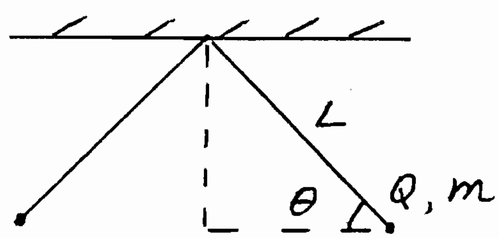
COULOMB'S LAW: $F_E = \frac{1}{4\pi\epsilon_0}\frac{qQ}{r^2} = \frac{KqQ}{r^2}$

$\epsilon_0 = 8.85 \times 10^{-12}\ [C^2/Nm^2]$ $K = 9 \times 10^9\ [Nm^2/C^2]$

ELEMENTARY CHARGE $\begin{cases} \text{PROTON} = 1.6 \times 10^{-19}\ C \\ \text{ELECTRON} = -1.6 \times 10^{-19}\ C \end{cases}$

1. FIND THE CHARGE, IN COULOMBS, OF A FERRIC ION, Fe^{+3}. $(4.8 \times 10^{-19}\ C)$

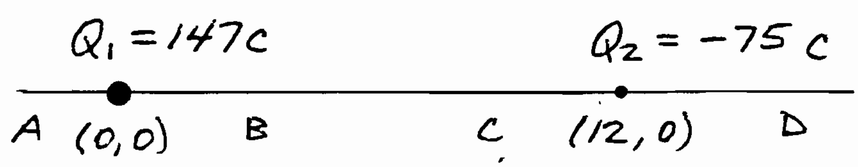
2. INITIALLY, THE ELECTRIC FORCE BETWEEN TWO CHARGES IS 360 N. ONE CHARGE IS INCREASED BY A FACTOR OF FIFTEEN. THE OTHER IS DECREASED TO ONE-FOURTH OF ITS INITIAL VALUE. THEY ARE THEN MOVED FIVE TIMES FURTHER APART. FIND THE FINAL FORCE BETWEEN THEM. (54 N)

3. 

$L = 5\ m$ $\theta = 53.13°$
$m = 48\ KG$
BOTH PARTICLES HAVE THE SAME MASS AND POSITIVE CHARGE. FIND:

A) TENSION IN THE ROPE (600 N) B) ELECTRICAL REPULSIVE FORCE (360 N) C) CHARGE ON ONE OF THE PARTICLES $(1.2 \times 10^{-3}\ C)$ D) NUMBER OF EXCESS PROTONS ON THAT PARTICLE $(7.5 \times 10^{15}$ PROTONS)

4. IN A HYDROGEN ATOM, AN ELECTRON, WHOSE MASS IS 9.11×10^{-31} KG, ORBITS A PROTON AT A RADIUS OF 5.3×10^{-11} m. EACH HAS A CHARGE OF MAGNITUDE 1.6×10^{-19} C. FIND THE ELECTRON'S SPEED AND KINETIC ENERGY. $(2.18 \times 10^6\ m/s,\ 2.17 \times 10^{-18}\ J)$

5. 

Q_1 AND Q_2 ARE IMMOBILE.

a) A SMALL MOVEABLE CHARGE, $+q$, IS NOW PLACED ON THE X-AXIS. IN WHICH ZONE(S) WOULD

IT ALWAYS BE PUSHED TO THE LEFT? TO THE RIGHT?

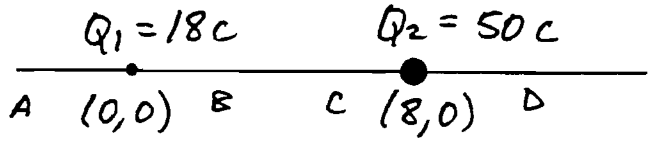
b) FIND THE LOCATION AT WHICH IT WOULD FEEL NO FORCE.

c) $+q$, WHOSE CHARGE IS 6×10^{-8} C, IS PLACED AT LOCATION (21, 0). FIND THE NET FORCE ON IT.

d) $+q$, 6×10^{-8} C, IS PLACED AT LOCATION (4.5, 0). FIND THE NET FORCE ON IT.

ANSWERS: (LEFT: A, RIGHT: B, C; D; (42, 0); −320; 4640N)

6.



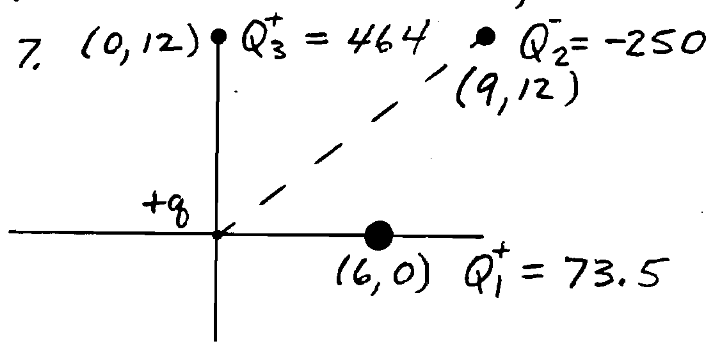
SMALL MOVABLE $+q$ IS PLACED ON THE X-AXIS.

A) IN WHICH ZONE(S) IS IT ALWAYS PUSHED TO THE LEFT? TO THE RIGHT?

B) FIND THE POINT AT WHICH IT FEELS NO FORCE.

ANSWERS: (LEFT: A, C RIGHT: D; (3, 0))

7.



$q = +8 \times 10^{-9}$ C LOCATED AT THE ORIGIN. FIND THE NET FORCE ON IT DUE TO Q_1^+, Q_2^- AND Q_3^+.

ANSWER: (195N AT 59.49° INTO 3RD QUADRANT)

8. TWO POSITIVE CHARGES OF DIFFERENT MAGNITUDE Q_1 AND Q_2 HAVE A COMBINED TOTAL OF 8C. WHEN THEY ARE 25 m APART, EACH FEELS A REPULSIVE FORCE OF 2.16×10^{8} N. FIND THE CHARGE ON EACH PARTICLE. (3C AND 5C)

9. AN INITIAL CHARGE Q_0 IS DIVIDED INTO TWO PARTS, q AND $Q_0 - q$. THESE TWO CHARGES ARE SEPARATED BY DISTANCE r.

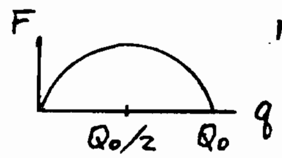
A) IN TERMS OF Q_0, q AND r, FIND A FORMULA FOR THE REPULSIVE FORCE BETWEEN THE TWO.

