Physics 202  Spring 2016

Lecturer name (Ford or Christian?) ________________ Lab Section ________

Name (signature as on ID) __________________________ Name (printed) __________________________

Exam 1 Chapters 17-19 in Young, Adams, Chastian 10e

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

(6 pts) 1. A small object with negative charge \( q = -5.0 \times 10^{-4} \) C is released from rest at point \( a \) and moves in the electric field produced by other charges. At point \( b \) the object has kinetic energy 0.12 J. If the electric potential at point \( a \) due to the other charges is 600 V, what is the electric potential at point \( b \) ?

(a) 360 V
(b) 840 V
(c) 120 V
(d) 240 V
(e) none of the above answers

(6 pts) 2. When a small object with negative charge \( q = -5.00 \times 10^{-4} \) C is at point \( a \) the electric field at point \( a \) exerts a force on the object that has magnitude 0.0200 N and that is in the \(-x\)-direction. The electric field at point \( a \) is

(a) 0.0250 N/C in the \(+x\)-direction
(b) 0.0250 N/C in the \(-x\)-direction
(c) 40.0 N/C in the \(+x\)-direction
(d) 40.0 N/C in the \(-x\)-direction
(e) none of the above answers

(6 pts) 3. Points \( a \) and \( b \) are on the \( x\)-axis and are in a region of uniform electric field. Point \( a \) is at \( x = -0.20 \) m and point \( b \) is at \( x = +0.30 \) m. The electric potential at point \( a \) is 700 V and the electric potential at point \( b \) is 500 V. What are the magnitude and direction of the electric field in this region?

(a) 400 N/C in the \(+x\)-direction
(b) 400 N/C in the \(-x\)-direction
(c) 4000 N/C in the \(+x\)-direction
(d) 4000 N/C in the \(-x\)-direction
(e) 800 N/C in the \(+x\)-direction
(f) 800 N/C in the \(-x\)-direction
(g) none of the above answers
4. A hollow conducting sphere has inner radius $R_1 = 0.60$ cm and outer radius $R_2 = 0.80$ cm. The sphere has a net charge of $+5Q$ where $Q$ is positive. A small object with negative charge $-2Q$ is in the air space at the center of the hollow sphere. What is the charge on the outer surface of the sphere?

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

5. You have a parallel plate capacitor with capacitance $C_0$ in vacuum, held at a constant potential $V$. The charge on the capacitor is $Q_0$, and the electric field inside the capacitor is $E_0$. Now you insert a dielectric with constant $K = 5.0$ into the capacitor and the capacitance, charge, and electric field change to $C$, $Q$, and $E$. Which of the following is true?

(a) $Q > Q_0$; $C > C_0$; $E > E_0$
(b) $Q > Q_0$; $C > C_0$; $E = E_0$
(c) $Q < Q_0$; $C = C_0$; $E = E_0$
(d) $Q > Q_0$; $C < C_0$; $E = E_0$
(e) None of the above

6. In which of the two circuits shown in the figure will the capacitors charge more slowly when the switch is closed?

(a) Circuit (a)
(b) Circuit (b)
(c) The capacitors will charge at the same rate in the two circuits.
(6 pts) 7. You have a battery supplying emf $\mathcal{E} = 6$ V and negligible internal resistance. You also have three resistors with values $R_1 = 100 \, \Omega$, $R_2 = 200 \, \Omega$, and $R_3 = 400 \, \Omega$. What resistor combination will minimize power consumption?

a) 

\begin{center}
\begin{tikzpicture}
  \node at (0,0) {$R_1$};
  \node at (0,-1) {$R_2$};
  \node at (0,-2) {$R_3$};
  \node at (0,-3) {$+$};
  \node at (0,-4) {$-$};
  \draw [->] (0,-1) -- (0,-2);
  \draw [->] (0,-2) -- (0,-3);
\end{tikzpicture}
\end{center}

$\mathcal{E} = 6$ V

b) 

\begin{center}
\begin{tikzpicture}
  \node at (0,0) {$R_1$};
  \node at (0,-1) {$R_2$};
  \node at (0,-2) {$R_3$};
  \node at (0,-3) {$+$};
  \node at (0,-4) {$-$};
  \draw [->] (0,-1) -- (0,-2);
  \draw [->] (0,-2) -- (0,-3);
\end{tikzpicture}
\end{center}

$\mathcal{E} = 6$ V

c) 

\begin{center}
\begin{tikzpicture}
  \node at (0,0) {$R_1$};
  \node at (0,-1) {$R_2$};
  \node at (0,-2) {$R_3$};
  \node at (0,-3) {$+$};
  \node at (0,-4) {$-$};
\end{tikzpicture}
\end{center}

$\mathcal{E} = 6$ V

d) Power consumption will be the same in all cases.
On the following problems show all your work. Partial credit will be given, if earned. Write your answers in the blanks provided. All answers must include the correct plus or minus sign and the correct units.

(14 pts) 8. A \textit{negative} point charge \( q_1 = -6.00 \times 10^{-9} \text{ C} \) is on the \(+x\)-axis at \( x = +0.300 \text{ m} \). A \textit{positive} point charge \( q_2 = +6.00 \times 10^{-9} \text{ C} \) is on the \(-x\)-axis at \( x = -0.300 \text{ m} \). Point \( P \) is on the \(+y\)-axis at \( y = +0.400 \text{ m} \).

a) What is the net electric potential at point \( P \) due to the two charges \( q_1 \) and \( q_2 \)?

Ans. ________________

b) What are the \( x \) and \( y \) components of the net electric field at point \( P \) due to \( q_1 \) and \( q_2 \)? Be sure to indicate whether each component is positive or negative.

Ans. \( E_x = \) ________________

\( E_y = \) ________________
(14 pts) 9. A positive point charge \( q_1 = +4.00 \times 10^{-9} \) C is on the +x-axis at \( x = +0.400 \) m. A negative point charge \( q_2 = -8.00 \times 10^{-9} \) C is on the -x-axis at \( x = -0.400 \) m. Other than at \( x = \pm \infty \), what is the x-coordinate of the point on the x-axis where the net electric field due to the two charges is zero?

Ans. \( x = \) __________
(15 pts) 10. The circuit in the sketch consists of three resistors and a battery with emf $\mathcal{E} = 9.0$ V and negligible internal resistance. $R_1 = 2.0 \, \Omega$, $R_2 = 12.0 \, \Omega$, and $R_3 = 4.0 \, \Omega$.

![Circuit Diagram]

$\mathcal{E} = 9 \, V$

(a) What is the current flowing through each resistor?

Ans. $I_1 =$

$I_2 =$

$I_3 =$

(b) What is the voltage across each resistor?

Ans. $V_1 = $

$V_2 =$

$V_3 =$

(c) What is the power dissipated by each resistor?

Ans. $P_1 =$

$P_2 =$

$P_3 =$
(15 pts) 11. The circuit in the sketch consists of three capacitors and a battery with voltage $V = 24 \text{ V}$. Assume the capacitors have reached equilibrium at their final charge values. $C_1 = 6.0 \ \mu\text{F}$, $C_2 = 10.0 \ \mu\text{F}$, and $C_3 = 2.0 \ \mu\text{F}$.

![Circuit Diagram]

a) What is the equivalent capacitance?

Ans. $C_{eq} =$ ______________

b) What is the potential drop across each capacitor?

Ans. $V_1 =$ ______________

Ans. $V_2 =$ ______________

Ans. $V_3 =$ ______________

c) What is the charge on each capacitor?

Ans. $Q_1 =$ ______________

Ans. $Q_2 =$ ______________

Ans. $Q_3 =$ ______________