10.5/11/12

Physics 102 – General Physics – Spring 2023 – Activity 3

Name: Clara Greer ID Number: [redacted]

Instructions:

1. This activity is worth 12 points, 6 per problem.
2. Give all numerical answers to 3 significant figures. Clearly indicate your final answer (by putting a box around it, for example). Include units. Show all work, especially any algebra steps and substitutions.
3. You may use your course notes, the online textbook, and a calculator.
4. You are allowed to work in small groups of 2 or 3.

Useful information:

The elementary charge has magnitude of $e = 1.602 \times 10^{-19}\ C$

Electric charge on a proton: $+1e$ Electric charge on an electron: $-1e$

Electron mass: $m_e = 9.11 \times 10^{-31}\ kg$

Acceleration due to gravity: $g = 9.8\ \frac{m}{s}$ Gravitational force law near Earth's surface: $F = mg$

Coulomb's Force: $F_e = \frac{kqQ}{r^2}$ Electric Field: $E = \frac{kQ}{r^2}$

Coulomb's constant: $k = 8.99 \times 10^9\ \frac{Nm^2}{C^2}$

Potential Difference: $\Delta V = \frac{\Delta PE}{q}$ Voltage between points A and B: $\Delta V = Ed$

Capacitance: $C = \frac{Q}{V}$ Parallel Plate Capacitor with Dielectric: $C = \kappa\varepsilon_0 \frac{A}{d}$

Permittivity of Free Space: $\varepsilon_0 = 8.85 \times 10^{-12}\ \frac{F}{m}$

1) A) Will the electric field strength between two parallel conducting plates exceed the breakdown strength for air (3.00×10^6 V/m) if the plates are separated by 1.30 mm and a potential difference of 6.40×10^3 V is applied? (Do a calculation and then answer Yes or No.)

$E = \frac{V}{d}$ $V = 6.4 \times 10^3$ $d = 1.30\ mm = 1.3 \times 10^{-3}$

$E = \frac{6.4 \times 10^3}{1.3 \times 10^{-3}} = 4.92 \times 10^6$ which

$4.92 \times 10^6 > 3.0 \times 10^6$

therefore yes, it will exceed strength

B) How close together (in mm) can the plates be with this applied voltage?

$d = \frac{V}{E}$

$\frac{6.4 \times 10^3}{3.0 \times 10^6} = 2.1 \times 10^{-3}\ m = 2.1\ mm$

-.5 2.13 mm

2) A) What is the capacitance (in μF) of a parallel plate capacitor having plates of area 1.70 m^2 that are separated by 0.0250 mm of polystyrene? (Polystyrene has a dielectric constant of 2.56.)

$\kappa = 2.56$ $\quad C = \kappa \frac{A}{d} = \kappa \varepsilon_0 \frac{A}{d}$

$C = 2.56 \cdot 8.84 \times 10^{-12} \frac{F}{m} \cdot \frac{1.70\,m^2}{2.5 \times 10^{-5}\,m}$

$C = 1.54 \times 10^{-6} = 1.54\,\mu F$

B) What charge (in μC) does it hold when 8.00 V is applied to it?

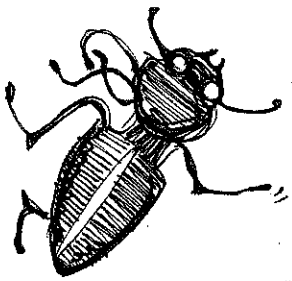
$C = Q/V \Rightarrow Q = CV$

$Q = 1.54 \times 10^{-6} \cdot 9V$ 13.9μC

$Q = 12.3 \times 10^{-6} = 12.3\,\mu C$

FAME IS A BEE
IT HAS A SONG
IT HAS A STING
AH, TOO,
IT HAS
A WING.

—EMILY DICKENSON



BUG'S PSALM

The bugs' psalm:
don't get crushed.
Afterlives feel meaningless
but spring will come,
push out the nubs
the kids braid into
pallets
take up your pallet
from lawn's hardly
touched.
The small think gods
just roll on clouds.
Bugs think gods just
crush

BY Rodney Koeneke

Approximate answers (remember to use 3 sig figs for your answers):

1) A) Yes B) ~2 *mm*

2) A) ~2 μF B) ~10 μC

Physics 102 – General Physics – Spring 2023 – Activity 2

(12)

Name: Clara Gorski ID Number:

Instructions:

1. This activity is worth 12 points, 6 per problem.
2. Give all numerical answers to 3 significant figures. Clearly indicate your final answer (by putting a box around it, for example). Include units. Show all work, especially any algebra steps and substitutions.
3. You may use your course notes, the textbook, and a calculator.
4. You are allowed to work in groups.

