

2.7 Electric flux $\Phi_E \rightarrow$ scalar

The electric field passing through a given area A or integral of the electric field over the closed surface

$$\Phi_E = \iint \vec{E} \cdot d\vec{A}$$

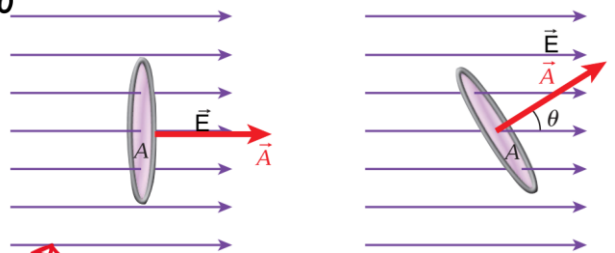
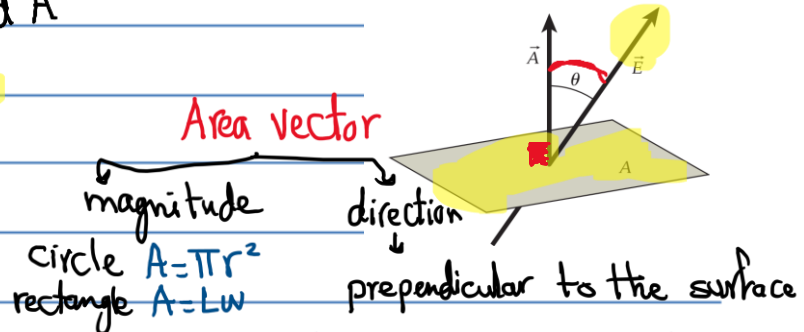
$$\Phi_E = E A \cos \theta$$

E : electric field N/C

A : Area m^2

Φ_E : electric flux $N \cdot m^2/C$

θ : angle between E and area vector (normal)



E perpendicular to the surface:

enter
leave

$$\theta = 180^\circ$$

$$\cos 180 = -1$$

$$\Phi_E = -EA$$

$$\theta = 0$$

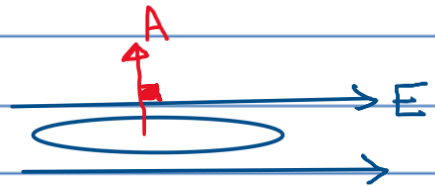
$$\cos 0 = 1$$

$$\Phi_E = +EA$$

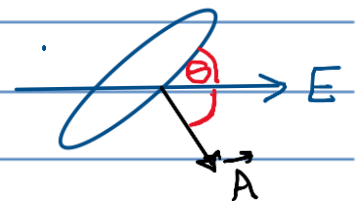
E is parallel to the surface

$$\theta = 90^\circ$$

$$\cos 90 = 0 \quad \Phi_E = 0$$



E makes angle θ with the surface
enter $90 + \theta$ out $90 - \theta$



E makes angle θ with the normal



If $E=200 \text{ N/C}$ as shown in the figure ($l=10\text{cm}$)

$$A = l^2$$

Find the electric flux through:

The right face

$$\Phi_E = E A \cos \theta$$

$$\Phi_E = 200 \times 0.10^2 \cos(0) = 2 \text{ N}\cdot\text{m}^2/\text{C}$$

The left face

$$\Phi_E = E A \cos \theta$$

$$\Phi_E = 200 \times 0.10^2 \cos(180) = -2 \text{ N}\cdot\text{m}^2/\text{C}$$

The upper face

$$\Phi_E = E A \cos(90) = 0$$

The cube

$$\Phi_E = 0$$

If $\vec{E} = 200\hat{x} - 300\hat{y} + 400\hat{z} \text{ N/C}$ as shown in the figure ($l=10\text{cm}$)

Find the electric flux through:

