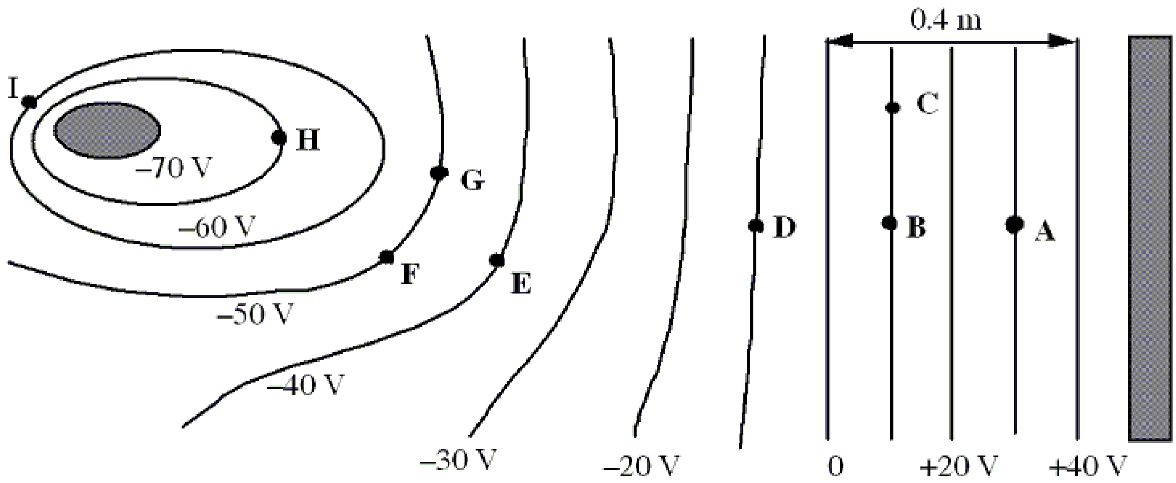
29. The sketch below shows cross sections of equipotential surfaces between two charged conductors that are shown in solid grey. Various points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **I**.



At which of the labeled points will the electric field have the greatest magnitude?

G
A
D
I
H

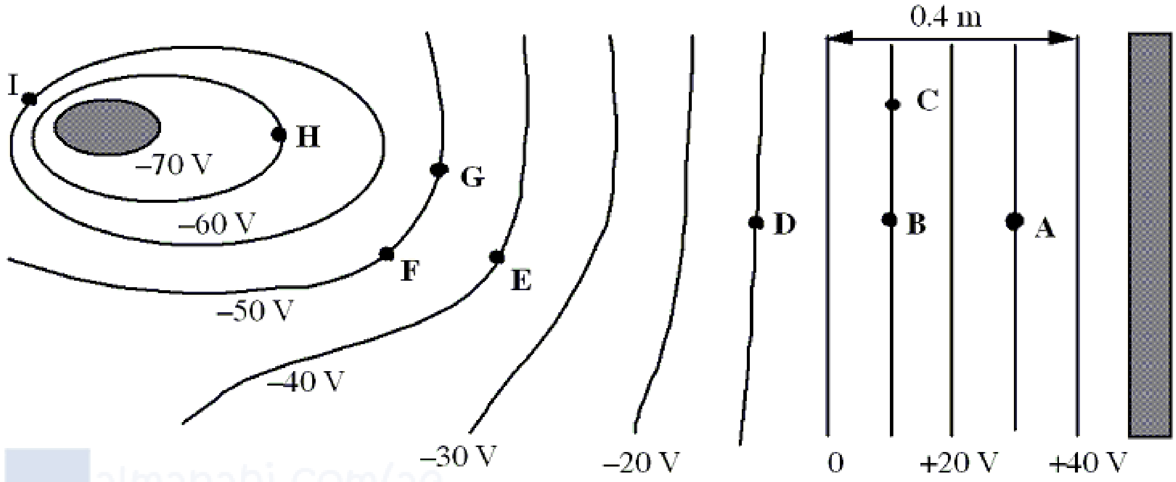
30. The sketch below shows cross sections of equipotential surfaces between two charged conductors that are shown in solid grey. Various points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **I**.



At which of the labeled points will an electron have the greatest potential energy?

A
G
I
D
H

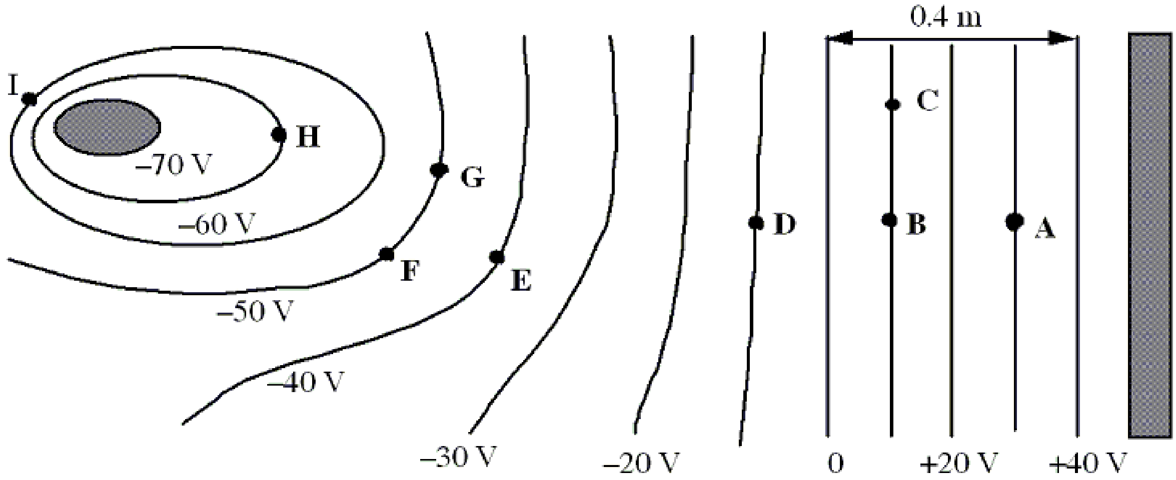
31. The sketch below shows cross sections of equipotential surfaces between two charged conductors that are shown in solid grey. Various points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **I**.



What is the potential difference between points **B** and **E**?

10 V | 30 V
40 V | 50 V
60 V

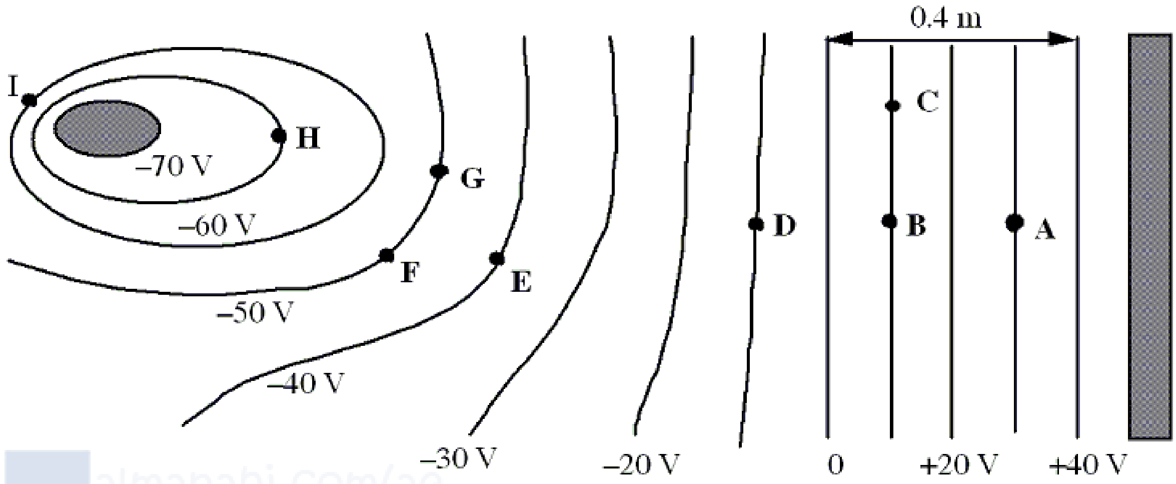
32. The sketch below shows cross sections of equipotential surfaces between two charged conductors that are shown in solid grey. Various points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **I**.



What is the direction of the electric field at **B**?

toward **A** | toward **D**
toward **C** | into the page
up and out of the page

33. The sketch below shows cross sections of equipotential surfaces between two charged conductors that are shown in solid grey. Various points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **I**.



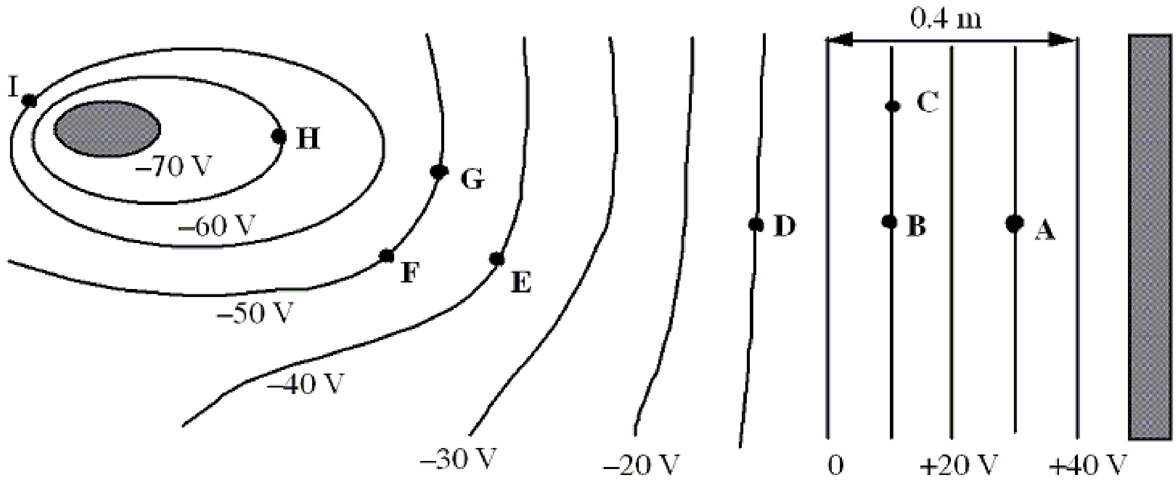
How much work is required to move a -1.0 mC charge from **A** to **E**?

