

Name: Solutions

Date: \_\_\_\_\_

Quiz name: Ch. 20 - Electrostatics

1. A solid conducting sphere is given a positive charge  $Q$ . How is the charge  $Q$  distributed in or on the sphere?

- A It is concentrated at the center of the sphere.
- B It is uniformly distributed throughout the sphere.
- C Its density decreases radially outward from the center.
- D It is uniformly distributed on the surface of the sphere only.



This is so charges can be as far apart from each other as possible

2. One joule of work is needed to move one coulomb of charge from one point to another with no change in velocity. Which of the following is true between the two points?

- A The current is one ampere.
- B The potential difference is one volt.
- C The electric field strength is one newton per coulomb.
- D The electric field strength is one joule per electron.

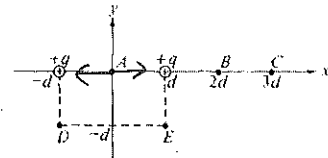
$$\Delta V = \frac{W}{Q} = \frac{1 \text{ J}}{1 \text{ C}} = 1 \text{ V}$$

Two positive charges of magnitude  $q$  are each a distance  $d$  from the origin  $A$  of a coordinate system as shown above.

3. At which of the following points is the electric field least in magnitude?

- A
- B
- C
- D
- E

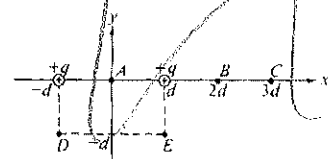
$$\sum E_A = 0$$



Two positive charges of magnitude  $q$  are each a distance  $d$  from the origin  $A$  of a coordinate system as shown above.

4. At which of the following points is the electric field greatest in magnitude?

- A
- B
- C
- D
- E



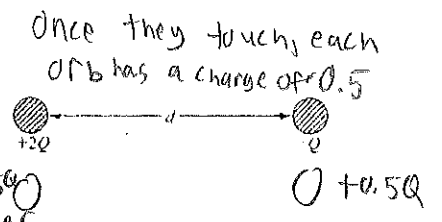
Two identical conducting spheres are charged to  $+2Q$  and  $-Q$ , respectively, and are separated by a distance  $d$  (much greater than the radii of the spheres) as shown above. The magnitude of the force of attraction on the left sphere is  $F_1$ . After the two spheres are made to touch and then are re-separated by distance  $d$ , the magnitude of the force on the left sphere is  $F_2$ .

5. Which of the following relationships is correct?

- (A)  $2F_1 = F_2$
- (B)  $F_1 = F_2$
- (C)  $F_1 = 2F_2$
- (D)  $F_1 = 8F_2$

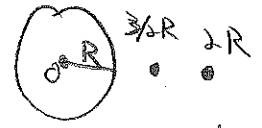
$$F_{old} = k \frac{(2Q)(-Q)}{d^2} = -2 \frac{kQ^2}{d^2}$$

$$F_{new} = k \frac{(0.5Q)(0.5Q)}{d^2} = 0.25 \frac{kQ^2}{d^2} \rightarrow 8 \text{ times smaller}$$



6. A hollow metal sphere of radius R is positively charged. Of the following distances from the center of the sphere, which location will have the greatest electric field strength?

- (A) 0 (center of the sphere)
- (B)  $3R/2$
- (C)  $2R$
- (D) None of the above because the field is of constant strength

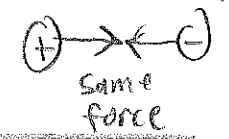


The closer, the larger the electric field. However, the electric field is zero inside the conductor, so it can't be largest at "0".

7. Two isolated charges, +q and -2q, are 2 centimeters apart. If F is the magnitude of the force acting on charge -2q, what are the magnitude and direction of the force acting on charge +q?

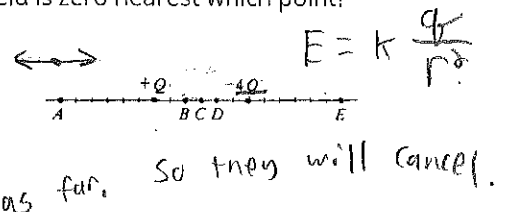
- (A)  $F/2$ : toward charge -2q
- (B)  $2F$ : away from charge -2q
- (C)  $F$ : toward charge -2q
- (D)  $F$ : Away from charge -2q

Newton's 3rd Law states the forces need to be equal and opposite!



