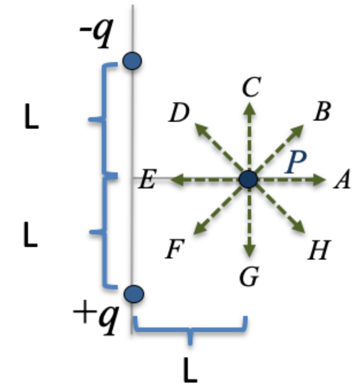
Physics 207 – Exam 1

Sections (207-212, 543-583) – September 23rd, 2021

Right answer indicated by 🡐. Number of points indicated in parenthesis, zero otherwise

1) [7 pts] Point P is at 3equal distance from two fixed point charges +q and –q as shown. If a **negative** point charge is placed on P, which dashed arrow on the figure shows the direction of the net electrical **force** felt by the charge at P due to the fixed charges?



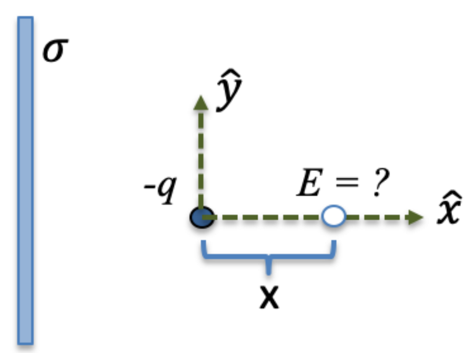
A. A (2)
B. B
C. C (4)
D. D
E. E (2)
F. F
G. G (7) 🡐
H. H

2) [8 pts] In the previous problem, if the charge at point P is -q, the magnitude of the force felt by that charge is :

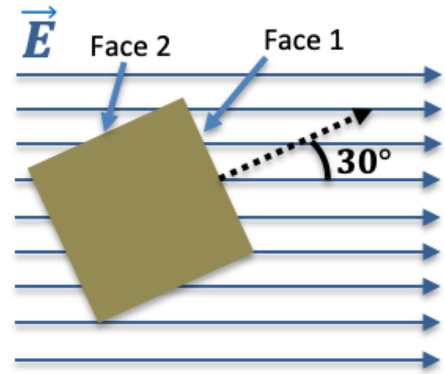
A. $\frac{2kq^2 L}{(2L^2)^{3/2}}$ (8) 🡐
B. $\frac{kq^2 L}{(2L^2)^{3/2}}$ (6)
C. $\frac{2kq^2 L}{(L^2)^{3/2}}$ (4)
D. $\frac{2kq^2 L^2}{(2L^2)^3}$
E. $\frac{kq^2 L}{(2L^2)^3}$
F. $\frac{2kq^2 L}{(L^2)^3}$

3) [8 pts] A negative point charge –q is at the coordinate origin, at some distance from an infinitely long plate with uniform charge σ per unit area as shown in the picture. The electric field a distance *x* from the point charge as shown in the figure is:

A. $\left(\frac{\sigma}{2\varepsilon_0} - k\frac{q}{x^2}\right)\hat{x}$ (8) 🡐
B. $\left(\frac{\sigma}{2\varepsilon_0} + k\frac{q}{x^2}\right)\hat{x}$ (4)
C. $\left(-\frac{\sigma}{2\varepsilon_0} - k\frac{q}{x^2}\right)\hat{x}$ (5)
D. $\left(-\frac{\sigma}{2\varepsilon_0} + k\frac{q}{x^2}\right)\hat{x}$ (2)
E. $\left(\frac{\sigma}{2\varepsilon_0} - k\frac{q}{x}\right)\hat{x}$ (3)
F. $\left(\frac{\sigma}{2\varepsilon_0} + k\frac{q}{x}\right)\hat{x}$ (3)
G. $\left(-\frac{\sigma}{2\varepsilon_0} - k\frac{q}{x}\right)\hat{x}$ (1)
H. $\left(-\frac{\sigma}{2\varepsilon_0} + k\frac{q}{x}\right)\hat{x}$ (1)

