**PART A: MULTIPLE CHOICE**

1.   What is the force between a 1.50×10^{-5} C charge and a 1.03×10^{-5} C charge that are separated by a distance of 12.0 m?

    (A) 9.66×10^{-3} N
    (B) 1.16×10^{-1} N
    (C) 9.66×10^{9} N
    (D) 1.16×10^{11} N

2.   How far apart are two charges of 0.150 C and 0.0750 C if the force between them is 4.25 N?

    (A) 4.20×10^{-8} m
    (B) 2.05×10^{-4} m
    (C) 4.88×10^{3} m
    (D) 2.38×10^{7} m

3.   What is the electric force between two point charges of 1.5×10^{-6} C and 2.0×10^{-6} C that are separated by a distance of 0.50 m?

    (A) 6.0×10^{-12} N
    (B) 1.2×10^{-11} N
    (C) 5.4×10^{-2} N
    (D) 1.1×10^{-1} N

4.   The electric force between two charges is 0.012 N. What is the new electric force if the distance between the charges is doubled, and the value of one charge is tripled?

    (A)   0.0080 N
    (B)   0.0090 N
    (C)   0.016 N
    (D)   0.018 N

5.   What is the magnitude of the electric force between two point charges of 4.5×10^{-6} C and 2.5×10^{-5} C, that are separated by a distance of 0.015 m?

    (A) 7.5×10^{-9} N
    (B) 5.0×10^{-7} N
    (C) 6.8×10^{1} N
    (D) 4.5×10^{3} N

6.   What is the electric force between a -1.7×10^{-6} C charge and a -2.0×10^{-6} C charge separated by a distance of 0.25 m?

    (A) 5.7×10^{-11} N
    (B) 4.9×10^{-10} N
    (C) 1.2×10^{-1} N
    (D) 4.9×10^{-1} N

7. What is the electrostatic force between two protons separated by a distance of 1.0×10^{-6} m?

    (A) -9.0×10^{21} N
    (B) -2.3×10^{-16} N
    (C) $+2.3 \times 10^{-16}$ N
    (D) $+9.0 \times 10^{21}$ N

8. Two identical spheres with charges Q_1 and Q_2 are separated by a distance, d. What will happen to the electric force experienced if the charge on one sphere is doubled, and the distance between the spheres is also doubled?

    (A) decrease by a factor of 2
    (B) decrease by a factor of 4
    (C) increase by a factor of 2
    (D) increase by a factor of 4

9. Two charged particles are separated by a distance, d. What happens to the magnitude of the force between the particles if the distance between the particles is divided in two, $\frac{1}{2}d$?

    (A) decreases by a factor of 2
    (B) decreases by a factor of 4
    (C) increases by a factor of 2
    (D) increases by a factor of 4

10. The electrostatic force between two charged spheres, X and Y, doubles. What could explain this situation?

    (A) The charge on only sphere Y has doubled.
    (B) The charge on only sphere Y has halved.
    (C) The distance between spheres X and Y has doubled.
    (D) The distance between spheres X and Y has halved.

11. Three charged spheres are lined up horizontally as shown. Spheres X and Y have identical charge Q. What charge on sphere Z will result in a net force of 0 on sphere Y?
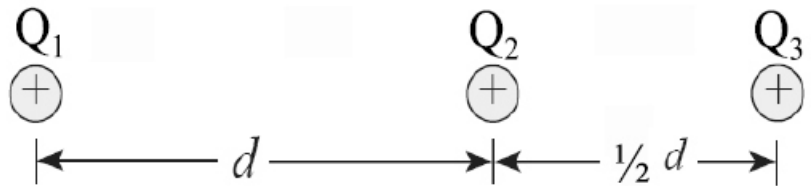
    (A) $-4Q$

    (B) $-\frac{1}{4}Q$

    (C) $+\frac{1}{4}Q$

    (D) $+4Q$
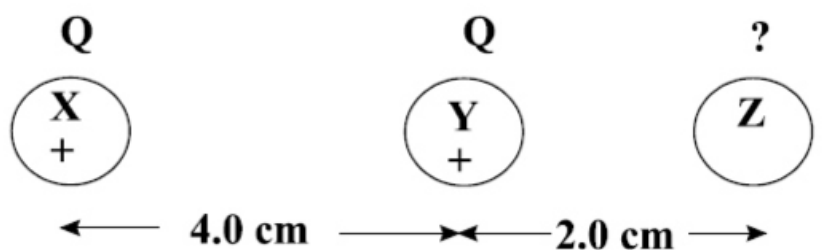
12. If the charges on each of two identical spheres are doubled and the distance between the charges is halved, by what factor is the electrostatic force increased?

    (A) 2
    (B) 4
    (C) 8
    (D) 16

13. Three identical electric charges are shown in the diagram below. What is the direction of the net electric force on Q_2 due to Q_1 and Q_3?

(A) into the page
(B) out of the page
(C) to the left
(D) to the right

Q_1 $\quad\quad\quad$ Q_2 $\quad\quad\quad$ Q_3

$\oplus$ $\quad\quad\quad$ $\oplus$ $\quad\quad\quad$ $\oplus$

$\longleftarrow\quad\quad d \quad\quad\longrightarrow\!\!\longleftarrow\; \tfrac{1}{2}\,d \longrightarrow$

14. Two charged objects attract each other with a force, F. By what factor would the force increase if one charge is doubled, the other charge is tripled, and the distance between their centres is reduced to one quarter its original value?

