Charge

- Atoms of matter are made of ___________ with ___ charge, ___________ with ___ charge, and ___________ with ___ charge.
- >99% of atomic mass is _________ and _________ found in the __________. ___ of the mass is electrons in the _________ ________.
- On Earth, all positive charge comes from __________ and all negative charge from ________.
- If able to move freely, like charges (_____, _____) will _________ each other; unlike charges (_____, _____) will _________. (Fortunately for us, if positive charge are pushed really close together another force called the nuclear force becomes even stronger than the repulsion. So, atoms like those in our bodies can be made, but only with really high pressures (center of ________).

Conductors, insulators and semi-conductors

- ____________ are made of atoms that hold tightly to their electrons (i.e._______, ________)
- ______________ are made of atoms that share electrons freely (i.e._________, __________).
- ______________ can behave like either ____________ or ____________ depending on added impurities and external voltages (i.e. _________________)
- (Note: Free moving electrons are good at transferring KE to neighboring atoms, so good electrical conductors are also good ___________ conductors. This is why _________ is used for pots and wires, but ___________ is used for pot _________ and wire ____________.)

Moving Charge

- The SI unit for charge is the ___________. A proton has a charge of 1.6×10^{-19} C or +1*e* (elementary charge). An electron has a charge of ____________ or ____.
- A static shock like when ____ is a couple microcoulombs. A ______________ transfers about a dozen Coulombs of charge. (Even in this case <0.01% of the atoms involved have unbalances protons/electrons.) Small amounts of unbalance charge have much __________ effects than small amounts of mass, and nature "works hard" to get charges to ____________.
- There are two basic ways to separate/unbalance charges: high voltages and friction. For simplicity and safety, we will use _____________.
- When two objects rub together, each holds on to its _____________ with different strengths. Materials that easily loose ____________ become _____________ charged after being rubbed.
- There **NO** easy way to tell which object is negative and which is positive after friction, but determining relative charges: ___________, ____________, or __________/__________ can be determined.

Electric Quantities U7P1b

- Electric ________ - push/pull of _____________ on other ____________.

  ____=___________=(___)=(______________), k=___________

  - $F_E < 0$ when ____________________________________(means ______________).
  - $F_E > 0$ when ____________________________________(means ______________).
- Electric ________ - the expected _________ per amount of _____________ that can be felt in a region of space. ____=___________=(_____)
- Electric __________ _________ - the ability to do _______ in the future because of the ____________ of charges compared to each other (also, the amount of _____ that was lost to get the charges to their positions. ____=___________=(_____)
- Electric __________ (a.k.a. ____________) - the expected _________ per amount of _____________ that can be gained going between two points. ____=___________=(_____)

Comparing gravity to electricity – (Force, Field, PE, Voltage)

Drawing Electric Fields U7P1c

- E-Fields are useful because they let you predict __________ ________ and therefore (by ___=____) ______________.
- But, the only way to measure E-field strength is to measure ___________ __________ first and then divide by the size of the ___________ that is getting ______/ ______. We call a charge that is used to determine ___________ a test charge.
- Test charges, by convention, are chosen to be ____________. A test charge, by necessity, should be small enough so that is doesn't create a large __________ of its own that would distort the E-field you are trying to measure. (Note: To measure Earth's gravity field you can use something small compared to Earth like a __________, but not ____________.)
- There are ___ rules to drawing E-fields.
  1. E-fields point the direction a test charge would be ____________. The direction is therefore ___________ positive charges and ____________ negative charges.) Also, two field lines can never _____________
  2. Denser packed field lines mean ____________ field strength.
  3. Where E-fields from multiple charged objects overlap, the field from one object ____________ the field of another object, but direction must be _____________.
  4. Charges inside neutral conductors will be pushed around until the field they create __________ the external field.
     - E-field in conductors equals _________.
     - E-field at conductor's surface points _____________ to surface.
  5. Extra like charges inside a charged conductor always move _______________ each other.
     - Excess charge moves to the ____________ of a conductor.
     - Sharp corners have ________ charge density than smooth areas (think __________ rod).

Electric Potential Energy and Electric Potential (___________) U7P1d

- Conservation of __________ tells us that if a conservative force (i.e. _________, _________, etc.) slows an object down then ____ must be changing into an ________ amount of ____.
- If a test charge (______, ___________ charge) is shot at a large, positive charge, it will feel a __________ _________ and lose _____ and gain ____________ ___________ ____________.

* PE_{Ei} and PE_{Ef} typically equal zero at __________. A different zero can be chosen, however, because it is really ________ that matters.

- Like electric field is __________ _____ ______________ and lets you predict what would happen to the ___________ of a test charge if put in a location; voltage (_________________) is __________ ____ _______________ and lets you __________ what how much ______ a test charge would gain from an electric field when moving between two ___________.
- Since PE_E does the same job as gravitational ______, it can be visualized like a ______. Places at the same _________ around a hill have the same PE_g. Places at the same _________ around a hill of PE_E or hill of _________ have the same _____ and form a line of ___________.

1. Positive charges _____ KE following a Field line, but neither gain nor loose KE going __________ to a Field line, because field shows direction of _________.
2. Since lines of equipotential show where PE_E is constant and therefore KE is ___________, field lines and lines of equipotential are always _____________.

Plane Geometry	F_E	E	PE_E	V
F_E				
E				
PE_E				
V				

Capacitors

- At its simplest, a ______________ is made of to ____________, ______________ plates separated by an _____________ like _____.
- When a DC voltage source (i.e. _______________) is attached to a _____________, _____ flow from one plate to the ___________ terminal (end) of the battery and from the __________ ___________ to the other plate.
- At first, it is _______ to move electrons (-e), but as more ____ are added to the negative plate new -e feel an ___________ ____________ force. Similarly, it gets ___________ to remove -e from the ____________ plate because they feel an ____________ ___________ force.
- Greater the plate area is _________ to stuff more e- on. (______ space to spread out). So, capacitance = ____ α ______
- The closer the plates are together, the ______ the E-field from one plate pulls on charges of the other plate. So, C α ______.
- So, C α ______ = ________ where ε_o (the dielectric constant for ______) = ______________
- Also, to have a good capacitance means to be able to hold _________ of charge using a _______ battery (_________). So, ____________ also equals C= ____ = ________/________

Combining Capacitors in Series

- Capacitors on the ________ wire are in _________.
- When a battery removes an -e from C_3 and adds an _____ to _____, the charges in the all the other plates rebalance. So, the total unbalance charge collected in each capacitor is _______. $q_{\text{from bat}}$ =____________________.
- Since the battery is the only __________ source it provides _________ to the charges, which is used up in the capacitors (which gain _____). So, $V_{\text{from bat}}$ = ________________
- Combining these rules with C=____ yields ______= ________________

C_{series} = ________________

Combining Capacitors in Parallel

- Capacitors on ________ branches of a wire are in __________ if the "tops" of the capacitors have the same ____ as each other, and the bottoms have the same ____ as each other. This also means V_{bat} = ________________
- Since charge from the battery has multiple _______ to choose from. q_{bat}=________________.
- Yielding ____=________________ So, $C_{\|}$ = ________________