



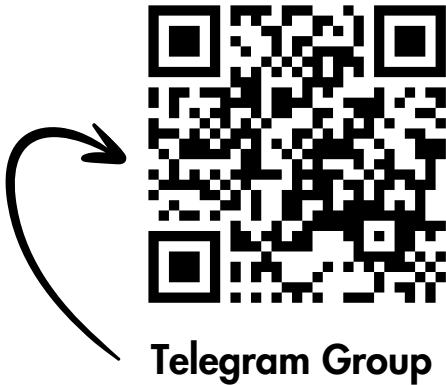
Physics

الشرح بالانجليزي

Worksheets

First Term 2024-25

12ADV



Telegram Group



الحل على موقع الأكاديمية



+971 50 821 0248



<https://www.manasra.academy>

تقديم واعداد الأستاذ: علاء الفقيه



First Term Physics Course

- 1 Recorded classes to explain the entire material of the 1st term
- 2 Electronic trial exams just like the Ministry's Exams
- 3 Recorded Classes to review EoT1 and previous year's questions
- 4 Talk to the teacher directly via WhatsApp to answer questions
- 5 Worksheets for the 1st Term and their solutions
- 6 Technical support for the website 24 hours 7 days a week

باقة الفيزياء للفصل الأول

- 1 حصص مسجلة لشرح كامل مادة الفصل الأول
- 2 امتحانات الكترونية محاكية لامتحانات الوزارة
- 3 حصص مسجلة لمراجعة الهيكل واسئلة السنوات السابقة
- 4 التحدث مع الأستاذ عن طريق الواتساب للإجابة عن الأسئلة
- 5 ملازم الفصل الأول وحلولها
- 6 دعم فني للموقع 24 ساعة 7 أيام في الأسبوع





Unit 1: Electrostatic Force

(1.2) Electric charges:

Why does an object get a charge?

Objects get a charge when electrons transfer to (or from) a neutral object.

Two kinds of electric charge:

1- **Negative charge:** Like that of a hard rubber rubbed by a piece of wool. Wool loses electrons and gets a positive charge, and rubber gains electrons getting a negative charge.

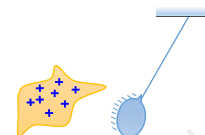
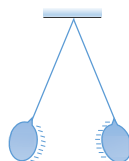
2- **Positive charge:** Like that of a glass rubbed by a piece fur. Glass loses electrons and gets a positive charge, and fur gains electrons getting a negative charge.



(Law of electrostatic charge)

1- **Attraction force:** Opposite charges attract.

2- **Repulsion force:** Like charges repel.



Law of charge conservation:

The total electric charge of an isolated system is conserved.

Charge is quantized:

Electric charge occurs only in integral multiples of a minimum size. (Any charge Q can be expressed as a whole number N multiplied by the elementary charge e)

Multiples of the charge of an electron.

$$Q = N \times e$$

Number of electrons (pointing to N)

Elementary charge (pointing to e)

Charge quantity (pointing to Q)

where $e = 1.602 \times 10^{-19} \text{ C}$ is the elementary charge.

$$Q = e (N_p - N_e)$$

Note: The unit of electric charge is the coulomb (C).

$$(C = A.S)$$





Q1: The figure shows a blue ball which initially has a charge of $+9.6 \times 10^{-8} \text{ C}$, then it touches a neutral red ball. After the balls are separated, the red ball has a charge of $+4.8 \times 10^{-8} \text{ C}$, what is the charge on the blue ball?



- A) -4.8 C B) $+4.8 \text{ C}$ C) $-4.8 \times 10^{-8} \text{ C}$ D) $+4.8 \times 10^{-8} \text{ C}$

Q2: A piece of a metal with a charge of (0.0 C) contains $(1.6 \times 10^{20} \text{ protons})$. What is the number of **electrons** in this piece?

- A) $8.0 \times 10^{19} \text{ electron}$ B) $1.6 \times 10^{20} \text{ electron}$ C) $3.2 \times 10^{20} \text{ electron}$ D) 0.0 electron

Q3: Which one of these systems has the most negative charge?

- A) 2 electrons B) 3 electrons and 1 proton
C) 5 electrons and 5 protons D) N electrons and N – 3 protons

Q4: A conductor carrying a charge of $(q = -8 \text{ nC})$, so there is:

- A) $5 \times 10^{10} \text{ excess electrons}$ B) $5 \times 10^{10} \text{ deficit electrons}$
C) $5 \times 10^{13} \text{ excess electrons}$ D) $5 \times 10^{13} \text{ deficit electrons}$

Q5: When an object is negatively charged; this means that the object:

- A) Gains electrons. اكتسب الإلكترونات B) Loses electrons. فقد الإلكترونات
C) Gains protons. اكتسب بروتونات D) Loses protons. فقد بروتونات



Q6: How many electrons does it take to make 1.00 C of charge?

- A) 1.6×10^{19} B) 6.60×10^{19} C) 3.2×10^{16} D) 6.24×10^{18}

Q7: Which of the following indicates the correct expression for the law of electric charges?

- A) The charge of a body is an integer number of the fundamental charge
B) Same charges repel each other, and different charges attract each other
C) Different charges repel and like charges attract
D) The total amount of electric charge in a closed system does not change

Q8: When two bodies are charged, the total charge before and after charging remains constant.

This corresponds to:

- A) The charge quantum principle
B) The law of conservation of charge
C) The law of induction
D) Coulomb's law

Q9: A neutral conducting sphere has been charged with a charge $+8.32\mu\text{C}$. Which of the following is correct about the sphere?

- A) Gain 5.20×10^{13} protons.
B) Lose 5.20×10^{13} electrons.
C) Gain 8.32×10^6 protons.
D) Lose 8.32×10^6 electrons.





(1.3) Insulators, Conductors, Semiconductors and Superconductors:

1- **Insulators:**

Materials that don't conduct electricity are called Insulators. (Electrons can't move through it.) Typical insulators are glass, plastic and cloth.

2- **Conductors:**

Materials that conduct electricity well are called conductors. (Electrons can move through it.) Typical solid conductors are metals like copper. Electrolytes and organic tissue are also conductors.

3- **Semiconductors:**

A class of materials called **semiconductors** can change from being an insulator to being a conductor and back to an insulator again.

a) **Intrinsic semiconductors:**

These materials are insulators at absolute zero, but its conductivity increases with temperature. Examples: Chemically pure crystals of gallium arsenide, germanium, or, especially, silicon.

b) **Extrinsic semiconductors:**

These materials are produced by doping (adding of minute amount of other material that can act as electron donors or electron receptors).

