1. **Question Details Electric Force (3) [735032]**

Tipler 22.17 - A charge of -1.0 µC is located at the origin, a second charge of 4.6 µC is located at \(x = 0, \ y = 0.1\) m, and a third charge of 9 µC is located at \(x = 0.2\) m, \(y = 0\). Find the force that acts on the -1.0 µC charge.

Solution or Explanation
The magnitude of the force due to the 9 µC charge is given by Coulomb's Law.
\[
F = \frac{(8.99 \times 10^9 \text{ Nm}^2/\text{C}^2) \times (1.0 \times 10^{-6} \text{ C}) \times (9 \times 10^{-6} \text{ C})}{(0.2 \text{ m})^2} = 2.02 \text{ N}.
\]
Since they are oppositely charged, they attract and the force points in the +x direction.

The force from the 4.6 charge is found in the same way.
\[
F = \frac{(8.99 \times 10^9 \text{ Nm}^2/\text{C}^2) \times (1.0 \times 10^{-6} \text{ C}) \times (4.6 \times 10^{-6} \text{ C})}{(0.1 \text{ m})^2} = 4.14 \text{ N}.
\]
Since they are oppositely charged, they attract and the force points in the +y direction.

These add together to give you the final answer.

2. **Question Details Electric Fields (5) [735027]**

A point charge of 6 µC is located at \(x = -3.0\) cm, and a second point charge of -33 µC is located at \(x = +4.0\) cm. Where should a third charge of +6.0 µC be placed so that the electric field at \(x = 0\) is zero?

Solution or Explanation
The total electric field at \(x = 0\) is given by Coulomb's law for each point charge added as vectors.
\[
(8.99 \times 10^9 \text{ Nm}^2/\text{C}^2) \times (6 \times 10^{-6} \text{ C})/(9 \text{ cm}^2) \times (x) + (8.99 \times 10^9 \text{ Nm}^2/\text{C}^2) \times (33 \times 10^{-6} \text{ C})/(16 \text{ cm}^2) \times (x) - (8.99 \times 10^9 \text{ Nm}^2/\text{C}^2) \times (6 \times 10^{-6} \text{ C})/(x \text{ cm}^2) \times (x).
\]
The direction of each of these vectors is away from the charge for positive charges and toward the charge for negative charges. The direction of the electric field from the +6.0 µC charge is unknown. However, it is easy to find. Since both of the other charges impart an electric field in the positive x direction, then the electric field here must be in the negative x direction to be able to get a sum of zero.

The rest is simply algebra. Note that since the direction is to the left for the +6.0 µC charge, then it must be to the right of zero. Thus, the value of x is positive.

3. **Question Details Electric Fields (4) [735021]**
The diagram shows two point charges. The charge on 1 is $2.8 \mu C$ and the charge on 2 is $6.7 \mu C$. What is the resultant electric force on a $3 \text{ nC}$ charge placed at the point $r = (6 \text{ m}) \hat{x} + (-3 \text{ m}) \hat{y}$?

![Diagram showing two point charges and a 3 nC charge](image)

Solution or Explanation:
The electric force from each charge has a magnitude given by the formula

$$F = k \frac{q q_0}{r^2},$$

where $q$ is the charge causing the force and $q_0$ is the charge receiving the force.

The components are then

$$F_x = F \cos \theta = F \frac{\Delta x}{r}$$

and

$$F_y = F \sin \theta = F \frac{\Delta y}{r}.$$

You then simply add the components of the electric force from each charge. Check the direction. The electric force is repulsive for like charges.
4. **Question Details** Electric Charge (1) [1048219]

Which of the following is not an intrinsic physical property of a fundamental particle?

- ○ *`Size`
- · × `Time`
- ○ *`Charge`
- ○ *`Spin`
- ○ *`Mass`

**Solution or Explanation**

We learned about fundamental particles and their intrinsic physical properties on the first day of class. Intrinsic physical properties are those which are the same for all fundamental particles of a given type everywhere and at any time.

5. **Question Details** Electric Charge (2) [1048339]

Dr. Mike rubs his hair on a balloon, giving the balloon \(2.90 \times 10^{11}\) excess electrons. If there is no other change to the balloon, what is its change in mass?

- ○ *`3.18 \times 10^{-41}\text{ kg}`
- · × *`2.64 \times 10^{-19}\text{ kg}`
- ○ *`3.14 \times 10^{-42}\text{ kg}`
- ○ *`1.60 \times 10^{-19}\text{ kg}`
- ○ *`9.11 \times 10^{-31}\text{ kg}`

**Solution or Explanation**

Take the number of excess electrons \(N_e = 2.90 \times 10^{11}\) and multiply by the mass of each electron \(m_e = 9.11 \times 10^{-31}\) kg to get a total of \(M = 3.14 \times 10^{-19}\) kg.