B) WE DO AN EXPERIMENT. WE DIVIDE Q_0 INTO THE TWO PARTS WITH DIFFERENT PERCENTAGES ALOTTED TO EACH PARTICLE. IN EACH CASE, WE MEASURE THE FORCE OF REPULSION BETWEEN THE TWO. MATHEMATICALLY, THE CHANGE IN THE FORCE AS WE DO THIS EXPERIMENT IS EXPRESSED AS THE DERIVATIVE OF F WITH RESPECT TO q. IN TERMS OF Q_0, q AND r, FIND A FORMULA FOR dF/dq.

C) SET dF/dq EQUAL TO ZERO TO FIND A FORMULA FOR q IN TERMS OF Q_0 SO THAT THE REPULSIVE FORCE BETWEEN THE TWO PARTICLES IS MAXIMUM.

D) SKETCH A GRAPH OF F VERSUS q.

ANSWERS: $F = \dfrac{k\,(Q_0 q - q^2)}{r^2}$, $\dfrac{dF}{dq} = \dfrac{k}{r^2}(Q_0 - 2q)$,

$q = \dfrac{Q_0}{2}$, 

10. TWO UNKNOWN POSITIVE CHARGES FEEL A REPULSIVE FORCE OF 23040 N WHEN THEY ARE 1.25×10^4 m APART. WE THEN TOUCH THE TWO PARTICLES TOGETHER. WE RETURN THEM TO SEPARATION OF 1.25×10^4 m. THEIR REPULSIVE FORCE IS NOW 36000 N. FIND THE CHARGE ON EACH PARTICLE:

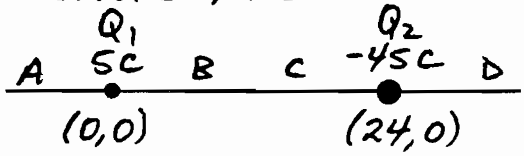
A) INITIALLY (40 C, 10 C)

B) FINALLY (25 C, 25 C : NOTE MAXIMUM FORCE)

11. PROTONS IN COSMIC RAYS STRIKE THE EARTH'S UPPER ATMOSPHERE AT A RATE OF 1500 PROTONS/m^2·SEC. THE RADIUS OF THE EARTH IS 6.4×10^6 m. FIND THE CURRENT INCIDENT ON THE EARTH DUE TO THIS RADIATION. (.124 AMPS)

ELECTRIC FIELD

1.



A) IN WHICH ZONE IS THE ELECTRIC FIELD ZERO?

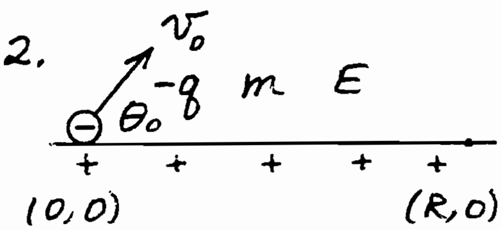
B) FIND THE POINT AT WHICH THE ELECTRIC FIELD IS ZERO.

C) IN TERMS OF X, FIND AN EQUATION FOR THE ELECTRIC FIELD IN ZONE A. SIMILARLY FOR ZONE B.

D) SKETCH A GRAPH OF THE ELECTRIC FIELD VERSUS X.

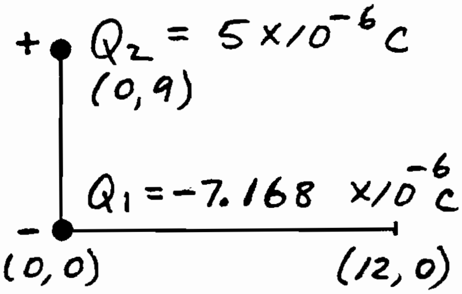
E) IN TERMS OF X, FIND AN EQUATION WHOSE SOLUTION WOULD FIND THE LOCATION OF THE MAXIMUM ELECTRIC FIELD IN ZONE A. SIMILARLY, FOR THE LOCATION OF THE MINIMUM IN ZONE B.

2.



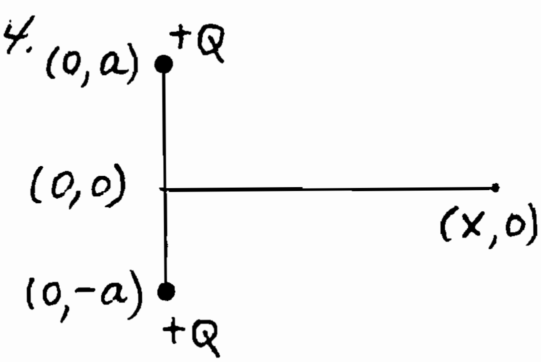
THE POSITIVE PLATE HAS ELECTRIC FIELD E. WE SHOOT AN ELECTRON OF MASS m, CHARGE $-q$ AT VELOCITY v_0 AT θ_0. IN TERMS OF THOSE VARIABLES, FIND A FORMULA FOR THE POINT AT WHICH IT HITS THE PLATE. GRAVITY IS NEGLIGIBLE.

3.



FIND THE ELECTRIC FIELD AT POINT (12, 0) DUE TO $-Q_1$ AND Q_2.

4.

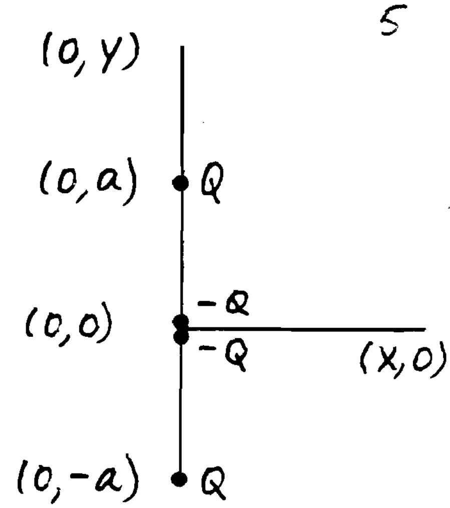


A) IN TERMS OF Q, a AND X, FIND A FORMULA FOR THE ELECTRIC FIELD AT $(X, 0)$.

B) FIND AN APPROXIMATE FORMULA FOR THE ELECTRIC FIELD IN PART A WHEN $X \gg a$.

5. AN ELECTRIC QUADRAPOLE CONSISTS OF FOUR CHARGES. IN TERMS OF Q, a, X AND y, FIND FORMULAS FOR THE TOTAL ELECTRIC FIELD AT: A) $(X,0)$ AND B) $(0,Y)$

C) USE THE BINOMIAL THEOREM TO FIND AN APPROXIMATION TO THE ELECTRIC FIELD AT $(X,0)$ WHEN $x \gg a$. SIMILARLY AT $(0,Y)$

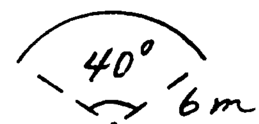


BINOMIAL THEOREM

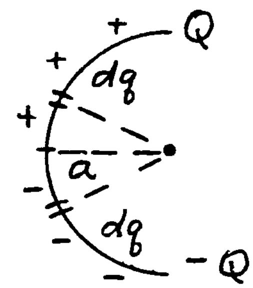
$$(1+X)^n = 1 + \frac{nX}{1!} + \frac{n(n-1)}{2!}X^2 + \frac{n(n-1)(n-2)}{3!}X^3 + \ldots$$

6. A WIRE, WHOSE LENGTH IS 4 m, CARRIES 54 C OF CHARGE UNIFORMLY DISTRIBUTED ALONG ITS LENGTH. FIND ITS LINEAR CHARGE DENSITY.