The right face

$$\Phi_E = E_x A \cos \theta$$

$$\Phi_E = 200 \times 0.10^2 \cos(0) = 2 \text{ N}\cdot\text{m}^2/\text{C}$$

The left face

$$\Phi_E = 200 \times 0.10^2 \cos(180) = -2 \text{ N}\cdot\text{m}^2/\text{C}$$

The upper face

$$\Phi_E = 300 \times 0.10^2 \cos(180) = -3 \text{ N}\cdot\text{m}^2/\text{C}$$

The lower face

$$\Phi_E = 300 \times 0.10^2 \cos(0) = +3 \text{ N}\cdot\text{m}^2/\text{C}$$

The front face

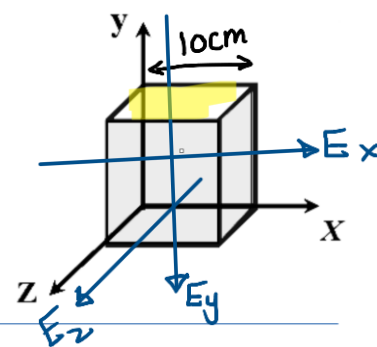
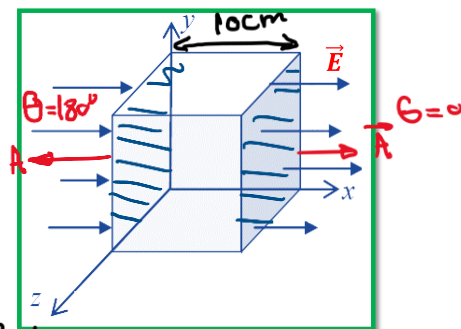
$$\Phi_E = 400 \times 0.10^2 \cos(0) = +4 \text{ N}\cdot\text{m}^2/\text{C}$$

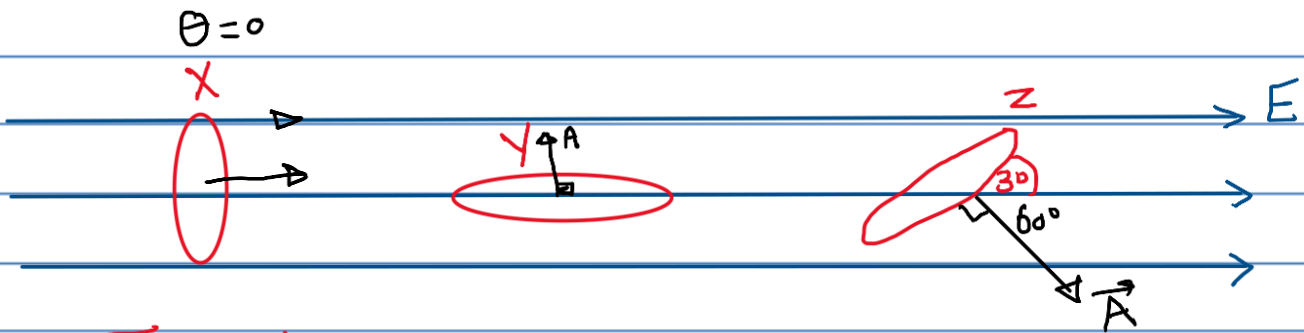
The back face

$$\Phi_E = 400 \times 0.10^2 \cos(180) = -4 \text{ N}\cdot\text{m}^2/\text{C}$$

The cube

$$\Phi_E = 0$$





Three identical loops as shown

Which Loop has no electric flux?

Y

parallel to E

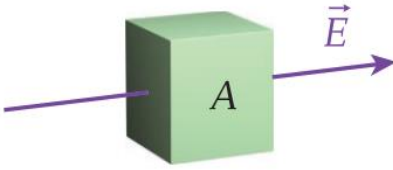
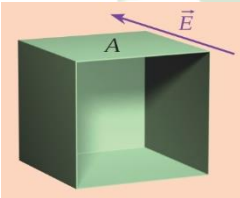
$$\theta = 90^\circ$$

$$\cos(90) = 0 \quad \Phi_E = 0$$

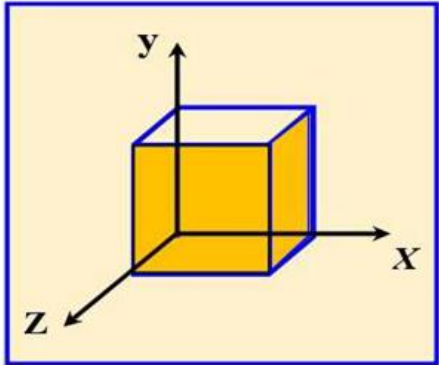
Find $\frac{\Phi_{Ex}}{\Phi_{Ez}} = ?$

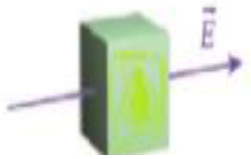
$$\frac{\Phi_{Ex}}{\Phi_{Ez}} = \frac{\cancel{E} \cancel{A} \cos 0}{\cancel{E} \cancel{A} \cos 60} = \frac{\cos(0)}{\cos(60)} = \frac{1}{\frac{1}{2}} = 2$$