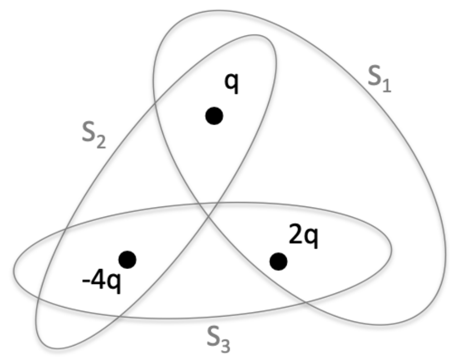


4) [8 pts] a cube of side L is tilted 30 degrees with respect to a homogenous external electric field of magnitude E. The flux through the faces 1 and 2 indicated in the picture are (face 1, face 2):



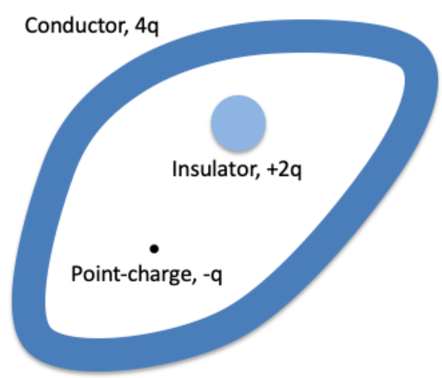
A. $EL^2\cos(30), -EL^2\sin(30)$ (8) ←
B. $EL^2\cos(30), -EL^2\cos(30)$ (4)
C. $EL^2\sin(30), -EL^2\sin(30)$ (4)
D. $EL^2\sin(30), -EL^2\cos(30)$
E. $-EL^2\cos(30), EL^2\sin(30)$ (2)
F. $-EL^2\cos(30), EL^2\cos(30)$ (2)
G. $-EL^2\sin(30), EL^2\sin(30)$ (2)
H. $-EL^2\sin(30), EL^2\cos(30)$

5) [7 pts] Three Gaussian surfaces S_1, S_2, S_3 are enclosing charges as shown. The flux enclosed by each corresponding surface can be ordered from the most positive to the most negative as:



A. $\Phi_1 > \Phi_2 > \Phi_3$ (4)
B. $\Phi_1 > \Phi_3 > \Phi_2$ (7) ←
C. $\Phi_2 > \Phi_3 > \Phi_1$
D. $\Phi_2 > \Phi_1 > \Phi_3$ (4)
E. $\Phi_3 > \Phi_1 > \Phi_2$ (4)
F. $\Phi_3 > \Phi_2 > \Phi_1$

6) [7 pts] A closed hollow conductor with net charge 4q encloses inside a point-like charge -q, and an insulator with charge 2q as shown in the figure. Find the total charge distributed in the **outer surface** of the conductor:

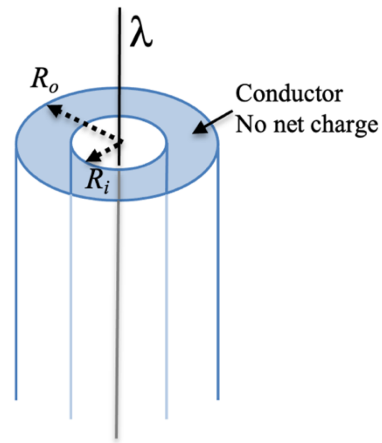


A. -2q
B. -1q
C. 0q
D. 1 q
E. 2 q
F. 3 q
G. 4 q (2)
H. 5 q (7) ←

7) [8 pts] Two thin concentric spherical shells have radii R_1 and R_2 with $R_1 < R_2$. A total charge of -2Q is uniformly spread in the inner shell and a total charge of Q is spread on the outer shell. The electric field in the region between the two shells, at $R1 < r < R2$, is