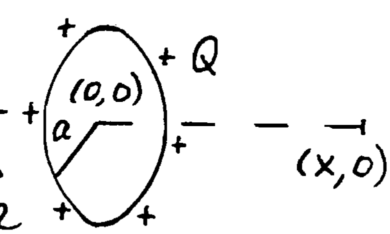
7. AN ARC OF WIRE, WHOSE RADIUS OF CURVATURE IS 6 m, SUBTENDS AN ANGLE OF 40°. A TOTAL CHARGE OF 98 C IS UNIFORMLY DISTRIBUTED ALONG THE WIRE. FIND ITS LINEAR CHARGE DENSITY.



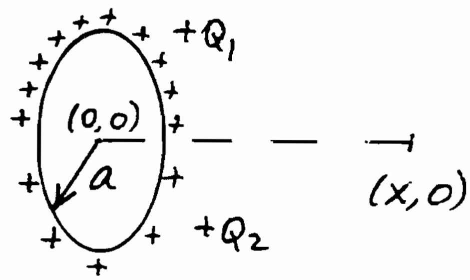
8. A SEMICIRCLE OF WIRE, WHOSE RADIUS OF CURVATURE IS a, CARRIES CHARGE $+Q$ EVENLY DISTRIBUTED ALONG ITS TOP HALF AND $-Q$ ALONG ITS BOTTOM HALF. FIND THE X AND Y COMPONENTS OF ITS ELECTRIC FIELD AT ITS CENTER OF CURVATURE. ONLY Q AND a ARE ALLOWED IN OUR FORMULA.



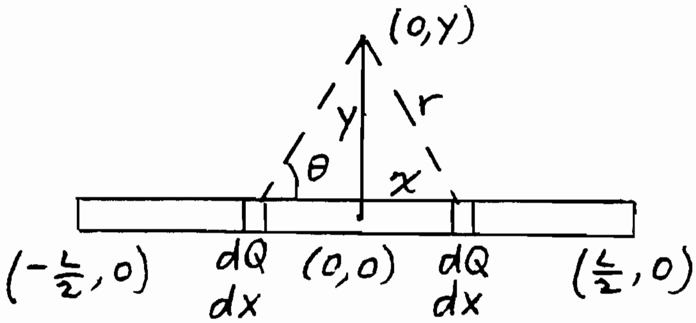
9. A CIRCULAR RING OF WIRE OF RADIUS a HAS TOTAL CHARGE Q UNIFORMLY DISTRIBUTED ALONG ITS LENGTH. WE STAND AT AXIAL LOCATION X. IN TERM OF Q, a AND X, FIND FORMULAS FOR E_X AND E_y AT OUR LOCATION.



10. A RING OF WIRE OF RADIUS "a" HAS CHARGE $+Q_1$ EVENLY DISTRIBUTED OVER ITS UPPER HALF AND CHARGE $+Q_2$ EVENLY DISTRIBUTED OVER ITS LOWER HALF. WE STAND AT AXIAL LOCATION $(x, 0)$. IN TERMS OF Q_1, Q_2, a AND x, FIND FORMULAS FOR E_x AND E_y AT OUR LOCATION. USE THE PRINCIPLE OF SUPERPOSITION; THAT IS, $E_{x\,TOTAL} = E_{x1} + E_{x2}$ AND SIMILARLY FOR E_y.



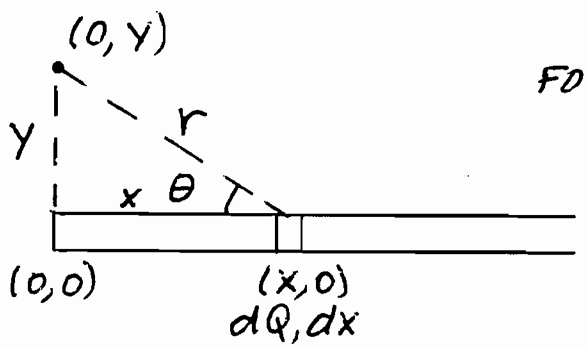
11. A STRAIGHT WIRE OF LENGTH L HAS LINEAR CHARGE DENSITY λ. WE STAND AT LOCATION $(0, y)$. IN TERMS OF L, λ AND y, FIND FORMULAS OF E_x AND E_y AT OUR LOCATION. RELEVANT INTEGRALS:



$$\int \frac{dx}{(x^2+y^2)^{3/2}} = \frac{x}{y^2(x^2+y^2)^{1/2}}$$

WHERE y IS CONSTANT.

12. A SEMI-INFINITE WIRE HAS LINEAR CHARGE DENSITY λ. WE STAND AT LOCATION $(0, y)$. IN TERMS OF λ AND y, FIND A FORMULA FOR E_x AND FOR E_y AT OUR LOCATION. RELEVANT INTEGRALS:



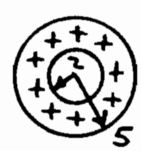
FOR E_x: $$\int \frac{x\,dx}{(x^2+y^2)^{3/2}} = -\frac{1}{(x^2+y^2)^{1/2}}$$

FOR E_y: $$\int \frac{dx}{(x^2+y^2)^{3/2}} = \frac{x}{y^2(x^2+y^2)^{1/2}}$$

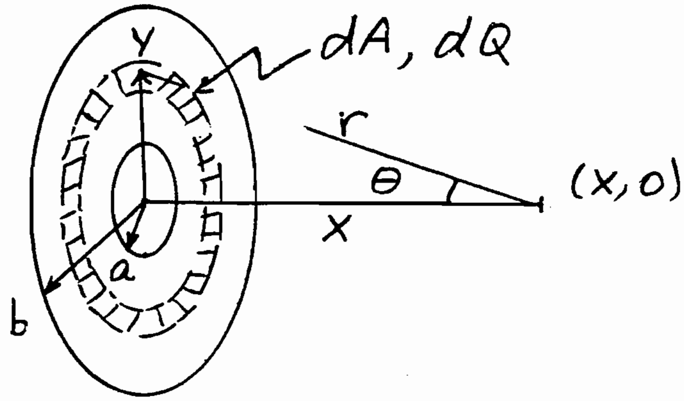
FINALLY, COMBINE OUR TWO FORMULAS FOR E_x AND E_y TO FIND THE MAGNITUDE OF THE TOTAL ELECTRIC FIELD AND ITS DIRECTION.