Useful information:

The elementary charge:

Electric charge of a proton: $+1e$ Electric charge of an electron: $-1e$

Electron mass: $m_e = 9.11$

Acceleration due to gravity: $g = 9.8$ Gravitational force law near Earth's surface: $F = mg$

Coulomb's Force: $F_e = \frac{kqQ}{r^2}$ Electric Field: $E = \frac{kQ}{r^2}$

Coulomb's constant: $k = 8.99 \times 10^9 \frac{Nm^2}{C^2}$

Questions:

1) A hydrogen atom contains a single electron that moves in a circular orbit about a single proton. Assume the proton is stationary, and the electron has a speed of 8.7×10^5 m/s. Find the radius between the stationary proton and the electron orbit within the hydrogen atom.

Recall the force needed for an object to move in a circle is the *centripetal force*: $F_{centripetal} = \frac{mv^2}{r}$

$\frac{kqQ}{r^2} = \frac{mv^2}{r} \rightarrow r = \frac{kqQ}{mv^2}$

$r = \frac{(8.99 \cdot 10^9 \frac{Nm^2}{C^2})|(+1e)(-1e)|}{(9.11 \cdot 10^{-31})(8.7 \cdot 10^5)^2} = 3.346 \cdot 10^{-10}$

$3.35 \cdot 10^{-10}$ m

2) Point charges of 21.0 μC and 48.0 μC are placed 0.500 m apart. What are the magnitude and direction of the net electric field halfway between them?

$\frac{k|q_1|}{r^2} = \frac{(8.99 \cdot 10^9 \frac{N \cdot m^2}{C^2})|21.0 \cdot 10^{-6} C|}{(0.25 m)^2} = E_1 = 3.02 \cdot 10^6$

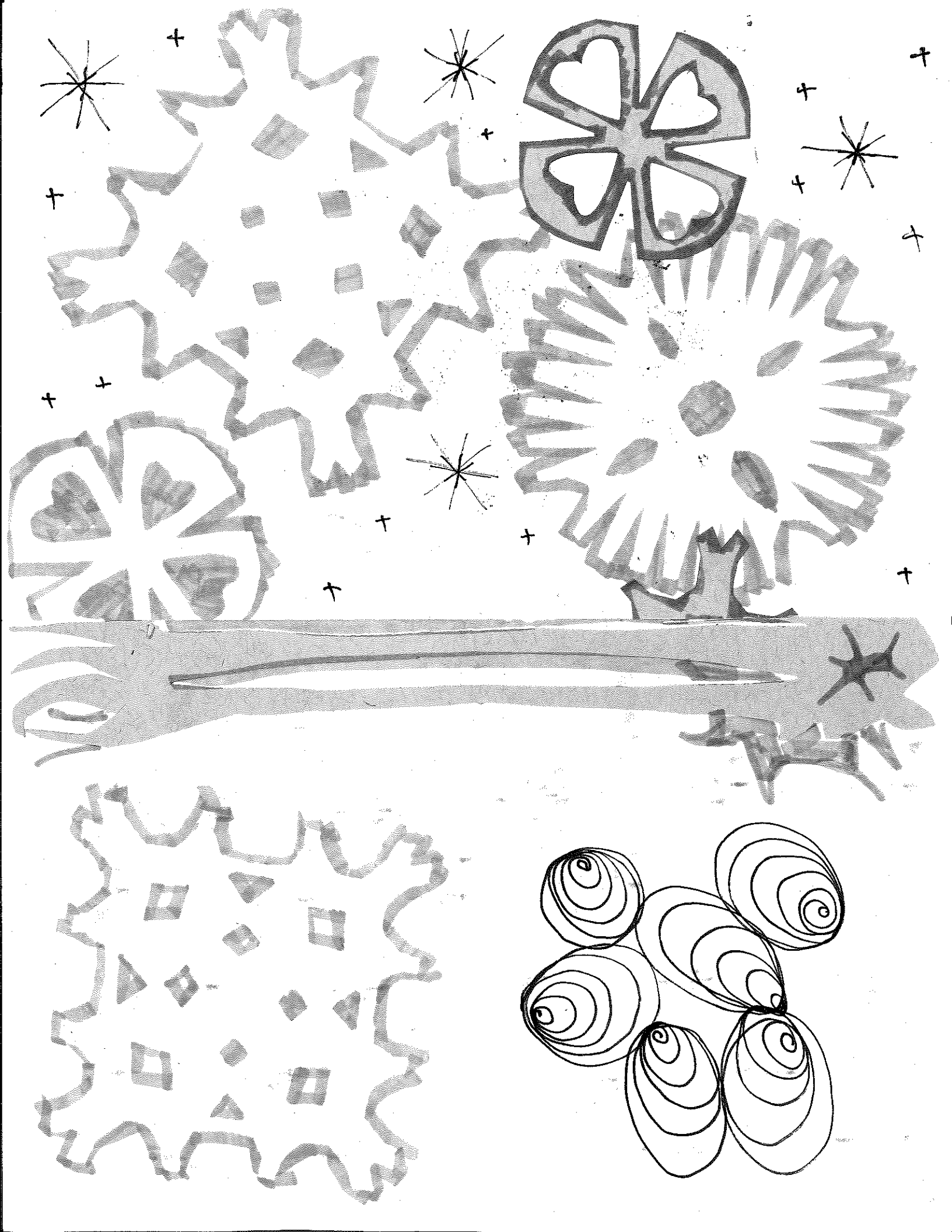
$\frac{k|q_2|}{r^2} = \frac{(8.99 \cdot 10^9 \frac{N \cdot m^2}{C^2})|48.0 \cdot 10^{-6} C|}{(0.25 m)^2} = E_2 = 6.904 \cdot 10^6$

