

electrostatics

or, electric forces when nothing is moving.

ph 106-4

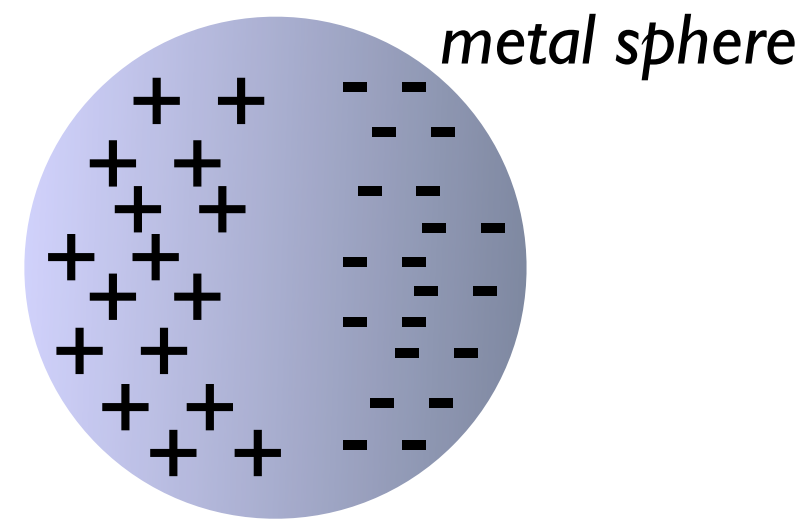
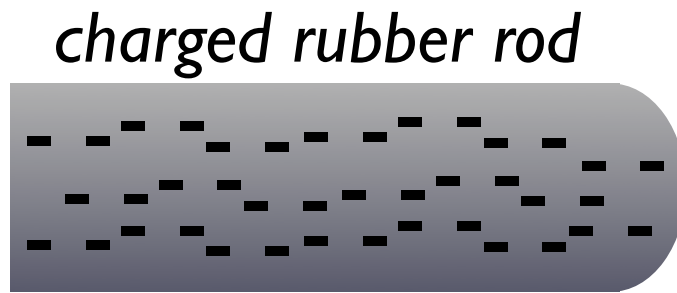
Summarizing the properties of charge:

1. Charge is quantized in units of $|e| = 1.6 \times 10^{-19} \text{ C}$
2. Electrons carry one unit of negative charge, $-e$
3. Protons carry one unit positive charge, $+e$
4. Objects become charged by gaining or losing electrons, not protons
5. Electric charge is always conserved

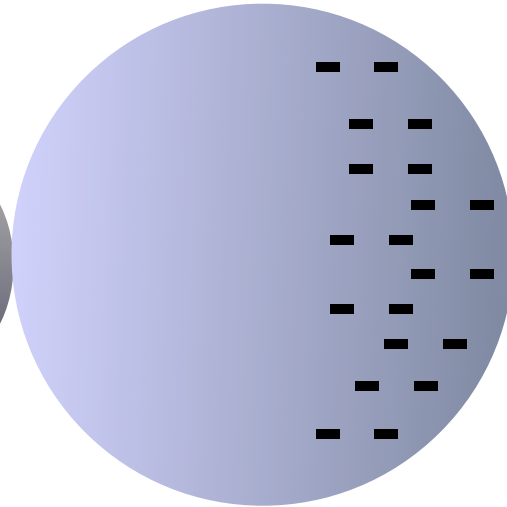
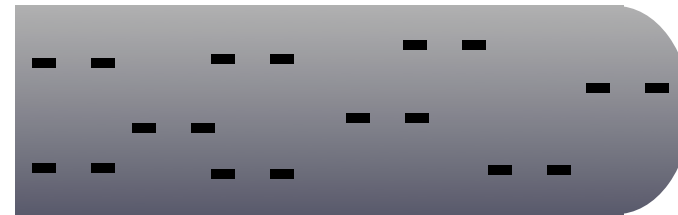
Table 3.1: *Properties of electrons, protons, and neutrons*

Particle	Charge [C]	[e]	Mass [kg]
electron (e^-)	-1.60×10^{-19}	-1	9.11×10^{-31}
proton (p^+)	$+1.60 \times 10^{-19}$	+1	1.67×10^{-27}
neutron (n^0)	0	0	1.67×10^{-27}

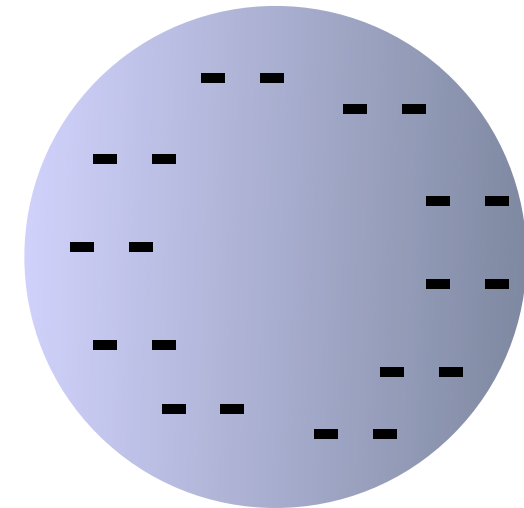
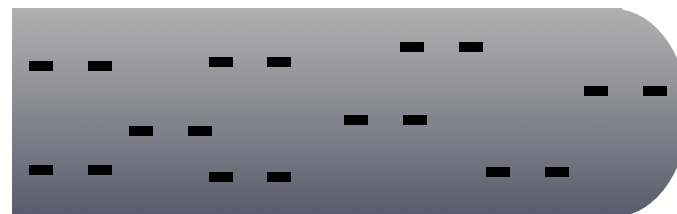
a) before