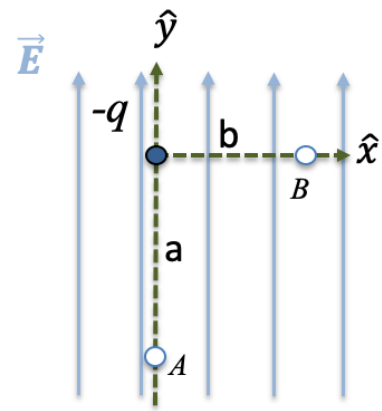
A. pointing outward with magnitude $k\,Q/r^2$ (2)
B. pointing inward with magnitude $k\,Q/r^2$ (4)
C. pointing outward with magnitude $k\,2Q/r^2$ (6)
D. pointing inward with magnitude $k\,2Q/r^2$ (8) ←
E. pointing outward with magnitude $k\,Q/r$
F. pointing inward with magnitude $k\,Q/r$ (2)
G. pointing outward with magnitude $k\,2Q/r$
H. pointing inward with magnitude $k\,2Q/r$ (2)

8) [8 pts] A long string with charge density per unit length λ, is at the center of long hollow cylindrical conductor with no net charge, internal radius of R_i and external radius R_o as shown in the figure. The charge per unit area σ induced **in the inner surface** of the conductor is:



A. $\sigma = \frac{+\lambda}{2\pi R_i}$ (5)
B. $\sigma = \frac{-\lambda}{2\pi R_i}$ (8) ←
C. $\sigma = \frac{+\lambda}{\pi R_i}$ (2)
D. $\sigma = \frac{-\lambda}{\pi R_i}$ (3)
E. $\sigma = \frac{+\lambda}{2\pi R_i^2}$ (1)
F. $\sigma = \frac{-\lambda}{2\pi R_i^2}$ (2)
G. $\sigma = \frac{+\lambda}{\pi R_i^2}$ (1)
H. $\sigma = \frac{-\lambda}{\pi(R_0^2 - R_i^2)}$

9) [8 pts] In a region of space there is a constant electric field of magnitude E_0 in the Y direction, superimposed with the electric field of a point charge -q at the origin. Compute the difference in electric potential at points B and A, V_B-V_A, as located in the figure.



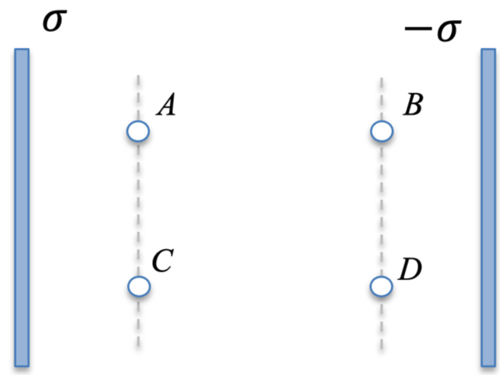
A. $+E_0 a + kq\frac{(a-b)}{ab}$ (3)
B. $+E_0 a - kq\frac{(a-b)}{ab}$ (5)
C. $-E_0 a + kq\frac{(a-b)}{ab}$ (4)
D. $-E_0 a - kq\frac{(a-b)}{ab}$ (8) ←
E. $+E_0 b + kq\frac{(a-b)}{ab}$ (2)
F. $+E_0 b - kq\frac{(a-b)}{ab}$ (4)
G. $-E_0 b + kq\frac{(a+b)}{ab}$
H. $-E_0 b - kq\frac{(a+b)}{ab}$

10) [8 pts] At locations A and B, the electric potential has the values V_A=20 V and V_B= - 10 V. A small particle with charge q = -2 μC is released from rest at one of the locations and passes through the other location with kinetic energy K. Which of the following statement is true?

