

- 3) They both depend on 2 objects, their distance apart, and a constant (k or G). In Coulomb's law the force depends on the charge of the objects, in gravitation it depends on the mass of the objects. Gravitation can only attract, but Coulomb's law can have attraction or repulsion.
- 4) 4 times (1/4 as strong); 9 times (1/9 as strong)
- 6) Conductor: charge easily flows through, Insulator: charge does not flow through, Semiconductor: can have electricity flow under certain conditions
- 7) positively charged: has lost electrons, negatively charged: has extra electrons
- 8) negative
- 10) contact: electrons physically move between two objects, induction: a charged object pushes or pulls electrons in a nearby object to create a charge difference in that second object
- 12) Neutral object can gain an induced charge due to the charge object and the two will be attracted
- 13) A tree will attract lightning. The lightning could easily jump from the tree to you on its way to the ground.
- 14) Electric potential is the potential energy (work) divided by the charge.
- 15) a unit of potential difference, 1Joule/1Coulomb

Exercises

- 4) The wire grounds the car to remove any acquired charge. If the person inside the car has a charge, he will shock the toll collector when he gives him the money.
- 5) So they will connect the tank to the ground. Otherwise, the tank could gain a static charge and produce a spark when someone or something touches it.
- 6) The charge would be conducted through the metal down into the leaves. Now the leaves have the same charge and are repelled from each other.
- 8) No. A charged body near the electroscope would induce a charge in the metal ball on top and the opposite charge in the leaves. Since both leaves have the same charge they are repelled.
- 14) House with no lightning rod is safer. A lightning rod "attracts" lightning because it is high and a sharp point. If the rod is ungrounded the lightning would go through the house (bad.) A house without a lightning rod would still be damaged by lightning strikes, but they would not occur as often as one with an ungrounded rod.
- 18) The water molecules in the air will cause charges to dissipate into the air, meaning objects do not hold a charge as easily and they can't be charged as much as they would if the air were dry.
- 22) 10V; 10J
- 25) The lightning goes through the metal frame of the car and sparks between the frame and the ground. It is easier for the lightning to go through metal than a person, keeping the spark from traveling through a person.
- 26) No. All of the charge resides on the outside of a charged conductor.

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42. a)2F b) $\frac{1}{4}F$ c) $\frac{1}{9}F$ d)4F e) $\frac{3}{4}F$
44. $1.0 \times 10^{-8} N$ away from each other
45. 250N toward the other charge
49. $q_A = 5.2 \times 10^{-7} C$
 $q_B = 1.5 \times 10^{-6} C$
51. a. 18N right b. 42N left
60. 370N, 17 degrees below the negative x axis

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67. 30000 N/C up
70. both charges have field lines leaving the charge. The $2\mu C$ charge must have twice the number of lines leaving it compared to the $1\mu C$ charge
77. 1.4J
81. 3500 N/C
82. $2\mu F$
83. 150V