+3.0 × 10^{-5} J -4.0 × 10^{-5} J

+7.0 × 10^{-5} J -7.0 × 10^{-5} J

zero joules

34. The sketch below shows cross sections of equipotential surfaces between two charged conductors that are shown in solid grey. Various points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **I**.



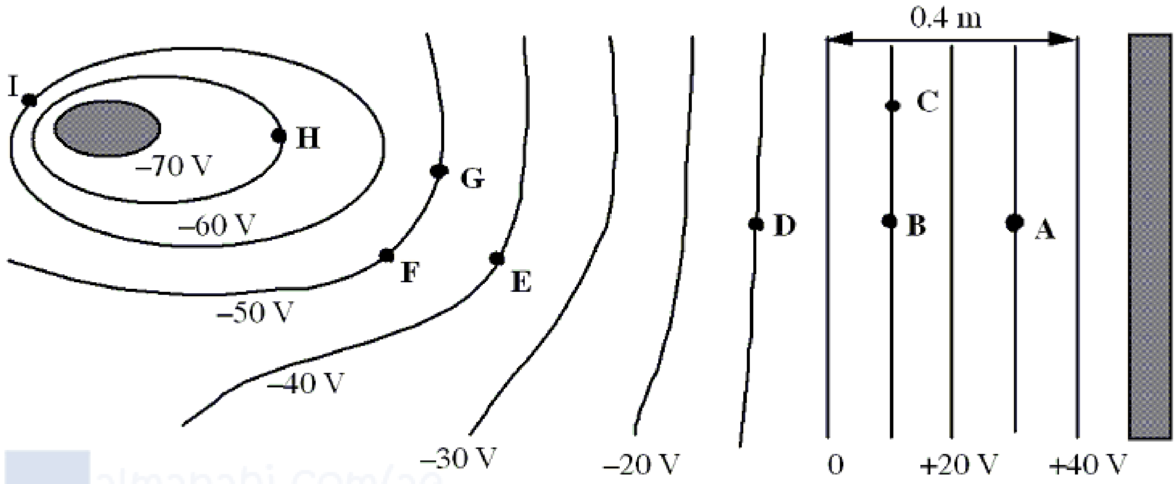
How much work is required to move a -1.0 mC charge from **B** to **D** to **C**?

+2.0 × 10^{-5} J -2.0 × 10^{-5} J

+4.0 × 10^{-5} J -4.0 × 10^{-5} J

zero joules

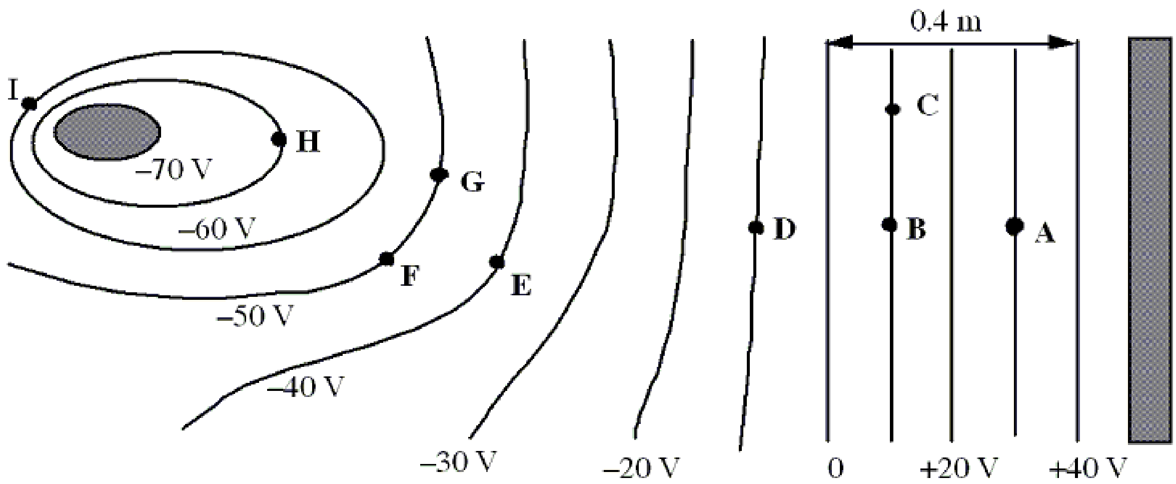
35. The sketch below shows cross sections of equipotential surfaces between two charged conductors that are shown in solid grey. Various points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **I**.



A positive point charge is placed at **F.** Complete the following statement: When it is released,

no force will be exerted on it
a force will cause it to move toward **E**
a force will cause it to move toward **G**
a force will cause it to move away from **E**
it would subsequently lose kinetic energy

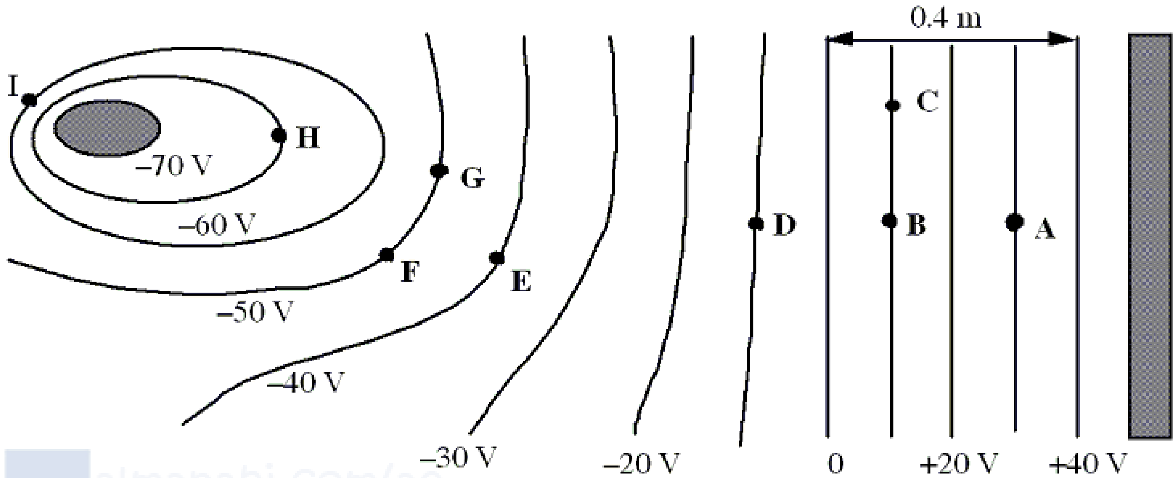
36. The sketch below shows cross sections of equipotential surfaces between two charged conductors that are shown in solid grey. Various points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **I**.



What is the magnitude of the electric field at point **A**?

10 V/m
25 V/m
30 V/m
75 V/m
100 V/m

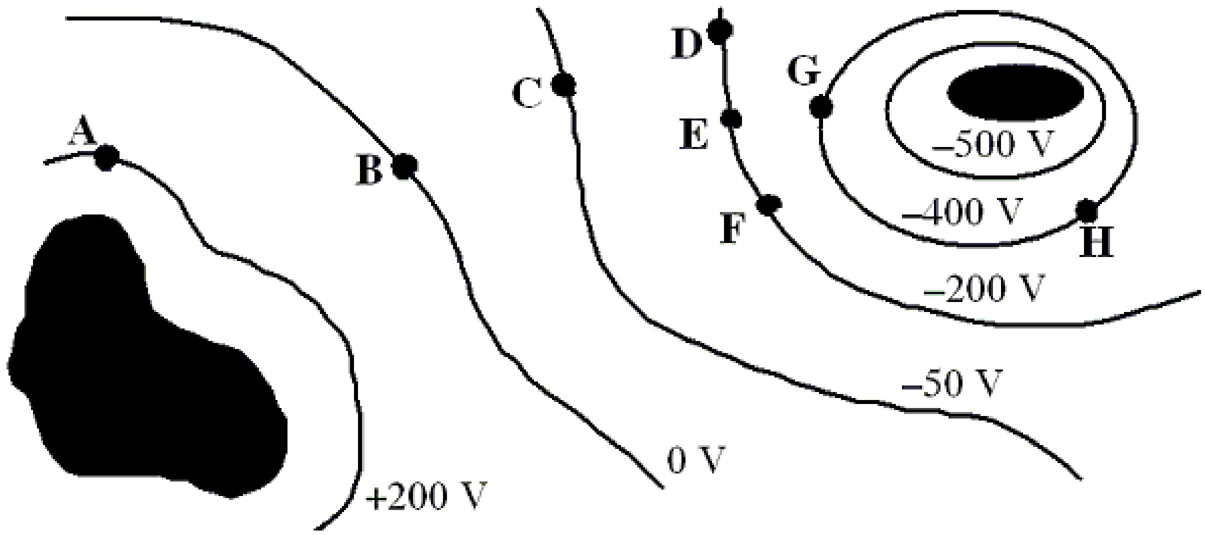
37. The sketch below shows cross sections of equipotential surfaces between two charged conductors that are shown in solid grey. Various points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **I**.



A point charge gains 50 mJ of electric potential energy when it is moved from point **D** to point **G**. Determine the magnitude of the charge.

1.0 mC
1.3 mC
25 mC
50 mC
130 mC

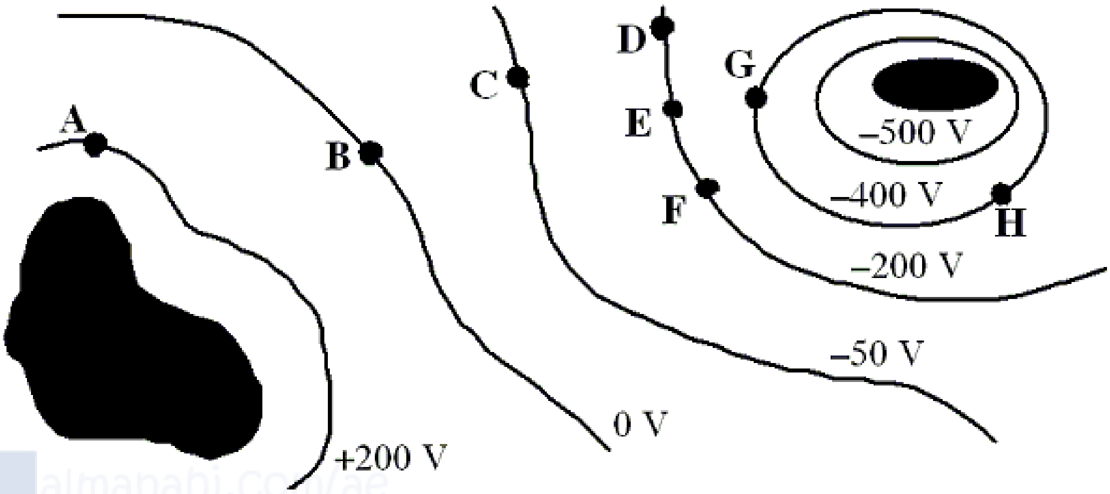
38. The sketch shows cross sections of equipotential surfaces between two charged conductors shown in solid black. Points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **H**.