Note the mass of an electron is always positive!

6. **Question Details** Electric Flux and Gauss' Law (3) [742614]

Consider a uniform electric field \(E = 1.8 \text{ kN/C}\). What is the flux of this field through a square of side 16 cm if the normal to its plane makes a \(26^\circ\) angle with the \(x\) axis?

- ○ *`202.00 \text{ kN} \cdot \text{m}^2/\text{C}`
- ○ *`20.20 \text{ N} \cdot \text{m}^2/\text{C}`
- ○ *`414.16 \text{ kN} \cdot \text{m}^2/\text{C}`
- ○ *`41.41 \text{ N} \cdot \text{m}^2/\text{C}`
- ○ *`20.20 \text{ mN} \cdot \text{m}^2/\text{C}`

**Solution or Explanation**


The flux in this case is just
\[ \phi = E \cos \theta = E L^2 \cos \phi. \]
Don't forget to convert cm to m.

7. **Question Details** Electric Potential Difference (3) [742615]

Three charges, +q, +Q, and -Q, are placed at the corners of an equilateral triangle as shown in Figure 21-32. If the potential at the center of the triangle is 0 V, what is the value of +q?

![Figure 21-32](image)

Solution or Explanation
The potential from the bottom two charges is
\[ V = \frac{k (+Q)}{r} + \frac{k (-Q)}{r} = 0 \text{ V}. \]
Any charge on the +q point would add to the potential. Therefore, it must be neutral.

8. **Question Details** Electric Potential Energy (4) [735034]

Two spheres are mounted on identical horizontal springs and rest on a frictionless table, as in the drawing. When the spheres are uncharged, the spacing between them is 0.0500 m, and the springs are unstrained. When each sphere has a charge of +1.60 \( \mu \text{C} \), the spacing doubles. Assuming that the spheres have a negligible diameter, determine the spring constant of the springs.

![Diagram](image)

Solution or Explanation
Conservation of energy works well for this solution. Initially, the energy is zero. Thus, the sum of the final energies must also be zero. There are only two types of energy present - elastic potential energy \( (U_{\text{elastic}}) \) and electric potential energy \( (U_{\text{electric}}) \). As the balls move, the electric potential energy decreases; whereas, the elastic potential energy increases. The change is such that,
\[ k q^2 / r = 2(1/2 K x^2) \]
where \( x \) is the displacement of each spring and \( r \) is the final distance between the balls. Remember that there are 2 springs. Notice
that I have made the spring constant K to distinguish it from \( k = 8.99 \times 10^9 \) Nm\(^2\)/C\(^2\).

To find \( x \) and \( r \), we must carefully consider what happened. Since the spacing of 0.0500 m doubles, then \( r = 2 \times (0.0500 \text{ m}) = 0.1 \text{ m} \). The displacement of each spring on the other hand is given by the change in \( r \) or \( x = 0.0500 \text{ m} \). But wait! This displacement takes place on 2 springs each changing an equal amount. Thus each spring compresses \( x = (0.0500 \text{ m}) / 2 = 0.025 \text{ m} \). Thus, \( k \frac{q^2}{(0.1 \text{ m})} = K (0.025 \text{ m})^2 \).

We can now solve for \( K \).

9. **Question Details** Electric Force (3) [735023]

Two balls with the different non-zero charges are placed on the x-axis. One is 3 m to the right of the origin the other is the same distance to the left. What is always true about the force on another charged ball at the origin due to these charges?

- w'04'It is to the left.
- x'03'It has no x-component.
- z'01'It is up.
- y'10'It has no y-component.
- y'03'It is zero.

**Solution or Explanation**
The force from both other balls on the center one point along the x-axis. Since we do not know the value of the charges, we do not know the magnitudes of these forces. However, when they are added together, the y-component will be zero. The x-component may point either way (left or right) depending on the values of the charges.

10. **Question Details** Electric Flux and Gauss' Law (3) [735030]

Consider two concentric conducting spheres (Figure 23-34). The outer sphere is hollow and initially has a charge \( Q_1 = -6Q \) deposited on it. The inner sphere is solid and has a charge \( Q_2 = +1Q \) on it.

Electrostatic equilibrium is established.

How much charge is on the outer surface of the outside sphere?

- y'03'6 Q
- x'03'-1 Q
- w'05'5 Q
- y'10'-5 Q
- z'01'0 Q

**Solution or Explanation**
The electric field in the material of both the sphere and shell must be zero. The only way for this to occur is if the charge inside the inner surface of the shell is such that its charge plus the solid's charge is zero. The rest of the excess charge from the shell moves to the outside of the shell.