Solution to HW Problems
Chapter 24

104 Phys

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1. An electric field with a magnitude of 3.50 kN/C is applied along the x axis. Calculate the electric flux through a rectangular plane 0.350 m wide and 0.700 m long assuming that (a) the plane is parallel to the yz plane; (b) the plane is parallel to the xy plane; (c) the plane contains the y axis, and its normal makes an angle of 40.0° with the x axis.

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a) the plane is $\perp$ to E

$\therefore \theta = 0$ تذكر اتجاه السطح عمو $\perp$ السطح

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

$= 3.5 \times 10^3 \times \underbrace{(0.35 \times 0.7)}_{\text{Area}} \cos 0$

$= 858 \ N \cdot m^2 / C$

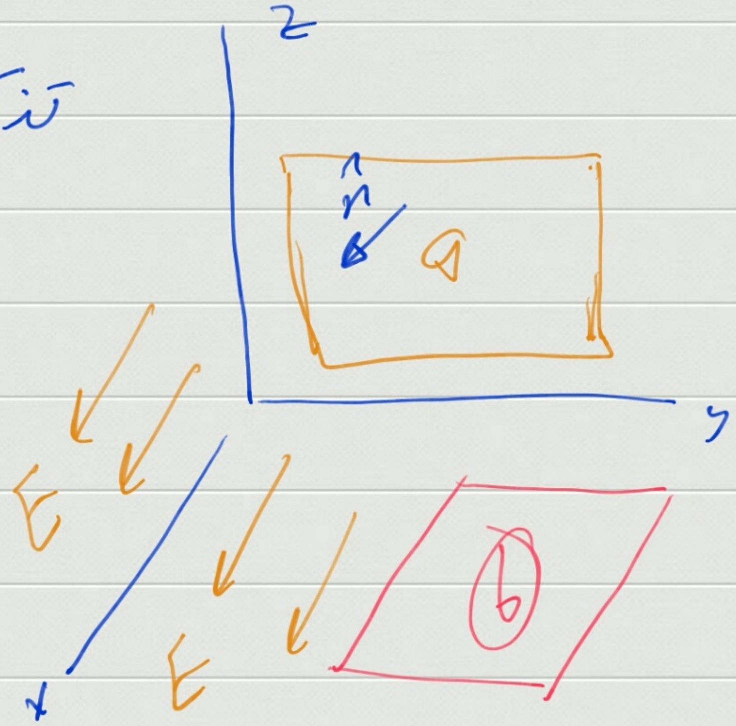
b) in this case $\theta = 90^\circ$

$\therefore \Phi_E = 0$

c) $\Phi_E = E A \cos 40$

$= 3.5 \times 10^3 \times (0.35 \times 0.7) \cos 40$

$= 657 \ N \cdot m^2 / C$.



11. Four closed surfaces, S_1 through S_4, together with the charges $-2Q$, Q, and $-Q$ are sketched in Figure P24.11. (The colored lines are the intersections of the surfaces with the page.) Find the electric flux through each surface.

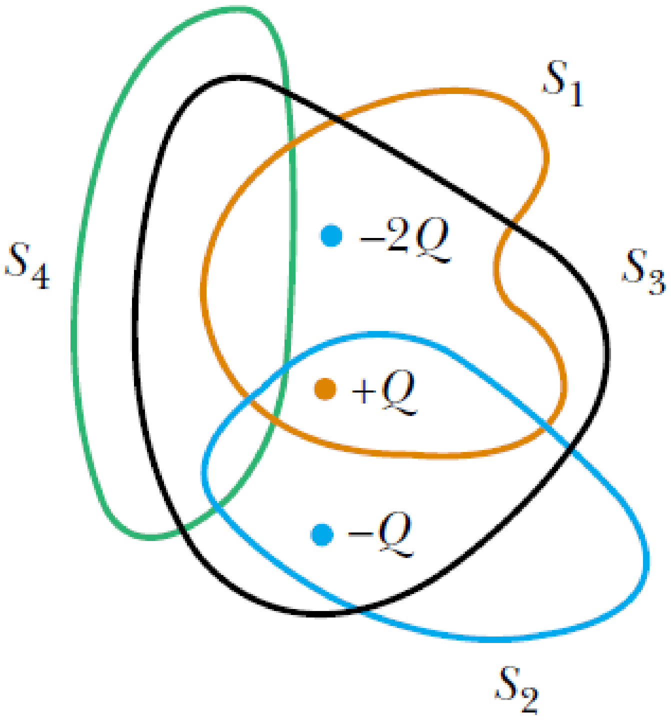


Figure P24.11

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we have: $\Phi_E = \frac{Q_{in}}{\epsilon_0}$

for S_1: $\Phi_E = \frac{-2Q+Q}{\epsilon_0} = -\frac{Q}{\epsilon_0}$ (1)

for S_2: $\Phi_E = \frac{+Q-Q}{\epsilon_0} = 0$ (2)

for S_3: $\Phi_E = \frac{-2Q+Q-Q}{\epsilon_0} = -\frac{2Q}{\epsilon_0}$ (3)

for S_4: $\Phi_E = \frac{0}{\epsilon_0} = 0$ (5)

