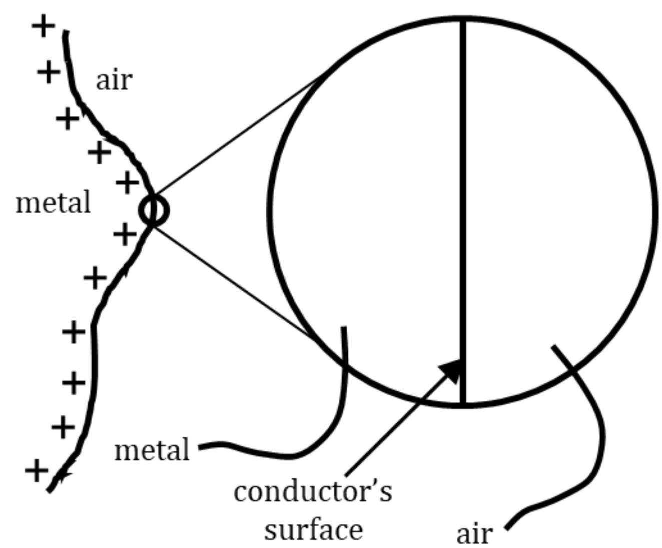
APPC, E & M: Unit A HW 8

Name: ______________________________
Hr: ___ Due at beg of hr on: __________

UA, HW8, P1
Reference Video: "Conductors in Electrostatic Equilibrium (Part I)"
YouTube, lasseviren1, ELECTRIC POTENTIAL DIFFERENCE (VOLTAGE) playlist

The figure shows a blow-up view of a very tiny portion of an isolated conductor in electrostatic equilibrium. There is a net (+) charge on the conductor. The blow-up shows a small portion of the conductor's surface, as well as the metal and the air outside the conductor.



A. In the figure, draw several small (+) signs on the blow-up's surface. Use the label σ_{local} to indicate the localized charge-per-unit-area that exists in the blown-up region.

B. Draw a Gaussian cylinder, such that its axis is normal to the conductive surface. One cap of the cylinder should be within the metal; the other cap, in the air. Label the area of one of the caps as *A*.

C. Decide if there is an electric flux Φ_E through these portions of the Gaussian cylinder: (circle)

-- cylinder cap inside the metal YES NO -- cylinder wall inside the metal YES NO

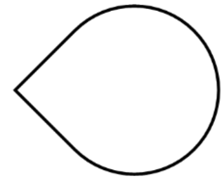
-- cylinder cap outside the metal YES NO -- cylinder wall outside the metal YES NO

D. Now, use Gauss's law on the portion(s) of your answer(s) to Part C to derive an equation for the electric field *E* at any point on the surface of a charged conductor. Start with the equation-definition of Gauss's law, then show your work and box in your answer. (The Gaussian cylinder you drew should be of aid to you.)

E. In the blown-up part of the figure, sketch proper *E* field lines at the conductor's surface. Be sure to use arrows to show the direction of the field.

UA, HW8, P2
Reference Video: "Conductors in Electrostatic Equilibrium (Part II)"
YouTube, lasseviren1, ELECTRIC POTENTIAL DIFFERENCE (VOLTAGE) playlist

The figure at right represents a conductor in electrostatic equilibrium. The conductor has a net (–) charge.



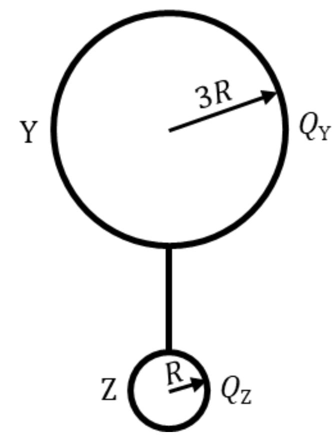
A. Draw several (8-12, maybe?) (–) signs into the figure, to show how the charge is distributed (i.e., the spacing) on the conductor's surface.

B. Draw some E field lines (include arrows) into the figure, to show the approximate electric field around the conductor.

C. Within the entire body of the conductor, the E field is ______________ and the potential V is ______________.

New situation: Two metal spheres, Y and Z, are connected by a metal wire, as shown. Y has a charge Q_Y; Z has a charge Q_Z. The total net charge on the two-spheres-and-wire system is $+4Q$. Your task is to determine how the $+4Q$ is distributed throughout the system, assuming the surface area of (and charge on) the wire is negligible.

net charge on system = $+4Q$



D. What is true of the electric potential V for any part of this system?
Hint: This answer should agree with your answer from the end of Part C.

E. The equation for the potential V at the surface of a sphere of radius r is the same as that for the potential V at a distance r from a point charge Q. Write that equation here.

F. Using your answer to Part E as a guide, as well as the values given in the figure, write two equations, one for V_Y and one for V_Z.

G. Combine your answers to Parts D and F. After some cancellation, you will be able to obtain a relationship between Q_Y and Q_Z. Show your work, then box in that relationship, once you've found it.

H. Based on the net charge on the entire system (see figure) and your answer to Part G, determine (in terms of Q) the precise amount of charge that IS Q_Y and the precise amount of charge that IS Q_Z.