8. Charges +Q and -4Q are situated as shown above. The net electric field is zero nearest which point?

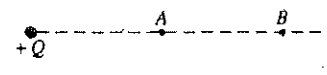
- (A) +Q exerts a leftward electric field of point A.
- (B)
- (C) -4Q exerts a rightward electric field on point A and is twice as far.
- (D)
- (E)



9. The diagram above shows an isolated, positive charge Q. Point (B) is twice as far away from Q as point A. The ratio of the electric field strength at point A to the electric field strength at point B is

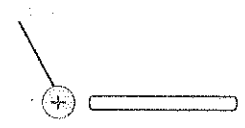
- (A) 8 to 1
- (B) 4 to 1
- (C) 2 to 1
- (D) 1 to 2

$E = k \frac{q}{r^2}$  since r is doubled to get to B, the electric field is reduced to  $\frac{1}{4}$ .



10. A rod attracts a positively charged hanging ball. The rod is

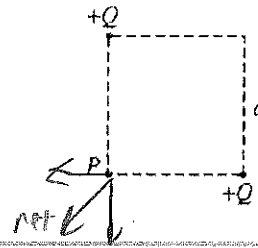
- (A) Positive
- (B) Negative
- (C) Neutral
- (D) Either A or C
- (E) Either B or C



The figure above shows two particles, each with a charge of +Q, that are located at the opposite corners of a square of side d.

11. What is the direction of the net electric field at point P?

- (A) Up & Left
- (B) Up & Right
- (C) Down & Left
- (D) Down & Right

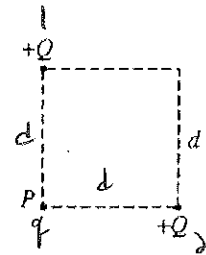


The figure above shows two particles, each with a charge of +Q, that are located at the opposite corners of a square of side d.

12. What is the potential energy of a particle of charge +q that is held at point P?

- (A) Zero
- (B)  $\sqrt{2}(kqQ/d)$
- (C)  $2kqQ/d$
- (D)  $2\sqrt{2}(kqQ/d)$

$V_1 = k \frac{qQ}{d}$  Voltage is  
 $V_2 = k \frac{qQ}{d}$  Scalar, not  
 Vector  
 $V_{total} = V_1 + V_2 = 2k \frac{qQ}{d}$

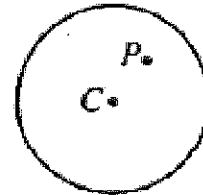


13.

- (A) It is zero at C, but at P it is not zero and is directed inward.
- (B) It is zero at C, but at P it is not zero and is directed outward.
- (C) It is not zero at either point.
- (D) It is zero at both points.

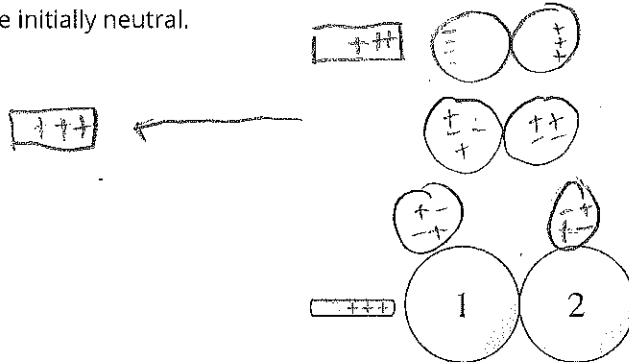
The hollow metal sphere shown above is positively charged. Point C is the center of the sphere and point P is any other point within the sphere. Which of the following is true of the electric field at these points?

zero everywhere  
inside a conductor



Metal spheres 1 and 2 are touching. Both are initially neutral.

- a) The charged rod is brought near.
- b) The charged rod is then removed.
- c) The spheres are separated.



14. Afterward, the charges on the sphere are:

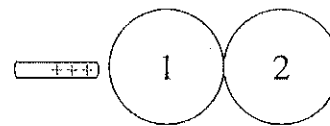
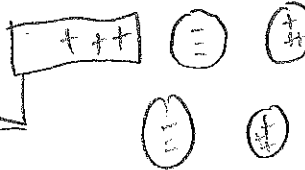
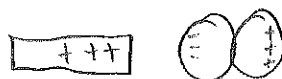
- (A)  $Q_1$  is + and  $Q_2$  is +
- (B)  $Q_1$  is + and  $Q_2$  is -
- (C)  $Q_1$  is - and  $Q_2$  is +
- (D)  $Q_1$  is - and  $Q_2$  is -
- (E)  $Q_1$  is 0 and  $Q_2$  is 0

Metal spheres 1 and 2 are touching. Both are initially neutral.

