4. (same picture) What can we tell about $v_y$?
   
   a) $v_y$ will increase
   b) $v_y$ will stay constant
   c) $v_y$ will decrease

5. (same picture) What can we tell about the acceleration? [magnitude only]
   
   a) The acceleration will increase
   b) The acceleration will stay constant
   c) The acceleration will decrease
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| **1.** | This is to identify the exam version you have – IMPORTANT  
Mark the | as answer for number 1 |
| **2.** | This is to identify the exam version you have – IMPORTANT  
Mark the | as answer for number 2 |
| **3.** |  
While the charge flies through that field …  
What can we tell about \( v_x \)?  

a) \( v_x \) will increase  
b) \( v_x \) will stay constant  
c) \( v_x \) will decrease  

| **4.** | (same picture) What can we tell about \( v_y \)?  

a) \( v_y \) will become more positive  
b) \( v_y \) will stay constant  
c) \( v_y \) will become more negative  

| **5.** | (same picture) What can we tell about the acceleration? [magnitude only]  

a) The acceleration will increase  
b) The acceleration will stay constant  
c) The acceleration will decrease |
6. Two point charges, $q_1 = +q$ and $q_2 = -2q$, are fixed at positions on the x-axis, as shown below. If you were to place a third (positive) point charge somewhere so that the force on it would be zero, you should place that charge at which location?

A) on the x-axis to the left of the two charges
B) off of the x-axis
C) on the x-axis to the right of the two charges
D) on the x-axis in between the two charges

[Diagram of two charges on the x-axis]

7. A conducting spherical shell (below) is concentric with a solid conducting sphere. Initially, each conductor carries zero net charge. A charge of $+2Q$ is placed on the inner surface of the spherical shell. After equilibrium is achieved, the charges on the surface of the solid sphere, $q_1$, the inner surface of the spherical shell, $q_2$, and the outer surface of the spherical shell, $q_3$, are which of the following?

A) $q_1 = -Q$, $q_2 = +Q$, $q_3 = +Q$
B) $q_1 = 0$, $q_2 = 0$, $q_3 = +2Q$
C) $q_1 = 0$, $q_2 = +2Q$, $q_3 = 0$
D) $q_1 = +Q$, $q_2 = -Q$, $q_3 = +3Q$

[Diagram of a conducting spherical shell with charge distribution]
8. The electric potential is monotonously increasing along the +x axis. From this we can conclude that the x component of the electric field is which of the following?

   a) E is constant and points in the +x-direction
   b) E is constant and points in the -x-direction
   c) E is monotonously increasing and points in the +x-direction
   d) E is monotonously increasing and points in the +x-direction
   e) zero

9. A is a solid conducting sphere of radius R has an excess charge Q. The electrical potential at the surface of the sphere is:

   \[ V = \frac{Q}{4 \pi \varepsilon_o R} \]  
   [but be very careful when attempting to use this equation!]

A second uncharged conducting sphere B of radius R/2 is brought to a distance >> R from the first sphere. The two spheres are connected by a fine conducting wire. What can you say about the electrical potential of each of the two spheres now they are connected?

1. Both potentials are zero.
2. Potential of A is twice the potential of B.
3. Potential of A is half the potential of B.
4. Potential of A is equal to the potential of B.
5. None of the above

10. What maximum power can be generated from an 18 V battery using any combination of one 6.0-Ω resistor and one 9.0-Ω resistor?

   a. 54 W
   b. 71 W
   c. 90 W
   d. 80 W
   e. 22 W
11. Charges $q = -40 \text{ pC}$ and $Q = +30 \text{ pC}$ are placed on the $x$ axis at $x = 0$ and $x = 2.0 \text{ m}$, respectively. [the ‘p’ in pC stands for $10^{12}$]

Determine the net flux through a spherical surface (radius = 1.0 m) centered on the origin.

- a. $-9.6 \text{ N} \cdot \text{m}^2/\text{C}$
- b. $-6.8 \text{ N} \cdot \text{m}^2/\text{C}$
- c. $-8.5 \text{ N} \cdot \text{m}^2/\text{C}$
- d. $-4.5 \text{ N} \cdot \text{m}^2/\text{C}$
- e. $-1.1 \text{ N} \cdot \text{m}^2/\text{C}$

12. Determine the energy stored in $C_1$, when $C_1 = 10 \mu\text{F}$, $C_2 = 12 \mu\text{F}$, $C_3 = 15 \mu\text{F}$, and $V_0 = 70 \text{ V}$.

- a. 6.5 mJ
- b. 5.1 mJ
- c. 3.9 mJ
- d. 8.0 mJ
- e. 9.8 mJ

13. A battery supplying $40 \text{ V}$ is connected to the circuit shown in which $R_1 = 12\Omega$, $R_2 = 4\Omega$, and $R_3 = 7\Omega$.

What is the rate of joule heating (power) in the resistor $R_1$?

- A) 3.33 W
- B) 4 W
- C) 10 W
- D) 11.5 W
- E) 12 W
A rigid rod of length L has a charge +Q at the top end and a charge -Q at the bottom end. The center of the rod lies on the x axis a distance L from the origin. Q = 1C; L = 1m. The rod is parallel to the y axis. The force on a charge +2Q situated at the origin due to the rod is:

First, do complete the drawing of this and think!

[expressed as (x-component of F, y-component of F)]

A) (0, 1.79 \text{k}_e)
B) (1.28 \text{k}_e, 0)
C) (0, -1.43 \text{k}_e)
D) (1.41 \text{k}_e, 0.707 \text{k}_e)
E) (0.125 \text{k}_e, 0)