13. A HEMISPHERICAL SHELL, WHOSE RADIUS OF CURVATURE IS 5 m, HAS SURFACE CHARGE DENSITY .764 C/m^2. FIND ITS TOTAL CHARGE.

14. A FLAT WASHER HAS OUTER RADIUS OF 5 m AND INNER RADIUS OF 2 m. IT CARRIES CHARGE 494.5 C UNIFORMLY DISTRIBUTED OVER ITS SURFACE. FIND ITS SURFACE CHARGE DENSITY.



15. A FLAT WASHER, WHOSE INNER RADIUS IS "a" AND WHOSE OUTER RADIUS IS "b," HAS SURFACE CHARGE DENSITY σ. WE STAND AT LOCATION $(x,0)$ ALONG ITS AXIS. IN TERMS OF σ, a, b AND x, FIND A FORMULA FOR THE ELECTRIC FIELD AT OUR LOCATION.



RELEVANT INTEGRAL:

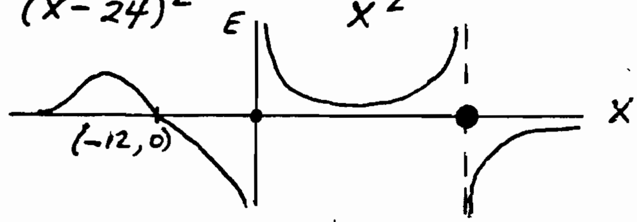
$$\int \frac{y\,dy}{(y^2+x^2)^{3/2}} = \frac{-1}{(y^2+x^2)^{1/2}}$$

ANSWER: $E_x = \dfrac{\sigma x}{2\epsilon_0}\left[\dfrac{1}{(x^2+a^2)^{1/2}} - \dfrac{1}{(x^2+b^2)^{1/2}}\right]$

ANSWERS:

1. ZONE A, $(-12, 0)$, $E_A = \dfrac{405\times10^9}{(x-24)^2} - \dfrac{45\times10^9}{x^2}$,

$$E_B = \frac{405\times10^9}{(x-24)^2} + \frac{45\times10^9}{x^2}$$



ZONE A MAXIMUM: $x^3+9x^2-216x+1728=0$

ZONE B MINIMUM: $10x^3-72x^2+1728x-13824=0$

3. 312 N/C AT 22.62° INTO THIRD QUADRANT

2. $R = (2mv_0^2\sin\theta\cos\theta)/(qE)$

4. $\vec{E} = \left(\dfrac{2Qx}{4\pi\epsilon_0(x^2+a^2)^{3/2}},\ 0\right)$ $\qquad \vec{E} = \left(\dfrac{1}{4\pi\epsilon_0}\dfrac{2Q}{x^2},\ 0\right)$

5. $E = \left(\dfrac{1}{4\pi\epsilon_0}\right)(2Q)\left(\dfrac{x}{(x^2+a^2)^{3/2}} - \dfrac{1}{x^2}\right)$ ALONG X AXIS BACK TOWARD THE ORIGIN.

$$E = \left(\frac{1}{4\pi\epsilon_0}\right)(Q)\left[\frac{1}{(y-a)^2} + \frac{1}{(y+a)^2} - \frac{2}{y^2}\right]$$ ALONG +Y AXIS

$$E = \left(\frac{1}{4\pi\epsilon_0}\right)\frac{(-3Qa^2)}{x^4} \qquad E = \left(\frac{1}{4\pi\epsilon_0}\right)\frac{(6Qa^2)}{y^4}$$

6. 13.5 c/m $\qquad$ 7. 23.4 c/m $\qquad$ 8. $E_x = 0$, $E_y = \dfrac{-Q}{\pi^2\epsilon_0 a^2}$

9. $E_x = \dfrac{Qx}{4\pi\epsilon_0(x^2+a^2)^{3/2}}$ $\qquad E_y = 0$

10. $E_x = \dfrac{(Q_1+Q_2)\,x}{4\pi\epsilon_0(x^2+a^2)^{3/2}}$ $\qquad E_y = \dfrac{(Q_2-Q_1)\,a}{2\pi^2\epsilon_0(x^2+a^2)^{3/2}}$

11. $E_x = 0$ $\qquad E_y = \dfrac{\lambda L}{2\pi\epsilon_0 y\sqrt{L^2+4y^2}}$

12. $E_x = -\lambda/(4\pi\epsilon_0 y)$ $\quad E_y = \lambda/(4\pi\epsilon_0 y)$ $\quad E = \lambda\sqrt{2}/(4\pi\epsilon_0 y)$

DIRECTION: 45° INTO THE SECOND QUADRANT

13. 120 c $\qquad$ 14. 7.5 c/m^2

GAUSS' LAW

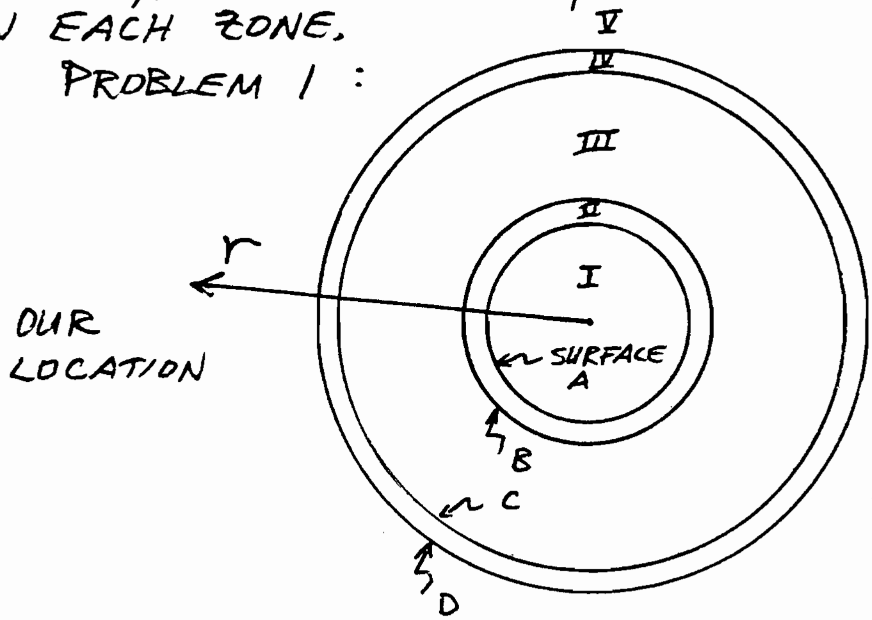
$$\oint \vec{E} \cdot d\vec{S} = \frac{q_{INSIDE}}{\epsilon_0}$$

STATIONARY CHARGES CREATE ELECTRIC FIELDS.