b) contact



c) after

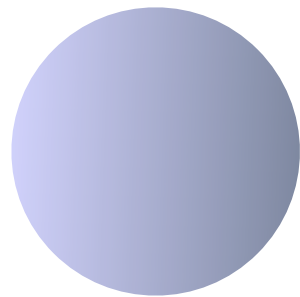




“Little pieces of tissue paper (or light grains of sawdust) are attracted by a glass rod rubbed with a silk handkerchief (or by a piece of sealing wax or a rubber comb rubbed with flannel).”

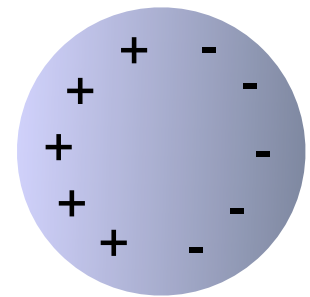
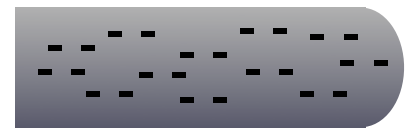
- from a random 1902 science book

*neutral
metal sphere*

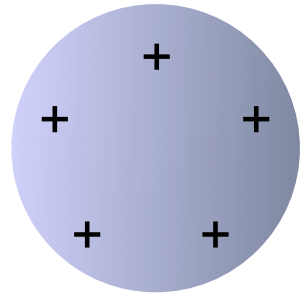
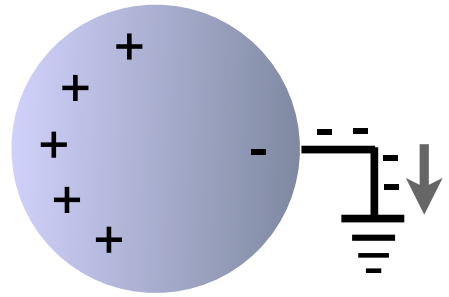
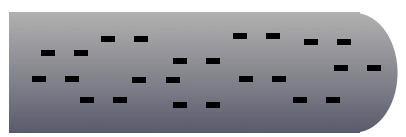
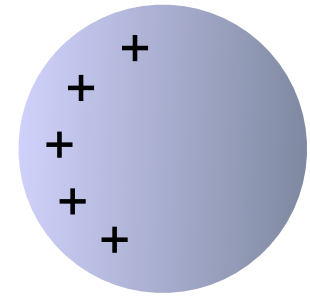
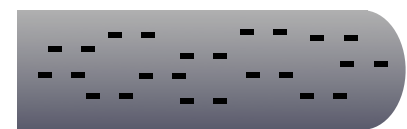


b)

*charged
rubber rod*



d)



