Name _____

Hour _____

AP Physics: Chapter 15 Electrostatics

Question A:

How many electrons must be removed from an electrically neutral silver dollar in order to give it a charge of +2.4 μC?

Question B:

A metal sphere initially has a charge of +8.0 μC. What is its net charge after 6.0×10^{13} electrons have been placed on it?

Question C:

In the Millikan oil drop experiment, an electric field is used to suspend charged oil drops, allowing the charge of an electron to be determined. Suppose that a certain negatively charged oil drop of mass 3.918×10^{-16} kg remains suspended when the electric field is adjusted to 8000.0 N/C.

a) Determine the required direction of the electric field in order for the negatively charged oil drop to remain suspended.
b) Calculate the magnitude of the charge on the oil drop.
c) Suppose the charge on this particular oil drop is increased, while the mass remains constant. What is the next largest charge possible for the oil drop to posses?
d) If the same oil drop possessed the larger charge determined in Part *c*, calculate the new electric field strength required for the drop to remain suspended.

Question D:

In a grain elevator on Farmer Jerry's farm, kernels of grain become electrically charged while falling through the elevator. One kernel of grain is charged with $+2.0 \times 10^{-16}$ C, while another holds $+5.0 \times 10^{-16}$ C. Determine the magnitude and direction of the electrostatic force between the kernels while they are separated by .050 m.

Question E:

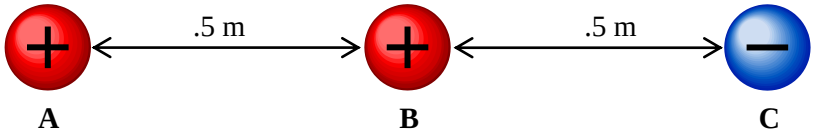
A 6.5×10^{-5} kg raindrop acquires 25 extra electrons as it falls through the atmosphere. The raindrop passes .080 m from the bulb on the end of a car antenna, which is charged with +2.0 μC.

a) Determine the unbalanced charge on the raindrop.
b) Determine the magnitude and direction of the electrostatic force between the raindrop and the antenna.
c) Determine the acceleration of the raindrop at this position.

Question F:

Three metal spheres are arranged as shown in the diagram below. Spheres A and B have a charge of +1.0 μC and Sphere C has a charge of –1.0 μC.

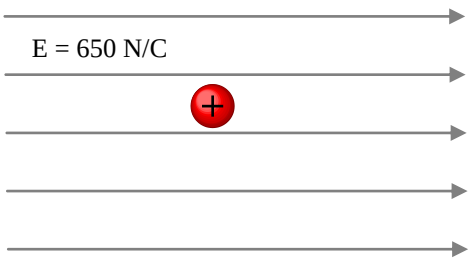
a) Calculate the net force acting on Sphere A.
b) Calculate the net force acting on Sphere C.



Question G:

A proton is released in a uniform electric field of magnitude 650 N/C as shown in the diagram at right.

a) Calculate the net force, including direction, acting on proton.
b) Calculate the acceleration of the proton.

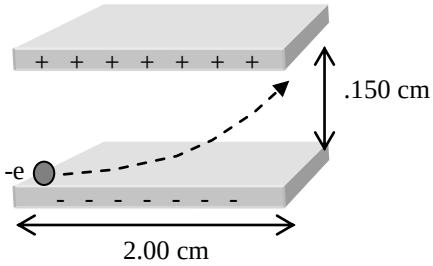


AP Physics: Chapter 16
Electrical Energy

Question A:
If a proton is released from rest in a uniform electric field, does its electric potential increase or decrease? Explain.

Question B:
a) Calculate the speed of a proton that is accelerated from rest through a potential difference of 120 V.
b) Calculate the speed of an electron that is accelerated through the same potential difference.

Question C:
An electron enters a uniform electrical field, as shown in the diagram at right. The initial horizontal velocity of the electron is 7.00×10^6 m/s, and it follows the path shown as it is acted upon by the electric field. Calculate the magnitude of the electrical field.



Question D:
If the electric potential at some point is zero, can you conclude that there are no charges in the vicinity of that point? Explain.