1. WITHOUT ANY MATHEMATICAL ANALYSIS, FIND FORMULAS FOR THE: A) ELECTRIC FIELD IN EACH ZONE
   B) CHARGE ON THE INNER AND ON THE OUTER SURFACE OF EACH CONDUCTION SHELL.

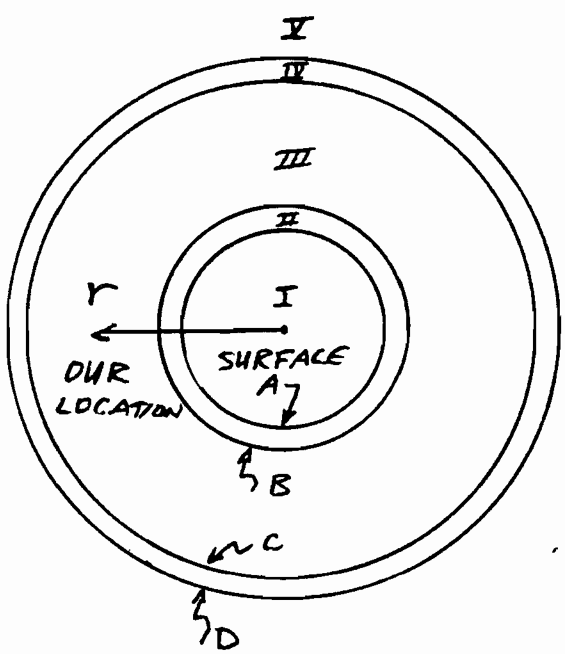
FINALLY, QUANTITATIVELY SKETCH THE ELECTRIC FIELD IN EACH ZONE.

PROBLEM 1 :



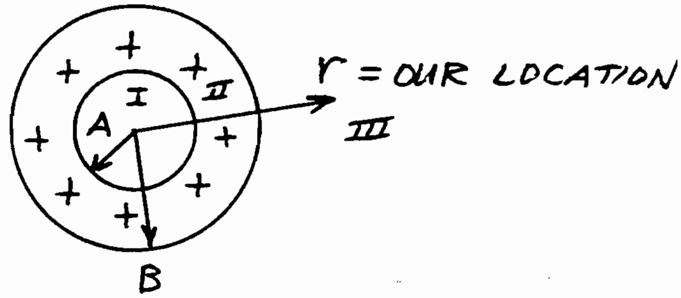
AT THE CENTER, WE PUT $+3Q$; ON THE INNER SHELL $+17Q$; ON THE OUTER SHELL $+12Q$.

PROBLEM 2 :



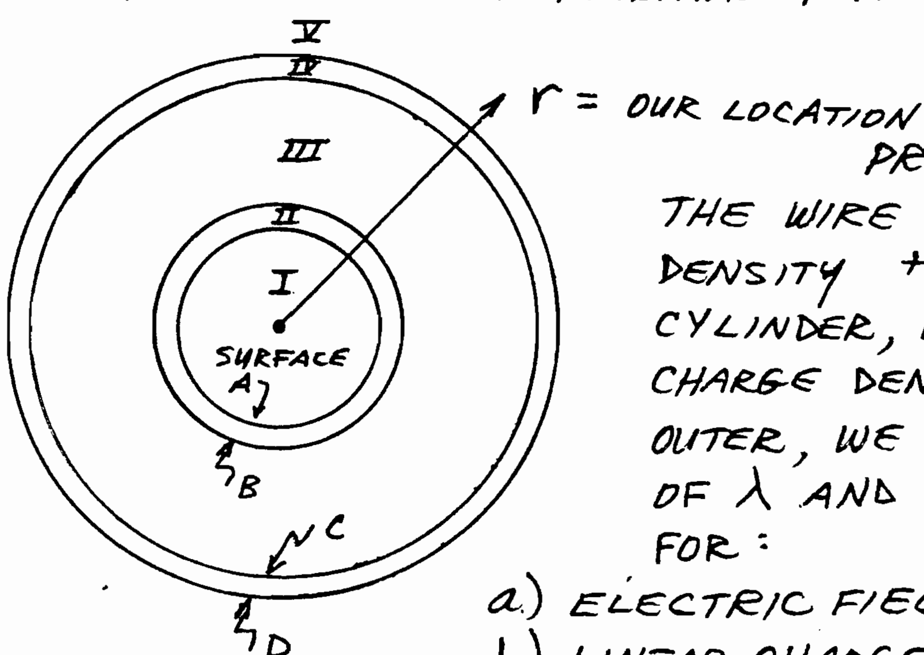
AT THE CENTER, WE PUT $-3Q$; ON THE INNER SHELL $+15Q$; ON THE OUTER SHELL $-42Q$.

2. A NON-CONDUCTING SPHERE, WHICH IS HOLLOW ON THE INSIDE, HAS INNER RADIUS A AND OUTER RADIUS B. IT CARRIES CHARGE DENSITY ρ [C/m^3] UNIFORMLY SPREAD THROUGHOUT ITS VOLUME. IN TERMS OF ρ, A, B AND r, FIND FORMULAS FOR THE ELECTRIC FIELD IN EACH ZONE. SKETCH A GRAPH OF E VERSUS r.



3. THE NON-CONDUCTING SPHERE OF PROBLEM 2 HAS $+\rho$ [C/m^3] SPREAD THROUGHOUT, AS SHOWN ABOVE. WE NOW PUT A CHARGE OF $-Q$ AT ITS CENTER. FIND A FORMULA FOR THE ELECTRIC FIELD IN EACH ZONE AND SKETCH A GRAPH OF E VERSUS r. ASSUME THAT THE TOTAL POSITIVE CHARGE EXCEEDS THE NEGATIVE.

4. TWO CONCENTRIC CONDUCTING CYLINDERS HAVE A WIRE RUNNING LONGITUDINALLY AT THEIR CENTER.



PROBLEM 1

THE WIRE HAS LINEAR CHARGE DENSITY $+4\lambda$. ON THE INNER CYLINDER, WE PUT LINEAR CHARGE DENSITY $+7\lambda$. ON THE OUTER, WE PUT $+9\lambda$. IN TERMS OF λ AND r, FIND FORMULAS FOR:

a) ELECTRIC FIELD IN EACH ZONE

b) LINEAR CHARGE DENSITY FOR EACH SURFACE.

c) QUANTITATIVELY SKETCH THE ELECTRIC FIELD IN EACH ZONE.

