1. D This problem might cause difficulties if you forget to include the radius of the positively charged sphere itself in your calculations. When you do include that extra distance, the ratio looks like this:

$$\frac{k-Q_oQ_t}{(3r)^2} : \frac{k-2Q_oQ_t}{(6r)^2}$$

$$\frac{1}{9r^2} : \frac{2}{36r^2} = 2:1$$

2. C The negatively charged rod repels negative charges, which will move down the wire, and when the wire is cut, the sphere will be positively charged.
To understand response **III**, think about how work would add energy to a positive charge (our reference test charge is always positive) when we pull it from the ground closer to the positive sphere. When it arrives at the sphere, the positive charge will have gained potential energy.

3. B Coulomb is the unit of charge. (farad - capacitance; ampere - current; volt - potential)

4. C Quartz is crystalline silicon dioxide (SiO_2). Crystals of covalent molecules are typically poor conductors.

5. C We can determine the magnitude of an electric field using the following equation:

$$E = \frac{F}{q_t} = k\frac{q}{r^2}$$

which gives

$$\frac{\left(9 \times 10^9 \frac{N\,m^2}{C}\right)\left(1 \times 10^{-5}\,C\right)}{\left(3 \times 10^{-2}\,m\right)^2} = 1 \times 10^8\,\frac{N}{C}$$

us:

6. D
Positive charges, beginning where these electrons are, would have potential energy due to the external field. The negatively charged electrons, though, must travel against the field. As they do so, their kinetic energy expends as work against the field, which is stored as potential energy, and they slow down (Remember conservation of energy. We are storing what was kinetic energy as potential energy in the field, much like throwing a ball upwards against gravity). The third response is correct, because the convention is to draw field lines corresponding to the direction of force produced on positive test charges. The force is against our negative electrons here, so they are moving with the field lines.

7. A
In moving from a region of high to low potential, the positively charged alpha particles accelerate (aquire kinetic energy (heat)), as the field performs work upon them. The amount of work equals the potential (V) times the charge that moves across it (C) (remember that having doubly charged particles gives us two moles of

$$\left(1 \times 10^{-3}\,V\ \left(\text{or } \frac{J}{C}\right)\right)\left(1.9 \times 10^{5}\,C\right) = 1.9 \times 10^{2}\,J$$

charge):
The amount of temperature change associated with such an increase in the heat content of our particles can be found utilizing our molar heat

$$1.9 \times 10^2\,J = \frac{3}{2}\left(8\,\frac{J}{mol\ ^\circ K}\right)\Delta T$$

$$\Delta T = 15\,K$$

capacity:

8. B
The more area on the plates, the more charge can be stored, and the closer they are, the greater their mutual electrostatic force interactions, which pull charges onto the plates.

9. A
Dielectrics are substances composed of polar molecules which align themselves in opposition to the field between the capacitors. By superposition (a fancy word for addition) the dipole moments of the dielectric molecules weakens the external field intensity.

10. B
Moving them apart takes work. Where is the energy going? Into increasing the potential energy of the charge separation, which becomes manifest upon discharge.

11. C
The charged particle moves against the electric force (thus storing energy in the field) and with the gravitation force (thus gravitational potential energy is being expended).

12. A
We draw the field lines to represent the force which would be produced on a positive test charge.

13. C The electric field produced by two charged plates approximates uniformity (It is the same value everywhere between the plates, no matter how close we get toward one or the other). The potential difference equals the field times the distance (think about your units):

$$V = E \times d$$

The magnitude of the field can thus be found:

$$(1 \times 10^5 \text{ V}) = E \times (1 \times 10^{-1})$$
$$E = (1 \times 10^6 \tfrac{\text{N}}{\text{C}})$$

14. A We are comparing two instances where the net force on the droplet is zero (constant velocity in one instance, rest in the other). In both cases the force acting downward is gravity. The upward force from each instance is thus equal to the other.
As for the other choices: The electric force is conservative, while friction is not; and the friction force performs work, while the electric force does not when the droplet is stationary.

15. C Electric charge is quantized, therefore not continuously divisible.

16. A We can derive the following expression, which we then express in terms of the voltage, from the condition of static equilibrium of the particle in suspension between the plates:

$$Eq = mg$$
$$\frac{V}{d}q = mg$$
$$V = \frac{mgd}{q}$$