What is the magnitude of the potential difference between points **A** and **H**?

100 V
200 V
400 V
600 V
700 V

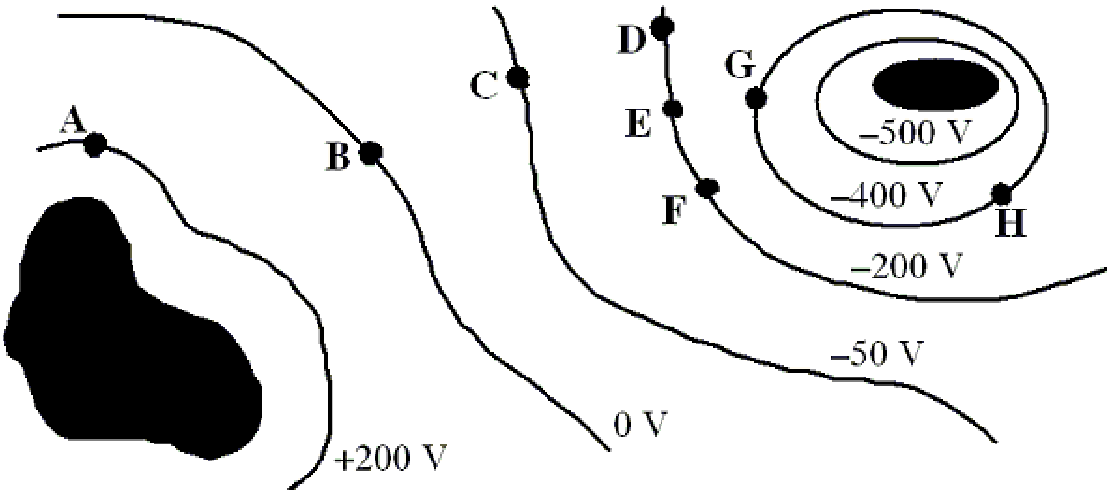
39. The sketch shows cross sections of equipotential surfaces between two charged conductors shown in solid black. Points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **H**.



What is the direction of the electric field at point **E**?

toward **G**
toward **H**
toward **F**
toward **B**
toward **C**

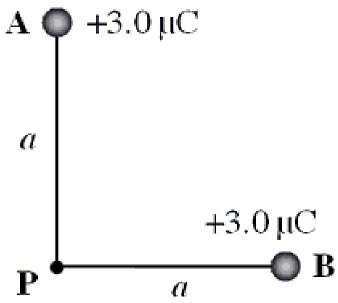
40. The sketch shows cross sections of equipotential surfaces between two charged conductors shown in solid black. Points on the equipotential surfaces near the conductors are labeled **A**, **B**, **C**, ..., **H**.



How much work is required to move a +6.0 μC point charge from B to F to D to A?

$+1.2 \times 10^{-3}$ J
$+3.6 \times 10^{-3}$ J
zero joules
-1.2×10^{-3} J
-3.6×10^{-3} J

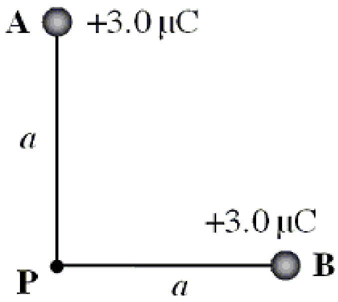
41. Two positive charges are located at points **A** and **B** as shown in the figure. The distance from each charge to the point **P** is $a = 2.0$ m.



Determine the magnitude of the electric field at the point **P**

3.38×10^3 V/m
6.75×10^3 V/m
9.55×10^3 V/m
1.35×10^4 V/m
2.70×10^4 V/m

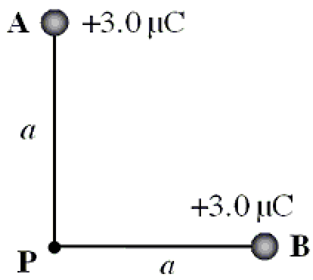
42. Two positive charges are located at points **A** and **B** as shown in the figure. The distance from each charge to the point **P** is $a = 2.0$ m.



Which statement is true concerning the direction of the electric field at **P**?

The direction is toward **A**
The direction is toward **B**
The direction is directly away from **A**
The direction makes a 45° angle above the horizontal direction
The direction makes a 135° angle below the horizontal direction

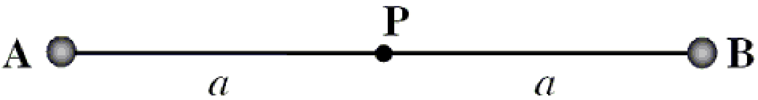
43. Two positive charges are located at points **A** and **B** as shown in the figure. The distance from each charge to the point **P** is $a = 2.0$ m.



Determine the electric potential at the point **P**.

1.35×10^4 V
1.89×10^4 V
2.30×10^4 V
2.70×10^4 V
3.68×10^4 V

44. 69. Suppose that the charges are rearranged as shown in this figure. Which one of the following statements is true for this new arrangement?



The electric field will be zero, but the electric potential remains unchanged
Both the electric field and the electric potential are zero at **P**
The electric field will remain unchanged, but the electric potential will be zero
The electric field will remain unchanged, but the electric potential will decrease
Both the electric field and the electric potential will be changed and will be non-zero

45. An isolated system consists of two conducting spheres **A** and **B**. Sphere **A** has five times the radius of sphere **B**. Initially, the spheres are given equal amounts of positive charge and are isolated from each other. The two spheres are then connected by a conducting wire.
Note: The potential of a sphere of radius *R* that carries a charge *Q* is $V = kQ/R$, if the potential at infinity is zero.

Which one of the following statements is true *after* the spheres are connected by the wire?

The electric potential of **A** is 1/25 as large as that of **B**
The electric potential of **A** equals that of **B**
The electric potential of **A** is 25 times larger than that of **B**
The electric potential of **A** is 1/5 as large as that of **B**
The electric potential of **A** is five times larger than that of **B**

46. An isolated system consists of two conducting spheres **A** and **B**. Sphere **A** has five times the radius of sphere **B**. Initially, the spheres are given equal amounts of positive charge and are isolated from each other. The two spheres are then connected by a conducting wire.
Note: The potential of a sphere of radius *R* that carries a charge *Q* is $V = kQ/R$, if the potential at infinity is zero.

Determine the ratio of the charge on sphere **A** to that on sphere **B**, q_A/q_B, after the spheres are connected by the wire

1
1/5
5
25
1/25

47. Which of the following is not a vector?

electric force
electric field
electric potential
electric line of force

48. One joule per coulomb is a

newton
volt
electron-volt
farad

49. Two identical aluminum objects are insulated from their surroundings. Object A has a net charge of excess electrons. Object B is grounded. Which object is at a higher potential?

A
B
Both are at the same potential
cannot be determined without more information

50. A small, charged ball is accelerated from rest to a speed v by a 500 V potential difference. If the potential difference is changed to 2000 V, what will the new speed of the ball be?

v
2v
4v
16v

51. For a proton moving in the direction of the electric field

its potential energy increases and its electric potential decreases
its potential energy decreases and its electric potential increases
its potential energy increases and its electric potential increases
its potential energy decreases and its electric potential decreases

52. The energy acquired by a particle carrying a charge equal to that on the electron because of moving through a potential difference of one volt is referred to as

a joule
an electron-volt
a proton-volt
a coulomb

53. The electron-volt is a unit of

voltage
current
power
energy

54. 5) For an electron moving in a direction opposite to the electric field

its potential energy increases and its electric potential decreases
its potential energy decreases and its electric potential increases
its potential energy increases and its electric potential increases
its potential energy decreases and its electric potential decreases

55. Several electrons are placed on a hollow conducting sphere. They

clump together on the sphere's outer surface
clump together on the sphere's inner surface
become uniformly distributed on the sphere's outer surface
become uniformly distributed on the sphere's inner surface

56. One electron-volt corresponds to:

8.0×10^{-20} J 1.6×10^{-19} J
9.5×10^{-17} J 1.9×10^{-16} J

57. The absolute potential at 2.0 m from a positive point charge is 100 V. What is the absolute potential 4.0 m away from the same point charge?

25 V   50 V
200 V   400 V

58. A surface on which all points are at the same potential is referred to as

a constant electric force surface
a constant electric field surface
an equipotential surface
an equivoltage surface

59. A negative charge is moved from point A to point B along an equipotential surface.

The negative charge performs work in moving from point A to point B
Work is required to move the negative charge from point A to point B
Work is both required and performed in moving the negative charge from point A to point B
No work is required to move the negative charge from point A to point B

60. The absolute potential at 2.0 m from a negative point charge is -100 V. What is the absolute potential 4.0 m away from the same point charge?

-25 V   -50 V
-200 V   -400 V

61. The absolute potential at the exact center of a square is 3.0 V when a charge of +Q is located at one of the square's corners. What is the absolute potential at the square's center when each of the other corners is also filled with a charge of +Q?

zero   3.0 V
9.0 V   12 V

62. An equipotential surface must be

parallel to the electric field at any point
perpendicular to the electric field at any point

63. The absolute potential at the center of a square is 3.0 V when a charge of +Q is located at one of the square's corners. What is the absolute potential at the square's center when a second charge of -Q is placed at one of the remaining corners?

zero | 3.0 V
6.0 V | 9.0 V

64. Consider a uniform electric field of 50 N/C directed toward the east. If the voltage measured relative to ground at a given point in the field is 80 V, what is the voltage at a point 1.0 m directly east of the point?

15 V | 30 V
90 V | 130 V

65. It takes 50 J of energy to move 10 C of charge from point A to point B. What is the potential difference between points A and B?

