Proportional Reasoning with Coulomb's Law
Lesson Notes

Focus Questions:

- How can you predict the effect of varying charge upon the value of the electric force?
- How can you predict the effect of varying separation distance upon the value of the electric force?

Coulomb's Law

The force of attraction or repulsion between two charged objects is …

- directly proportional to the product of their charges
- inversely proportional to the square of their separation distance

$$F_{elect} \propto \frac{Q_A \cdot Q_B}{d^2}$$

Q stands for the quantity of charge on Object A and B

d stands for the distance between the centers of A and B

- As either of the Q value increases, the F_{elect} _____.
- As either of the d value increases, the F_{elect} _____.

Effect of Charge upon Electric Force

F_{elect} is directly proportional to the product of the charges. As either charge increases, the force increases ... and increases by the same factor that the charge is increased by.

Examples

- If Q_A is doubled, then F_{elect} is _____.
- If Q_A is tripled, then F_{elect} is _____.
- If Q_A is halved, then F_{elect} is _____.
- If both Q_A and Q_B is doubled, then F_{elect} is _____.
- If Q_A is doubled and Q_B is tripled, then F_{elect} is _____.
- If Q_A is tripled and Q_B is halved, then F_{elect} is _____.

More Illustrations:

Which two rows demonstrate that ...

1. doubling Q_A will double F_{elect}? _____
2. doubling Q_B will double F_{elect}? _____
3. doubling both Q_A and Q_B will quadruple F_{elect}? _____
4. quadrupling Q_A will quadruple F_{elect}? _____
5. halving Q_A will halve F_{elect}? _____
6. tripling Q_A will triple F_{elect}? _____
7. halving Q_A and doubling Q_B will have no effect upon F_{elect}? _____

	Q_A	Q_B	F_{elect}
A.	2.0 μC	4.0 μC	5.0 N
B.	4.0 μC	4.0 μC	10.0 N
C.	2.0 μC	8.0 μC	10.0 N
D.	4.0 μC	8.0 μC	20.0 N
E.	8.0 μC	4.0 μC	20.0 N
F.	1.0 μC	4.0 μC	2.5 N
G.	6.0 μC	4.0 μC	15.0 N
H.	1.0 μC	8.0 μC	5.0 N

Effect of Separation Distance upon Electric Force

F_{elect} is inversely proportional to the square of the separation distance. As distance increases, the force decreases ... and decreases by the square of the factor that the distance is increased by.

Examples:

- If **d** is doubled, then $\mathbf{F_{elect}}$ becomes _____ of the original value.
- If **d** is tripled, then $\mathbf{F_{elect}}$ becomes _____ of the original value.
- If **d** is quadrupled, then $\mathbf{F_{elect}}$ becomes _____ of the original value.
- If $\mathbf{Q_A}$ is halved, then $\mathbf{F_{elect}}$ is _____.

More Illustrations

Which two rows demonstrate that ...

1. doubling d will cause F_{elect} to be 1/4-th the original value? _____
2. tripling d will cause F_{elect} to be 1/9-th the original value? _____
3. quadrupling d will cause F_{elect} to be 1/16-th the original value? _____
4. halving d will cause F_{elect} to quadruple? _____
5. decreasing d by a factor of 4 will cause F_{elect} to be 16 times the original value? _____

	d	F_{elect}
A.	20.0 cm	16.0 N
B.	40.0 cm	4.0 N
C.	60.0 cm	1.8 N
D.	80.0 cm	1.0 N
E.	10.0 cm	64.0 N
F.	5.0 cm	256.0 N

Practice

Complete the following statements:

Objects 1 and 2 attract with a force of 24.0 units. If the charge of ...

a. … Object 1 is tripled, then the new electric force will be _____ units.
b. … Object 1 is halved, then the new electric force will be _____ units.
c. … both objects is doubled, then the new electric force will be _____ units.
d. … Object 1 is doubled and Object 2 is tripled, then the new electric force will be _____ units.

Objects 1 and 2 attract with a force of 24.0 units. If the separation distance is

e. … doubled, then the new electric force will be _____ units.
f. … halved, then the new electric force will be _____ units.
g. … tripled, then the new electric force will be _____ units.