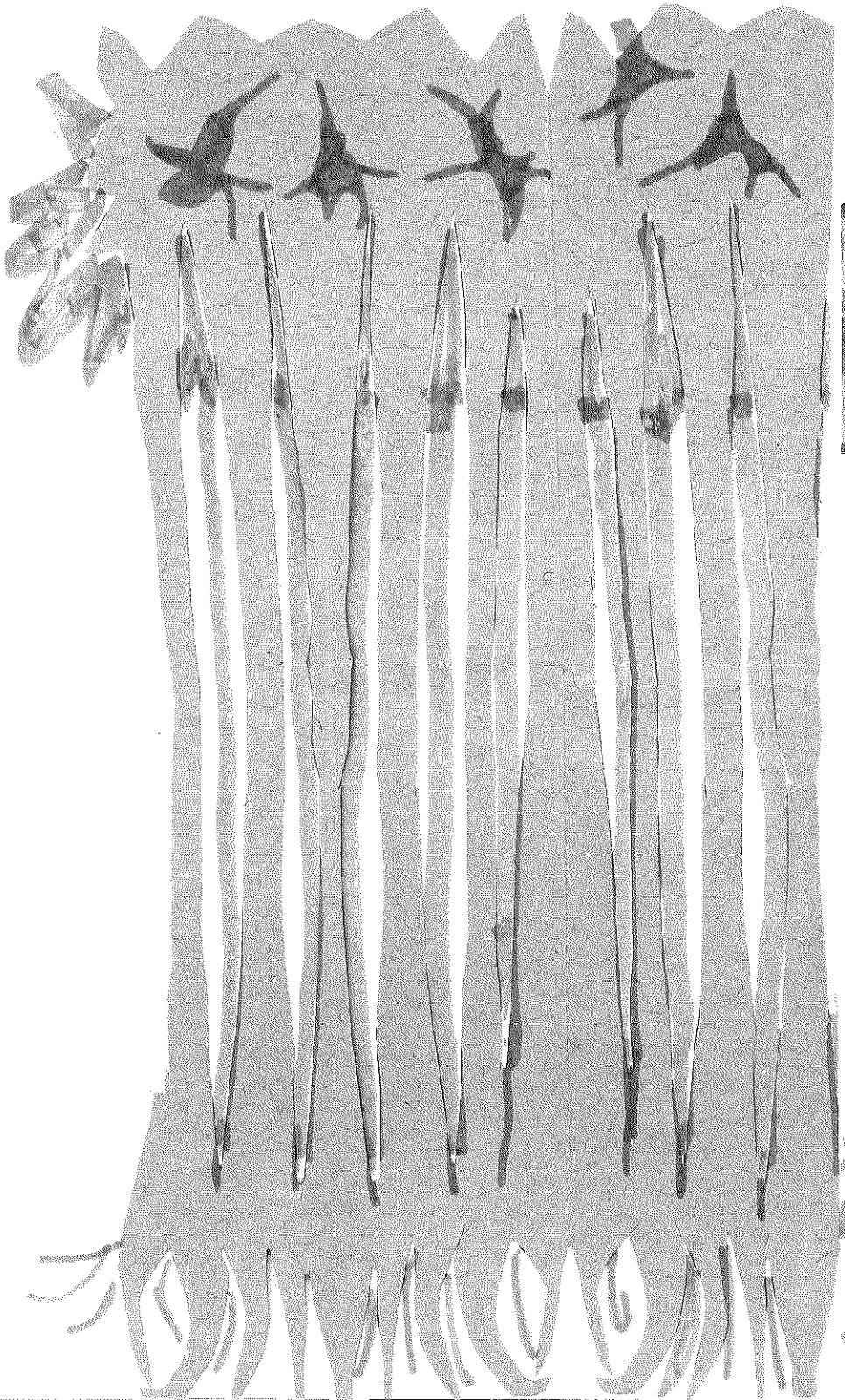
$E_2 - E_1 = 6.904 \cdot 10^6 - 3.02 \cdot 10^6 = 3.88 \cdot 10^6 \frac{N}{C}$