Question E:
Give a physical explanation of the fact that the potential energy of a pair of like charges is positive whereas the potential energy of a pair of unlike charges is negative.

Question F:
A point charge of 9.00×10^{-9} C is located at the origin. How much work is required to bring a positive charge of 3.00×10^{-9} C from infinity to the location $x = 30.0$ cm?

Question G:
Two point charges are arranged in the alignment shown below.
a) Use solid lines to sketch the electric field lines around the point charges.
b) Use dotted lines to sketch the equipotential lines around the point charges.

Question H:
Two equipotential surfaces surround a $+1.50 \times 10^{-8}$ C point charge. How far is the 190 Volt surface from the 75.0 Volt surface?

Question I:
A parallel-plate capacitor has an area of 2.0 cm^2, and the plates are separated by 2.0 mm with air between them. How much charge does this capacitor store when connected to a 6.0 V battery?

Question J:
Consider various combinations of three capacitors, each with a capacitance of 2.0 μF.
a) Sketch the circuit arrangement with the largest equivalent capacitance and calculate that capacitance.
b) Sketch the circuit arrangement with the smallest equivalent capacitance and calculate that capacitance.
c) Sketch the circuit arrangement with an equivalent capacitance of 3.0 μF.

Question K:

An electron moves at a velocity of 5.5 x 10^6 m/s as it travels from the cathode to the screen of Jeffrey's computer.

a) Calculate the kinetic energy of the electron.

b) Calculate the potential difference required to accelerate the electron to this velocity.

Question L:

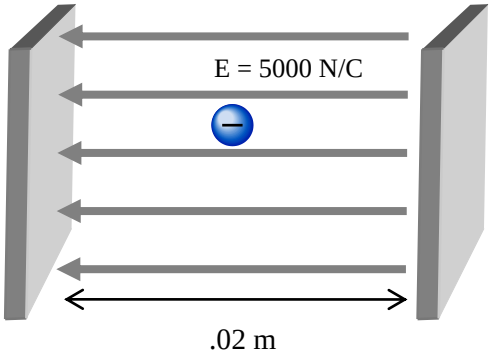
Two parallel conducting plates, each of area 0.30 m^2, are separated by a distance of .020 m of air. One plate has charge $+Q$; the other has charge $-Q$. An electric field of 5000 N/C is directed to the left in the space between the plates, as shown in the diagram at right. An electron is initially located at a point midway between the plates.

a) Determine which plate is positive (+) and which is negative (-).

b) Determine the potential difference between the plates.

c) Determine the magnitude of the electrostatic force on the electron at this location and state its direction.

d) If the electron is released from rest at this location midway between the plates, determine its speed just before striking one of the plates. Assume that gravitational effects are negligible.

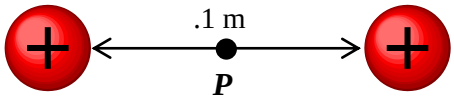


Question M:

Two point charges of magnitude +5.0 x 10^{-6} C each are separated by .10 m as shown below. Point *P* is located halfway between the two charges.

a) Determine the electric potential at Point *P*.

b) A third point charge of magnitude +2.0 x 10^{-6} C is located a very large distance away. Determine the amount of work required to bring this point charge to Point *P*.



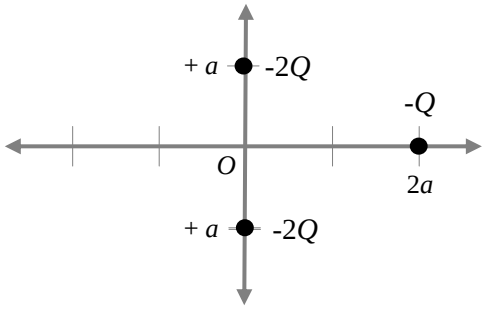
Question N:

The figure at right shows two point charges, each of charge $-2Q$, fixed on the *y*-axis at $y = +a$ and at $y = -a$. A third point charge of charge $-Q$ is placed on the *x*-axis at $x = 2a$. Express all algebraic answers in terms of Q, a, and fundamental constants.

a) Derive an expression for the magnitude of the net force on the charge $-Q$ due to the other two charges, and state its direction.

b) Derive an expression for the magnitude of the net electric field at the origin due to all three charges, and state its direction.

c) Derive an expression for the electric potential at the origin due to all three charges.



