1. Points A [at (2, 3) m] and B [at (5, 7) m] are in a region where the electric field is uniform and given by \( \mathbf{E} = (4i + 3j) \text{ N/C} \). What is the potential difference \( V_A - V_B \)?
   a. 33 V  
   b. 27 V  
   c. 30 V  
   d. 24 V  
   e. 11 V

2. A particle (charge = +2.0 mC) moving in a region where only electric forces act on it has a kinetic energy of 5.0 J at point A. The particle subsequently passes through point B which has an electric potential of +1.5 kV relative to point A. Determine the kinetic energy of the particle as it moves through point B.
   a. 3.0 J  
   b. 2.0 J  
   c. 5.0 J  
   d. 8.0 J  
   e. 10.0 J

3. A proton (mass = \( 1.67 \times 10^{-27} \) kg, charge = \( 1.60 \times 10^{-19} \) C) moves from point A to point B under the influence of an electrostatic force only. At point A the proton moves with a speed of 50 km/s. At point B the speed of the proton is 80 km/s. Determine the potential difference \( V_B - V_A \).
   a. +20 V  
   b. -20 V  
   c. -27 V  
   d. +27 V  
   e. -40 V

4. If \( a = 30 \) cm, \( b = 20 \) cm, \( q = +2.0 \) nC, and \( Q = -3.0 \) nC in the figure, what is the potential difference \( V_A - V_B \)?
   a. +60 V  
   b. +72 V  
   c. +84 V  
   d. +96 V  
   e. +48 V
5. Four identical point charges (+6.0 nC) are placed at the corners of a rectangle which measures 6.0 m × 8.0 m. If the electric potential is taken to be zero at infinity, what is the potential at the geometric center of this rectangle?
   a. 58 V  
   b. 63 V  
   c. 43 V  
   d. 84 V  
   e. 11 V

6. Through what potential difference must an electron (starting from rest) be accelerated if it is to reach a speed of 3.0 \times 10^7 \text{ m/s}?
   a. 5.8 kV  
   b. 2.6 kV  
   c. 7.1 kV  
   d. 8.6 kV  
   e. 5.1 kV

7. A nonuniform linear charge distribution given by \( \lambda(x) = bx \), where \( b \) is a constant, is distributed along the \( x \) axis from \( x = 0 \) to \( x = +L \). If \( b = 40 \text{ nC/m}^2 \) and \( L = 0.20 \text{ m} \), what is the electric potential (relative to a potential of zero at infinity) at the point \( y = 2L \) on the \( y \) axis?
   a. 19 V  
   b. 17 V  
   c. 21 V  
   d. 23 V  
   e. 14 V

8. Two large parallel conducting plates are 8.0 cm apart and carry equal but opposite charges on their facing surfaces. The magnitude of the surface charge density on either of the facing surfaces is 2.0 nC/m². Determine the magnitude of the electric potential difference between the plates.
   a. 36 V  
   b. 27 V  
   c. 18 V  
   d. 45 V  
   e. 16 V
9. A charge of 40 pC is distributed on an isolated spherical conductor that has a 4.0-cm radius. Point A is 1.0 cm from the center of the conductor and point B is 5.0 cm from the center of the conductor. Determine the electric potential difference $V_A - V_B$.

a. +1.8 V  

b. +29 V  

c. +27 V  

d. +7.2 V  

e. +9.0 V  

10. Can the lines in the figure below be equipotential lines?

![Figure](image)

  a. No, because there are sharp corners.  
  b. No, because they are isolated lines.  
  c. Yes, because any lines within a charge distribution are equipotential lines.  
  d. Yes, they might be boundary lines of the two surfaces of a conductor.  
  e. It is not possible to say without further information.  

