BRAC UNIVERSITY

Principles of Physics-II (PHY-112)

Department of Mathematics and Natural Sciences

Quiz: 01, **Section**: 08

Date: February 7, 2024

Duration: 35 Minutes | **Spring 2024 (10F-29C)** | Marks: 15

Name: Student ID:

Use SI Units only. Read the questions properly before You start.

1. When a proton enters an $\vec{E}$ field perpendicularly, it experiences an acceleration that is — **(1)**
   ○ parallel to its initial motion ✓ perpendicular to its initial motion ○ anti-parallel to its initial motion ○ Need more information

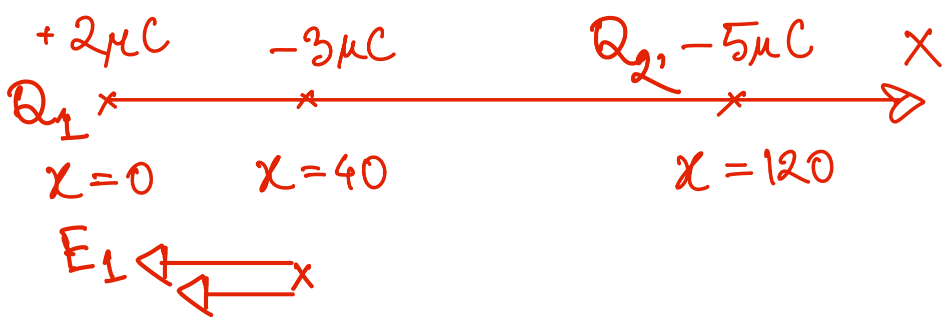
2. What condition must be followed to get an electric field equilibrium on either side of the two-point charges (positive) placed in the x-axis? **(1)**
   ○ $\vec{E}_+ + \vec{E}_- = 0$ ○ $E_+ = E_-$ ✓ No equilibrium can be found in the given location ○ $E_+ = -E_-$

3. "All observer charges experience the same field from a source at a fixed location." This statement implies— **(1)**
   ○ electric force remains fixed for all observers ○ electric field is observer dependent ✓ electric field is observer independent ○ Need more information

4. Two point charges placed r distance apart feels a mutual electrostatic force F_E. If both charges and the distance between them is tripled, the new force is— **(1)**
   ○ tripled ○ cubed ✓ same ○ one-third

5. "Two Electrically charged spheres in contact reach a charged equilibrium so that their charges match." This matching behavior implies which of the following properties of electric charge? **(1)**
   ✓ conservation of electric charges ○ additivity of electric charges ○ quantization of electric charges ○ flow of charge from high to low direction

6. Three point charges are placed at the following points on the x-axis: $+2\mu$C at $x = 0$ cm, -3μC at $x = 40$ cm, -5μC at $x = 120$ cm. Find E on the -3μC charge in component form. **(4)**



E_2

$$\vec{E}_{net} = \vec{E}_1 + \vec{E}_2$$

$$= \frac{-Q_1}{4\pi\varepsilon_0 r_1^2}\hat{i} - \frac{Q_2}{4\pi\varepsilon_0 r_2^2}\hat{i}$$

$r_1 = 40\times10^{-2}$ m.

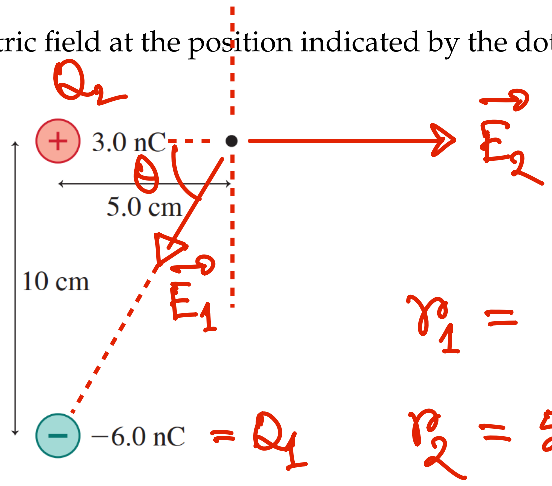
$r_2 = 80\times10^{-2}$ m.

