Chapter 13 Drill

The answers and explanations can be found in Chapter 17.

Section I: Multiple Choice

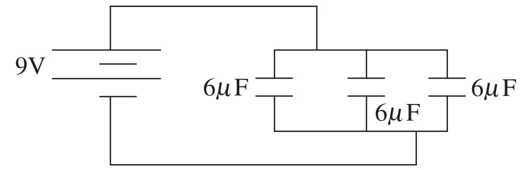
1. A capacitor is fully charged by a battery. The battery is disconnected, and a dielectric is inserted into the capacitor. Which of the following statements is/are true?

    I. The voltage will remain the same.
    II. The potential energy of the capacitor will increase.
    III. The capacitance of the capacitor will increase.

    (A) I only
    (B) I and II only
    (C) I and III only
    (D) II and III only
    (E) III only

2. If the electric field does negative work on a negative charge as the charge undergoes a displacement from Position A to Position B within an electric field, then the electrical potential energy

    (A) is negative
    (B) is positive
    (C) increases
    (D) decreases
    (E) cannot be determined from the information given



3. Three 6 μF capacitors are connected in parallel to a 9 V battery as shown above. Determine the energy stored in each capacitor.

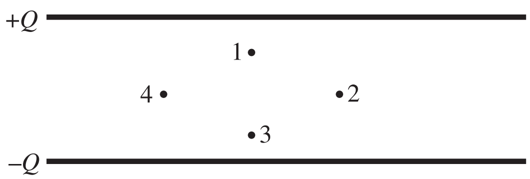
    (A) 243 J
    (B) 7.29×10^{-4} J
    (C) 8.10×10^{-5} J
    (D) 2.43×10^{-4} J
    (E) 27 J

4. Negative charges are accelerated by electric fields toward points

    (A) at lower electric potential
    (B) at higher electric potential
    (C) where the electric field is zero
    (D) where the electric field is weaker
    (E) where the electric field is stronger

5. A particle with a charge of $+q$ and mass m starts at rest and moves linearly from a position of high potential, A, to a position of low potential, B. Which of the following expressions will give the particle's speed at position B ?

    (A) $\sqrt{\dfrac{2q(V_A - V_B)}{m}}$
    (B) $\sqrt{\dfrac{2q(V_B - V_A)}{m}}$
    (C) $\sqrt{\dfrac{q(V_A - V_B)}{m}}$
    (D) $\sqrt{\dfrac{q(V_A - V_B)}{2m}}$
    (E) $\sqrt{\dfrac{2q(V_B - V_A)}{2m}}$

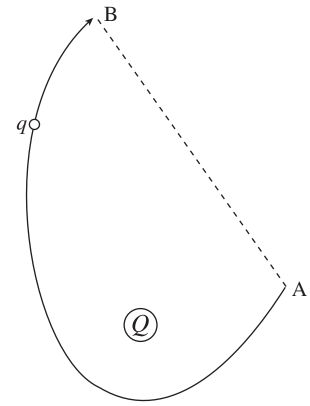


6. Which points in this uniform electric field (between the plates of the capacitor) shown above lie on the same equipotential?
   (A) 1 and 2 only
   (B) 1 and 3 only
   (C) 2 and 4 only
   (D) 3 and 4 only
   (E) 1, 2, 3, and 4 all lie on the same equipotential since the electric field is uniform.

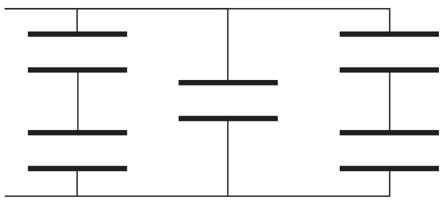
7. Two isolated and widely separated conducting spheres each carry a charge of $-Q$. Sphere 1 has a radius of a and Sphere 2 has a radius of $4a$. If the spheres are now connected by a conducting wire, what will be the final charge on each sphere?

	Sphere 1	Sphere 2
(A)	$-Q$	$-Q$
(B)	$-2Q/3$	$-4Q/3$
(C)	$-4Q/3$	$-2Q/3$
(D)	$-2Q/5$	$-8Q/5$
(E)	$-8Q/5$	$-2Q/5$

8. A parallel-plate capacitor is charged to a potential difference of ΔV; this results in a charge of $+Q$ on one plate and a charge of $-Q$ on the other. The capacitor is disconnected from the charging source, and a dielectric is then inserted. What happens to the potential difference and the stored electrical potential energy?
   (A) The potential difference decreases, and the stored electrical potential energy decreases.
   (B) The potential difference decreases, and the stored electrical potential energy increases.
   (C) The potential difference increases, and the stored electrical potential energy decreases.
   (D) The potential difference increases, and the stored electrical potential energy increases.
   (E) The potential difference decreases, and the stored electrical potential energy remains unchanged.