2.7 Electric Flux التدفق الكهربائي

1	
A cube that has faces of area A in a uniform electric field E, that is perpendicular to the plane of one face of the cube. What is the net electric flux passing through the cube?	مكعب مساحة وجهه A في مجال كهربائي منتظم E، عمودي على سطح أحد أوجه المكعب. ما هو التدفق الكهربائي الكلي الذي يمر عبر المكعب؟
	
2	
The figure shows a cube with faces of area A and one face missing. This five-sided cubical object is in a uniform electric field, perpendicular to one face. What is the net electric flux passing through the object?	يوضح الشكل مكعباً مساحة وجهه A ووجهاً ناقصاً للمكعب. يوجد هذا الشكل المكعب ذو الأوجه الخمسة في مجال كهربائي منتظم E وعمودي على أحد الأوجه. ما محصلة التدفق الكهربائي الذي يمر عبر المكعب؟
	

3

In the figure, a cube with side length (5.0 cm) is traversed by an electric field in the unit (N/C) according to the equation: $E = 2.0\hat{x} + 4.0\hat{y} + 6.0\hat{z}$ What is the magnitude of electric flux that passes through the two shaded faces of the cube (front and right)? Note: There are no charges inside the cube	في الشكل المجاور مكعب طول ضلعه (5.0cm) يجتازه مجال كهربائي بوحدة (N/C) وفق المعادلة: $E = 2.0\hat{x} + 4.0\hat{y} + 6.0\hat{z}$ ما مقدار التدفق الكهربائي الذي يجتاز الوجهين المظللين للمكعب (الأمامي والأيمن) ملاحظة: لا توجد شحنات داخل المكعب
	0.005 N.m ² /C
	0.030 N.m ² /C
	0.020 N.m ² /C
	0.015 N.m ² /C

4 According to the figure , a cube that has (5.0cm) side length in a uniform electric field (E=200N/C) , that is perpendicular to the plane of one face of the cube . What is the magnitude of electric flux that passing through the black face ?		حسب الشكل، مكعب طول ضلعه (5.0cm) في مجال كهربائي منتظم (E=200N/C)، عمودي على مستوى أحد أوجه المكعب. ما مقدار التدفق الكهربائي الذي يمر عبر الوجه الأسود؟	
			
0 N.m ² /C	-1.0 N.m ² /C	-0.5 N.m ² /C	-1.5 N.m ² /C

5

A uniform electric field ($E=28\text{N/C}$) is perpendicular to one face of a cube as shown in the figure, if the electric flux through the shaded left face is equal to $(-7.0 \text{ N.m}^2/\text{C})$. What is the length of the cube?

مجال كهربائي منتظم ($E=28\text{N/C}$) متعامد على أحد أوجه مكعب كما بالشكل، إذا كان التدفق الكهربائي عبر الوجه الأيسر المظلل يساوي $(-7.0 \text{ N.m}^2/\text{C})$. ما مقدار طول ضلع المكعب؟



$$L = 0.25\text{m}$$

$$L = 0.50\text{m}$$

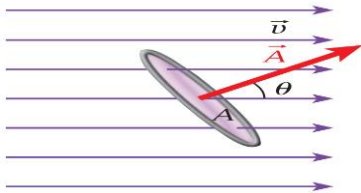
$$L = 2\text{m}$$

$$L = 19.6\text{m}$$

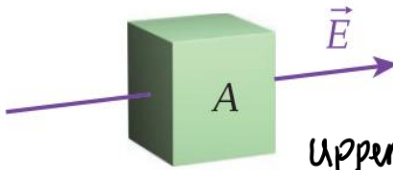
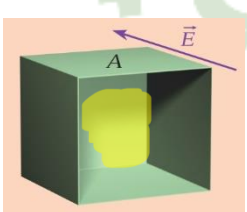
6

In the figure: If the electric flux passing the surface is $0.5AE$ What is the magnitude of the angle θ ?