* **N-type:** Extrinsic crystal doped with electron donor atoms (Phosphor), and the majority carriers are negative electrons.

* **P-type:** Extrinsic crystal doped with electron receptor atoms (Aluminum), and the majority carriers are the positive holes.

4- **Superconductors:**

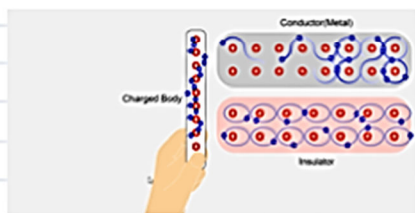
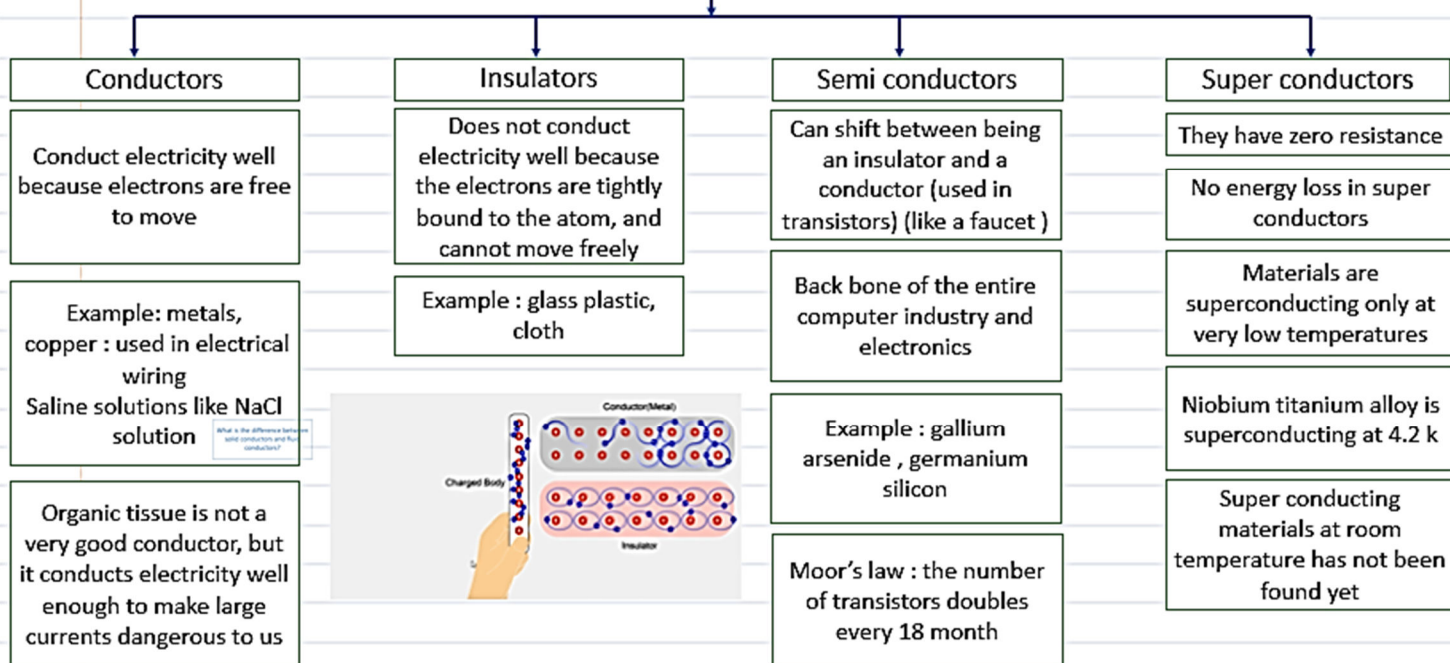
Superconductors are materials that have zero resistance to the conduction of electricity.

- Materials are superconducting only at very low temperatures.
- A typical superconductor is niobium-titanium alloy at liquid helium temperature (4.2 K).
- The so-called high T_c superconductors can be used at liquid nitrogen temperature (77.3 K).
- Superconductors are necessary for appliances that need high currents such as MRI.

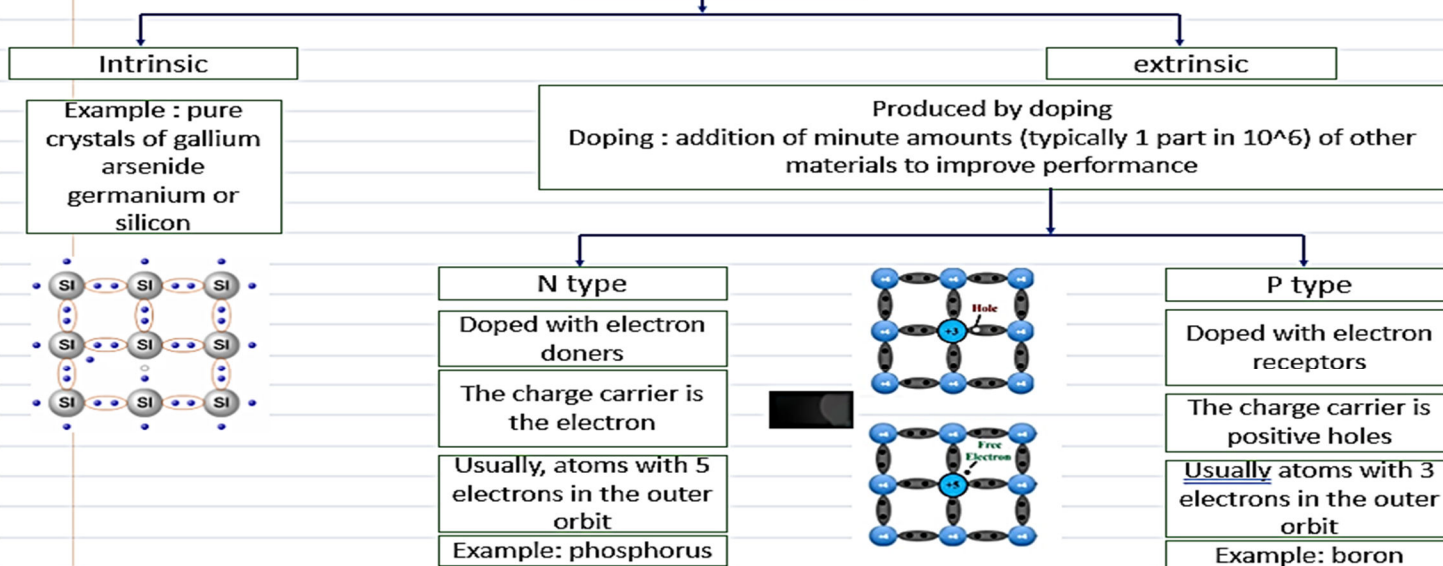




Materials



Semi conductors





Q10: Which of the following **materials** have $(R \rightarrow \infty \Omega)$?

