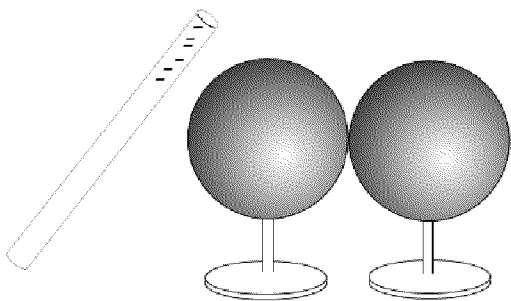1. Two identical conducting spheres are charged to $+Q$ and $+2Q$ respectively, and are separated by a distance d (much greater than the radii of the spheres). The magnitude of the force on the right sphere is F_1. After the two spheres are made to touch and then are reseparated by a distance d, the magnitude of the force on the right sphere is F_2. Which of the following relationships is correct?

   A) $2F_1 = F_2$

   B) $9F_1 = 8F_2$

   C) $F_1 = F_2$

   D) $8F_1 = 9F_2$

   E) $F_1 = 2F_2$

2.

   Two neutral conducting spheres are in contact when a negatively charged wand approaches but does not touch the left sphere. The two spheres are then separated. Which of the following choices describes the charge distribution in the two spheres?

   A) Left Sphere: Neutral
      Right Sphere: Neutral

   B) Left Sphere: Negatively Charged
      Right Sphere: Positively Charged

   C) Left Sphere: Positively Charged
      Right Sphere: Negatively Charged

   D) Left Sphere: Negatively Charged
      Right Sphere: Neutral

   E) Left Sphere: Positively Charged
      Right Sphere: Neutral

3.
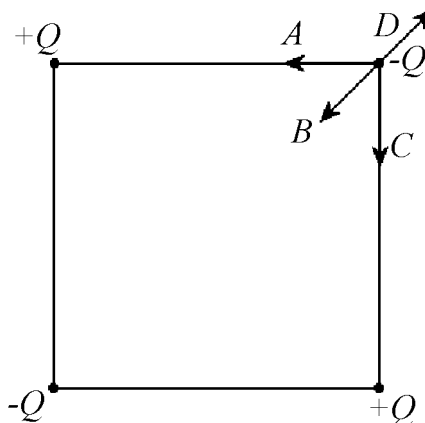
   Four point charges, each of the same magnitude, with varying signs are arranged at the corners of a square as shown. Which vector (A, B, C or D) shows the correct direction of the net force on the $-Q$ charge in the upper right corner of the square?

   A) A

   B) B

   C) C

   D) D

   E) The Net Force is 0

4. 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 $2R$?

   A) $\frac{F}{4}$

   B) $\frac{F}{2}$

   C) F

   D) $2F$

   E) $4F$

5. A charge Q exerts a 12 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?

A) 3 N

B) 6 N

C) 24 N

D) 36 N

E) 48 N

6.
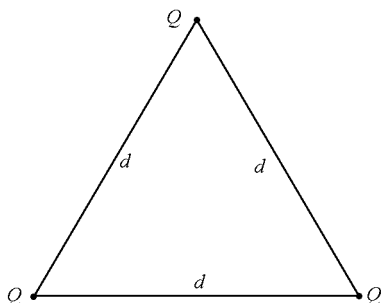
Three identical point charges, Q, are placed at the vertices of an equilateral triangle as shown in the figure. The length of each side of the triangle is d. Determine the magnitude and direction of the total electrostatic force on the charge at the top of the triangle.

A) $\dfrac{Q^2\sqrt{3}}{4\pi\varepsilon_0 d^2}$ upwards

B) $\dfrac{Q^2\sqrt{3}}{4\pi\varepsilon_0 d^2}$ downwards

C) $\dfrac{Q^2\sqrt{3}}{2\pi\varepsilon_0 d^2}$ upwards

D) $\dfrac{Q^2\sqrt{3}}{2\pi\varepsilon_0 d^2}$ downwards

E) The net force is 0.

7. A –4.0 µC charge is located 0.30 m to the left of a +6.0 µC charge. The electrostatic force on the positive charge is nearest to

A) 2.4 N to the right.

B) 2.4 N to the left.

C) 4.8 N to the right.

D) 4.8 N to the left.

E) 7.2 N to the right.

8. The distance between two negative point charges is doubled. The strength of the electrostatic force between these charges will

A) increase by a factor of 2

B) increase by a factor of 4

C) decrease by a factor of 2

D) decrease by a factor of 4

E) remain the same

9. The electrostatic force between two positive point charges doubles. Which of the following is the most likely explanation for this?

A) The mass of one of the particles doubled.

B) The charge on both particles doubled.

C) The charge on one particle was halved.

D) The distance between the charges was doubled.

E) The charge on one particle was quadrupled, while the other was halved.

10. Two 1 kg spheres each carry a charge of 1 C. Compared to the electrostatic force between the spheres, the gravitational force between them is

    A) much greater

    B) about equal

    C) much less

    D) more dependent upon the distance

    E) stronger if the charges are the same sign, but weaker if the charges have opposite signs

11. The motion of large bodies at great distances is governed primarily by gravity and not by the electrostatic force because

    A) gravity is a much stronger force than the electrostatic force

    B) the electrostatic force is felt only over short distances

    C) of the relative scarcity of antiparticles

    D) the majority of matter is electrically neutral

    E) the electrostatic force is canceled out by the magnetic force

12. Base your answer on the following picture (not to scale), with charges of –q and +3q a distance 2L apart along the x-axis.
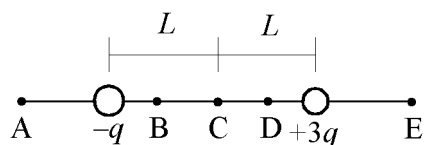
   In the diagram above, at which of the points would a positive test charge most likely feel no electrostatic force?