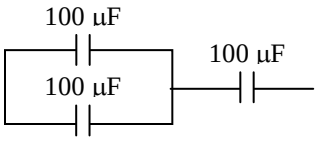
Question O:

On Saturday nights, Greg goes to the Frisco Disco, where he can dance to the strobe light. The strobe contains a 200.0 μF capacitor and releases .20 C of charge in each flash. Calculate the required voltage of the strobe light.

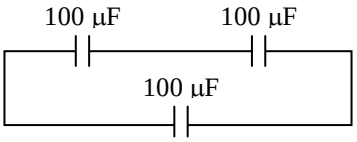
Question P:

Three capacitors of 100 μF each are combined as shown in the two arrangements below. Calculate the equivalent capacitance for . . .

a) Arrangement A.
b) Arrangement B.



Arrangement A

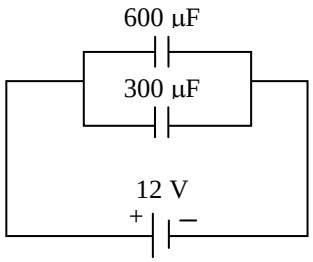


Arrangement B

Question Q:

Two capacitors of 600 μF and 300 μF are connected and attached to a 12.0 V power source as shown in the diagram at right.

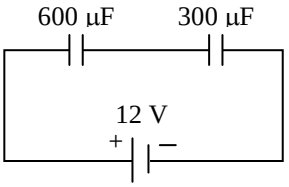
a) Calculate the equivalent capacitance of the circuit
b) Determine the potential difference across each capacitor.
c) Calculate the charge stored on each capacitor.



Question R:

Two capacitors of 600 μF and 300 μF are connected and attached to a 12.0 V power source as shown in the diagram at right.

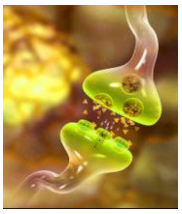
a) Calculate the equivalent capacitance of the circuit
b) Calculate the charge stored on each capacitor.
c) Calculate the potential difference across each capacitor.



Question S:

The human body uses billions of nerve cells known as neurons to transmit signals throughout the nervous system. These neurons can be modeled as capacitors of capacitance 2.7×10^{-13} F. If the energy discharged in one signal is 9.8×10^{-16} J, calculate . . .

a) the voltage across the cell membrane.
b) the charge stored in the neuron.



AP Physics: Chapter 17
Current and Resistance

Question A:
If charges flow very slowly through a metal, why does it not require several hours for a light to come on when you throw a switch?

Question B:
The compressor on an air conditioner draws 90.0 A when it starts up. If the start-up time is about .50 s, how much charge passes a cross-sectional area of the circuit in this time?

Question C:
When incandescent light bulbs burn out, they usually do so just after they are switched on. Why?

Question D:
Two light bulbs operate from 120 V, but one has a power rating of 25 W and the other has a power rating of 100 W. Which bulb has higher resistance? Which carries the greater current?

Question E:
Car batteries are often rated in ampere-hours. Does this designate the amount of current, power, energy, or charge that can be drawn from the battery?

Question F:
Household current in a circuit cannot generally exceed 15.0 A for safety reasons.
a) Calculate the maximum amount of charge that could flow through a household circuit in 1 minute.
b) Calculate the maximum number of electrons that could move through a portion of a household circuit in 1 minute.

Question G:
A 40.0 Watt light bulb in Mrs. Millard's living room lamp is connected to a 120.0 V outlet.
a) Calculate the resistance of the light bulb.
b) Would the light bulb still produce 40 Watts if it were connected to a 60 V source instead? Calculate the power to justify your answer.

Question H:
A small electric winch is connected to a 9.0 V battery and used to lift a 250 g mass at a constant velocity of .50 m/s.
a) Calculate the power exerted in the circuit.
b) Calculate the current flowing through the circuit.