$$= (-112.344\times10^3\,\hat{i} - 70.215\times10^3\,\hat{i})\ NC^{-1}.$$

$$= (-182.559\times10^3\,\hat{i})\ NC^{-1}.$$

7. What are the strength and direction of the electric field at the position indicated by the dot? **(4)**

$$\theta = \tan^{-1}\left(\frac{10}{5}\right) = 63.43^\circ$$



$$r_1 = 11.18 \times 10^{-2}\,m.$$

$$r_2 = 5 \times 10^{-2}\,m.$$

$$\vec{E}_{net} = \vec{E}_1 + \vec{E}_2$$

$$= \frac{Q_1}{4\pi\epsilon_0 r_1^2}\cos(\pi+\theta)\,\hat{i} + \frac{Q_1}{4\pi\epsilon_0 r_1^2}\sin(\pi+\theta)\,\hat{j} + \frac{Q_2}{4\pi\epsilon_0 r_2^2}\,\hat{i}$$

$$= \left(-1.9297 \times 10^{3}\,\hat{i} - 3.8586 \times 10^{3}\,\hat{j} + 10.7851 \times 10^{3}\,\hat{i}\right) NC^{-1}.$$

$$= \left(8.8554 \times 10^{3}\,\hat{i} - 3.8586 \times 10^{3}\,\hat{j}\right) NC^{-1}.$$

$$|\vec{E}_{net}| = 9.6595 \times 10^{3}\ NC^{-1}.$$

direction: $\tan^{-1}\left(\frac{E_y}{E_x}\right) = -23.54^\circ$; clockwise from +x axis.

8. Place a −5nC at the dot location from Question-6. Measure the angle direction it may or may not accelerate. The direction must be measured clockwise from the x-axis. **(2)**

Since there is a net $\vec{E}$ at the dot, the −5nC charge will accelerate in the direction opposite to $\vec{E}$.

direction of acceleration: $180^\circ - 23.54^\circ$

$= 156.455^\circ$; clockwise from +x axis.

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Date: February 7, 2024

Inspiring Excellence

Duration: 35 Minutes | **Spring 2024 (10F-29C)** | Marks: 15

Name: Student ID:

Use SI Units only. Read the questions properly before You start.

1. When a neutron enters an $\vec{E}$ field perpendicularly, it experiences an acceleration that is — **(1)**
   ○ parallel to its initial motion ○ perpendicular to its initial motion ○ anti-parallel to its initial motion ○ what acceleration?

2. What condition must be followed to get an electric field equilibrium on either side of the two-point charges (negative) placed in the x-axis? **(1)**
   ○ $\vec{E}_+ + \vec{E}_- = 0$ ○ $E_+ = E_-$ ○ No equilibrium can be found in the given location ○ $E_+ = -E_-$

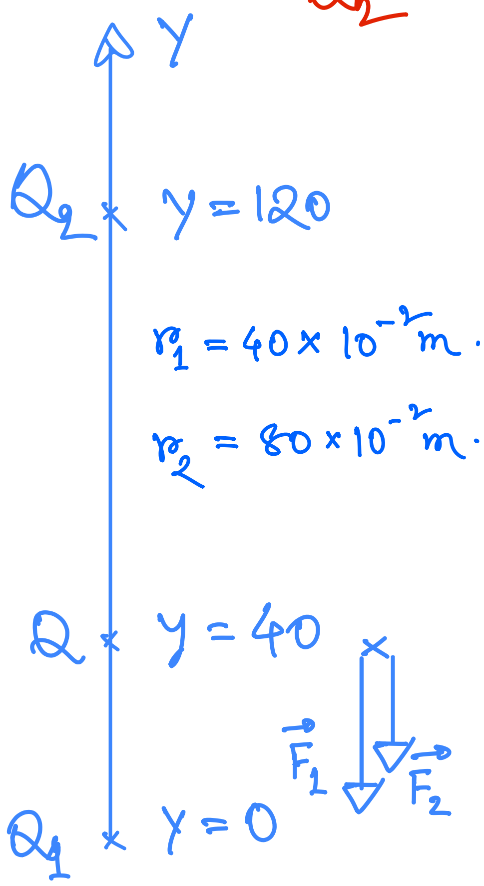
3. "All observer charges experience the same field from a source at a fixed location." This statement implies— **(1)**
   ○ electric force remains fixed for all observers ○ electric field is observer dependent ○ electric field is observer independent ○ Need more information