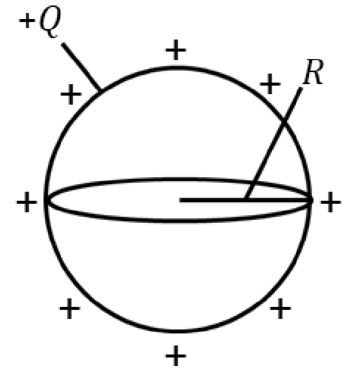
I. Suppose now that the system has the same net charge as before (i.e., $+4Q$), but now Spheres Y and Z have the same diameter, namely, $4R$. This will result in each sphere having a net charge of $+2Q$. What will be the potential of:

...Sphere Y?

...Sphere Z?

UA, HW8, P3
Reference Video: "Review of Unit on Electric Potential (Part I)"
YouTube, lasseviren1, ELECTRIC POTENTIAL DIFFERENCE (VOLTAGE) playlist

The figure shows a conducting sphere having a radius R and a net charge $+Q$.



A. Write the values (or expressions) for the following:

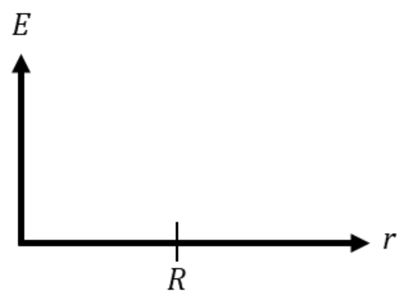
i. E for $r < R$

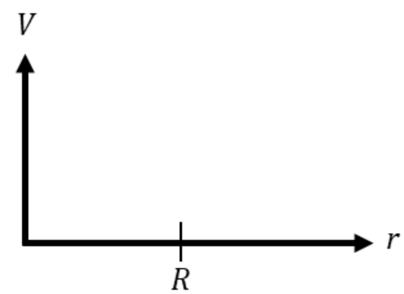
iii. V for $r < R$

ii. E for $r > R$

iv. V for $r > R$

B. Sketch the graphs at right. Above each discrete portion of the graph, write the corresponding value (or expression) that you determined in Part A. This way, you'll have the graph and the values (or expressions) all in a single diagram.



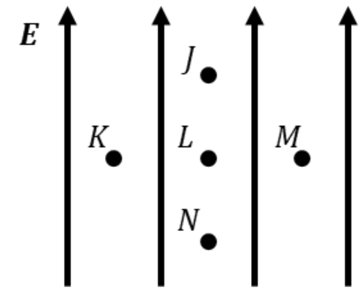


C. What are the two mistakes the narrator makes in this video?

UA, HW8, P4
Reference Video: "Review of Unit on Electric Potential (Part II)"
YouTube, lasseviren1, ELECTRIC POTENTIAL DIFFERENCE (VOLTAGE) playlist

A. Which point(s) has/have the… …highest potential?

…lowest potential?



B. Explain your answer to Part A.

C. Suppose now that there are three values of potential (200 V, 150 V, and 100 V), one of which can be assigned to each Point *J*-*N*. Which point(s) has/have which potential? (These answers should corroborate your answers to Part A.)

J = *K* = *L* = *M* = *N* =

D. Into the figure, draw three equipotential lines. Label each equipotential with the voltages from Part C.

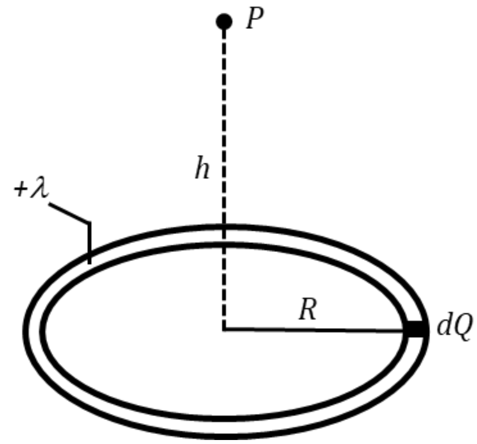
E. If you held an electron at Point *L* and then released it from rest, it would spontaneously move toward which point?

F. When the electron goes from Point *L* to the point in your Part E answer…

What type of energy is lost?	What type of energy is gained?	How many electron-volts (eV) of energy are transformed?

UA, HW8, P5
Reference Video: "Review of Unit on Electric Potential (Part III)"
YouTube, lasseviren1, ELECTRIC POTENTIAL DIFFERENCE (VOLTAGE) playlist

The figure shows a uniform ring of charge, having radius R and charge per unit length $+\lambda$. Your goal for this problem is to determine the potential V at Point P.



A. Does the potential at Point P have both a magnitude and a direction, or just a magnitude?

B. Explain your answer to Part A.

C. Using the equation for the potential due to a point charge as a starting point, write an expression (in terms of k, R, dQ, and h) for the differential contribution to the potential at Point P due to the differential amount of charge dQ.

D. Write an expression for the integral that needs to be solved, in this way:

i. Write "V ="

ii. Out of your answer to Part C, write the symbols for any and all constants.

iii. Write an integration sign.

iv. Write anything from your Part C answer that you haven't written yet. (It isn't much!)

E. Now, integrate your Part D answer. (This should be extremely easy to do.)

F. Finally, restructure your Part E answer in terms of k, R, λ, and h, i.e., eliminate the Q.