Multiple choice questions. Circle the correct answer. No work need be shown and no partial credit will be given.

(5 pts) 1. A small object with negative charge is in a region of uniform electric field. The force that the electric field exerts on the object is in the \(+x\) direction. What is the direction of the electric field?

\[
\begin{align*}
(a) & \quad +x \\
(b) & \quad -x \\
(c) & \quad +y \\
(d) & \quad -y
\end{align*}
\]

(5 pts) 2. There is a uniform electric field in the \(+x\) direction. Point \(a\) is at \(x = 0.20\, \text{m}\) and point \(b\) is at the origin. Which statement about the potentials \(V_a\) and \(V_b\) at these two points is correct?

\[
\begin{align*}
(a) & \quad V_a < V_b \\
(b) & \quad V_a > V_b \\
(c) & \quad V_a = V_b
\end{align*}
\]

(5 pts) 3. A small object with negative net charge moves from point \(a\) to point \(b\). The potential at \(a\) is greater than the potential at \(b\). That is, \(V_a > V_b\). During the motion the only force acting on the object is the electric force. Which statement about the kinetic energy \(K_a\) of the object at \(a\) and the kinetic energy \(K_b\) at \(b\) is correct?

\[
\begin{align*}
(a) & \quad K_a = K_b \\
(b) & \quad K_a > K_b \\
(c) & \quad K_a < K_b
\end{align*}
\]

(5 pts) 4. A parallel-plate capacitor with air between the plates is connected to a battery and the charge on the plates is \(Q\). A dielectric is then inserted between the plates, while the battery remains connected to the plates. After the dielectric has been inserted, the charge on the plates is

\[
\begin{align*}
(a) & \quad \text{less than } Q \\
(b) & \quad Q \\
(c) & \quad \text{greater than } Q
\end{align*}
\]
5. A parallel-plate capacitor has charge $Q$ on its plates. If the separation between the plates is increased, while the charge $Q$ on the plates stays the same, the energy stored in the capacitor

- (a) increases
- (b) stays the same
- (c) decreases

6. A solid conducting sphere of radius $R$ carries net positive charge $q$. If the electric potential at the surface of the sphere is $250$ V, then the electric potential at the center of the sphere is

- (a) zero
- (b) $250$ V
- (c) $500$ V
- (d) infinite

7. A hollow conducting sphere has inner radius $a$ and outer radius $b$. The hollow sphere has net charge $+5q$, where $q$ is a positive constant. A point charge $+2q$ is placed at the center of the hollow sphere, at $r = 0$. The total charge on the outer surface of the hollow sphere is

- (a) zero
- (b) $+2q$
- (c) $+3q$
- (d) $+5q$
- (e) $+7q$
- (f) $-2q$
- (g) none of the above answers

8. Two identical capacitors each have capacitance $C$. If the two capacitors are connected in series, the equivalent capacitance of the combination is

- (a) less than $C$
- (b) $C$
- (c) greater than $C$
On the following problems show all your work. Partial credit will be given if earned. Write your answers in the blanks provided.

(20 pts) 9. Point charge \( q_1 = -8.0 \times 10^{-9} \) C is on the \(+x\) axis at \( x = 0.30 \) m. Point charge \( q_2 = +5.0 \times 10^{-9} \) C is on the \(-x\) axis at \( x = -0.30 \) m. Point \( P \) is on the \(-y\) axis at \( y = -0.40 \) m.

a) What are the \( x \) and \( y \) components of the field produced by \( q_1 \) at point \( P \)? (Be sure to indicate the sign of each component.)

Ans. \( x +173 \) N/C

\( y +230 \) N/C

b) What are the \( x \) and \( y \) components of the field produced by \( q_2 \) at point \( P \)? (Be sure to indicate the sign of each component.)

Ans. \( x +108 \) N/C

\( y -144 \) N/C

c) What is the magnitude of the total electric field at point \( P \) that is produced by these two point charges?

Ans. 294 N/C
(20 pts) 10. A small plastic sphere with charge $q_1 = -4.0 \times 10^{-6} \text{ C}$ and mass $5.0 \times 10^{-3} \text{ kg}$ is projected toward a point charge $q_2 = +6.0 \times 10^{-4} \text{ C}$. The small sphere has an initial speed of $2.0 \times 10^2 \text{ m/s}$ and initially is a large distance from $q_2$. $q_2$ is held in place and doesn’t move. What is the speed of the small plastic sphere when it is 0.200 m from $q_2$?

Ans. 288 m/s
11. The capacitor network shown in the sketch is connected to a 24 V battery. Calculate the charge $Q$ and potential difference $V$ for each capacitor.

Ans. $Q_1 = 16 \mu C$
$Q_2 = 32 \mu C$
$Q_3 = 48 \mu C$
$V_1 = 8 \text{ V}$
$V_2 = 8 \text{ V}$
$V_3 = 16 \text{ V}$