4. Two point charges placed r distance apart feels a mutual electrostatic force F_E. If both charges and the distance between them is doubled, the new force is— **(1)**
   ○ doubled ○ halved ○ same ○ one-fourth

5. "Two Electrically charged spheres in contact reach a charged equilibrium so that their charges match." This matching behavior implies which of the following properties of electric charge? **(1)**
   ○ conservation of electric charges ○ additivity of electric charges ○ quantization of electric charges ○ flow of charge from high to low direction

6. Three point charges are placed at the following points on the y-axis: $+2.5\mu$C at $y = 0$ cm, -3μC at $y = 40$ cm, -5μC at $y = 120$ cm. Find F on the -3μC charge in component form. **(4)**

Q Q1 Q2



$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2$$

$$= \frac{-Q_1 Q}{4\pi\epsilon_0 r_1^2}\hat{j} - \frac{Q_2 Q}{4\pi\epsilon_0 r_2^2}\hat{j}$$

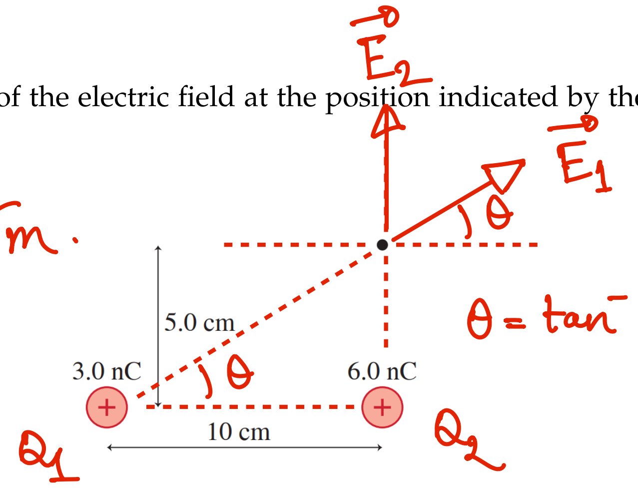
$$= (-421.291\times10^{-3}\hat{j} - 210.646\times10^{-3}\hat{j})\ \text{N}$$

$$= (-631.937\times10^{-3}\hat{j})\ \text{N}.$$

7. What are the strength and direction of the electric field at the position indicated by the dot? Complete the diagram for a perfect answer. **(4)**

$r_1 = 11.18 \times 10^{-2}$ m.

$r_2 = 5 \times 10^{-2}$ m.



$\theta = \tan^{-1}\left(\frac{5}{10}\right) = 26.57°$

$$\vec{E}_{net} = \vec{E}_1 + \vec{E}_2$$

$$= \frac{Q_1}{4\pi\epsilon_0 r_1^2}\cos(\theta)\,\hat{i} + \frac{Q_1}{4\pi\epsilon_0 r_1^2}\sin(\theta)\,\hat{j} + \frac{Q_2}{4\pi\epsilon_0 r_2^2}\,\hat{i}$$

$$= \left(1.9293 \times 10^3\,\hat{i} + 0.9649 \times 10^3\,\hat{j} + 21.57 \times 10^3\,\hat{i}\right) \text{NC}^{-1}.$$

$$= \left(23.4993 \times 10^3\,\hat{i} + 0.9649 \times 10^3\,\hat{j}\right) \text{NC}^{-1}.$$

$$|\vec{E}_{net}| = 23.519 \times 10^3 \text{ NC}^{-1}.$$

direction: $\tan^{-1}\left(\frac{E_y}{E_x}\right) = 2.35°$; anticlockwise from $+x$ axis.

8. Place a +5nC at the dot location from Question-6. Measure the angle direction it may or may not accelerate. The direction must be measured positively from the x-axis. **(2)**

Since there is a net $\vec{E}$ at the dot, the +5nC charge will accelerate in the direction parallel to $\vec{E}$.

direction of acceleration: 2.35°; anticlockwise from $+x$ axis.

Brac University

Principles of Physics-II (PHY-112)

Department of Mathematics and Natural Sciences

Quiz: 02, **Section**: 8

Date: February 28, 2024

Duration: 35 Minutes | **Spring 2024 (10F-31C)** | Marks: 15

Name: Student ID:

Use SI Units only. Partial Marks will be given for partially correct answers ONLY.