- a) The charged rod is brought near.
- b) The spheres are separated.
- c) The charged rod is then removed.

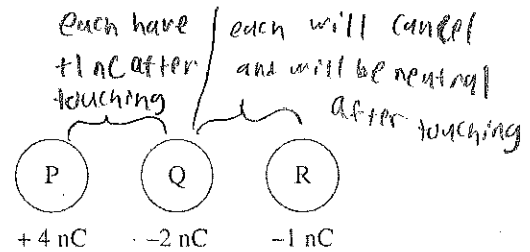
15. Afterward, the charges on the sphere are:

- (A)  $Q_1$  is + and  $Q_2$  is +
- (B)  $Q_1$  is + and  $Q_2$  is -
- (C)  $Q_1$  is - and  $Q_2$  is +
- (D)  $Q_1$  is - and  $Q_2$  is -
- (E)  $Q_1$  is 0 and  $Q_2$  is 0



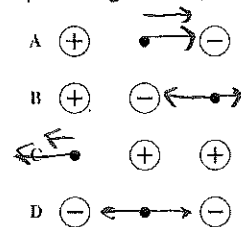
16. Identical metal spheres are initially charged as shown. Spheres P and Q are touched together and then separated. Then spheres Q and R are touched together and separated. Afterward the charge on sphere R is

- (A) -1 nC
- (B) -0.5 nC
- (C) 0 nC
- (D) 0.5 nC
- (E) 1 nC



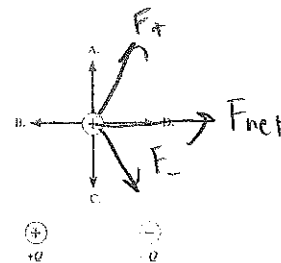
17. In each of the following cases, an identical small, positive charge is placed at the black dot. In which case is the force on the small charge the largest? (All charges shown are of equal magnitude.)

- (A) A
- (B) B
- (C) C
- (D) D



18. Which is the direction of the net force on the charge at the top?

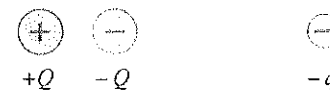
- (A) A
- (B) B
- (C) C
- (D) D
- (E) None of these



19. The direction of the force on charge -q is

- (A) Up
- (B) Down
- (C) Left
- (D) Right
- (E) zero

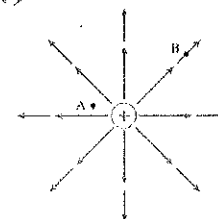
It is closer to the negative charge, so it will have a larger repulsive force than attractive.



20. At which point is the electric field stronger?

- (A) Point A
- (B) Point B
- (C) Not enough info

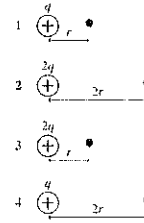
$E = k\frac{Q}{r^2} \rightarrow$  smaller  $r$  means larger  $E$ .



21. Rank in order, from largest to smallest, the magnitudes of the electric field at the black dot.

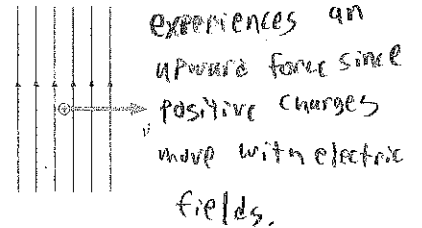
- (A) 3,2,1,4
- (B) 3,1,2,4
- (C) 1,4,2,3
- (D) 3,1,2,4

$$E = k \frac{q}{r^2}$$



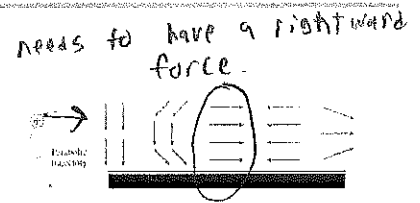
22. A proton is moving to the right in a vertical electric field. A very short time later, the proton's velocity is

- (A) Up
- (B) Up & Right
- (C) Right
- (D) Down & Right
- (E) Down



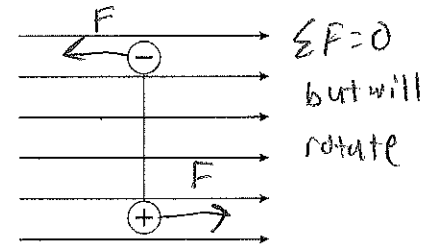
23. Which electric field is responsible for the proton's trajectory?