PROBLEM 2

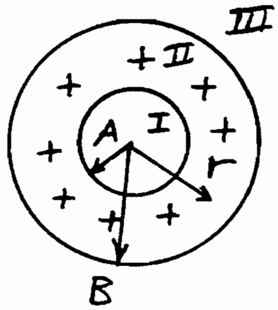
THE WIRE HAS LINEAR DENSITY -4λ. ON THE INNER CYLINDER, WE PUT LINEAR CHARGE DENSITY -9λ. ON THE OUTER CYLINDER, WE PUT LINEAR CHARGE DENSITY $+20\lambda$. IN TERMS OF λ AND r, FIND FORMULAS FOR THE:

a) ELECTRIC FIELD IN EACH ZONE.

b) LINEAR CHARGE DENSITY FOR EACH SURFACE.

c) QUANTITATIVELY SKETCH THE ELECTRIC FIELD IN EACH ZONE.

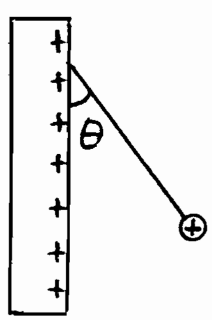
5. A HOLLOW, NON-CONDUCTING CYLINDER HAS INNER RADIUS "A" AND OUTER RADIUS "B." THROUGHOUT ITS VOLUME, IT CARRIES UNIFORM CHARGE DENSITY ρ [C/m³].



r = OUR LOCATION

IN TERMS OF ρ, A, B AND r, FIND FORMULAS FOR THE ELECTRIC FIELD IN EACH ZONE. THEN, SKETCH A GRAPH OF ELECTRIC FIELD VERSUS r.

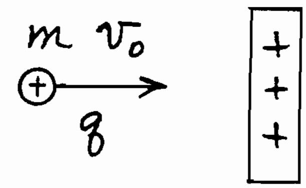
6. A VERTICAL INFINITE CONDUCTING SHEET HAS SURFACE CHARGE DENSITY σ [C/m²]. A SMALL PARTICLE OF MASS m AND CHARGE q IS ATTACHED TO THE SHEET WITH A STRING. IN TERMS OF q, m AND σ, FIND FORMULAS FOR THE:



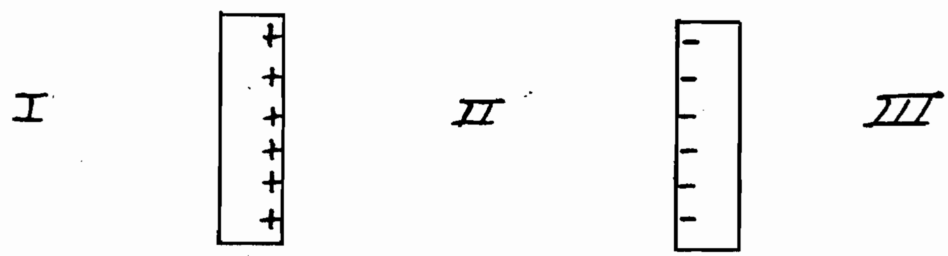
A) TENSION IN THE STRING.

B) ANGLE θ.

7. A PARTICLE OF CHARGE q AND MASS m IS SHOT AT VELOCITY v_0 TOWARD A VERTICAL INFINITE NON-CONDUCTING SHEET WHOSE SURFACE CHARGE DENSITY σ.
IN TERMS OF m, v_0, q AND σ, FIND A FORMULA FOR THE DISTANCE REQUIRED FOR THE PARTICLE TO STOP TO TURN AROUND.

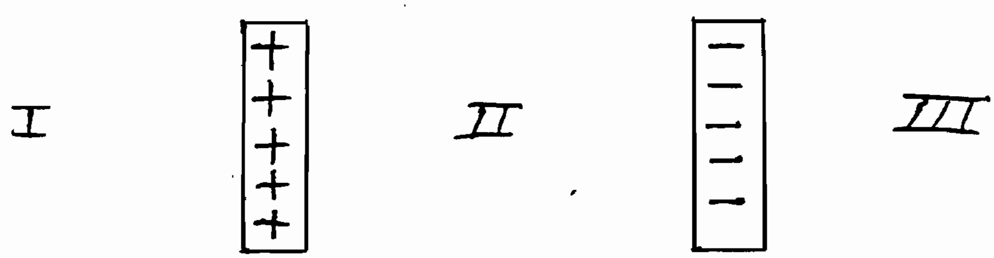


8. TWO PARALLEL CONDUCTING SHEETS EACH HAVE POSITIVE SURFACE CHARGE DENSITY σ. USE GAUSS' LAW TO FIND A FORMULA FOR THE ELECTRIC FIELD IN EACH ZONE. ONLY σ IS ALLOWED IN OUR ANSWER. THEN, SKETCH THE FIELD IN EACH ZONE.

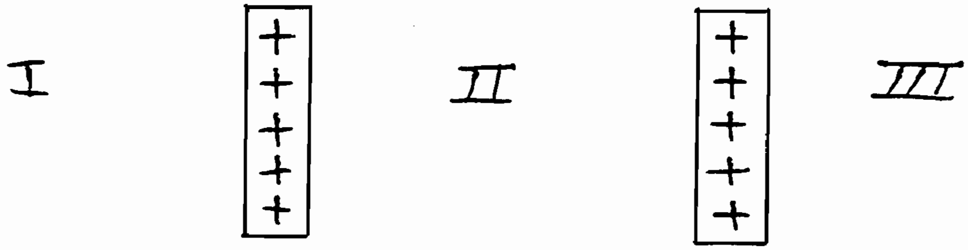


9. IN EACH CASE, USE THE PRINCIPLE OF SUPERPOSITION TO FIND A FORMULA FOR THE <u>NET</u> ELECTRIC FIELD IN EACH ZONE. ONLY σ IS ALLOWED IN OUR ANSWER. THEN, SKETCH THE <u>NET</u> FIELD IN EACH ZONE.

A) TWO PARALLEL NON-CONDUCTING SHEETS, EACH WITH SURFACE CHARGE DENSITY σ, ONE (+), ONE (−).

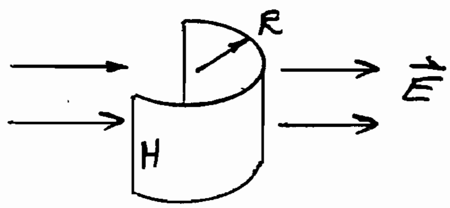


B) TWO PARALLEL NON-CONDUCTING SHEETS, EACH WITH SURFACE CHARGE DENSITY σ, BOTH (+).

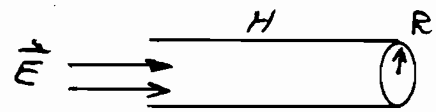


10. IN EACH CASE, FIND A FORMULA FOR THE ELECTRIC FLUX THROUGH EACH SURFACE. ONLY "E" AND THE GEOMETRIC CHARACTERISTICS OF THE SURFACE ARE ALLOWED IN OUR ANSWER.