- A) Superconductors B) Semiconductors C) Conductors D) Insulators

Q11: Which of the following statements is true about superconductors?

- A) The electrical resistance of superconductors is zero at room temperature
B) The electrical resistance of superconductors is zero at very low temperatures
C) Silicon and germanium are superconductors of electricity.
D) A large amount of energy is lost when the electric current passes through it.

Q12: In N-type semiconductors the majority of the carriers are:

- A) holes B) electrons C) protons D) neutrons

Q13: The dominant charge carriers in p-type semiconductors are:

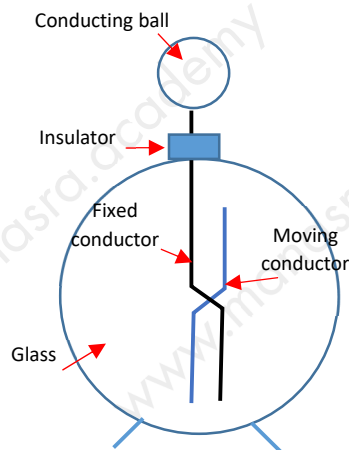
- A) holes B) electrons C) protons D) neutrons



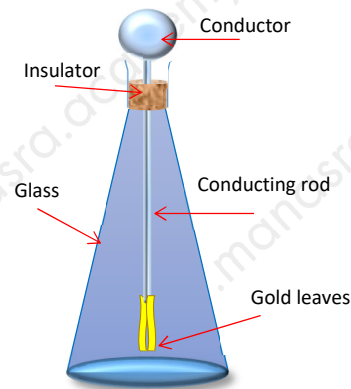


(1.4) Electrostatic charging:

Electroscope:



Electroscope



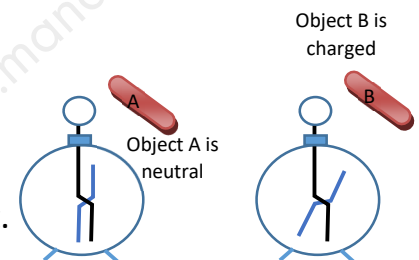
An electroscope is a device that gives an observable response when it is charged.

Electroscope -shown in Figure- has two conductors that in their neutral position are touching and oriented in a vertical direction. One of the conductors is hinged at its midpoint so that it will move away from the fixed conductor if a charge appears on the electroscope. These two conductors are in contact with a conducting ball on top of the electroscope, which allows charge to be applied or removed easily.

We can use the electroscope:

1- To test if an object is charged:

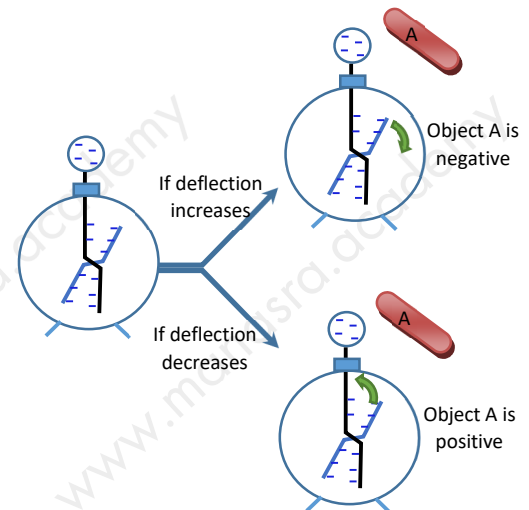
We use a neutralized electroscope with its two conductors adjacent. Bring an object near to the ball, if the free arm moves, the object is charged if not, the object is neutral.



2- To test the type of charge on a charged object:

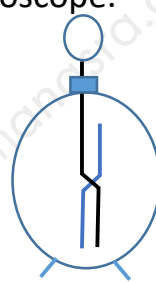
We use a negatively charged electroscope, with its movable conductor deflected.

Bring a charged object near to the ball, if the deflection increased, the object is negative, if it decreases, the object is positive.



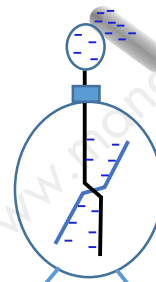
Types of electrostatic charging:**1- Charging by contact:**

- An uncharged electroscope.
- A negatively charged object touches the electroscope.
- The negatively charged object is removed.



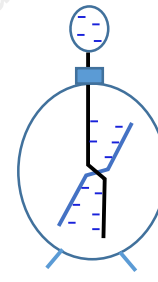
(a)

An un charged electroscope.



(b)

A negatively charged object touches the electroscope.

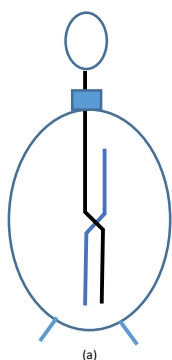


(c)

The negatively charged object is removed.

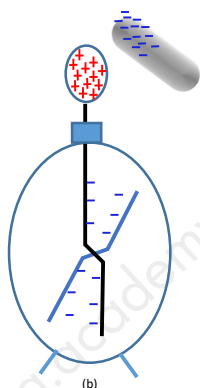
2- Charging by induction:

- An uncharged electroscope.
- A negatively charged object is brought close to the electroscope.
- A ground is connected to the electroscope.
- The connection to the ground is removed.
- A negatively charged object is taken away leaving the electroscope negatively charged.



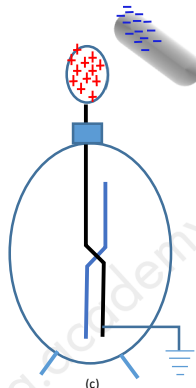
(a)

An un charged electroscope.



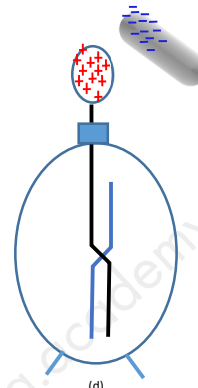
(b)

A negatively charged object is brought close to the electroscope.



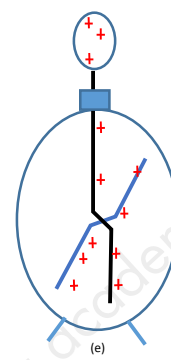
(c)

A ground is connected to the electroscope.



(d)

The connection to the ground is removed.