500 V | 50 V
5.0 V | 0.50 V

66. The net work done in moving an electron from point A, where the potential is -50 V, to point B, where the potential is +50 V, is

+1.6 ، 10-17 J | -1.6 ، 10-17 J
zero | none of the given answers

67. A proton, initially at rest, is accelerated through an electric potential difference of 500 V. What is the kinetic energy of the proton?

500 J | $8.0x10^{-17}$ J
$1.6x10^{-19}$ J | zero

68. A proton, initially at rest, is accelerated through an electric potential difference of 500 V. What is the speed of the proton?

$2.2x10^{5}$ m/s | $3.1x10^{5}$ m/s
$9.6x10^{10}$ m/s | zero

69. Starting from rest, a proton falls through a potential difference of 1200 V. What speed does it acquire?

$1.2x10^{5}$ m/s | $2.4x10^{5}$ m/s
$3.6x10^{5}$ m/s | $4.8x10^{5}$ m/s

70. How much work does 9.0 V do in moving $8.5x10^{18}$ electrons?

12 J | 7.7 J
1.4 J | 1.1 J

71. Consider a uniform electric field of 50 N/C directed toward the east. If the voltage measured relative to ground at a given point in the field is 80 V, what is the voltage at a point 1.0 m directly south of that point?

zero | 30 V
50 V | 80 V

72. A stationary electron is accelerated through a potential difference of 500 V. What is the velocity of the electron afterward?

$1.3x10^6$ m/s $2.6x10^6$ m/s
$1.3x10^7$ m/s $2.6x10^7$ m/s

73. A 4.0-g object carries a charge of 20 mC. The object is accelerated from rest through a potential difference, and afterward the ball is moving at 2.0 m/s. What is the magnitude of the potential difference?

800 kV 400 kV
800 V 400 V

74. A 6.0-V battery maintains the electrical potential difference between two parallel metal plates separated by 1.0 mm. What is the electric field between the plates?

6.0 V/m 600 V/m
6000 V/m zero

75. A uniform electric field, with a magnitude of 500 V/m, is directed parallel to the +x axis. If the potential at x = 5.0 m is 2500 V, what is the potential at x = 2.0 m?

500 V 1000 V
2000 V 4000 V

76. Consider a uniform electric field of 50 N/C directed toward the east. If the voltage measured relative to ground at a given point is 80 V, what is the voltage at a point 1.0 m directly west of that point?

30 V 50 V
80 V 130 V

77. If a Cu^{2+} ion drops through a potential difference of 12 V, it will acquire a kinetic energy (in the absence of friction) of

3.0 eV 6.0 eV
12 eV 24 eV

78. A proton moves 0.10 m along the direction of an electric field of magnitude 3.0 V/m. What is the change in kinetic energy of the proton?

$4.8x10^{-20}$ J $3.2x10^{-20}$ J
$1.6x10^{-20}$ J $8.0x10^{-21}$ J

79. What is the potential at $5.0x10^{-10}$ m from a nucleus of charge +50e?

120 V 140 V
170 V 210 V

80. Two parallel plates, separated by 0.20 m, are connected to a 12-V battery. An electron released from rest at a location 0.10 m from the negative plate. When the electron arrives at a distance 0.050 m from the positive plate, what is the potential difference between the initial and final points?

2.4 V 3.0 V
4.8 V 6.0 V

81. Two parallel plates, separated by 0.20 m, are connected to a 12-V battery. An electron released from rest at a location 0.10 m from the negative plate. When the electron arrives at a distance 0.050 m from the positive plate, how much kinetic energy does the electron gain?

$2.4\text{x}10^{-19}$ J | $4.8\text{x}10^{-19}$ J
$7.2\text{x}10^{-19}$ J | $9.6\text{x}10^{-19}$ J

82. Two parallel plates, separated by 0.20 m, are connected to a 12-V battery. An electron released from rest at a location 0.10 m from the negative plate. When the electron arrives at a distance 0.050 m from the positive plate, what is the speed of the electron?

$5.0\text{x}10^{5}$ m/s | $1.0\text{x}10^{6}$ m/s
$5.0\text{x}10^{6}$ m/s | $1.0\text{x}10^{7}$ m/s

83. A 5.0-nC charge is at (0, 0) and a -2.0-nC charge is at (3.0 m, 0). If the potential is taken to be zero at infinity, what is the electric potential at point (0, 4.0 m)?

15 V | 3.6 V
11 V | 7.7 V

84. A 5.0-nC charge is at (0, 0) and a -2.0-nC charge is at (3.0 m, 0). If the potential is taken to be zero at infinity, what is the electric potential energy of a 1.0-nC charge at point (0, 4.0 m)?

$1.5\text{x}10^{-8}$ J | $3.6\text{x}10^{-9}$ J
$1.1\text{x}10^{-8}$ J | $7.7\text{x}10^{-9}$ J

85. A 5.0-nC charge is at (0, 0) and a -2.0-nC charge is at (3.0 m, 0). If the potential is taken to be zero at infinity, what is the work required to bring a 1.0-nC charge from infinity to point (0, 4.0 m)?

$1.5\text{x}10^{-8}$ J | $3.6\text{x}10^{-9}$ J
$1.1\text{x}10^{-8}$ J | $7.7\text{x}10^{-9}$ J

86. Four charges of equal charge +q are placed at the corners of a rectangle of sides a and b. What is the potential at the center of the rectangle if q = 2.0 mC, a = 3.0 cm, and b = 4.0 cm?

$1.3\text{x}10^{6}$ V | $2.9\text{x}10^{6}$ V
$3.5\text{x}10^{6}$ V | $7.8\text{x}10^{6}$ V

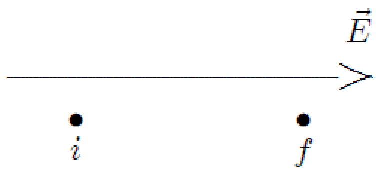
87. A square is 1.0 m on a side. Charges of +4.0 mC are placed in two diagonally opposite corners. In the other two corners are placed charges of +3.0 mC and -3.0 mC. What is the absolute potential in the square's center?

$1.0\text{x}10^{4}$ V | $1.0\text{x}10^{5}$ V
$1.0\text{x}10^{6}$ V | infinite

88. How much energy is necessary to place three charges, each of 2.0 mC, at the corners of an equilateral triangle of side 2.0 cm?

4.5 J | 5.4 J
6.7 J | 7.6 J

89. An electron moves from point i to point f, in the direction of a uniform electric field. During this displacement:



the work done by the field is positive and the potential energy of the electron-field system increases

the work done by the field is negative and the potential energy of the electron-field system increases

the work done by the field is positive and the potential energy of the electron-field system decreases

the work done by the field is negative and the potential energy of the electron-field system decreases

the work done by the field is positive and the potential energy of the electron-field system does not change

90. A particle with a charge of 5.5×10^{-8}C is 3.5 cm from a particle with a charge of -2.3×10^{-8} C.
The potential energy of this two-particle system, relative to the potential energy at infinite separation, is:

3.2×10^{-4} J — -3.2×10^{-4} J
9.3×10^{-3} J — -9.3×10^{-3} J
zero

91. A particle with a charge of 5.5×10^{-8}C is fixed at the origin. A particle with a charge of -2.3×10^{-8} C is moved from x = 3.5 cm on the x axis to y = 4.3 cm on the y axis. The change in potential energy of the two-particle system is:

3.1×10^{-3} J — -3.1×10^{-3} J
6.0×10^{-5} J — -6.0×10^{-5} J
0

92. A particle with a charge of 5.5×10^{-8} C charge is fixed at the origin. A particle with a charge of -2.3×10^{-8} C charge is moved from x = 3.5 cm on the x axis to y = 3.5 cm on the y axis. The change in the potential energy of the two-particle system is:

3.2×10^{-4} J — -3.2×10^{-4} J
9.3×10^{-3} J — -9.3×10^{-3} J
0

93. Three particles lie on the x axis: particle 1, with a charge of 1×10^{-8} C is at x = 1 cm, particle 2, with a charge of 2×10^{-8} C, is at x = 2 cm, and particle 3, with a charge of -3×10^{-8} C, is at x = 3 cm. The potential energy of this arrangement, relative to the potential energy for infinite separation, is:

$+4.9 \times 10^{-4}$ J
-4.9×10^{-4} J
$+8.5 \times 10^{-4}$ J
-8.5×10^{-4} J
zero

94. Two identical particles, each with charge q, are placed on the x axis, one at the origin and the other at x = 5 cm. A third particle, with charge −q, is placed on the x axis so the potential energy of the three-particle system is the same as the potential energy at infinite separation.
Its x coordinate is:

13 cm
2.5 cm
7.5 cm
10 cm
−5 cm

95. Choose the correct statement:

A proton tends to go from a region of low potential to a region of high potential
The potential of a negatively charged conductor must be negative
If E = 0 at a point P then V must be zero at P
If V = 0 at a point P then E must be zero at P
None of the above are correct

96. If 500 J of work are required to carry a charged particle between two points with a potential difference of 20V, the magnitude of the charge on the particle is:

0.040C
12.5C
20C
cannot be computed unless the path is given
none of these

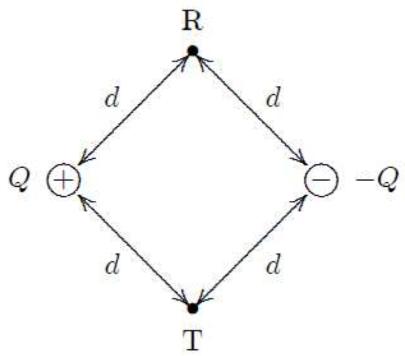
97. The potential difference between two points is 100V. If a particle with a charge of 2C is transported from one of these points to the other, the magnitude of the work done is:

200 J
100 J
50 J
100 J
2 J

98. During a lightning discharge, 30C of charge move through a potential difference of 1.0×10^{8} V in 2.0×10^{-2} s. The energy released by this lightning bolt is:

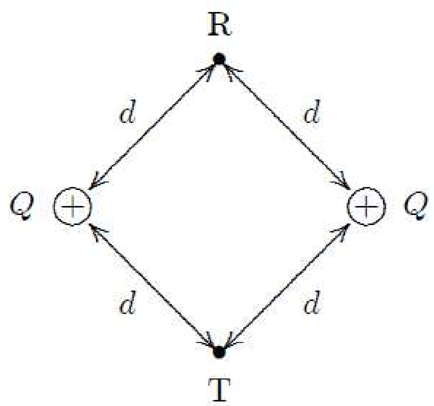
1.5×10^{11} J
3.0×10^{9} J
6.0×10^{7} J
3.3×10^{6} J
1500 J