↑ no charge inside

#

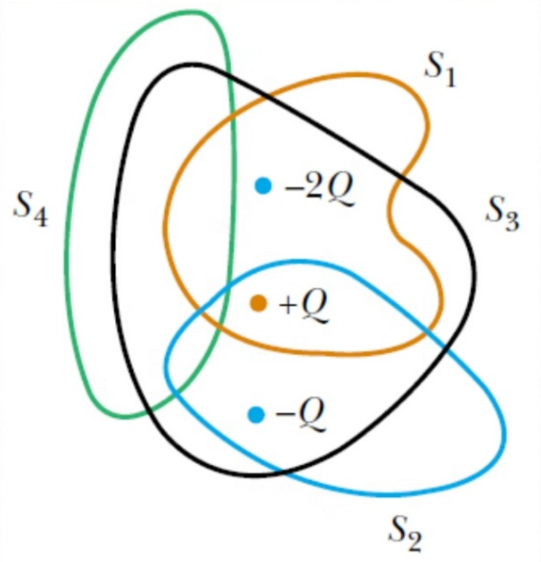

Figure P24.11

15. A point charge Q is located just above the center of the flat face of a hemisphere of radius R as shown in Figure P24.15. What is the electric flux (a) through the curved surface and (b) through the flat face?

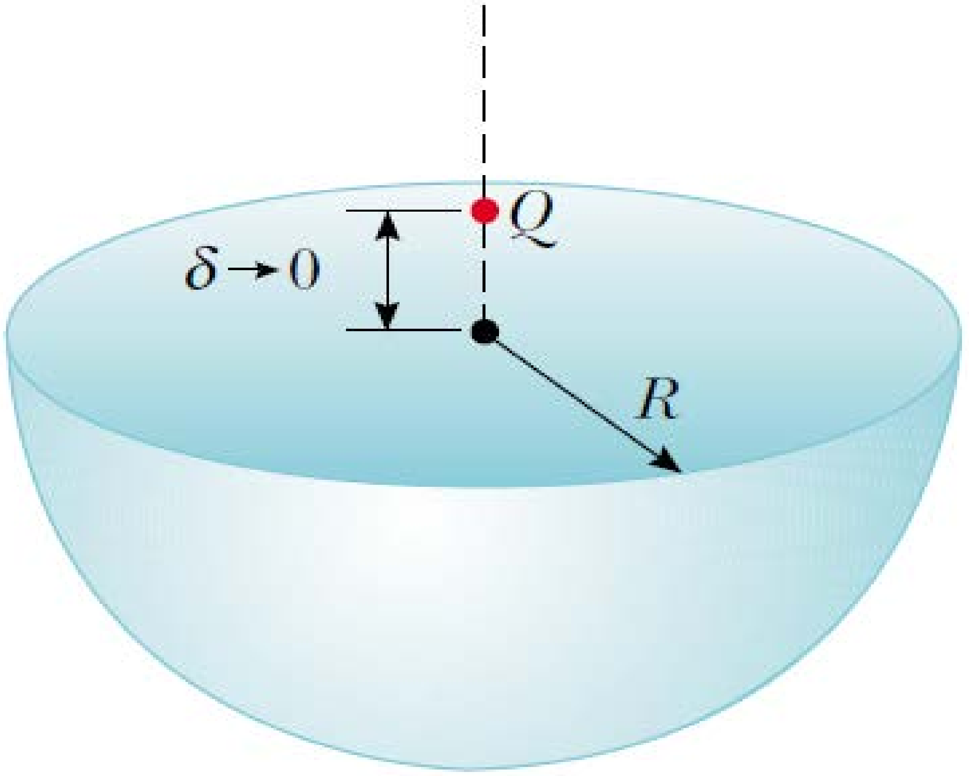

Figure P24.15

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a) الشحنة واقعة تقريباً في المركز

we have $E = k\frac{Q}{R^2}$

$\because \Phi_E = \int \bar{E}\cdot\bar{A}\,ds \qquad \theta = 0$

$\therefore \Phi_E = E A \cos\theta = k\frac{Q}{R^2}\cdot(2\pi R^2)$

½ مساحة الكرة

$= \frac{1}{4\pi\epsilon_0}\cdot\frac{Q}{R^2}\cdot 2\pi R^2$ (2)