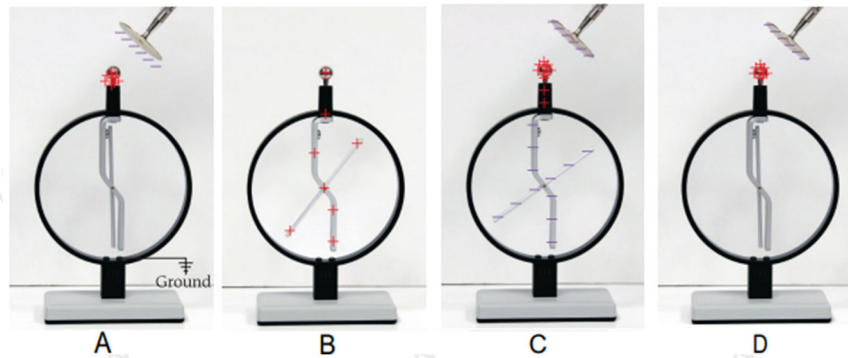
(e)

A negatively charged object is taken away leaving the electroscope negatively charged.





Q14: The diagram shows four steps for charging an electroscope in a **wrong order**. What is the **correct** order of these steps?



- A) D B A C B) D A C B
C) C A D B D) D C A B

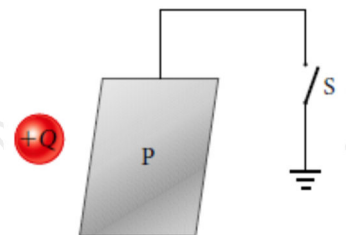
Q15: The charge by induction is used for charging:

- A) Insulators and conductors. B) Only conductors.
C) An object with insulating handle. D) Only insulators.

Q16: You bring a negatively charged rubber rod close to a grounded conductor without touching it. Then you disconnect the ground. What is the sign of the charge on the conductor after you remove the charged rod?

- A) positive B) negative
C) not charged D) cannot be determined from the given info

Q17: A metal plate is connected by a conductor to a ground through a switch. The switch is initially closed. A charge $+Q$ is brought close to the plate without touching it, and then the switch is opened. After the switch is opened, the charge $+Q$ is removed. What is the charge on the plate then?



- A) The plate is uncharged.
B) The plate is positively charged.
C) The plate is negatively charged.
D) The plate could be either positively or negatively charged, depending on the charge it had before $+Q$ was brought near.



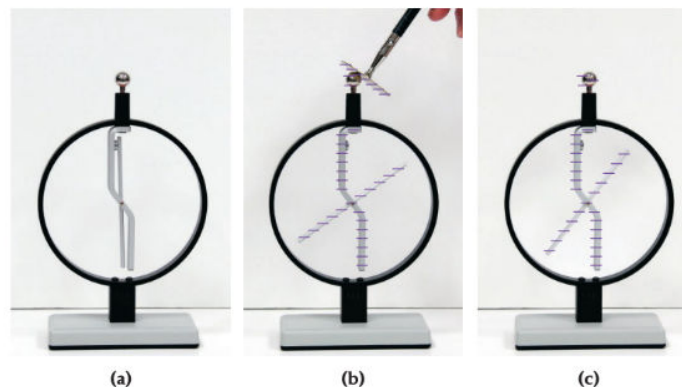


Q18: If a negatively charged insulating paddle touches the ball of the electroscope. When the paddle is removed, the best describe of the charge on paddle and the electroscope is:

- A) The paddle stays negative with less charge and the electroscope becomes negative.
- B) The paddle stays negative with same amount of charge and the electroscope becomes negative.
- C) The paddle stays negative with less charge and the electroscope becomes positive.
- D) The paddle become positive with less charge and the electroscope becomes negative.

Q19: The way of charging shown by the figure is:

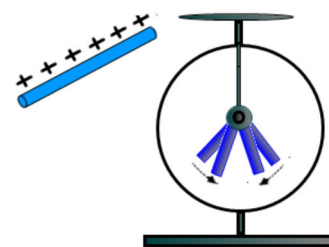
- A) Charging by contact
- B) Charging by induction and grounding
- C) Charging by induction
- D) Grounding



Q20: A positively charged rod is brought near a charged electroscope. As a result of doing this, the electroscope leaves move closer to each other.

What is the charge on the electroscope?

- A) Positive
- B) Negative
- C) It is neutral
- D) It depends on the distance between the electroscope and the rod



**(1.5) Electrostatic Forces – Coulomb's Law:**

Coulomb's Law gives the magnitude of the electric force exerted by a charge q_2 on a charge q_1 when the two charges are at rest.

$$F = k \frac{|q_1 q_2|}{r^2} \quad \text{where } k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2 \text{ is Coulomb's constant}$$

Notice that $k = \frac{1}{4\pi\epsilon_0}$ where $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$ is another constant called the electric permittivity of free space.

Coulomb's Law in vector form:

$$\vec{F}_{2 \rightarrow 1} = -k \frac{q_1 q_2}{r_{21}^3} (\vec{r}_2 - \vec{r}_1) = -k \frac{q_1 q_2}{r_{21}^2} \hat{r}_{21}$$

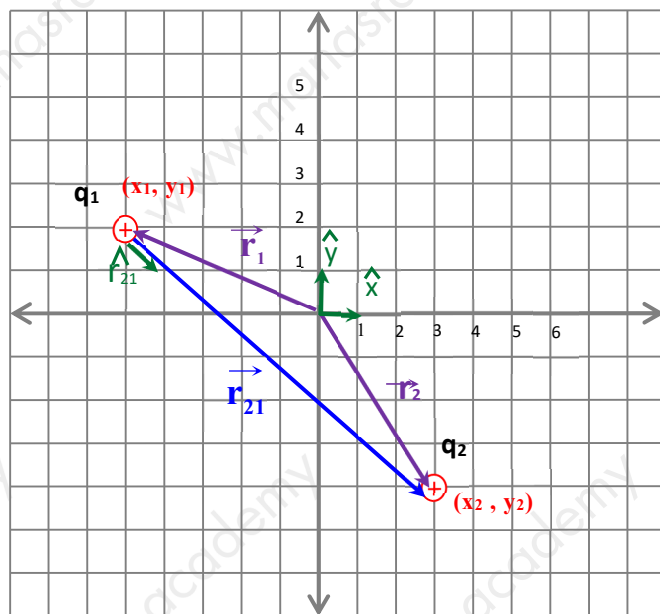
The negative sign indicates that the force is repulsive if both charges are positive or both charges are negative.

Where $\hat{r}_{21} = \frac{(\vec{r}_2 - \vec{r}_1)}{r_{21}}$ is a unit vector in the

direction from q_1 to q_2

$$\vec{r}_{21} = (x_2 - x_1)\hat{x} + (y_2 - y_1)\hat{y}$$

$$r_{21} = |\vec{r}_{21}| = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$



**Example:**

1- If $F_{21} = -30 \hat{r}_{12}$ Which of the following true:

A) q_1 negative and q_2 positive.