99. 11. Points R and T are each a distance d from each of two particles with charges of equal magnitudes and opposite signs as shown. If $k = 1/4\pi \epsilon_0$, the work required to move a particle with a negative charge q from R to T is:



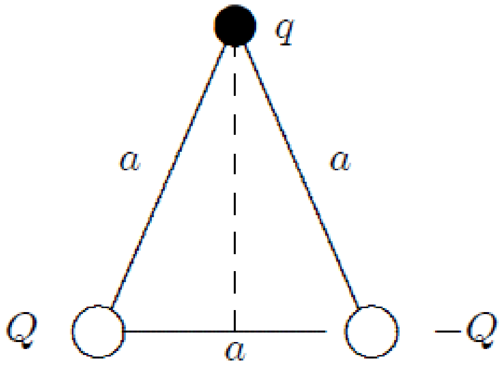
0
kqQ/d
kQq/(2d)
kqQ/d^2
$kqQ/(\sqrt{2}d)$

100. Points R and T are each a distance d from each of two particles with equal positive charges as shown. $k = 1/4\pi \epsilon_0$, the work required to move a particle with charge q from R to T is:



0
kqQ/d
kQq/(2d)
kqQ/d^2
$kqQ/(\sqrt{2}d)$

101. Two particles with charges Q and −Q are fixed at the vertices of an equilateral triangle with sides of length a. If k = 1/4π ϵ_0, the work required to move a particle with charge q from the other vertex to the center of the line joining the fixed particles is:



0
kQq/a^2
√2kQq/a
kQq/a
2kQq/a

CH 4 - Capacitors

Multiple-Choice Questions

1. The magnitude of the charge on the plates of an *isolated* parallel plate capacitor is doubled. Which one of the following statements is true concerning the capacitance of this parallel-plate system?
   The capacitance is decreased to one half of its original value
   The capacitance is increased to twice its original value
   The capacitance remains unchanged
   The capacitance depends on the electric field between the plates
   The capacitance depends on the potential difference across the plates

2. A parallel plate capacitor with plates of area *A* and plate separation *d* is charged so that the potential difference between its plates is *V*. If the capacitor is then isolated and its plate separation is decreased to *d*/2, what happens to the potential difference between the plates?
   The final potential difference is 4*V*
   The final potential difference is 2*V*
   The final potential difference is 0.5*V*
   The final potential difference is 0.25*V*
   The final potential difference is *V*

3. A parallel plate capacitor with plates of area *A* and plate separation *d* is charged so that the potential difference between its plates is *V*. If the capacitor is then isolated and its plate separation is decreased to *d*/2, what happens to its capacitance?
   The capacitance is twice its original value
   The capacitance is four times its original value
   The capacitance is eight times its original value
   The capacitance is one half of its original value
   The capacitance is unchanged

4. A parallel plate capacitor is fully charged at a potential *V*. A dielectric with constant k = 4 is inserted between the plates of the capacitor while the potential difference between the plates remains constant. Which one of the following statements is false concerning this situation?
   - The energy density remains unchanged
   - The capacitance increases by a factor of four
   - The stored energy increases by a factor of four
   - The charge on the capacitor increases by a factor of four
   - The electric field between the plates increases by a factor of four

5. Which one of the following changes will necessarily increase the capacitance of a capacitor?
   - decreasing the charge on the plates
   - increasing the charge on the plates
   - placing a dielectric between the plates
   - increasing the potential difference between the plates
   - decreasing the potential difference between the plates

6. Complete the following statement: When a dielectric with constant k is inserted between the plates of a charged *isolated* capacitor
   - the capacitance is reduced by a factor k
   - the charge on the plates is reduced by a factor of k
   - the charge on the plates is increased by a factor of k
   - the electric field between the plates is reduced by a factor of k
   - the potential difference between the plates is increased by a factor of k

7. A parallel plate capacitor has a potential difference between its plates of 1.6 V and a plate separation distance of 2.5 mm. What is the magnitude of the electric field if a material that has a dielectric constant of 3.4 is inserted between the plates?
   - 110 V/m
   - 170 V/m
   - 190 V/m
   - 240 V/m
   - 290 V/m

8. A capacitor has a very large capacitance of 10 F. The capacitor is charged by placing a potential difference of 2 V between its plates. How much energy is stored in the capacitor?
   - 2000 J
   - 500 J
   - 100 J
   - 40 J
   - 20 J

9. The effective area of each plate of a parallel plate capacitor is 2.1 m^2. The capacitor is filled with neoprene rubber (▪ = 6.4). When a 6.0-V potential difference exists across the plates of the capacitor, the capacitor stores 4.0 μC of charge. Determine the plate separation of the capacitor.
   - 7.2×10^{-5} m
   - 3.0×10^{-4} m
   - 1.8×10^{-4} m
   - 5.3×10^{-4} m
   - 8.2×10^{-5} m

10. A uniform electric field of 8 V/m exists between the plates of a parallel plate capacitor. How much work is required to move a +20 mC point charge from the negative plate to the positive plate if the plate separation is 0.050 m?
    - 0.4 J
    - 1.6 J
    - 8×10^{-4} J
    - 8×10^{-5} J
    - 8×10^{-6} J

11. A capacitor is initially charged to 3 V. It is then connected to a 6 V battery. What is the ratio of the final to the initial energy stored in the capacitor?
    - 3
    - 5
    - 6
    - 7
    - 9

12. A parallel plate capacitor has plates of area 2.0×10^{-3} m^2 and plate separation 1.0×10^{-4} m. Determine the capacitance of this system if air fills the volume between the plates.
    - 1.1×10^{-10} F
    - 1.8×10^{-10} F
    - 3.2×10^{-10} F
    - 4.4×10^{-10} F
    - 5.3×10^{-10} F

13. A parallel plate capacitor has plates of area 2.0×10^{-3} m^2 and plate separation 1.0×10^{-4} m. Air fills the volume between the plates. What potential difference is required to establish a 3.0 μC charge on the plates?
    - 9.3×10^{2} V
    - 2.4×10^{4} V
    - 1.7×10^{4} V
    - 6.9×10^{3} V
    - 3.7×10^{5} V

14. A potential difference of 120 V is established between two parallel metal plates. The magnitude of the charge on each plate is 0.020 C. What is the capacitance of this capacitor?
    - 170 μF
    - 24 μF
    - 7.2 μF
    - 0.12 F
    - 2.4 F

15. The plates of a parallel plate capacitor each have an area of 0.40 m^2 and are separated by a distance of 0.02 m. They are charged until the potential difference between the plates is 3000 V. The charged capacitor is then isolated.
    Determine the magnitude of the electric field between the capacitor plates.
    - 60 V/m
    - 120 V/m
    - 1.0×10^{5} V/m
    - 1.5×10^{5} V/m
    - 3.0×10^{5} V/m

16. The plates of a parallel plate capacitor each have an area of 0.40 m^2 and are separated by a distance of 0.02 m. They are charged until the potential difference between the plates is 3000 V. The charged capacitor is then isolated.
Determine the value of the capacitance.
9.0×10^{-11} F
1.8×10^{-10} F
3.6×10^{-10} F
4.8×10^{-10} F
6.4×10^{-10} F

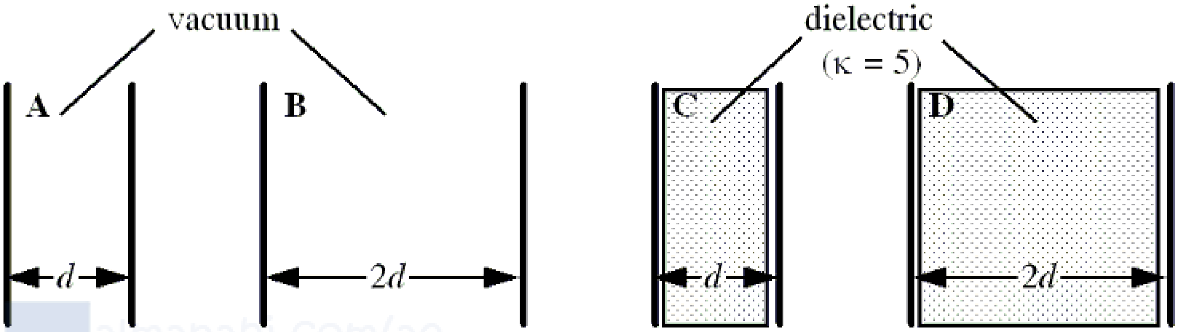
17. The plates of a parallel plate capacitor each have an area of 0.40 m^2 and are separated by a distance of 0.02 m. They are charged until the potential difference between the plates is 3000 V. The charged capacitor is then isolated.
Determine the magnitude of the charge on either capacitor plate.
1.8×10^{-7} C
2.7×10^{-7} C
4.9×10^{-7} C
5.4×10^{-7} C
6.8×10^{-7} C

18. The plates of a parallel plate capacitor each have an area of 0.40 m^2 and are separated by a distance of 0.02 m. They are charged until the potential difference between the plates is 3000 V. The charged capacitor is then isolated.
How much work is required to move a -4.0 mC charge from the negative plate to the positive plate of this system?
-1.2×10^{-2} J
$+1.2 \times 10^{-2}$ J
-2.4×10^{-2} J
$+2.4 \times 10^{-2}$ J
-5.4×10^{-2} J

19. The plates of a parallel plate capacitor each have an area of 0.40 m^2 and are separated by a distance of 0.02 m. They are charged until the potential difference between the plates is 3000 V. The charged capacitor is then isolated.Suppose that a dielectric sheet is inserted to completely fill the space between the plates and the potential difference between the plates drops to 1000 V. What is the capacitance of the system after the dielectric is inserted?
1.8×10^{-10} F
2.7×10^{-10} F
5.4×10^{-10} F
6.2×10^{-10} F
6.8×10^{-10} F

20. The plates of a parallel plate capacitor each have an area of 0.40 m^2 and are separated by a distance of 0.02 m. They are charged until the potential difference between the plates is 3000 V. The charged capacitor is then isolated.
Suppose that a dielectric sheet is inserted to completely fill the space between the plates and the potential difference between the plates drops to 1000 V. Determine the dielectric constant.
0.333
0.666
3.0
6.0
2000

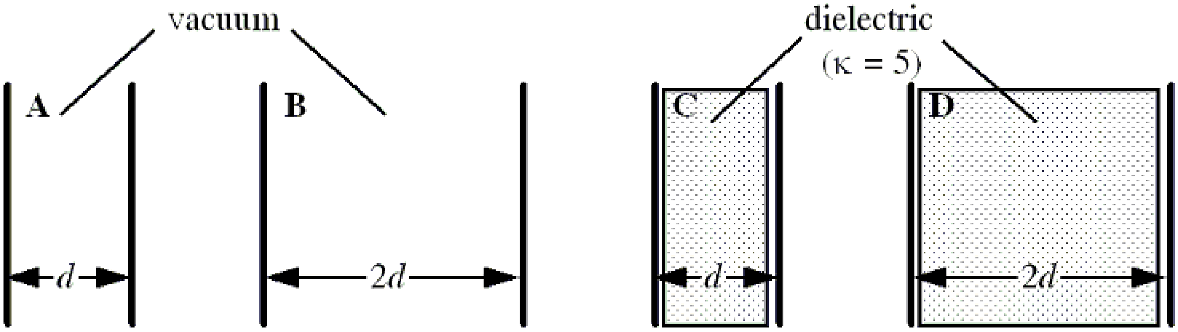
21. The figure below shows four parallel plate capacitors: A, B, C, and D. Each capacitor carries the same charge *q* and has the same plate area *A*. As suggested by the figure, the plates of capacitors A and C are separated by a distance *d* while those of B and D are separated by a distance 2*d*. Capacitors A and B are maintained in vacuum while capacitors C and D contain dielectrics with constant $\kappa = 5$.