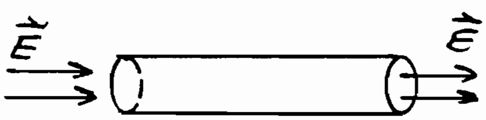
A) HEMICYLINDER



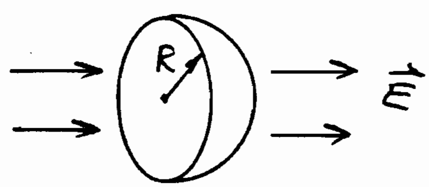
B) CYLINDER WITH ONLY ONE END CAP



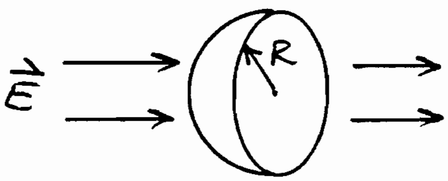
C) CYLINDER WITH TWO END CAPS



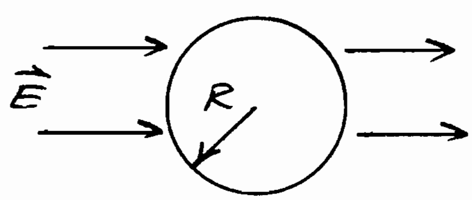
D) HEMISPHERE



E) HEMISPHERE

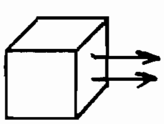


F) SPHERE



G) BOX

EACH FACE HAS AREA "A".

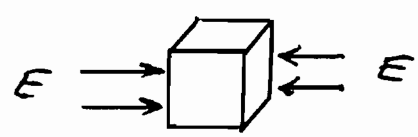


$\vec{E}$ PENETRATES ONLY ONE FACE, OUTWARDS

H) BOX

A = AREA OF ONE FACE.

$\vec{E}$ PENETRATES TWO FACES, INWARDS

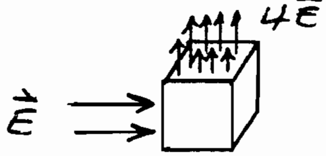


I) BOX

A = AREA OF ONE FACE

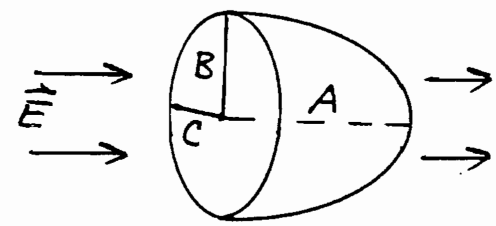
$\vec{E}$ PENETRATES ONE FACE INWARD

$4\vec{E}$ PENETRATES ANOTHER OUTWARD.



THERE IS NO ELECTRIC FIELD PENETRATING THE OTHER FACES.

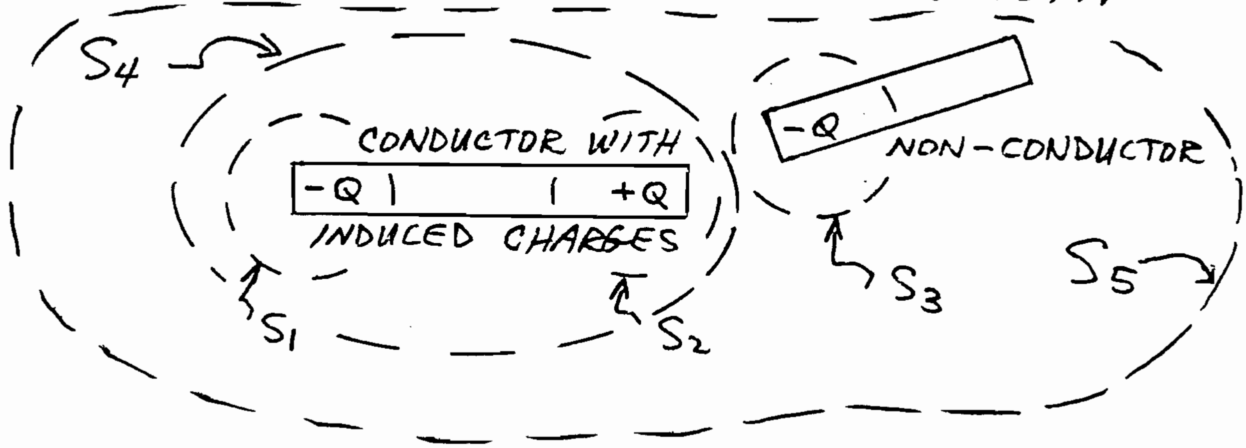
I) HEMI-ELLIPSOID



ITS EQUATION IS

$$\frac{x^2}{A^2} + \frac{y^2}{B^2} + \frac{z^2}{C^2} = 1$$

11. AN UNCHARGED CONDUCTING BAR IS POLARIZED BY HOLDING A CHARGED NON-CONDUCTOR NEAR IT.



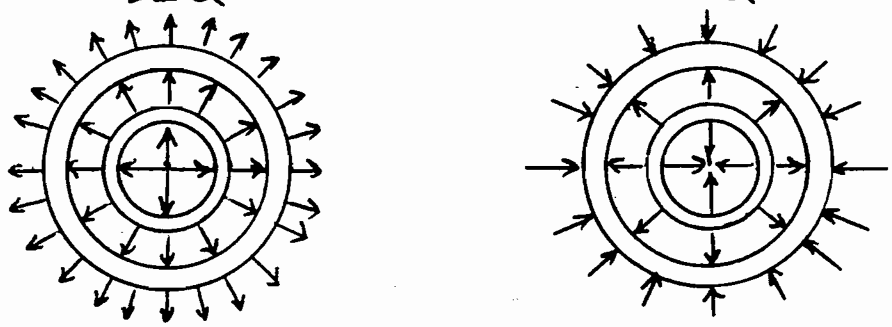
IN TERMS OF Q, FIND A FORMULA FOR THE ELECTRIC FLUX THROUGH EACH OF THE CLOSED SURFACES S_1, S_2, S_3, S_4 AND S_5.

ANSWERS

1.