1. Which of the following conditions will give nonsensical results with Gauss's Law?— **(1)**
   ◯ Gaussian surfaces symmetric with $\vec{E}$ ◯ Open Gaussian surfaces ◯ Gaussian surfaces asymmetric with $\vec{E}$ ◯ Enclosed charge within the Gaussian Surface

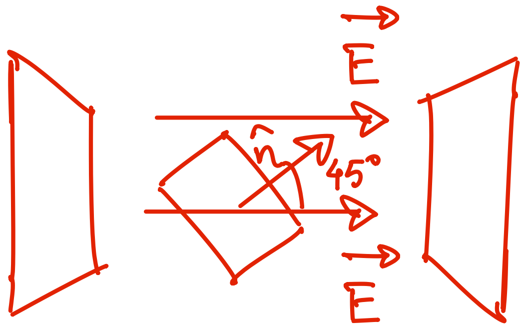
2. A proton moving in a *potential downhill* $(+ \rightarrow -)$. The following happens— **(1)**
   ◯ $U\uparrow K\uparrow$ ◯ $U\uparrow K\downarrow$ ◯ $U\downarrow K\uparrow$ ◯ $U\downarrow K\downarrow$

3. The differential version of Gauss's Law measures which of the following? **(1)**
   ◯ divergence of $\vec{E}$ ◯ enclosed charge within a Gaussian surface ◯ curl of $\vec{E}$ ◯ flux of $\vec{E}$

4. Parabolic deflection of a charged particle (system) in uniform $\vec{E}$ field occurs due to— **(1)**
   ◯ work done by the system ◯ work done on the system ◯ no work has been done ◯ energy exchanged from outside

5. "Coulomb Forces are the reason Electric Potential Energy exists" This statement— **(1)**
   ◯ is True ◯ is False ◯ We require Force first to exchange energy ◯ Cannot be determined from the information provided

6. Two 100 cm^2 parallel plates are spaced 2.0 cm apart. One is charged to +5.0 nC, the other to −5.0 nC. A 1.0 cm × 1.0 cm surface between the plates is tilted to where its normal makes a 45° angle with the electric field. What is the electric flux through this surface? **(4)**



$$\Phi_E = EA\cos\theta$$

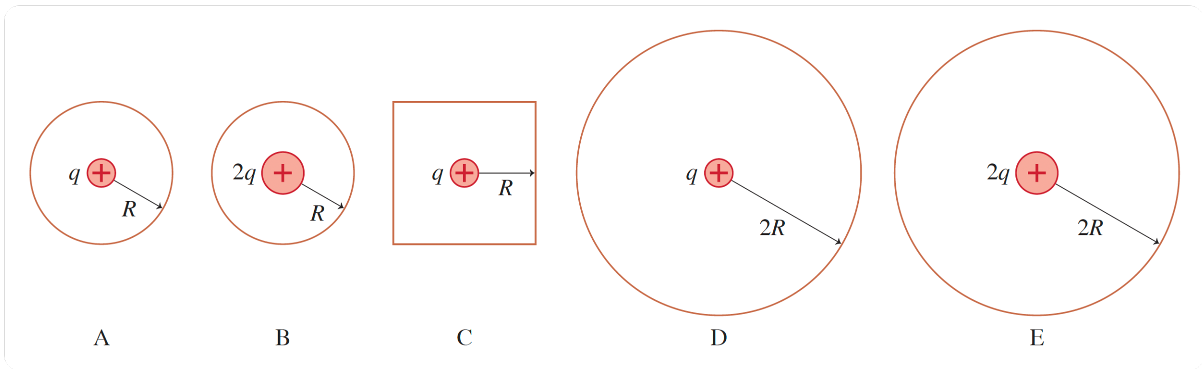
$$= \frac{\sigma}{\epsilon_0}\times A\cos\theta$$

$$= \frac{Q}{\epsilon_0 A}\times A\cos\theta$$

$$= \frac{Q}{\epsilon_0}\cos\theta = \frac{5\times10^{-6}\,C\times\cos(45^\circ)}{8.854\times10^{-12}\,C^2N^{-1}m^{-2}}$$

$$= 399.306\times10^{3}\,Nm^2C^{-1}$$

7. These are two-dimensional cross-sections through three-dimensional closed spheres and a cube. Rank in order, from largest to smallest, the electric fluxes Φ_A to Φ_E through surfaces A to E. **(3)**