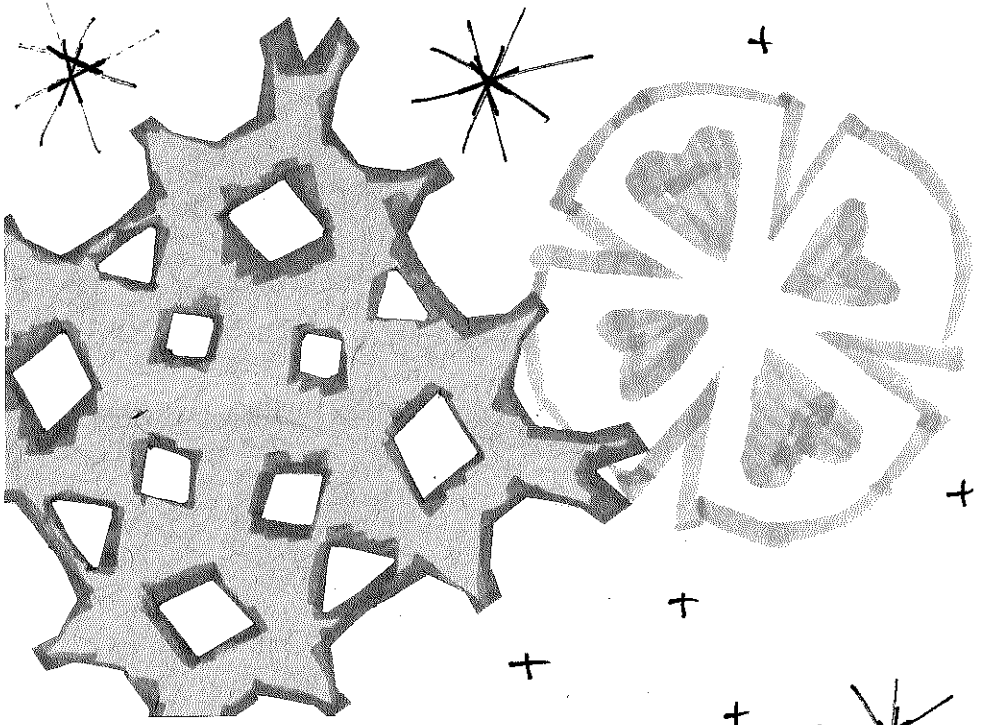
towards smaller charge

Approximate answers (remember to use 3 sig figs for your answers):

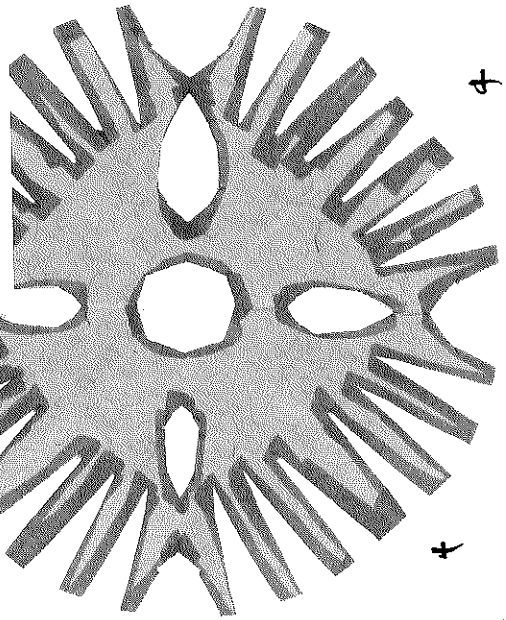
1) $\sim 3 \times 10^{-10}\ m$ 2) $\sim 4 \times 10^6 \frac{N}{C}$, *towards smaller charge*