$= \frac{Q}{2\epsilon_0}$ #

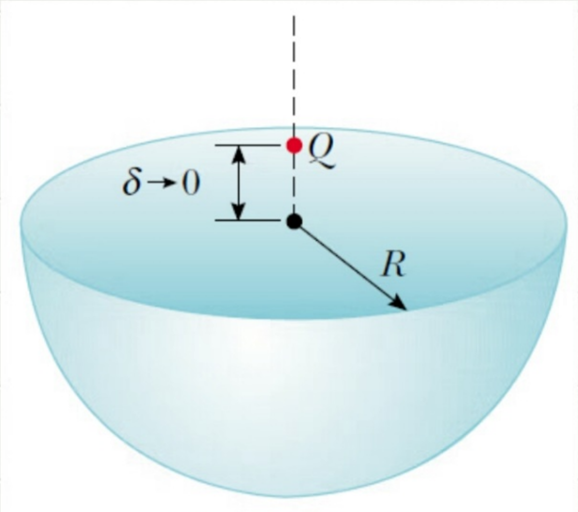

Figure P24.15

b) عندما ندرس السطح المنحني نلاحظ أن السطح كامل خارج الشحنة

∴ المحصلة = 0 لأن الشحنة $= Q_{in}$ صفر

$\therefore \Phi_s + \Phi_{Flat} = 0 \rightarrow \Phi_{Flat} = -\Phi_s = -Q/2\epsilon_0$ #

24. A solid sphere of radius 40.0 cm has a total positive charge of 26.0 μC uniformly distributed throughout its volume. Calculate the magnitude of the electric field (a) 0 cm, (b) 10.0 cm, (c) 40.0 cm, and (d) 60.0 cm from the center of the sphere.

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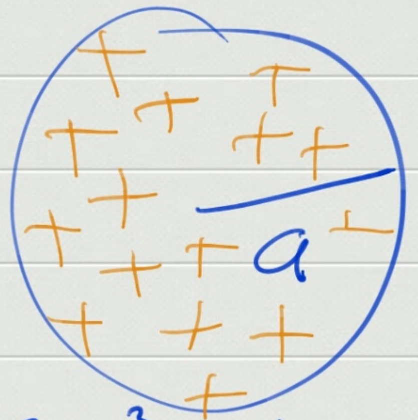
$R = 40\,cm$

Remember $E = k \frac{q}{a^3} r$ (inside) and $k \frac{q}{r^2}$ (outside)



a) $r = 0 \rightarrow E = 0$

b) $r = 0.1 \rightarrow E = 9 \times 10^{9} \times \frac{26 \times 10^{-6}}{0.4^3} \times 0.1 = 365 \times 10^{3}\ N/C$

c) $r = 0.4\,m \rightarrow E = 9 \times 10^{9} \times \frac{26 \times 10^{-6}}{0.4^3} \times 0.4 = 1.46 \times 10^{6}\ N/C$

d) $r = 0.6\,m \rightarrow$

$\rightarrow E = 9 \times 10^{9}\ \frac{26 \times 10^{-6}}{0.6^2} = 649 \times 10^{3}\ N/C$

↑ r^2

37. A large flat horizontal sheet of charge has a charge per unit area of 9.00 $\mu C/m^2$. Find the electric field just above the middle of the sheet.

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$$\therefore E = \frac{\sigma}{2\epsilon_0} = \frac{9 \times 10^{-6}}{2(8.85 \times 10^{-12})} = 5.08 \times 10^{3} \ N/C \uparrow$$

41. A very large, thin, flat plate of aluminum of area A has a total charge Q uniformly distributed over its surfaces. Assuming the same charge is spread uniformly over the *upper* surface of an otherwise identical glass plate, compare the electric fields just above the center of the upper surface of each plate.

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(1) for Aluminum [conductor] $E = \frac{\sigma}{\epsilon_0} = \frac{Q/2A}{\epsilon_0} = \frac{Q}{2A\epsilon_0}$ (1)

(2) for glass (insulator) $E = \frac{\sigma}{2\epsilon_0} = \frac{Q/A}{2\epsilon_0} = \frac{Q}{2A\epsilon_0}$ (2)

∴ Same field

لاحظ بالسؤال الأول Q تتوزع على الوجهين وفي الثاني على وجه
واحد فقط.