Which list below places the capacitors in order of *increasing* capacitance?

A, B, C, D
B, A, C, D
A, B, D, C
B, A, D, C
D, C, B, A

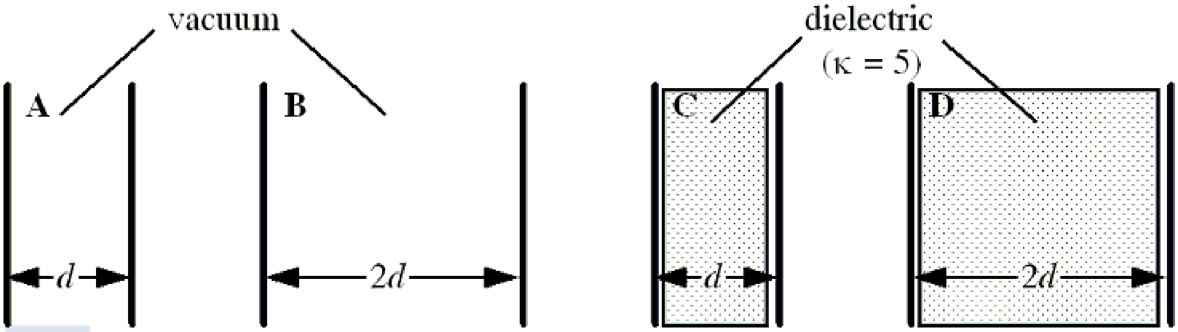
22. The figure below shows four parallel plate capacitors: A, B, C, and D. Each capacitor carries the same charge *q* and has the same plate area *A*. As suggested by the figure, the plates of capacitors A and C are separated by a distance *d* while those of B and D are separated by a distance 2*d*. Capacitors A and B are maintained in vacuum while capacitors C and D contain dielectrics with constant $\kappa = 5$.



Which capacitor has the largest potential difference between its plates?

A
B
C
D
A and D are the same and larger than B or C

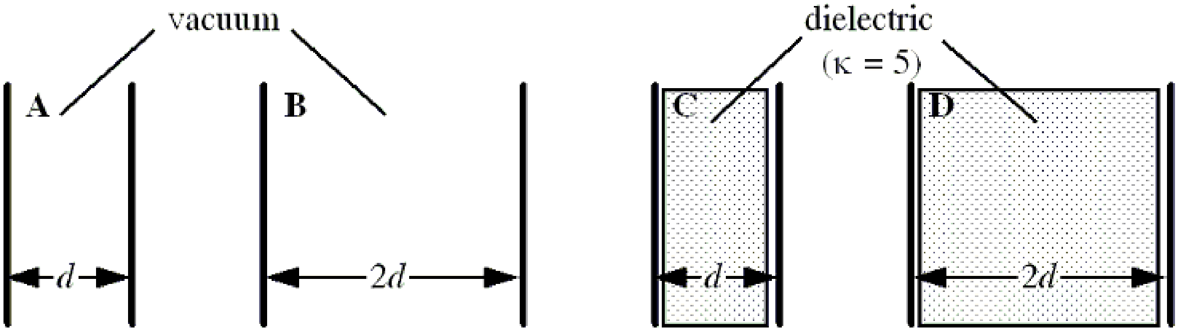
23. The figure below shows four parallel plate capacitors: A, B, C, and D. Each capacitor carries the same charge *q* and has the same plate area *A*. As suggested by the figure, the plates of capacitors A and C are separated by a distance *d* while those of B and D are separated by a distance 2*d*. Capacitors A and B are maintained in vacuum while capacitors C and D contain dielectrics with constant $\kappa = 5$.



Which capacitor is storing the greatest amount of electric potential energy?

A
B
C
D
Since all four carry the same charge, each will store the same amount of energy

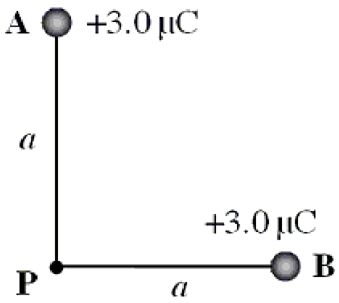
24. The figure below shows four parallel plate capacitors: A, B, C, and D. Each capacitor carries the same charge *q* and has the same plate area *A*. As suggested by the figure, the plates of capacitors A and C are separated by a distance *d* while those of B and D are separated by a distance 2*d*. Capacitors A and B are maintained in vacuum while capacitors C and D contain dielectrics with constant $\kappa = 5$.



At what distance from a 1.0-C charge is the electric potential equal to 12 V?

8.3×10^7 m
7.5×10^8 m
9.0×10^8 m
1.1×10^9 m
3.0×10^9 m

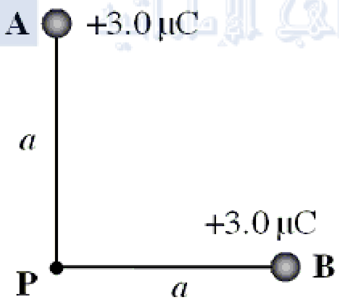
25. Two positive charges are located at points A and B as shown in the figure. The distance from each charge to the point P is a = 2.0 m.



Determine the magnitude of the electric field at the point P.

- 3.38×10^3 V/m
- 6.75×10^3 V/m
- 9.55×10^3 V/m
- 1.35×10^4 V/m
- 2.70×10^4 V/m

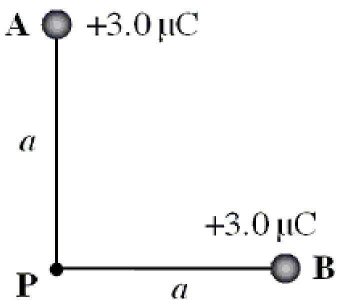
26. Two positive charges are located at points A and B as shown in the figure. The distance from each charge to the point P is a = 2.0 m.



Which statement is true concerning the direction of the electric field at P?

- The direction is toward A
- The direction is toward B
- The direction is directly away from A
- The direction makes a 45° angle above the horizontal direction
- The direction makes a 135° angle below the horizontal direction

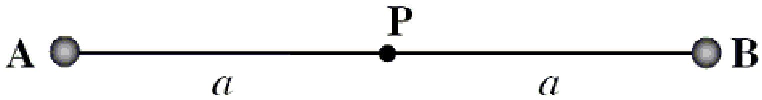
27. Two positive charges are located at points A and B as shown in the figure. The distance from each charge to the point P is a = 2.0 m.



Determine the electric potential at the point P.

- 1.35×10^4 V
- 1.89×10^4 V
- 2.30×10^4 V
- 2.70×10^4 V
- 3.68×10^4 V

28. Suppose that the charges are rearranged as shown in this figure. Which one of the following statements is true for this new arrangement?



The electric field will be zero, but the electric potential remains unchanged.
Both the electric field and the electric potential are zero at P.
The electric field will remain unchanged, but the electric potential will be zero.
The electric field will remain unchanged, but the electric potential will decrease.
Both the electric field and the electric potential will be changed and will be non-zero.

29. An isolated system consists of two conducting spheres A and B. Sphere A has five times the radius of sphere B. Initially, the spheres are given equal amounts of positive charge and are isolated from each other. The two spheres are then connected by a conducting wire.
Note: The potential of a sphere of radius R that carries a charge Q is $V = kQ/R$, if the potential at infinity is zero.

Which one of the following statements is true *after* the spheres are connected by the wire?
The electric potential of A is 1/25 as large as that of B.
The electric potential of A equals that of B.
The electric potential of A is 25 times larger than that of B.
The electric potential of A is 1/5 as large as that of B.
The electric potential of A is five times larger than that of B.

30. An isolated system consists of two conducting spheres A and B. Sphere A has five times the radius of sphere B. Initially, the spheres are given equal amounts of positive charge and are isolated from each other. The two spheres are then connected by a conducting wire.
Note: The potential of a sphere of radius R that carries a charge Q is $V = kQ/R$, if the potential at infinity is zero.
Determine the ratio of the charge on sphere A to that on sphere B, q_A/q_B, after the spheres are connected by the wire.

1 1/5
5 25
1/25

31. Two parallel-plate capacitors are identical in every respect except that one has twice the plate area of the other. If the smaller capacitor has capacitance C, the larger one has capacitance

C/2. C.
2C. 4C.

32. A parallel-plate capacitor has a capacitance of C. If the area of the plates is doubled and the distance between the plates is halved, what is the new capacitance?

C/4 C/2
2C 4C

33. A battery charges a parallel-plate capacitor fully and then is removed. The plates are immediately pulled apart. (With the battery disconnected, the amount of charge on the plates remains constant.) What happens to the potential difference between the plates as they are being separated?

It increases.
It decreases.
It remains constant.
cannot be determined from the information given

34. If the electric field between the plates of a given capacitor is weakened, the capacitance of that capacitor

increases
decreases
does not change
cannot be determined from the information given

35. The plates of a parallel-plate capacitor are maintained with constant voltage by a battery as they are pulled apart. During this process, the amount of charge on the plates must

increase
decrease
remain constant
either increase or decrease. There is no way to tell from the information given

36. The plates of a parallel-plate capacitor are maintained with constant voltage by a battery as they are pulled apart. What happens to the strength of the electric field during this process?