    A) A

    B) B

    C) C

    D) D

    E) E

13. Two identical positive charges are brought close together, then released from rest. As the charges move away, they will have

    A) increasing velocity and increasing acceleration

    B) increasing velocity and decreasing acceleration

    C) decreasing velocity and decreasing acceleration

    D) decreasing velocity and increasing acceleration

    E) increasing velocity and constant acceleration

14.
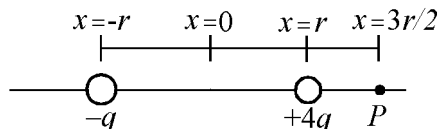
    In the diagram above, what is the force a small negative test charge of magnitude z would feel at point P?

    A) $\dfrac{12kqz}{25r^2}$

    B) $\dfrac{-396kqz}{25r^2}$

    C) $\dfrac{4kqz}{3r^2}$

    D) $\dfrac{-4kqz}{3r^2}$

    E) 0

15. A charge $+Q$ is fixed in position as a small charge $+q$ is brought near it and released from rest. Of the graphs shown, which best represents a, the acceleration of the $+q$ charge as a function of r, its distance from $+Q$?
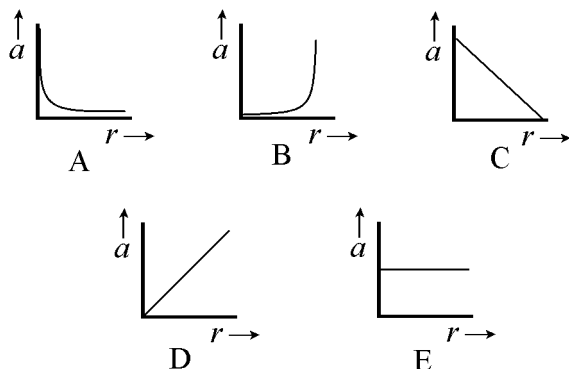
A) A

B) B

C) C

D) D

E) E

16. A charge $+Q$ is fixed in position as a small charge $+q$ is brought near it and released from rest. Which best describes the magnitude of the velocity of the charge $+q$ as r, the distance between the charges increases?

A) The magnitude of the velocity will increase, and its rate of increase will also increase.

B) The magnitude of the velocity will increase, but its rate of increase will decrease.

C) The magnitude of the velocity will remain constant.

D) The magnitude of the velocity will decrease, and its rate of decrease will also decrease.

E) The magnitude of velocity will increase, but its rate of decrease will increase.

17. Two isolated charges, $+q$ and $+2q$ are 4 centimeters apart. If F is the force acting on the charge $+q$, what is the magnitude and direction of the force on the charge $+2q$?

A) $\frac{1}{2}F$ toward charge $+2q$

B) $\frac{1}{2}F$ away from charge $+2q$

C) $2F$ toward charge $+2q$

D) F away from charge $+q$

E) $2F$ away from charge $+q$

18. Which procedure will double the force between two point charges?

A) doubling the distance between the charges

B) doubling the magnitude of one charge

C) doubling the magnitude of both charges

D) halving the distance between the charges

E) halving the magnitude of one charge

19. If the distance between two charged particles is doubled, as well as the charge of one of the particles, the electrostatic force between the particles

A) remains the same

B) increases by a factor of 2

C) increase by a factor of 4

D) decreases by a factor of 2

E) decreased by a factor of 4

20. If the distance between two charged particles is doubled as well as both of the masses of the charged particles, the gravitational force between them would

A) be doubled

B) be halved

C) remain constant

D) be quadrupled

E) be squared

21. Two charged spheres are a fixed distance apart. If the charge on each of sphere is increased from 2 C to 6 C, the electrostatic force between the spheres is

A) 3 times as great

B) 4 times as great

C) 8 times as great

D) 9 times as great

E) 16 times as great

Base your answers to questions **22** through **24** on the following:

A neutron, a proton, and an electron are initially at the same distance from a relatively large stationary nucleus moving at a constant velocity. Assume the masses of the proton and neutron are equal.

22. Which is the first particle to reach the nucleus?

A) the neutron

B) the proton

C) the electron

D) both the neutron and the proton reach it simultaneously

E) all three reach at the same time

23. Which particle experiences the greatest force?

A) the neutron

B) the proton

C) the electron

D) the electron and the proton feel the same force

E) the proton and the neutron feel the same force

24. Which particle experiences the greatest acceleration?

A) the neutron

B) the proton

C) the electron

D) the electron and the proton experience the same acceleration

E) the neutron and the proton experience the same acceleration

1.   B

2.   C

3.   B

4.   A

5.   A

6.   A

7.   B

8.   D

9.   E

10.   C

11.   D

12.   A

13.   B

14.   B

15.   A

16.   B

17.   D

18.   B

19.   D

20.   C

21.   D

22.   C

23.   D

24.   C

Name _____   Class _____   Date _____

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

13. _____

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24. _____