	PROBLEM 1	PROBLEM 2
$E_I =$	$\frac{1}{4\pi\epsilon_0}\frac{3Q}{r^2}$	$\frac{1}{4\pi\epsilon_0}\frac{-3Q}{r^2}$
$E_{II} =$	0	0
$E_{III} =$	$\frac{1}{4\pi\epsilon_0}\frac{20Q}{r^2}$	$\frac{1}{4\pi\epsilon_0}\frac{12Q}{r^2}$
$E_{IV} =$	0	0
$E_V =$	$\frac{1}{4\pi\epsilon_0}\frac{32Q}{r_2}$	$\frac{1}{4\pi\epsilon_0}\frac{-30Q}{r^2}$
SURFACE A =	$-3Q$	$+3Q$
SURFACE B =	$20Q$	$+12Q$
SURFACE C =	$-20Q$	$-12Q$
SURFACE D =	$32Q$	$-30Q$

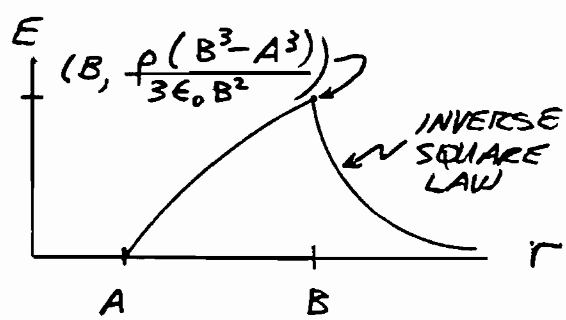
SKETCH



2. $E_I = 0$

$$E_{II} = \frac{\rho}{3\epsilon_0}\left(r - \frac{A^3}{r^2}\right)$$

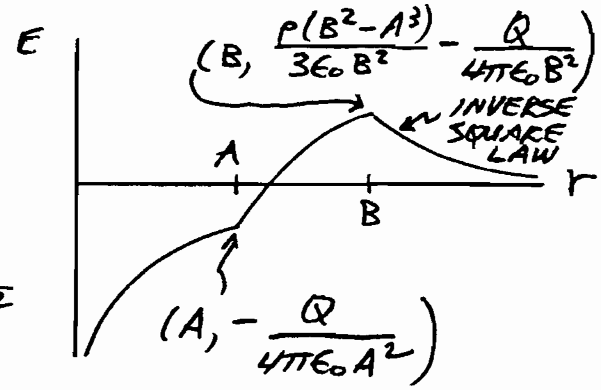
$$E_{III} = \frac{\rho\,(B^3 - A^3)}{3\epsilon_0 r^2}$$



3. $E_I = \frac{1}{4\pi\epsilon_0}\frac{-Q}{r^2}$

$$E_{II} = \frac{\rho}{3\epsilon_0}\left(r - \frac{A^3}{r^2}\right) - \frac{Q}{4\pi\epsilon_0 r^2}$$

$$E_{III} = \frac{\rho\,(B^3 - A^3)}{3\epsilon_0 r^2} - \frac{Q}{4\pi\epsilon_0 r^2}$$

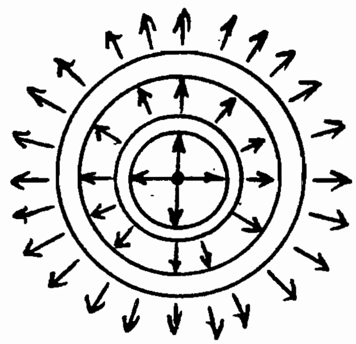


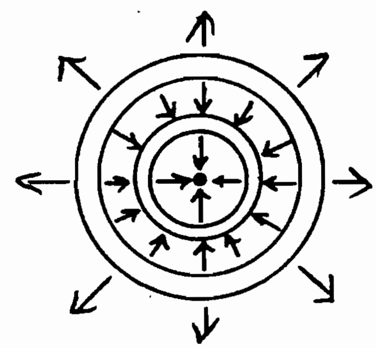
ANSWERS:

4.

	PROBLEM 1	PROBLEM 2
$E_I =$	$\dfrac{4\lambda}{2\pi\epsilon_0 r}$	$\dfrac{-4\lambda}{2\pi\epsilon_0 r}$
$E_{II} =$	0	0
$E_{III} =$	$\dfrac{11\lambda}{2\pi\epsilon_0 r}$	$\dfrac{-13\lambda}{2\pi\epsilon_0 r}$
$E_{IV} =$	0	0
$E_{V} =$	$\dfrac{20\lambda}{2\pi\epsilon_0 r}$	$\dfrac{7\lambda}{2\pi\epsilon_0 r}$
SURFACE A =	-4λ	$+4\lambda$
SURFACE B =	$+11\lambda$	-13λ
SURFACE C =	-11λ	$+13\lambda$
SURFACE D =	$+20\lambda$	$+7\lambda$

SKETCH

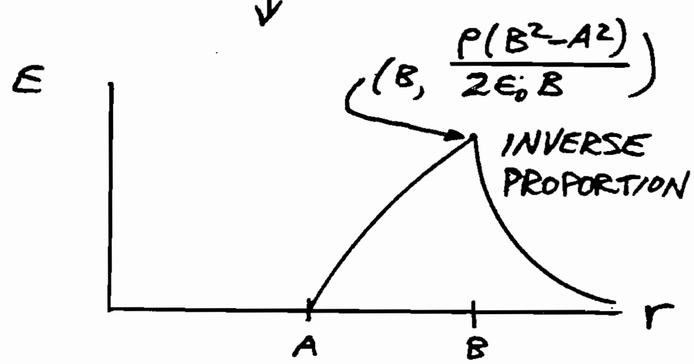




5. $E_I = 0$

$$E_{II} = \frac{\rho(r^2 - A^2)}{2\epsilon_0 r}$$

$$E_{III} = \frac{\rho(B^2 - A^2)}{2\epsilon_0 r}$$

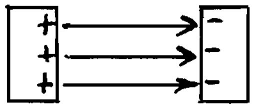


6. $F_T = \sqrt{m^2 g^2 + \dfrac{q^2\sigma^2}{\epsilon_0^2}}$ $\qquad \theta = \tan^{-1}\left(\dfrac{q\sigma}{\epsilon_0 m g}\right)$

7. $X = \dfrac{\epsilon_0 m v_0^2}{q\sigma}$

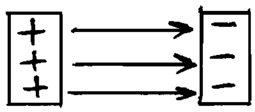
ANSWERS:

8.



$E = 0$ $\quad E = \frac{\sigma}{\epsilon_0}$ $\quad E = 0$

9. A)



$E = 0$ $\quad E = \frac{\sigma}{\epsilon_0}$ $\quad E = 0$

B)

$E = \frac{\sigma}{\epsilon_0}$ $\quad E = 0$ $\quad E = \frac{\sigma}{\epsilon_0}$

10. A) $\Phi = E(2RH)$ B) $\Phi = E(\pi R^2)$ C) $\Phi = 0$ J) $\Phi = E\pi BC$

D) $\Phi = E(\pi R^2)$ E) $\Phi = -E(\pi R^2)$ F) $\Phi = 0$

G) $\Phi = EA$ H) $\Phi = -2EA$ I) $\Phi = 3EA$

11. $\Phi_1 = -\frac{Q}{\epsilon_0}$, $\Phi_2 = \frac{Q}{\epsilon_0}$, $\Phi_3 = -\frac{Q}{\epsilon_0}$, $\Phi_4 = 0$, $\Phi_5 = -\frac{Q}{\epsilon_0}$