B) q_1 positive and q_2 negative.

C) q_1 and q_2 with same kind of charge.

D) $q_1 = q_2$

2- $q_1 = 2 \times 10^{-4} \text{C}$, $q_2 = -4 \times 10^{-4} \text{C}$ are placed on $(-5\text{m}, 2\text{m})$ and $(3\text{m}, -4\text{m})$ in order.

Which answer represent F_{21} :

A) $7.2 \hat{r}_{21}$

B) $-7.2 \hat{r}_{21}$

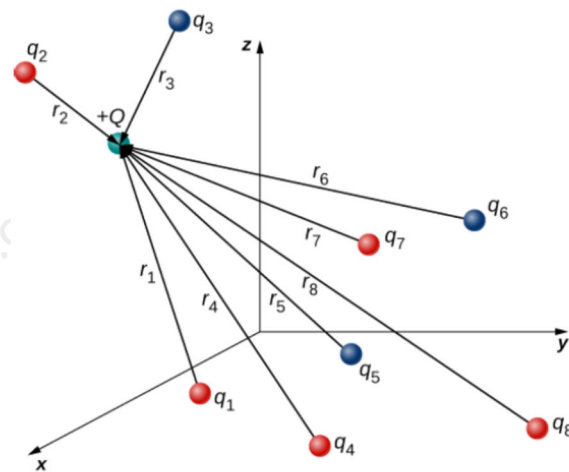
C) $0.72 \hat{r}_{21}$

D) $-0.72 \hat{r}_{21}$

Superposition principle:

If a specific charge Q is affected by a group of other charges the total force on Q is the resultant of the individual forces from each of the surrounding charges.

$$\vec{F}_{Net \rightarrow Q} = \vec{F}_{1 \rightarrow Q} + \vec{F}_{2 \rightarrow Q} + \vec{F}_{3 \rightarrow Q} + \dots$$

**Q21: In Figure shown:**

1- Calculate the magnitude of the force exerted by q_1 on q_2 .

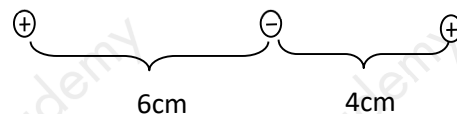
2- Calculate the magnitude of the force exerted by q_3 on q_2 .

3- What is the resultant force acting on q_2 ?

$q_2 = 24 \mu\text{C}$

$q_1 = -12 \mu\text{C}$

$q_3 = 25 \mu\text{C}$

**Solution:**

$$1- F_{12} = k \times \frac{|q_1 q_2|}{r^2} \Rightarrow F_{12} = 9 \times 10^9 \times \frac{12 \times 10^{-6} \times 24 \times 10^{-6}}{(6 \times 10^{-2})^2} = 720 \text{ N}$$

To the right

$$2- F_{32} = k \times \frac{|q_3 q_2|}{r^2} \Rightarrow F_{32} = 9 \times 10^9 \times \frac{25 \times 10^{-6} \times 24 \times 10^{-6}}{(10 \times 10^{-2})^2} = 540 \text{ N}$$

To the left

$$3- F_{net} = F_{12} - F_{32} = 720 - 540 = 180 \text{ N} \quad \text{To the right}$$





Q22: In Figure shown:

1- Calculate the force exerted on q_1 .

2- Calculate the magnitude of the force exerted on q_2 .

Solution:

$$1- F_{21} = k_c \times \frac{q_2 q_1}{r^2}$$

$$F_{21} = 9 \times 10^9 \times \frac{4 \times 10^{-6} \times 1.2 \times 10^{-6}}{(4 \times 10^{-2})^2} = 27 \text{ N}$$

$$F_{31} = 9 \times 10^9 \times \frac{3 \times 10^{-6} \times 1.2 \times 10^{-6}}{(3 \times 10^{-2})^2} = 36 \text{ N}$$

$$F_{net} = \sqrt{F_{21}^2 + F_{31}^2} \Rightarrow F_{net} = \sqrt{27^2 + 36^2} = 45 \text{ N}$$

$$\theta = \tan^{-1}\left(\frac{F_{31}}{F_{21}}\right) \Rightarrow \theta = \tan^{-1}\left(\frac{36}{27}\right) \Rightarrow \theta = 53^\circ$$

$$2- F_{12} = F_{21} = 27 \text{ N}$$

$$F_{32} = 9 \times 10^9 \times \frac{3 \times 10^{-6} \times 4 \times 10^{-6}}{(5 \times 10^{-2})^2} = 43.2 \text{ N}$$

$$F_{32x} = F_{32} \cos(\alpha) = 43.2 \times \frac{4}{5} = 34.56 \text{ N}$$

$$F_{32y} = F_{32} \sin(\alpha) = 43.2 \times \frac{3}{5} = 25.92 \text{ N}$$

$$F_x = F_{32x} - F_{12} = 34.56 - 27 = 7.56 \text{ N}$$

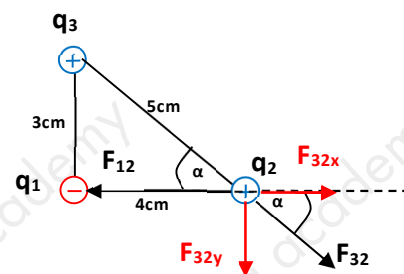
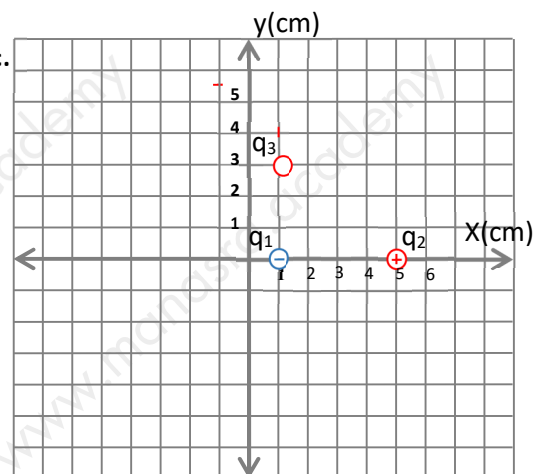
$$F_y = -F_{32y} = -25.92 \text{ N}$$

$$F_{net} = \sqrt{F_x^2 + F_y^2} \Rightarrow F_{net} = \sqrt{(7.56)^2 + (-25.92)^2} = 27 \text{ N}$$

$$q_1 = -1.2 \mu\text{C}$$

$$q_2 = 4 \mu\text{C}$$

$$q_3 = 3 \mu\text{C}$$





Q23: In Figure shown, use the given data to Calculate the force exerted by q_2 on q_1 in terms of the unit vectors.