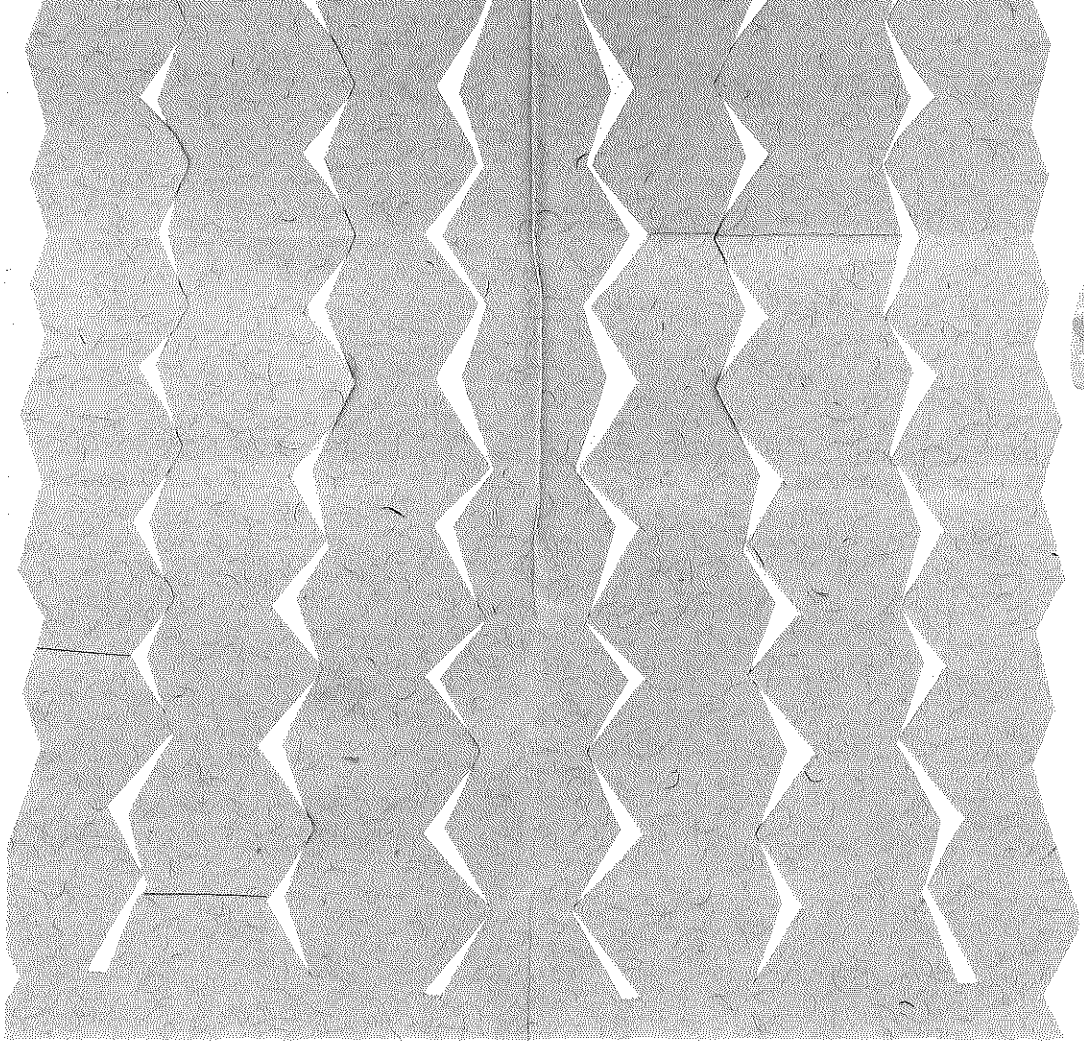
someday I'll
get my prints...



CLARA

and like printsy haha, get it?

as in I get a printed pic of myself in here,



April
2023