(A) 6
(B) 16
(C) 24
(D) 96

15. The magnitude of the electrostatic force between two charges is F. If the distance d between the charges is decreased to ½ d, what is the new force between the charges?

(A) $\tfrac{1}{8}$ F

(B) $\tfrac{1}{2}$ F

(C) 2 F

(D) 4 F

16. In the diagram below sphere A and B exert a 4.0 N force on each other. If all three spheres have equal charges, what is the net force on sphere C?

$\oplus$ $\longleftarrow$ X $\longrightarrow$ $\oplus$ $\longleftarrow$ X $\longrightarrow$ $\ominus$
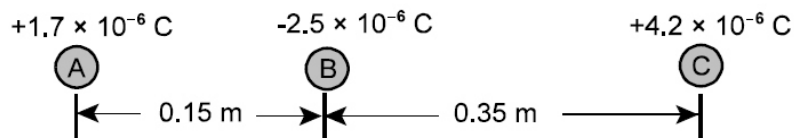
A $\quad\quad\quad$ B $\quad\quad\quad$ C
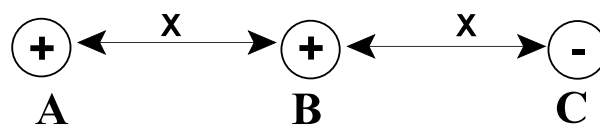
(A) 0 N
(B) 2.0 N
(C) 5.0 N
(D) 8.0 N

17. The magnitude of the electrostatic force between two charges is F. If the distance (d) between the charges is increased to d, what is the new force between the charges?
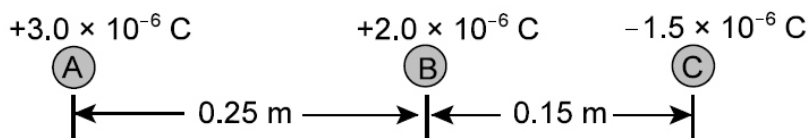
(A) F

(B) $\dfrac{2}{3}$ F

(C) $\dfrac{4}{9}$ F

(D) $\dfrac{9}{4}$ F

PART B: WRITTEN RESPONSE

1.   Three charged objects are arranged as shown. Calculate the net electric force on
        object B due to the presence of objects A and C. **JUNE 2009**

+1.7 × 10⁻⁶ C   -2.5 × 10⁻⁶ C   +4.2 × 10⁻⁶ C
     (A)   (B)   (C)
        |←—— 0.15 m ——→|←——— 0.35 m ———→|

2.   Three charged objects are arranged as shown. Calculate the magnitude and
        direction of the net electric force on object B due to the presence of objects A
        and C. **JUNE 2008**

+3.0 × 10⁻⁶ C   +2.0 × 10⁻⁶ C   − 1.5 × 10⁻⁶ C
    (A)   (B)   (C)
       |←——— 0.25 m ———→|←— 0.15 m —→|

3.   Three charged objects are arranged as shown. Calculate the net force on Y due
        to the presence of X and Z. **AUGUST 2007**

        (X)- - - - - - - - - - - -(Y)- - - - - - - - - - - -(Z)
                    0.10 m   0.15 m
+2.0 × 10⁻⁶ C   -1.0 × 10⁻⁶ C   +3.0 × 10⁻⁶ C

4.   Two identically charged objects are placed 2.0 cm apart. The force of repulsion between
        them is 2.8 × 10⁻² N. August 2004

        (i)   Determine the magnitude of the charge on each object.

        (ii)   The charge on one object is doubled and the charge on the other is tripled. How
                will this change affect the magnitude of the electrical force between them?

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PART B: WRITTEN RESPONSE
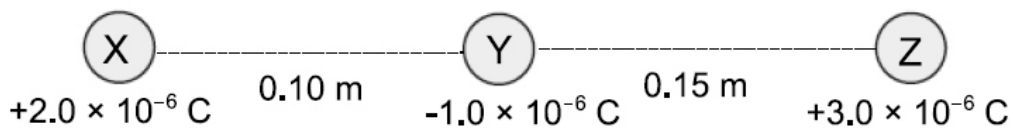
1.   Three charged objects are arranged as shown. Calculate the net electric force on
        object B due to the presence of objects A and C. **JUNE 2009**

$+1.7 \times 10^{-6}$ C -2.5×10^{-6} C $+4.2 \times 10^{-6}$ C
     (A)   (B)   (C)
        |←—— 0.15 m ——→|←——— 0.35 m ———→|

2.   Three charged objects are arranged as shown. Calculate the magnitude and
        direction of the net electric force on object B due to the presence of objects A
        and C. **JUNE 2008**

$+3.0 \times 10^{-6}$ C $+2.0 \times 10^{-6}$ C $- 1.5 \times 10^{-6}$ C
    (A)   (B)   (C)
       |←——— 0.25 m ———→|←— 0.15 m —→|

3.   Three charged objects are arranged as shown. Calculate the net force on Y due
        to the presence of X and Z. **AUGUST 2007**

        (X)- - - - - - - - - - - -(Y)- - - - - - - - - - - -(Z)
                    0.10 m   0.15 m
$+2.0 \times 10^{-6}$ C -1.0×10^{-6} C $+3.0 \times 10^{-6}$ C

4.   Two identically charged objects are placed 2.0 cm apart. The force of repulsion between
        them is 2.8×10^{-2} N. August 2004

        (i)   Determine the magnitude of the charge on each object.

        (ii)   The charge on one object is doubled and the charge on the other is tripled. How
                will this change affect the magnitude of the electrical force between them?

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