Solution:

$$\vec{F}_{2 \rightarrow 1} = -k \frac{|q_1||q_2|}{(|\vec{r}_{21}|)^3} \vec{r}_{21}$$

$$\vec{r}_{21} = (x_2 - x_1)\hat{x} + (y_2 - y_1)\hat{y}$$

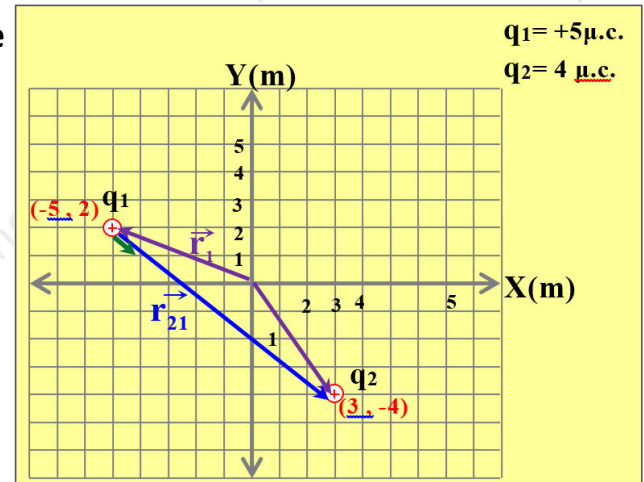
$$\vec{r}_{21} = (3 - (-5))\hat{x} + (-4 - 2)\hat{y}$$

$$\vec{r}_{21} = (8)\hat{x} + (-6)\hat{y}$$

$$|\vec{r}_{21}| = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \Rightarrow |\vec{r}_{21}| = \sqrt{(8)^2 + (-6)^2} = 10 \text{ m}$$

$$\vec{F}_{2 \rightarrow 1} = -9 \times 10^9 \frac{5 \times 10^{-6} \times 4 \times 10^{-6}}{(10)^3} [8\hat{x} - 6\hat{y}] \Rightarrow \vec{F}_{2 \rightarrow 1} = -1.8 \times 10^{-4} [8\hat{x} - 6\hat{y}]$$

$$\vec{F}_{2 \rightarrow 1} = [-1.44 \times 10^{-3}\hat{x} + 1.08 \times 10^{-3}\hat{y}]$$





Q24: In Figure shown, use the given data to Calculate the force exerted on q4.

Solution:

$$F = k_c \times \frac{q}{r^2} \times q$$

$$F_{14} = 9 \times 10^9 \times \frac{1.8 \times 10^{-6} \times 4.8 \times 10^{-6}}{(6 \times 10^{-2})^2} = 21.6 \text{ N}$$

$$F_{24} = 9 \times 10^9 \times \frac{2 \times 10^{-6} \times 4.8 \times 10^{-6}}{(10 \times 10^{-2})^2} = 8.64 \text{ N}$$

$$F_{34} = 9 \times 10^9 \times \frac{1.6 \times 10^{-6} \times 4.8 \times 10^{-6}}{(8 \times 10^{-2})^2} = 10.8 \text{ N}$$

$$F_{24_x} = F_{24} \cos(\alpha) = 8.64 \times \frac{8}{10} = 6.9 \text{ N}$$

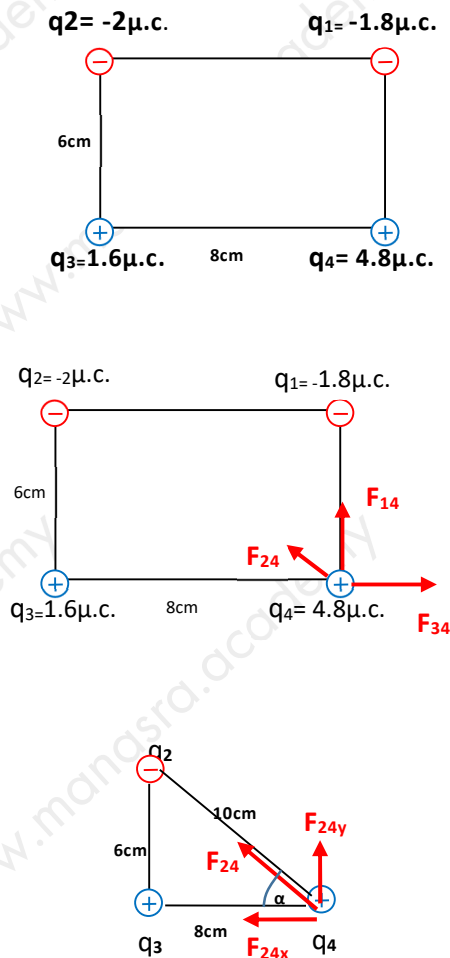
$$F_{24_y} = F_{24} \sin(\alpha) = 8.64 \times \frac{6}{10} = 5.2 \text{ N}$$

$$F_x = F_{34} - F_{24_x} = 10.8 - 6.9 = 3.9 \text{ N}$$

$$F_y = F_{14} + F_{24_y} = 21.6 + 5.2 = 26.8 \text{ N}$$

$$F_{net} = \sqrt{F_x^2 + F_y^2} \Rightarrow F_{net} = \sqrt{3.9^2 + 26.8^2} = 27.1 \text{ N}$$

$$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right) \Rightarrow \theta = \tan^{-1}\left(\frac{26.8}{3.9}\right) \Rightarrow \theta = 81.7^\circ$$



Q25: Two identical point charges q1 and q2 are 0.5 m apart, if the magnitude of electrostatic force between them is 0.02N , What is the absolute value of the charge q1?

A) 0.746μC

B) $5.56 \times 10^{-13} \text{ C}$

C) 1.49μC

D) $2.23 \times 10^{-12} \text{ C}$

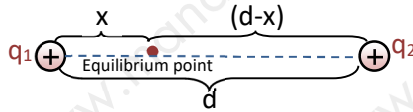


**Equilibrium points:**

Points on the line passing through two charges at which the net force on a third charge is zero.

***Two like charges:**

Equilibrium point lays between charges.