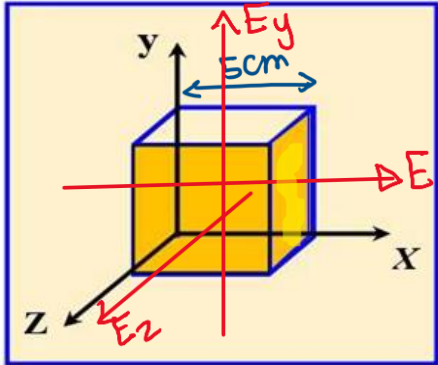
في الشكل المقابل: إذا كان التدفق الكهربائي الذي يجتاز السطح $0.5AE$ ما مقدار الزاوية θ ؟



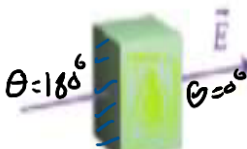
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 Right $\Phi_E = +EA$ Left $\Phi_E = -EA$ upper, lower, front and back $\Phi_E = 0$ $\theta = 90^\circ$ Cube $\Phi_E = \text{zero}$	
2	
The figure shows a cube with faces of area A and one face missing. This five-sided cubical object is in a uniform electric field, perpendicular to one face. What is the net electric flux passing through the object?	يوضح الشكل مكعباً مساحة وجهه A ووجهاً ناقصاً للمكعب. يوجد هذا الشكل المكعب ذو الأوجه الخمسة في مجال كهربائي منتظم E وعمودي على أحد الأوجه. ما محصلة التدفق الكهربائي الذي يمر عبر المكعب؟
 back $\Phi_E = EA \cos(0)$ Cube $\Phi_E = +EA$	

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In the figure, a cube with side length (5.0 cm) is traversed by an electric field in the unit (N/C) according to the equation: $E = 2.0\hat{x} + 4.0\hat{y} + 6.0\hat{z}$ What is the magnitude of electric flux that passes through the two shaded faces of the cube (front and right)? Note: There are no charges inside the cube	في الشكل المجاور مكعب طول ضلعه (5.0cm) يجتازه مجال كهربائي بوحدة (N/C) وفق المعادلة: $E = 2.0\hat{x} + 4.0\hat{y} + 6.0\hat{z}$ ما مقدار التدفق الكهربائي الذي يجتاز الوجهين المظللين للمكعب (الأمامي والأيمن) ملاحظة: لا توجد شحنات داخل المكعب
	0.005 N.m²/C 0.030 N.m²/C 0.020 N.m²/C 0.015 N.m²/C
Right Front $\Phi_E = E_x A \cos \theta = 2 \times 0.05^2 \cos(0) = 5 \times 10^{-3} \text{ N.m}^2/\text{C}$ $\Phi_E = E_z A \cos \theta = 6 \times 0.05^2 \cos(0) = 1.5 \times 10^{-2} \text{ N.m}^2/\text{C}$ $\Phi_{R+R} = 5 \times 10^{-3} + 1.5 \times 10^{-2} = 0.02 \text{ N.m}^2/\text{C}$	

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 $L = 5.0 \text{ cm} = 0.05 \text{ m}$ $E = 200 \text{ N/C}$	$\Phi_E = E A \cos \theta$ $\Phi_E = 200 \times 0.05^2 \cos(180) = -0.5 \text{ N.m}^2/\text{C}$
0 N.m²/C	-1.0 N.m²/C -0.5 N.m²/C -1.5 N.m²/C

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$$L = 0.25\text{m}$$

$$L = 0.50\text{m}$$

$$L = 2\text{m}$$

$$L = 19.6\text{m}$$

$$E = 28 \text{ N/C}$$

$$\Phi_E = -7.0 \text{ N.m}^2/\text{C}$$

$$L = ?$$

$$\Phi_E = E A \cos \theta$$

$$-7.0 = 28 \times L^2 \times \cos(180)$$

$$L = \sqrt{\frac{-7.0}{28 \times \cos(180)}}$$

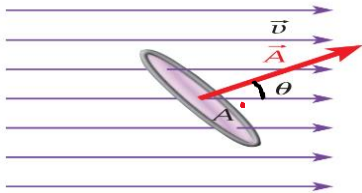
Find the volume of cube

$$V = L^3 = 0.125 \text{ m}^3$$

6

In the figure: If the electric flux passing the surface is $0.5AE$. What is the magnitude of the angle θ ?

في الشكل المقابل: إذا كان التدفق الكهربائي الذي يجتاز السطح $0.5AE$ ما مقدار الزاوية θ ؟



$$\Phi_E = 0.5 AE$$

$$\theta = ?$$

$$\Phi_E = E A \cos \theta$$

$$0.5 AE = E A \cos \theta$$

$$\theta = \cos^{-1}(0.5) = 60^\circ$$

Find the angle between E and the surface

$$90 - 60 = 30^\circ$$