It increases
It decreases
It remains constant
cannot be determined from the information given

37. A dielectric material such as paper is placed between the plates of a capacitor. What happens to the capacitance?

no change becomes larger
becomes smaller becomes infinite

38. A dielectric material such as paper is placed between the plates of a capacitor holding a fixed charge. What happens to the electric field between the plates?

no change becomes stronger
becomes weaker reduces to zero

39. A parallel-plate capacitor is connected to a battery and becomes fully charged. The capacitor is then disconnected, and the separation between the plates is increased in such a way that no charge leaks off. The energy stored in this capacitor has

increased	decreased
not changed	become zero

40. Doubling the capacitance of a capacitor holding a constant charge causes the energy stored in that capacitor to

quadruple	double
decrease to one half	decrease to one fourth

41. Doubling the voltage across a given capacitor causes the energy stored in that capacitor to

quadruple	double
reduce to one half	reduce to one fourth

42. What charge appears on the plates of a 2.0-mF capacitor when it is charged to 100 V?

50 mC	100 mC
150 mC	200 mC

43. A parallel-plate capacitor has plates of area 0.50 m2 separated by a distance of 2.0 mm. What is this capacitor's capacitance?

250 F	50 F
2.2×10^{-9} F	4.4×10^{-10} F

44. A parallel-plate capacitor is filled with air, and the plates are separated by 0.050 mm. If the capacitance is 17.3 pF, what is the plate area?

4.9×10^{-5} m^2	9.8×10^{-5} m^2
2.4×10^{-4} m^2	4.8×10^{-4} m^2

45. A parallel-plate capacitor has plates of area 0.20 m^2 separated by a distance of 1.0 mm. What is the strength of the electric field between these plates when this capacitor is connected to a 6.0-V battery?

1200 N/C	3000 N/C
6000 N/C	1500 N/C

46. A parallel-plate capacitor has a plate separation of 5.0 cm. If the potential difference between the plates is 2000 V, with the top plate at the higher potential, what is the electric field between the plates?

100 N/C upward	100 N/C downward
40000 N/C upward	40000 N/C downward

47. A 6.0-mF air capacitor is connected across a 100-V battery. After the battery fully charges the capacitor, the capacitor is immersed in transformer oil (dielectric constant = 4.5). How much additional charge flows from the battery, which remained connected during the process?

1.2 mC	1.7 mC
2.1 mC	2.5 mC

48. A charge of 60 mC is placed on a 15 mF capacitor. How much energy is stored in the capacitor?

120 J	4.0 J
240 mJ	120 mJ

49. 20 V is placed across a 15 mF capacitor. What is the energy stored in the capacitor?

150 mJ	300 mJ
3.0 mJ	6.0 mJ

50. A charge of 2.00 mC flows onto the plates of a capacitor when it is connected to a 12.0-V battery. How much work was done in charging this capacitor?

24.0 mJ	12.0 mJ
144 mJ	576 J

51. If a 10-mF capacitor is charged so that it stores 2.0×10^{-3} J of energy, what is the voltage across it?

5.0 V	10 V
15 V	20 V

52. A parallel-plate capacitor consists of plates of area 1.5×10^{-4} m^2 and separated by 1.0 mm.
The capacitor is connected to a 12-V battery. What is the capacitance?

1.3×10^{-15} F	2.6×10^{-15} F
1.3×10^{-12} F	2.6×10^{-12} F

53. A parallel-plate capacitor consists of plates of area 1.5×10^{-4} m^2 and separated by 1.0 mm. The capacitor is connected to a 12-V battery. What is the charge on the plates?

1.6×10^{-11} C	3.2×10^{-11} C
1.6×10^{-14} C	3.2×10^{-14} C

54. A parallel-plate capacitor consists of plates of area 1.5×10^{-4} m^2 and separated by 1.0 mm. The capacitor is connected to a 12-V battery. What is the electric field between the plates?

12 V/m	1.2×10^{2} V/m
1.2×10^{3} V/m	1.2×10^{4} V/m

55. A parallel-plate capacitor is constructed with plate area of 0.40 m^2 and a plate separation of 0.10 mm. How much charge is stored on it when it is charged to a potential difference of 12 V?

0.21 mC 0.42 mC
0.63 mC 0.84 mC

56. A parallel-plate capacitor is constructed with plate area of 0.40 m^2 and a plate separation of 0.10 mm. How much energy is stored when it is charged to a potential difference of 12 V?

2.5 mJ 5.0 mJ
7.5 mJ 10 mJ

57. A 15-mF capacitor is connected to a 50-V battery and becomes fully charged. The battery is removed and a slab of dielectric that completely fills the space between the plates is inserted. If the dielectric has a dielectric constant of 5.0, what is the capacitance of the capacitor after the slab is inserted?

75 mF 20 mF
3.0 mF 1.0 mF

58. A 15-mF capacitor is connected to a 50-V battery and becomes fully charged. The battery is removed and a slab of dielectric that completely fills the space between the plates is inserted. If the dielectric has a dielectric constant of 5.0, what is the voltage across the capacitor's plates after the slab is inserted?

250 V 10 V
2.0 V 0.75 V

59. The units of capacitance are equivalent to:

J/C V/C
J^2/C C/J
C^2/J

60. A farad is the same as a:

J/V V/J
C/V V/C
N/C

61. A capacitor C “has a charge Q”. The actual charges on its plates are:

Q, Q Q/2, Q/2
Q, −Q Q/2, −Q/2
Q, 0

62. Each plate of a capacitor stores a charge of magnitude 1mC when a 100-V potential difference is applied. The capacitance is:

5 μF 10 μF
50 μF 100 μF
none of these

63. To charge a 1-F capacitor with 2C requires a potential difference of:

2V
0.2V
5V
0.5V
none of these

64. The capacitance of a parallel-plate capacitor with plate area A and plate separation d is given by:

$\varepsilon_0 d/A$
$\varepsilon_0 d/2A$
$\varepsilon_0 A/d$
$\varepsilon_0 A/2d$
Ad/ε_0

65. The capacitance of a parallel-plate capacitor is:

proportional to the plate area
proportional to the charge stored
independent of any material inserted between the plates
proportional to the potential difference of the plates
proportional to the plate separation

66. The plate areas and plate separations of five parallel plate capacitors are
capacitor 1: area A_0, separation d_0
capacitor 2: area $2A_0$, separation $2d_0$
capacitor 3: area $2A_0$, separation $d_0/2$
capacitor 4: area $A_0/2$, separation $2d_0$
capacitor 5: area A_0, separation $d_0/2$
Rank these according to their capacitances, least to greatest.

1, 2, 3, 4, 5
5, 4, 3, 2, 1
5, 3 and 4 tie, then 1, 2
. 4, 1 and 2 tie, then 5, 3
3, 5, 1 and 2 tie, 1, 4

67. The capacitance of a parallel-plate capacitor can be increased by:

increasing the charge
decreasing the charge
increasing the plate separation
decreasing the plate separation
decreasing the plate area

68. If both the plate area and the plate separation of a parallel-plate capacitor are doubled, the capacitance is:

doubled
halved
unchanged
tripled
quadrupled

69. If the plate area of an isolated charged parallel-plate capacitor is doubled:

the electric field is doubled
the potential difference is halved
the charge on each plate is halved
the surface charge density on each plate is doubled
none of the above

70. If the plate separation of an isolated charged parallel-plate capacitor is doubled:

the electric field is doubled
the potential difference is halved
the charge on each plate is halved
the surface charge density on each plate is doubled
none of the above

71. Pulling the plates of an isolated charged capacitor apart:

increases the capacitance
increases the potential difference
does not affect the potential difference
decreases the potential difference
does not affect the capacitance

72. If the charge on a parallel-plate capacitor is doubled:

the capacitance is halved
the capacitance is doubled
the electric field is halved
the electric field is doubled
the surface charge density is not changed on either plate

73. A parallel-plate capacitor has a plate area of $0.2 m^2$ and a plate separation of 0.1mm. To obtain an electric field of 2.0×10^6 V/m between the plates, the magnitude of the charge on each plate should be:

8.9×10^{-7} C
1.8×10^{-6} C
3.5×10^{-6} C
7.1×10^{-6} C
1.4×10^{-5} C

74. A parallel-plate capacitor has a plate area of $0.2 m^2$ and a plate separation of 0.1 mm. If the charge on each plate has a magnitude of 4×10^{-6} C the potential difference across the plates is approximately:

0
4×10^{-2} V
1×10^{2} V
2×10^{2} V
4×10^{8} V

75. The capacitance of a spherical capacitor with inner radius a and outer radius b is proportional to:

a/b
$b - a$
$b^2 - a^2$
$ab/(b - a)$
$ab/(b^2 - a^2)$

76. The capacitance of a single isolated spherical conductor with radius R is proportional to:

R
R^2
$1/R$
$1/R^2$
none of these

77. Two conducting spheres have radii of R_1 and R_2, with R_1 greater than R_2. If they are far apart the capacitance is proportional to:

$R_1R_2/(R_1 - R_2)$
$R_2/(1 - R_2/2)$
$(R_1 - R_2)/R_1R_2$
$R_2/(1 + R_2/2)$
none of these

78. The capacitance of a cylindrical capacitor can be increased by:

decreasing both the radius of the inner cylinder and the length
increasing both the radius of the inner cylinder and the length
increasing the radius of the outer cylindrical shell and decreasing the length
decreasing the radius of the inner cylinder and increasing the radius of the outer cylindrical shell
only by decreasing the length

79. A battery is used to charge a series combination of two identical capacitors. If the potential difference across the battery terminals is V and total charge Q flows through the battery during the charging process then the charge on the positive plate of each capacitor and the potential difference across each capacitor are:

Q/2 and V/2, respectively
Q and V , respectively
Q/2 and V , respectively
Q and V/2, respectively
Q and 2V , respectively

80. A battery is used to charge a parallel combination of two identical capacitors. If the potential difference across the battery terminals is V and total charge Q flows through the battery during the charging process then the charge on the positive plate of each capacitor and the potential difference across each capacitor are:

Q/2 and V/2, respectively
Q and V , respectively
Q/2 and V , respectively
Q and V/2, respectively
Q and 2V , respectively