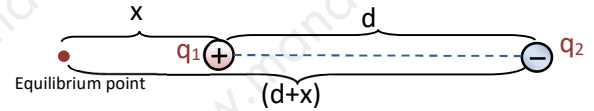
$$F_1 = F_2$$

$$k_c \frac{|q_1 q_3|}{x^2} = k_c \frac{|q_2 q_3|}{(d-x)^2}$$

$$\frac{\sqrt{|q_1|}}{x} = \frac{\sqrt{|q_2|}}{(d-x)}$$

***Two opposite charges:**

Equilibrium point lays outside the charges.



$$F_1 = F_2$$

$$k_c \frac{|q_1 q_3|}{x^2} = k_c \frac{|q_2 q_3|}{(d-x)^2}$$

$$\frac{\sqrt{|q_1|}}{x} = \frac{\sqrt{|q_2|}}{(d-x)}$$

Q26: In the figure shown

Determine the position of the equilibrium point.

What is the force exerted on a point charge ($5\mu\text{C}$) at equilibrium point?

Solution:

$$E_2 = E_1$$

$$k_c \frac{q_2}{x^2} = k_c \frac{q_1}{(d-x)^2}$$

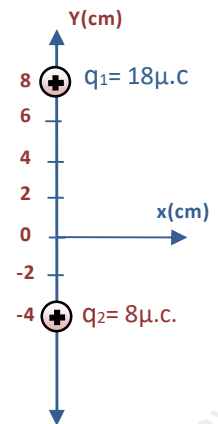
1-

$$\frac{\sqrt{q_2}}{x} = \frac{\sqrt{q_1}}{(d-x)}$$

$$\frac{\sqrt{8}}{x} = \frac{\sqrt{18}}{(12-x)} \Rightarrow \frac{\sqrt{4}}{x} = \frac{\sqrt{9}}{(12-x)} \Rightarrow \frac{2}{x} = \frac{3}{(12-x)}$$

$$3x = 24 - 2x \Rightarrow 5x = 24 \Rightarrow x = 4.8 \text{ cm}$$

2- $F = 0$





Q27: What is the magnitude of the electrostatic force that the two protons inside the nucleus of a helium atom exert on each other? ($r = 2 \times 10^{-15} \text{ m}$)

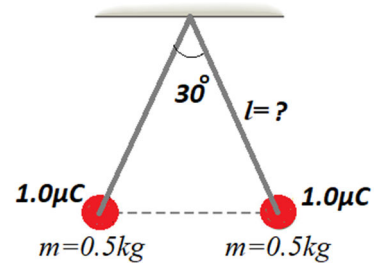
- A) 65 N B) 58 N C) 78 N D) 88 N

Q28: What is the magnitude of the electrostatic force between a gold nucleus and an electron of the gold atom in an orbit with radius $4.88 \times 10^{-12} \text{ m}$? Note: $q_{\text{gold}} = 79 e$

- A) $7.63 \times 10^{-4} \text{ N}$ B) $7.88 \times 10^{-12} \text{ N}$ C) $7.63 \times 10^{-2} \text{ N}$ D) $10.43 \times 10^{-5} \text{ N}$

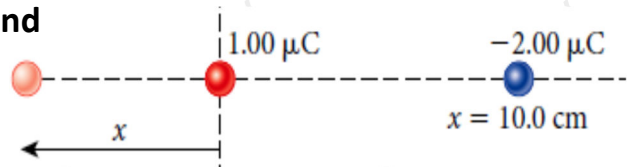
Q29: The figure shows two identical positively charged balls hanging from the ceiling by insulated massless ropes of equal length l . What is the length l ? ($g = 9.81 \text{ m/s}^2$)

- A) 8.28 cm B) 15.98 cm C) 4.28 cm D) 0.68 cm



Q30: A positive charge $q_1 = 1.00 \mu\text{C}$ is fixed at the origin, and a second charge $q_2 = -2.00 \mu\text{C}$ is fixed at $x = 10.0 \text{ cm}$. Where along the x-axis should a third charge be positioned so that it experiences no force?

- A) 24.14 cm from q_1 B) 34.14 cm from q_1 C) 24.14 cm from q_2 D) 10 cm from q_1



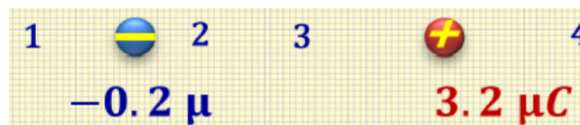


Q31: Three equal point charges are held in place as shown in Figure. If F_1 is the force on q due to Q_1 and F_2 is the force on q due to Q_2 , how do F_1 and F_2 compare?



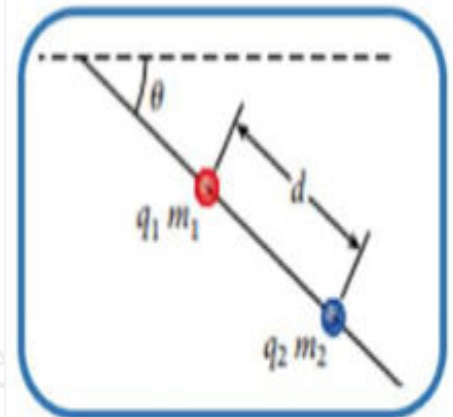
- A) $F_1 = 2F_2$ B) $F_1 = 3F_2$ C) $F_1 = 4F_2$ D) $F_1 = 9F_2$

Q32: The figure shows two points charges, where can the electrostatic force be absent?



- A) 1 B) 2 C) 3 D) 4

Q33: A bead with charge $q_1 = 2 \mu\text{C}$ is fixed in place at the end of a wire that makes an angle of $\theta = 30^\circ$ with the horizontal. A second bead with a charge of $-6 \mu\text{C}$ and slides without friction on the wire. The second bead balance when it is a distance of 0.4m from the first bead. What is the mass m_2 for the second bead?



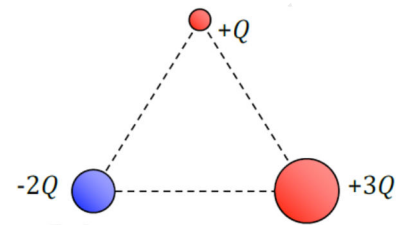
- A) 0.14 Kg
B) 0.77 Kg
C) 0.33 Kg
D) 0.44 Kg





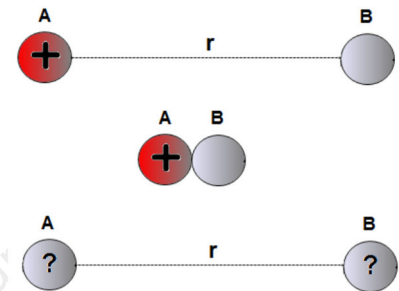
Q34: Three point-charges, of charge $+Q$, $-2Q$, and $+3Q$, are placed equidistant as shown. Which vector best describes the net direction of the electric force acting on the $+Q$ charge?

