Physics 112
Exam #1 Answers
September 20, 1999

1. At the origin, the electric field due to the charge at (–1 m, 0 m) points toward ***positive x***, while the fields from the two charges at (+2 m, 0 m) point toward ***negative x***. Therefore, to get the magnitude of the net field, we have: $E_{net} = [k(2)/1] - [k(2)/4] - [k(2)/4] = k$ N/C = 9.0×10^9 N/C. ***Answer: A***

2. The electric field produced by the three 2-C charges will not be affected either by the electron or the proton, which here act as test charges. Therefore, the field experienced by the proton will be the same magnitude and direction as the field experienced by the electron. ***Answer: C.***

3. The potential energy decreases by 36 J, which means that the kinetic energy must ***increase*** by 36 J. The initial kinetic energy is zero, so the final kinetic energy is 36 J. Since $\frac{1}{2} mv^2 = 36$ J, we see that $v^2 = (2)(36) \div 8 = 9\ m^2/s^2$, so v = 3 m/s. ***Answer: C.***

4. At the origin, the electric field from the electron points upward, toward positive *y*, and so does the electric field of the proton. Therefore, the fields add. ***Answer: D.***

5. The electric field magnitude is given by E = F/q = 36 N/4 C = 9 N/C. The direction of the field is in the same direction as the force on a positive test charge, which here is given to be south. Bringing in another test charge, such as the –8 C charge, will have no effect on this uniform electric field. ***Answer: H.***

6. (A) A ***source*** charge is a charge that produces the electric field of interest in a specific situation. There may be more than one source charge. It is true that ***every*** charge produces some electric field. However, charges that have very small magnitude, or that are very far away, produce very small electric fields that we can safely ignore. We call a charge a "***test***" charge if it has such small magnitude that when we place it in an electric field in some specific region, the "test" charge has ***no effect*** on that electric field. Because the "test" charge won't change the electric field in any way, we can use the test charge to probe the electric field, to determine the magnitude and direction of the electric field at a specific point in space. (A test charge may be positive or negative.)

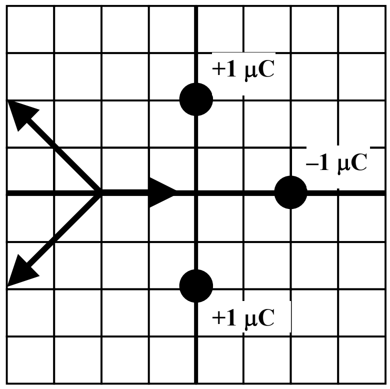
   (B) A ***uniform*** electric field is one that has the same magnitude and direction at every point in space. This means that a ***given*** test charge will experience the same force no matter ***where*** it is placed in that field. (However, a ***different*** test charge – with different magnitude or sign – will experience a ***different*** force than that first one did). A ***nonuniform*** electric field will have a magnitude and/or direction that varies from one location to another. Therefore, a given test charge will experience different forces, depending on its exact location.

7. If you assume the separation between adjacent charges is 1 m, and call the magnitude of each charge "q," then the net force on charge A is $kq^2(-1 - \frac{1}{4} + 1/9)$, on charge B it's $kq^2(1 - 1 + \frac{1}{4})$, on C it's $kq^2(\frac{1}{4} + 1 + 1)$, and on D it's $kq^2(-1/9 - \frac{1}{4} - 1)$. The one with the largest magnitude is the force on C. ***Answer: C.***

8. In a uniform field, the force on the positive charge must be in the opposite direction from the force on the negative charges. Also, the magnitude of the force on the 4q charge is twice that on the –2q charge, and that on the –2q charge is double that on the –q charge. Only diagram E meets all of these requirements. **Answer: E**

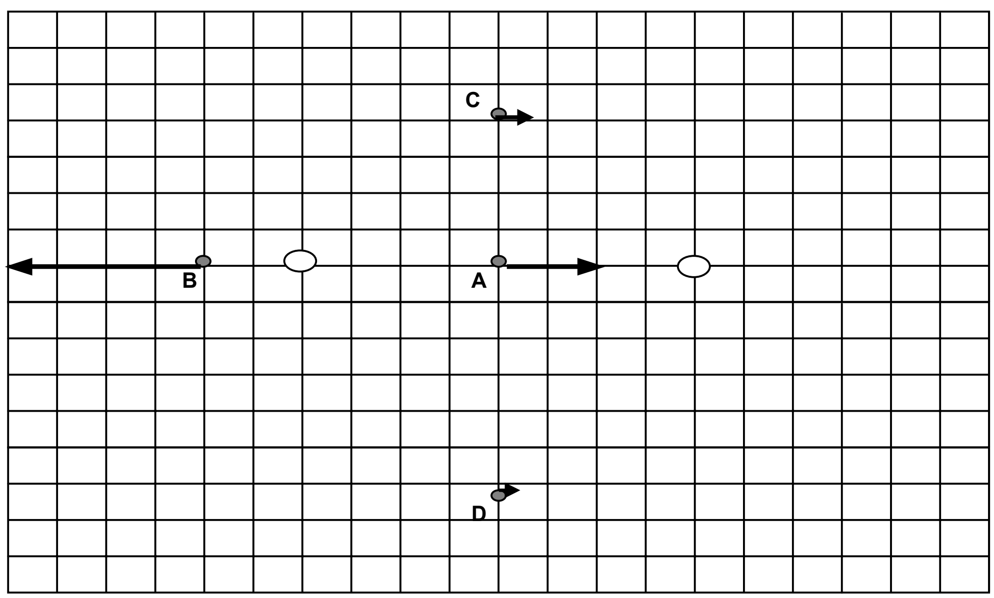
9. The point on the right is twice as far from the source charge as the point on the left; therefore, the field there must be ***one quarter*** the magnitude of the field on the left (since $E = kQ/r^2$). Also, the field on both sides of the source charge must point ***toward*** the (negative) source charge. Only choice F meets these requirements. **Answer: F**

10. (A)



(B) At the ***origin***, the fields from the two positive charges cancel each other, so the ***net*** field points toward the negative charge. **Answer: A.**

11.



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