- (A) A
- (B) B
- (C) C
- (D) D
- (E) E



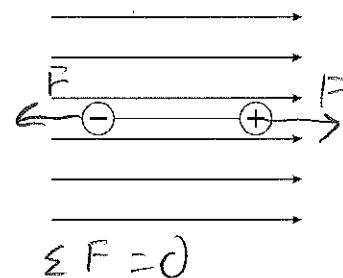
24. A dipole is held motionless in a uniform electric field. When the dipole is released, which of the following describes the subsequent motion?

- (A) The dipole moves to the right
- (B) The dipole moves to the left
- (C) The dipole rotates clockwise
- (D) The dipole rotates counterclockwise
- (E) The dipole remains motionless



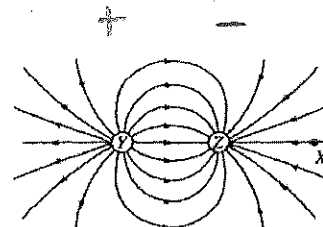
25. A dipole is held motionless in a uniform electric field. When the dipole is released, which of the following describes the subsequent motion?

- (A) The dipole moves to the right
- (B) The dipole moves to the left
- (C) The dipole rotates clockwise
- (D) The dipole rotates counterclockwise
- (E) The dipole remains motionless



26. The diagram above shows electric field lines in an isolated region of space containing two small charged spheres, Y and Z. Which of the following statements is true?

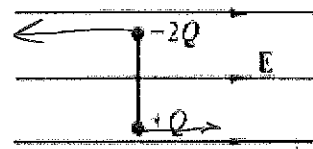
- A The charge on Y is negative and the charge on Z is positive
- B The strength of the electric field is the same everywhere
- C The electric field is strongest at point X
- D A small negatively charged object placed at point X would tend to move toward the ~~left~~



*Right the point X is closer to Z than Y, so it will repel.*

27. A rigid insulated rod, with two unequal charges attached to its ends, is placed in a uniform electric field  $E$  as shown above. The rod experiences a

- A net force to the left and a clockwise rotation
- B net force to the left and a counterclockwise rotation
- C net force to the right and a clockwise rotation
- D net force to the right and a counterclockwise rotation

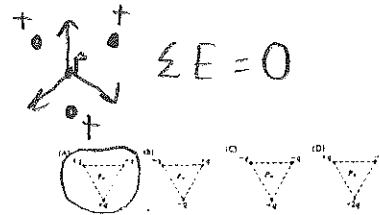


$\Sigma F = \text{left}$   
rotate  
counterclockwise

The following configurations of electric charges are located at the vertices of an equilateral triangle. Point P is equidistant from the charges.

28. In which configuration is the electric field at P equal to zero?

- A
- B
- C
- D

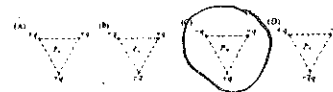


$\Sigma E = 0$   
hard to see

The following configurations of electric charges are located at the vertices of an equilateral triangle. Point P is equidistant from the charges.

29. In which configuration is the electric field at P pointed at the midpoint between two of the charges?

- A
- B
- C
- D

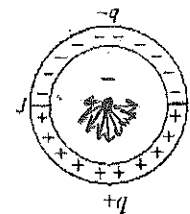


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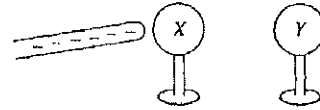
30. A circular ring made of an insulating material is cut in half. One half is given a charge  $-q$  uniformly distributed along its arc. The other half is given a charge  $+q$  also uniformly distributed along its arc. The two halves are then rejoined with insulation at the junctions J, as shown above. If there is no change in the charge distributions, what is the direction of the net electrostatic force on an electron located at the center of the circle?

- A Up
- B Down
- C Left
- D Right



31. Two metal spheres that are initially uncharged are mounted on insulating stands, as shown above. A negatively charged rubber rod is brought close to, but does not make contact with, sphere X. Sphere Y is then brought close to X on the side opposite to the rubber rod. Y is allowed to touch X and then is removed some distance away. The rubber rod is then moved far away from X and Y. What are the final charges on the spheres?