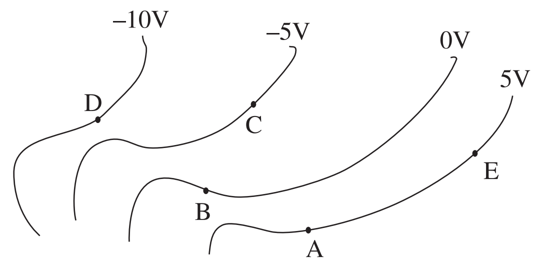


9. How much work would the electric field (created by the stationary charge Q) perform as a charge q is moved from Point A to B along the curved path shown? $V_A = 200$ V, $V_B = 100$ V, $q = -0.05$ C, length of line segment AB = 10 cm, length of curved path = 20 cm.
   (A) –10 J
   (B) –5 J
   (C) +5 J
   (D) +10 J
   (E) +2 J



10. If each of the capacitors in the array shown above is *C*, what is the capacitance of the entire combination?

    (A) *C*/2
    (B) 2*C*/3
    (C) 5*C*/6
    (D) 2*C*
    (E) 5*C*/3

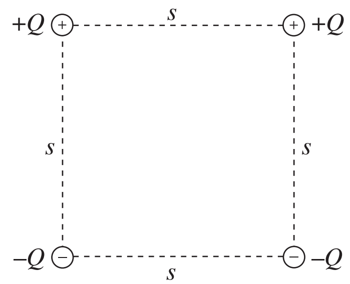


11. The diagram above shows equipotential lines produced by a charge distribution. A, B, C, D, and E are points in the plane. An electron begins at point A. The electron is then moved to point E and then from point E to point C. Which of the following correctly describes the work done *by the field* for each part of the movement?

	Movement from A to E	Movement from E to C
(A)	Negative	Positive
(B)	Zero	Positive
(C)	Zero	Negative
(D)	Negative	Zero
(E)	Positive	Positive

Section II: Free Response

1. In the figure shown, all four charges are situated at the corners of a square with sides *s*.



(a) What is the total electrical potential energy of this array of fixed charges?

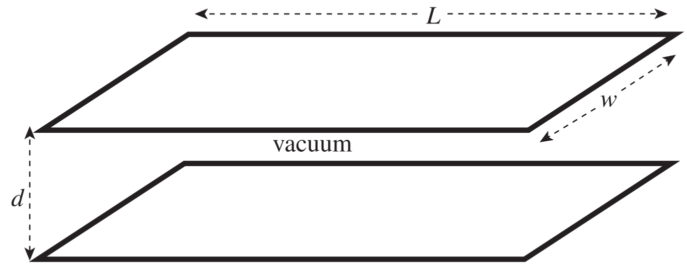
(b) What is the electric field at the center of the square?

(c) What is the electric potential at the center of the square?

(d) Sketch (on the diagram) the portion of the equipotential surface that lies in the plane of the figure and passes through the center of the square.

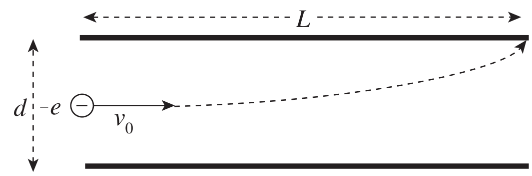
(e) How much work would the electric field perform on a charge q as it moved from the midpoint of the right side of the square to the midpoint of the top of the square?

2. The figure below shows a parallel-plate capacitor. Each rectangular plate has length L and width w, and the plates are separated by a distance d.



(a) Determine the capacitance.

An electron (mass m, charge $-e$) is shot horizontally into the empty space between the plates, midway between them, with an initial velocity of magnitude v_0. The electron just barely misses hitting the end of the top plate as it exits. (Ignore gravity.)



(b) In the diagram, sketch the electric field vector at the position of the electron when it has traveled a horizontal distance of $L/2$.

(c) In the diagram, sketch the electric force vector on the electron at the same position as in part (b).

(d) Determine the strength of the electric field between the plates. Write your answer in terms of L, d, m, e, and v_0.

(e) Determine the charge on the top plate.

(f) How much potential energy is stored in the capacitor?

3. A solid conducting sphere of radius a carries an excess charge of Q.

(a) Determine the electric field magnitude, $E(r)$, as a function of r, the distance from the sphere's center.

(b) Determine the potential, $V(r)$, as a function of r. Take the zero of potential at $r = \infty$.

(c) On the diagrams below, sketch $E(r)$ and $V(r)$. (Cover at least the range $0 < r < 2a$.)

4. A solid, nonconducting sphere of radius a has a volume charge density given by the equation $\rho(r) = \rho_0(r/a)^3$, where r is the distance from the sphere's center.

(a) Determine the electric field magnitude, $E(r)$, as a function of r.

(b) Determine the potential, $V(r)$, as a function of r. Take the zero of potential at $r = \infty$.

(c) On the diagrams below, sketch $E(r)$ and $V(r)$. Be sure to indicate on the vertical axis in each plot the value at $r = a$.