11. Which of the following represents the equipotential lines of a dipole?

![Options](image)

(a) (b) (c) (d) (e)

12. A charge is placed on a spherical conductor of radius $r_1$. This sphere is then connected to a distant sphere of radius $r_2$ (not equal to $r_1$) by a conducting wire. After the charges on the spheres are in equilibrium,

a. the electric fields at the surfaces of the two spheres are equal.  

b. the amount of charge on each sphere is $q/2$.  

c. both spheres are at the same potential.  

d. the potentials are in the ratio $\frac{V_2}{V_1} = \frac{q_2}{q_1}$.  

e. the potentials are in the ratio $\frac{V_2}{V_1} = \frac{r_2}{r_1}$.  

13. Determine the equivalent capacitance of the combination shown when $C = 12 \text{ pF}$.

![Image of a capacitor combination]

a. 48 pF  
b. 12 pF  
c. 24 pF  
d. 6.0 pF  
e. 59 pF

14. Determine the equivalent capacitance of the combination shown when $C = 45 \mu\text{F}$.

![Image of a capacitor combination]

a. 28 $\mu\text{F}$  
b. 36 $\mu\text{F}$  
c. 52 $\mu\text{F}$  
d. 44 $\mu\text{F}$  
e. 23 $\mu\text{F}$

15. How much energy is stored in the 50-$\mu\text{F}$ capacitor when $V_a - V_b = 22\text{V}$?

![Image of a capacitor combination]

a. 0.78 mJ  
b. 0.58 mJ  
c. 0.68 mJ  
d. 0.48 mJ  
e. 0.22 mJ
16. A parallel plate capacitor of capacitance $C_0$ has plates of area $A$ with separation $d$ between them. When it is connected to a battery of voltage $V_0$, it has charge of magnitude $Q_0$ on its plates. It is then disconnected from the battery and the plates are pulled apart to a separation $2d$ without discharging them. After the plates are $2d$ apart, the magnitude of the charge on the plates and the potential difference between them are

a. $\frac{1}{2} Q_0 \ \frac{1}{2} V_0$

b. $Q_0 \ \frac{1}{2} V_0$

c. $Q_0 \ V_0$

d. $Q_0 \ 2V_0$

e. $2Q_0 \ 2V_0$

17. A parallel plate capacitor is connected to a battery and charged to voltage $V$. Leah says that the charge on the plates will decrease if the distance between the plates is increased while they are still connected to the battery. Gertie says that the charge will remain the same. Which one, if either, is correct, and why?

a. Gertie, because the maximum voltage is determined by the battery.

b. Gertie, because the capacitance of the capacitor does not change.

c. Leah, because the capacitance decreases when the plate separation is increased.

d. Leah, because the capacitance increases when the plate separation is increased.

e. Neither, because the charge increases when the plate separation is increased.

18. A 15-µF capacitor and a 30-µF capacitor are connected in series, and charged to a potential difference of 50 V. What is the resulting charge on the 30-µF capacitor?

a. 0.70 mC

b. 0.80 mC

c. 0.50 mC

d. 0.60 mC

e. 0.40 mC
19. A 0.16 pF parallel-plate capacitor is charged to 10 V. Then the battery is disconnected from the capacitor. When \(1.00 \times 10^7\) positive charges of magnitude \(|e|\) are now placed on the positive plate of the capacitor, the voltage between the plates changes by

a. \(-8.9\) V.

b. \(-1.1\) V.

c. 0 V.

d. \(+1.1\) V.

e. \(+8.9\) V.

20. A parallel plate capacitor is charged to voltage \(V\) and then disconnected from the battery. Leopold says that the voltage will decrease if the plates are pulled apart. Gerhardt says that the voltage will remain the same. Which one, if either, is correct, and why?

a. Gerhardt, because the maximum voltage is determined by the battery.

b. Gerhardt, because the charge per unit area on the plates does not change.

c. Leopold, because charge is transferred from one plate to the other when the plates are separated.

d. Leopold, because the force each plate exerts on the other decreases when the plates are pulled apart.

e. Neither, because the voltage increases when the plates are pulled apart.