- A  $X = 0$   
 $Y = 0$
- B  $X = -$   
 $Y = +$
- C  $X = +$   
 $Y = -$
- D  $X = +$   
 $Y = -$



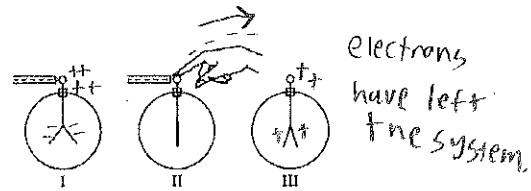
32. If the only force acting on an electron is due to a uniform electric field, the electron moves with constant

- A acceleration in a direction opposite to that of the field
- B acceleration in the direction of the field
- C speed in a direction opposite to that of the field
- D speed in the direction of the field

The uniform field will exert a constant force:  $F = k \frac{qQ}{r^2}$   
Thus a constant acceleration

33. When a negatively charged rod is brought near, but does not touch, the initially uncharged electroscope shown above, the leaves spring apart (I). When the electroscope is then touched with a finger, the leaves collapse (II). When next the finger and finally the rod are removed, the leaves spring apart a second time (III). The charge of the leaves is

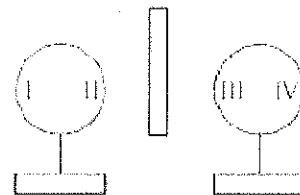
- A positive in both I and III
- B negative in both I and III
- C positive in I, negative in III
- D negative in I, positive in III



A charged rod is placed between two insulated conducting spheres as shown. The spheres have no net charge.

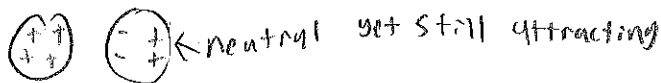
34. Region II has the same polarity as Region

- A I only
- B III only
- C IV only
- D I & IV only



35. It is possible for a neutral object to be attracted to a charged object

- A True
- B False



36. It is possible for a neutral particle to be attracted to a charged particle

- A True
- B False

Two small hollow metal spheres hung on insulating threads attract one another as shown. It is known that a positively charged rod will attract ball A.

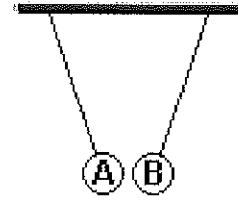
- I. Ball A has a positive charge
- II. Ball B has a negative charge
- III. Ball A and Ball B have opposite charges

37.

Which of the above can be correctly concluded about the charge on the balls?

- (A) I only
- (B) II only
- (C) III only
- (D) none of these

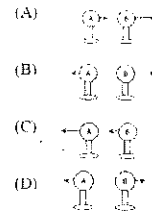
It is possible that  
A is neutral



Two uniformly charged non-conducting spheres on insulating bases are placed on an air table. Sphere A has a charge  $+3Q$  coulombs and sphere B has a charge  $+Q$  coulombs. Which of the following correctly illustrates the magnitude and direction of the electrostatic force between the spheres when they are released?

- 38.
- (A) A
  - (B) B
  - (C) C
  - (D) D

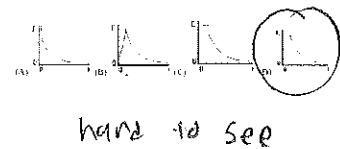
equal and opposite forces.



Which of the following graphs would best represent the electric field of a hollow sphere as a function of distance from its center when it is charged to a potential of 400,000 volts?

- 39.
- (A) A
  - (B) B
  - (C) C
  - (D) D

Electric field increases as you get closer. However  $E=0$  inside the sphere.



hard to see

Four positive charges are fixed at the corners of a square, as shown above. Three of the charges have magnitude  $Q$ , and the fourth charge has a magnitude  $2Q$ . Point P is at the center of the square at a distance  $r$  from each charge. What is the electric potential at Point P?

- 40.
- (A)  $kQ/r$
  - (B)  $2kQ/r$
  - (C)  $4kQ/r$
  - (D)  $5kQ/r$

$$V_1 = k \frac{Q}{r}$$

$$V_2 = k \frac{2Q}{r}$$

$$V_3 = k \frac{Q}{r}$$

$$V_4 = k \frac{Q}{r}$$

$$V_{\text{net}} = V_1 + V_2 + V_3 + V_4 = 5k \frac{Q}{r}$$