- A)  B)  C)  D) 



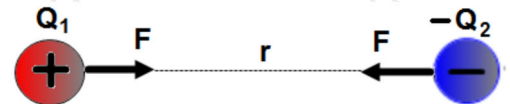
Q35: Sphere A carries a positive charge $4Q$ and sphere B is neutral. Initially the spheres are separated by a distance r . The spheres briefly touch each other and move to the initial separation. Which of the following is the correct expression for the force on each sphere after they moved to the original distance r ?

- A) $F = \frac{2kQ^2}{r^2}$ B) $F = \frac{kQ^2}{r^2}$ C) $F = \frac{8kQ^2}{r^2}$ D) $F = \frac{4kQ^2}{r^2}$



Q36: Two charges Q_1 and $-Q_2$ are separated by a distance r . The charges attract each other with a force F . What is the new force between the charges if the distance is cut to one-fourth and the magnitude of each charge is doubled?

- A) $16 F$ B) $64 F$
C) $48 F$ D) $1/64 F$

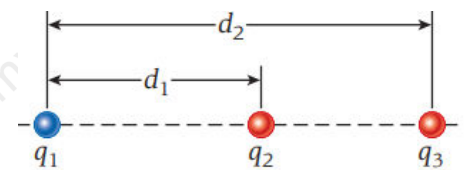




Q37: Two charges q_1 and q_2 a distance r away, they exert a force (10 N) on one another. If the distance decreased to half, the force exerted will be:

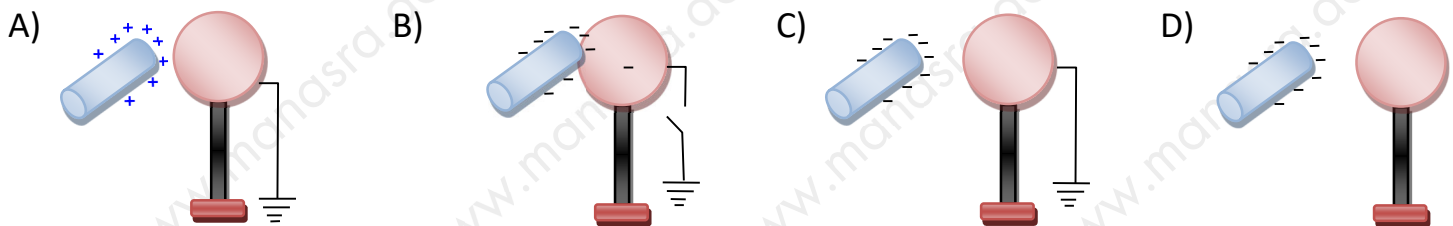
- A) 20 N B) 40 N C) 80 N D) 160 N

Q38: Consider three charges placed along the x-axis, as shown in the figure. The values of the charges are $q_1 = -8.10 \mu\text{C}$, $q_2 = 2.16 \mu\text{C}$, and $q_3 = 2.16 \text{ pC}$. The distance between q_1 and q_2 is $d_1 = 1.71 \text{ m}$. The distance between q_1 and q_3 is $d_2 = 2.62 \text{ m}$. What is the magnitude of the total electrostatic force exerted on q_3 by q_1 and q_2 ?



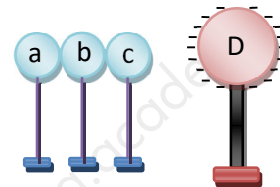
- A) $2.77 \times 10^{-8} \text{ N}$ B) $7.92 \times 10^{-6} \text{ N}$ C) $1.44 \times 10^{-5} \text{ N}$ D) $2.22 \times 10^{-4} \text{ N}$

Q39: The spherical conductor is neutral in one of the following figures:





Q40: Three conductors with insulator base put in contact as shown in figure, a negatively charged conductor D is brought close to the conductors, then conductor b is moved to lose contact with a and c, finally conductor D is taken away. The charges of the conductors a, b and c will be:

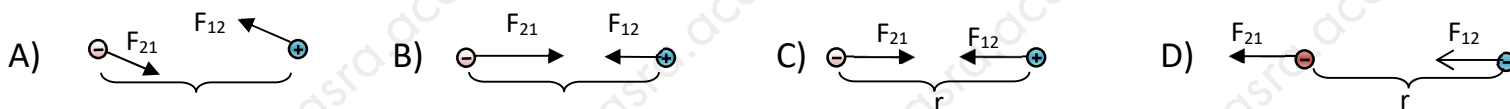


- A) c and a are positive but b is negative. B) c and a are negative but b is positive.
C) b and a are negative but c is positive. D) a is negative b is neutral and c is positive.

Q41: The force between a charge of $25 \mu\text{C}$ and a charge of $-10 \mu\text{C}$ is 8.0 N . What is the separation between the two charges?

- A) 0.15 m B) 0.28 m C) 0.45 m D) 0.53 m

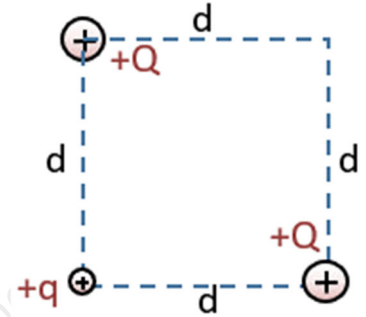
Q42: Two unlike charges with different magnitudes, the forces between them is best represented by:





Q43: As shown above, two particles, each of charge $+Q$, are fixed at opposite corners of a square that lies in the plane of the page. A positive test charge $+q$ is placed at a third corner. What is the direction of the force on the test charge due to the two other charges?

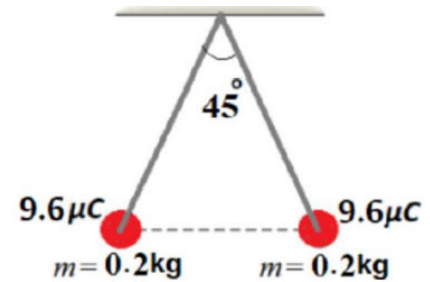
- A) ↘ B) ↗ C) ↙ D) ↓



Q44: Two identical positively charged balls hanging at rest from the ceiling by insulated massless ropes of equal length as shown in the figure. What is the distance between the two charges?

($g=9.81\text{m/s}^2$)

- A) 0.5 m
B) 1.5 m
C) 1.0 m
D) 0.0 m



Q45: Charge $q_1 = 1.4 \times 10^{-8} \text{ C}$ is placed at the origin. Charges $q_2 = -1.8 \times 10^{-8} \text{ C}$ and $q_3 = 2.1 \times 10^{-8} \text{ C}$ are placed at points (0.18 m, 0 m) and (0 m, 0.24 m), respectively, as shown in the figure.

Determine the net electrostatic force (magnitude and direction) on charge q_3 .