81. A 2-μF and a 1-μF capacitor are connected in series and a potential difference is applied across the combination. The 2-μF capacitor has:

twice the charge of the 1-μF capacitor
half the charge of the 1-μF capacitor
twice the potential difference of the 1-μF capacitor
half the potential difference of the 1-μF capacitor
none of the above

82. A 2-μF and a 1-μF capacitor are connected in parallel and a potential difference is applied across the combination. The 2-μF capacitor has:

twice the charge of the 1-μF capacitor
half the charge of the 1-μF capacitor
twice the potential difference of the 1-μF capacitor
half the potential difference of the 1-μF capacitor
none of the above

83. Let Q denote charge, V denote potential difference, and U denote stored energy. Of these quantities, capacitors in series must have the same:

Q only
V only
U only
Q and U only
V and U only

84. Let Q denote charge, V denote potential difference, and U denote stored energy. Of these quantities, capacitors in parallel must have the same:

Q only
V only
U only
Q and U only
V and U only

85. Capacitors C_1 and C_2 are connected in parallel. The equivalent capacitance is given by:

$C_1C_2/(C_1 + C_2)$
$(C_1 + C_2)/C_1C_2$
$1/(C_1 + C_2)$
C_1/C_2
$C_1 + C_2$

86. Capacitors C_1 and C_2 are connected in series. The equivalent capacitance is given by:

$C_1C_2/(C_1 + C_2)$
$(C_1 + C_2)/C_1C_2$
$1/(C_1 + C_2)$
C_1/C_2
$C_1 + C_2$

87. Capacitors C_1 and C_2 are connected in series and a potential difference is applied to the combination. If the capacitor that is equivalent to the combination has the same potential difference, then the charge on the equivalent capacitor is the same as:

the charge on C_1
the sum of the charges on C_1 and C_2
the difference of the charges on C_1 and C_2
the product of the charges on C_1 and C_2
none of the above

88. Capacitors C_1 and C_2 are connected in parallel and a potential difference is applied to the combination. If the capacitor that is equivalent to the combination has the same potential difference, then the charge on the equivalent capacitor is the same as:

the charge on C_1
the sum of the charges on C_1 and C_2
the difference of the charges on C_1 and C_2
the product of the charges on C_1 and C_2
none of the above

89. Two identical capacitors are connected in series and two, each identical to the first, are connected in parallel. The equivalent capacitance of the series connection is the equivalent capacitance of parallel connection.

twice
four times
half
one-fourth
the same as

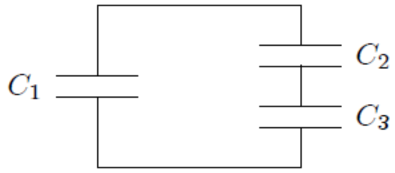
90. Two identical capacitors, each with capacitance C, are connected in parallel and the combination is connected in series to a third identical capacitor. The equivalent capacitance of this arrangement is:

2C/3
C
3C/2
2C
3C

91. A 2-µF and a 1-µF capacitor are connected in series and charged from a battery. They store charges P and Q, respectively. When disconnected and charged separately using the same battery, they have charges R and S, respectively. Then:

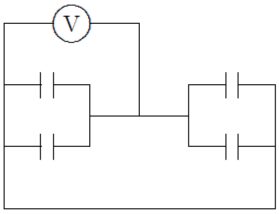
R > S > Q = P
P > Q > R = S
R > P = Q > S
R =P >S = Q
R > P > S = Q

92. Capacitor C_1 is connected alone to a battery and charged until the magnitude of the charge on each plate is 4.0×10^{-8} C. Then it is removed from the battery and connected to two other capacitors C_2 and C_3, as shown. The charge on the positive plate of C1 is then 1.0×10^{-8} C. The charges on the positive plates of C_2 and C_3 are:



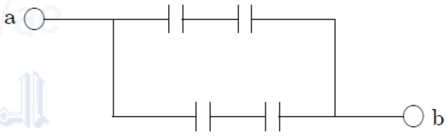
$q_2 = 3.0\times10^{-8}$ C and $q_3 = 3.0\times10^{-8}$ C
$q_2 = 2.0\times10^{-8}$ C and $q_3 = 2.0\times10^{-8}$ C
$q_2 = 5.0\times10^{-8}$ C and $q_3 = 1.0\times10^{-8}$ C
$q_2 = 3.0\times10^{-8}$ C and $q_3 = 1.0\times10^{-8}$ C
$q_2 = 1.0\times10^{-8}$ C and $q_3 = 3.0\times10^{-8}$ C

93. Each of the four capacitors shown is 500 µF. The voltmeter reads 1000V. The magnitude of the charge, in coulombs, on each capacitor plate is:



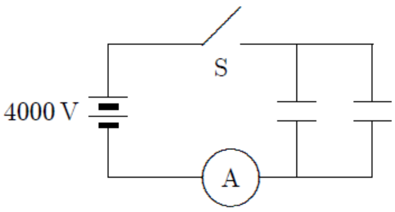
0.2 0.5
20 50
none of these

94. The diagram shows four 6-µF capacitors. The capacitance between points a and b is:



3 µF 4 µF
6 µF 9 µF
1 µF

95. Each of the two 25-µF capacitors shown is initially uncharged. How many coulombs of charge pass through the ammeter A after the switch S is closed?



0.10 0.20
10 0.05
none of these

96. 38. A 20-F capacitor is charged to 200V. Its stored energy is:
4000 J 4 J
0.4J 2000 J
0.1J

97. A charged capacitor stores 10C at 40V. Its stored energy is:
400 J 4 J
0.2J 2.5J
200 J

98. A 2-μF and a 1-μF capacitor are connected in series and charged by a battery. They store energies P and Q, respectively. When disconnected and charged separately using the same battery, they store energies R and S, respectively. Then:

R > P > S > Q
P > Q > R > S
R > P > Q > S
P >R>S >Q
R > S > Q > P

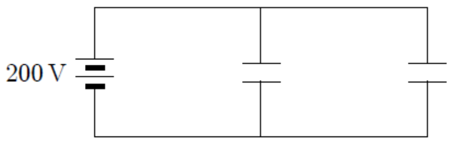
99. The quantity $(1/2)\epsilon_0 E^2$ has the significance of:

energy/farad
energy/coulomb
energy
energy/volume
energy/volt

100. Capacitors A and B are identical. Capacitor A is charged so it stores 4 J of energy and capacitor B is uncharged. The capacitors are then connected in parallel. The total stored energy in the capacitors is now:

16 J
8 J
4 J
2 J
1 J

101. To store a total of 0.040 J of energy in the two identical capacitors shown, each should have a capacitance of:



0.10 μF
0.50 μF0.10 μF
1.0 μF
1.5 μF
2.0 μF

102. A battery is used to charge a parallel-plate capacitor, after which it is disconnected. Then the plates are pulled apart to twice their original separation. This process will double the:

capacitance
surface charge density on each plate
stored energy
electric field between the two places
charge on each plate

103. A parallel-plate capacitor has a plate area of $0.3 m^2$ and a plate separation of 0.1 mm. If the charge on each plate has a magnitude of 5×10^{-6} C then the force exerted by one plate on the other has a magnitude of about:

0
5N
9N
1×10^4 N
9×10^5 N

104. 46. A certain capacitor has a capacitance of 5.0 μF. After it is charged to 5.0 μC and isolated, the plates are brought closer together so its capacitance becomes 10 μF. The work done by the agent is about:

zero
1.25×10^{-6} J
-1.25×10^{-6} J
8.3×10^{-7} J
-8.3×10^{-7} J

105. A dielectric slab is slowly inserted between the plates of a parallel plate capacitor, while the potential difference between the plates is held constant by a battery. As it is being inserted:

the capacitance, the potential difference between the plates, and the charge on the positive plate all increase

the capacitance, the potential difference between the plates, and the charge on the positive plate all decrease

the potential difference between the plates increases, the charge on the positive plate decreases, and the capacitance remains the same

the capacitance and the charge on the positive plate decrease but the potential difference between the plates remains the same

the capacitance and the charge on the positive plate increase but the potential difference between the plates remains the same

106. An air-filled parallel-plate capacitor has a capacitance of 1 pF. The plate separation is then doubled and a wax dielectric is inserted, completely filling the space between the plates. As a result, the capacitance becomes 2 pF. The dielectric constant of the wax is:

0.25
0.5
2.0
4.0
8.0

107. One of materials listed below is to be placed between two identical metal sheets, with no, air gap, to form a parallel-plate capacitor. Which produces the greatest capacitance?

material of thickness 0.1 mm and dielectric constant 2
material of thickness 0.2 mm and dielectric constant 3
material of thickness 0.3 mm and dielectric constant 2
material of thickness 0.4 mm and dielectric constant 8
material of thickness 0.5 mm and dielectric constant 11

108. Two capacitors are identical except that one is filled with air and the other with oil. Both capacitors carry the same charge. The ratio of the electric fields E_{air}/E_{oil} is:

between 0 and 1
0
1
between 1 and infinity
infinite

109. A parallel-plate capacitor, with air dielectric, is charged by a battery, after which the battery is disconnected. A slab of glass dielectric is then slowly inserted between the plates. As it is being inserted:

a force repels the glass out of the capacitor
a force attracts the glass into the capacitor
no force acts on the glass
a net charge appears on the glass
the glass makes the plates repel each other

110. Two parallel-plate capacitors with the same plate separation but different capacitance are connected in parallel to a battery. Both capacitors are filled with air. The quantity that is NOT the same for both capacitors when they are fully charged is:

potential difference
energy density
electric field between the plates
charge on the positive plate
dielectric constant

111. Two parallel-plate capacitors with the same plate area but different capacitance are connected in parallel to a battery. Both capacitors are filled with air. The quantity that is the same for both capacitors when they are fully charged is:

potential difference
energy density
electric field between the plates
charge on the positive plate
plate separation

112. Two parallel-plate capacitors with different plate separation but the same capacitance are connected in series to a battery. Both capacitors are filled with air. The quantity that is NOT the same for both capacitors when they are fully charged is:

potential difference
stored energy
electric field between the plates
charge on the positive plate
dielectric constant

113. Two parallel-plate capacitors with different capacitance but the same plate separation are connected in series to a battery. Both capacitors are filled with air. The quantity that is the same for both capacitors when they are fully charged is:

potential difference
stored energy
energy density
electric field between the plates
charge on the positive plate