$\Phi_E \propto Q_{enc}$ only.

$$(Q_{enc})_B = (Q_{enc})_E > (Q_{enc})_C = (Q_{enc})_A = (Q_{enc})_D$$

$$\Phi_B = \Phi_E > \Phi_C = \Phi_A = \Phi_D .$$

8. A negative charge q_1 is at a distance r from a positive point charge Q. Another charge $q_2 = \frac{q_1}{2}$ is at a distance $2r$ from Q. What is the ratio $U_1 : U_2$ of their potential energies due to their interactions with Q? Explain graphically why q_1 and q_2 must not repel each other. **(3)**

$$U_1 = \frac{q_1 Q}{4\pi\epsilon_0 r}$$

$$U_2 = \frac{q_2 Q}{4\pi\epsilon_0 \times 2r}$$

$$U_1 : U_2 = \frac{q_1 Q}{4\pi\epsilon_0 r} : \frac{q_2 Q}{4\pi\epsilon_0 \times 2r}$$

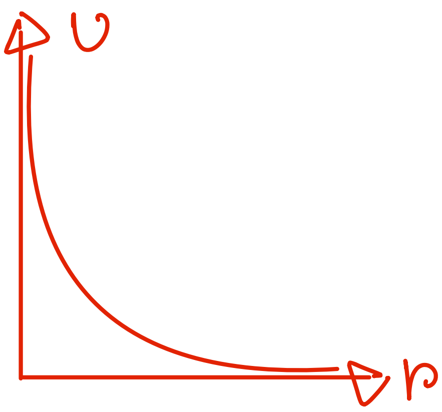
$$= \frac{q_1}{r} : \frac{q_1}{2\times 2r}$$

$$= 4 : 1$$

q_1 and q_2 are both negative.

They mutually want to decrease

U_{elec}. Only way to do it is to repel.



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Quiz: 02, **Section**: 8

Date: February 28, 2024

Inspiring Excellence

Duration: 35 Minutes **Spring 2024 (10F-31C)** Marks: 15

Name: Student ID:

Use SI Units only. Partial Marks will be given for partially correct answers ONLY.

1. The differential version of Gauss's Law DOES NOT measure which of the following? **(1)**
○ divergence of $\vec{E}$ ○ enclosed surface charge distribution ○ curl of $\vec{E}$ ○ flux of $\vec{E}$

2. Which of the following conditions need NOT be checked to apply Gauss's Law?— **(1)**
○ Gaussian surfaces have to be symmetric with $\vec{E}$ ○ Gaussian surfaces have to be open ○ Electric flux is to be measured ○ Enclosed charge amount needs to be measured

3. Parabolic deflection of a charged particle (system) in non-uniform $\vec{E}$ field occurs due to— **(1)**
○ work done by the system ○ work done on the system ○ no work has been done ○ energy exchanged from outside

4. "Electric Potential Energy is the reason Coulomb forces exist" This statement— **(1)**
○ is True ○ is False ○ We require Force first to exchange energy ○ Cannot be determined from the information provided

5. An electron moving in a *potential uphill* $(- \to +)$. The following happens— **(1)**
○ $U \uparrow K \uparrow$ ○ $U \uparrow K \downarrow$ ○ $U \downarrow K \uparrow$ ○ $U \downarrow K \downarrow$