A. The other location is A with K= 20 μ J (2)
B. The other location is A with K= 40 μ J (2)
C. The other location is A with K= 60 μ J (8) ←
D. The other location is A with K= 80 μ J (2)
E. The other location is B with K= 20 μ J
F. The other location is B with K= 40 μ J
G. The other location is B with K= 60 μ J (4)
H. The other location is B with K= 80 μ J

11) [7 pts] Two equal but opposite charged plates with uniformly distributed charges are as shown. Which of the following statement is **incorrect** ? [6 pts]

A. Position A is at a higher potential than position B
B. Position A is at a higher potential than position D
C. Position C is at a higher potential than position A (7) ←
D. Position C is at a higher potential than position B
E. Position C is at a higher potential than position D



12) [8 pts] A short line of length **h** is centered at the origin, aligned with the y-axis and has a non-uniform linear charge density $\lambda(y) = \alpha y^2$, where α is a known constant. The electric field produced by the charged line at the point (L,0) is given by :

A. $E_x(L,0) = \int_{-h/2}^{h/2} \frac{k\alpha y^2 L\, dy}{(L^2+y^2)^{3/2}}$ (8) ←

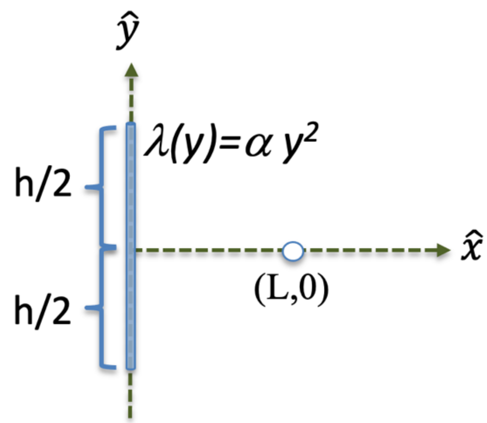
B. $E_x(L,0) = \int_{-h/2}^{h/2} \frac{k\alpha y^3\, dy}{(L^2+y^2)^{3/2}}$ (6)

C. $E_x(L,0) = \int_{-h/2}^{h/2} \frac{k\alpha y^2\, dy}{(L^2+y^2)}$ (4)

D. $E_x(L,0) = \int_{-h/2}^{h/2} \frac{k\alpha y^2 L\, dy}{(L^2+y^2)^3}$

E. $E_x(L,0) = \int_{-h/2}^{h/2} \frac{k\alpha y^3 L^2\, dy}{(L^2+y^2)^3}$

F. $E_x(L,0) = \int_{-h/2}^{h/2} \frac{k\alpha L^2\, dy}{(L^2+y^2)^3}$



13) [8 pts] A charge of value **3q** is fixed at the origin, and a charge **-q** is fixed at position (0,b). A third charge of value **q** is then moved from infinity to position (a,0) as shown in the figure. Assuming the potential of the third charge at infinity is zero, the work done **by the electric force** as the third charge is moved from infinity to its final position (a,0) is:

A. $+k\frac{3q^2}{a} + k\frac{q^2}{b}$

B. $-k\frac{3q^2}{a} + k\frac{q^2}{b}$ (4)

C. $+k\frac{3q^2}{a} - k\frac{q^2}{b}$

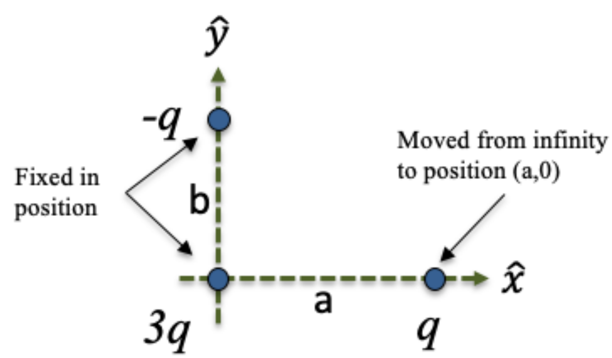
D. $-k\frac{3q^2}{a} - k\frac{q^2}{b}$ (4)

E. $+k\frac{3q^2}{a} + k\frac{q^2}{\sqrt[2]{a^2+b^2}}$ (4)

F. $-k\frac{3q^2}{a} + k\frac{q^2}{\sqrt[2]{a^2+b^2}}$ (8) ←

G. $+k\frac{3q^2}{a} - k\frac{q^2}{\sqrt[2]{a^2+b^2}}$ (2)

H. $-k\frac{3q^2}{a} - k\frac{q^2}{\sqrt[2]{a^2+b^2}}$ (4)



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