10 Electric charge, force, and field – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	**Write it 3 times** (English)		
Electric charge			
Coulomb's law			
conductor			
insulator			
conduction			
induction			
electric field			

Recall

You have already seen electric charge in action:

- Rub a balloon on your hair and it sticks to the wall – that is static electricity.
- Like charges push apart; opposite charges pull together.
- A metal wire lets charge flow; plastic does not.

This sheet makes the force between charges exact. Each idea has a worked example.

New ideas

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1 Electric charge

Electric charge comes in two kinds, positive and negative. Like charges **repel**, opposite charges **attract**. Charge is carried by electrons moving from one object to another.

2 Coulomb's law

The force between two point charges is **Coulomb's law**:

$$F = \frac{kq_1q_2}{r^2},$$

with $k = 9.0 \times 10^9$. Like gravity it is an inverse-square law, but it can push **or** pull.

Worked example. Two charges of 3.0 μC and 2.0 μC sit 0.10 m apart: $F = \dfrac{9.0 \times 10^9 \times (3.0 \times 10^{-6})(2.0 \times 10^{-6})}{(0.10)^2} = 5.4$ N.

3 Conductors, insulators, and charging

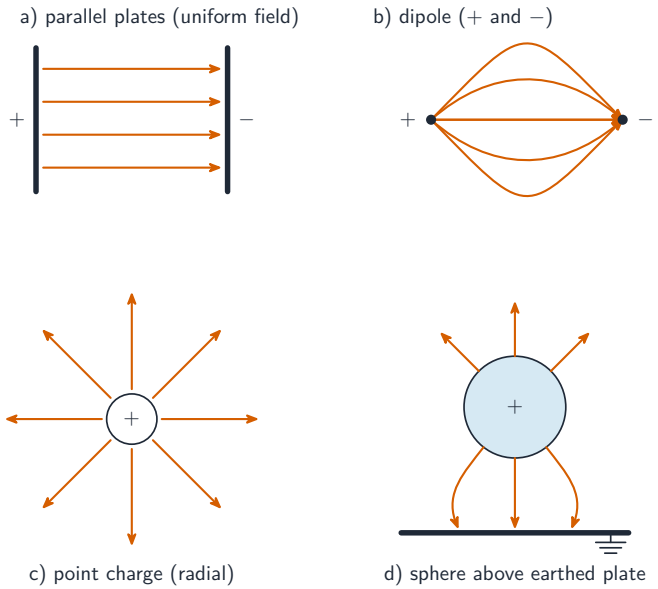
A **conductor** lets charge move freely (metals); an **insulator** holds it in place (plastic, rubber). Objects charge up by **friction** (rubbing), by **conduction** (touching), or by **induction** (a nearby charge pushes charge around inside a neutral object).

4 The electric field

An **electric field** E is the force felt per unit of charge:

$$E = \frac{F}{q}, \qquad \text{so a charge in a field feels} \qquad F = qE.$$

Field lines point away from positive charges and toward negative ones.



Worked example. A field of 2000 N/C acts on a 3.0×10^{-6} C charge: $F = qE = 3.0 \times 10^{-6} \times 2000 = 6.0 \times 10^{-3}$ N.

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> **Watch out:** Coulomb's law is inverse-square – **doubling** the distance makes the force **four times smaller**, not two times. Always square the distance.

Practice

Try these in order. The methods are all above.

2.1 State whether the force is a push or a pull between (a) two positive charges, (b) a positive and a negative charge. [2]

2.2 Two charges of 4.0 μC and 1.0 μC are 0.20 m apart. Find the force between them ($k = 9.0 \times 10^9$). [3]

2.3 Give one example each of a good conductor and a good insulator. [2]

2.4 A field of 500 N/C acts on a 2.0×10^{-6} C charge. Find the force on it. [2]

2.5 Two charges are moved from 0.10 m apart to 0.20 m apart. State what happens to the force between them, and by what factor. [2]