6. A positive charge q_A is at a distance r from a negative point charge Q. Another charge $q_B = \frac{q_1}{4}$ is at a distance $2r$ from Q. What is the ratio $U_1 : U_2$ of their potential energies due to their interactions with Q? Explain graphically why q_A and q_B must not attract each other. **(3)**

$$U_1 = \frac{q_1 Q}{4\pi\epsilon_0 r}$$

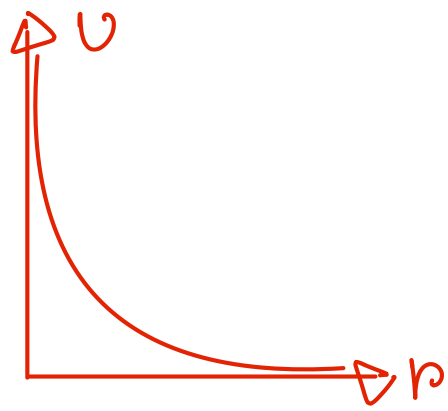
$$U_2 = \frac{q_2 Q}{4\pi\epsilon_0 \times 2r}$$

$$U_1 : U_2 = \frac{q_1 Q}{4\pi\epsilon_0 r} : \frac{q_2 Q}{4\pi\epsilon_0 \times 2r}$$

$$= \frac{q_1}{r} : \frac{q_1}{4 \times 2r}$$

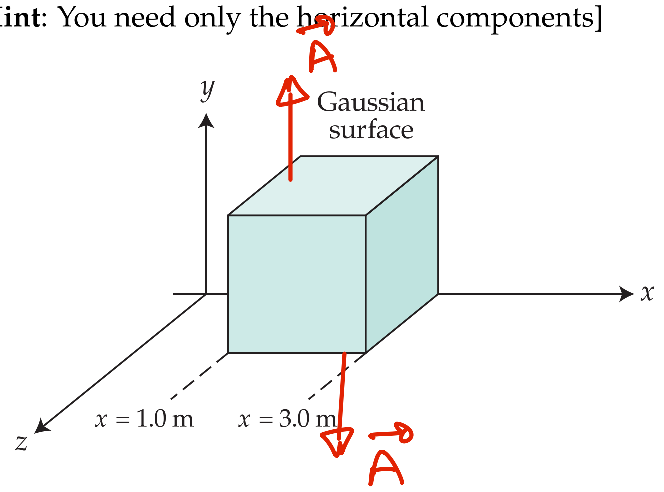
$$= 8 : 1$$

q_1 and q_2 are both positive.
they mutually want to decrease
U_{elec}, Only way to do it is to repel.



7. A nonuniform electric field given by $\vec{E} = -3x\hat{i} - 4y\hat{j}$ pierces the Gaussian cube. What is the electric flux through the ~~right~~ face and the ~~left~~ face? [**Hint**: You need only the horizontal components] **(3)**

top bottom



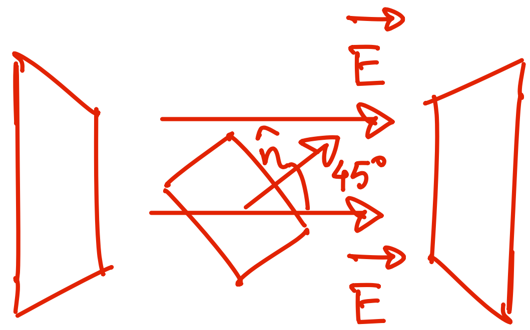
$$\Phi_E^{top} = \vec{E}\cdot\vec{A} = (-3x\hat{i} - 4y\hat{j})\,NC^{-1} \cdot (3-1)^2\,\hat{j}\,m^2$$

$$= (-16y)\,Nm^2C^{-1}.$$

$$\Phi_E^{bottom} = \vec{E}\cdot\vec{A} = (-3x\hat{i} - 4y\hat{j})\,NC^{-1} \cdot (3-1)^2(-\hat{j})\,m^2$$

$$= (+16y)\,Nm^2C^{-1}.$$

8. Two $100\,\text{cm}^2$ parallel plates are spaced 200.0 mm apart. One is charged to $+5.0\,\mu\text{C}$, the other to $-5.0\,\mu\text{C}$. A $1.5\,\text{cm} \times 1.5\,\text{cm}$ surface between the plates is tilted to where its normal vector is parallel with the electric field. What is the electric flux through this surface? **(4)**



$$\Phi_E = EA\cos\theta$$

$$= \frac{\sigma}{\epsilon_0} \times A\cos\theta$$

$$= \frac{Q}{\epsilon_0 A} \times A\cos\theta$$

$$= \frac{Q}{\epsilon_0}\cos\theta = \frac{5\times10^{-6}\,C \times \cos(45^\circ)}{8.854\times10^{-12}\,C^2N^{-1}m^{-2}}$$

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