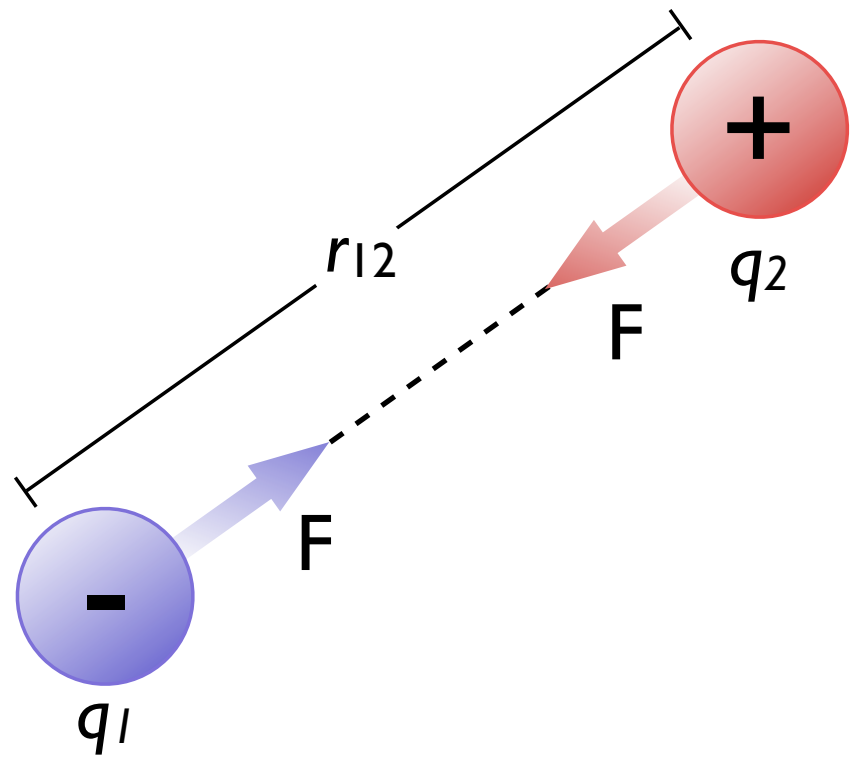
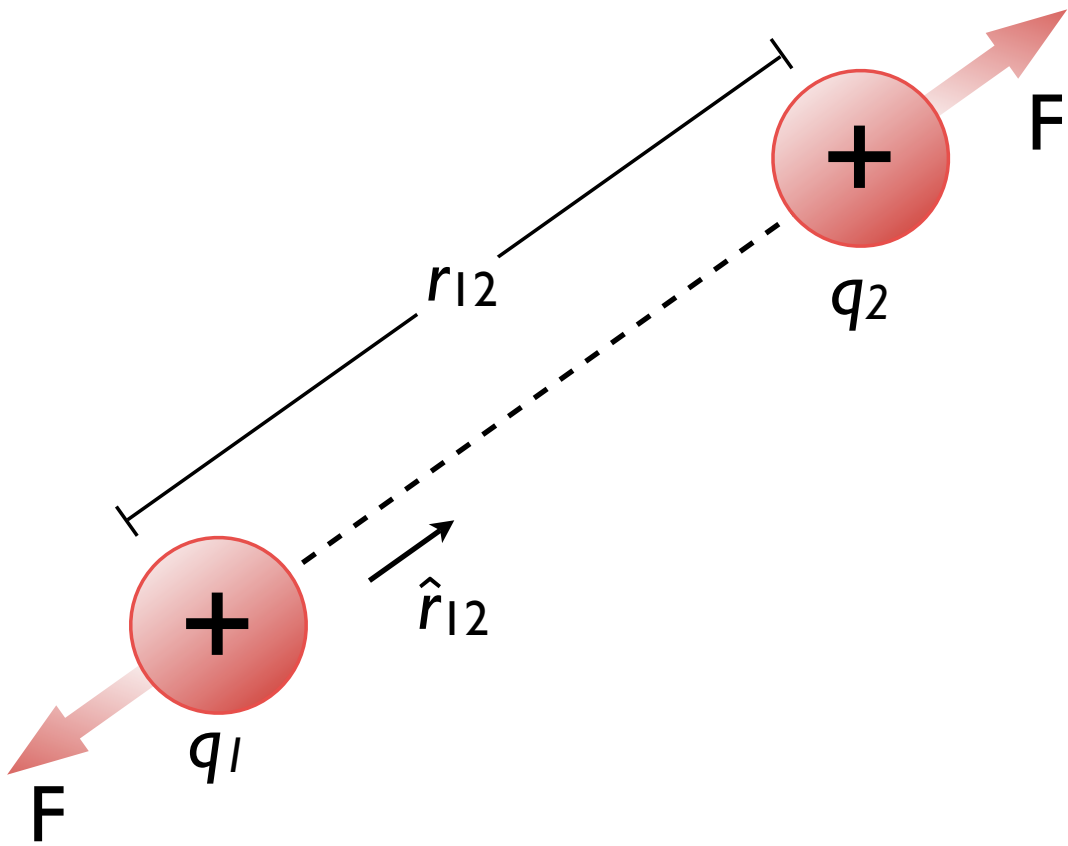
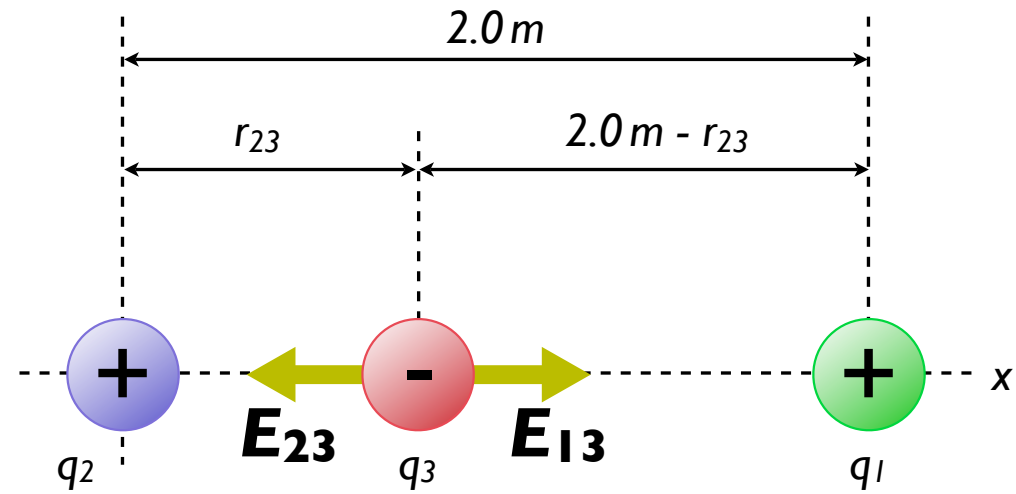


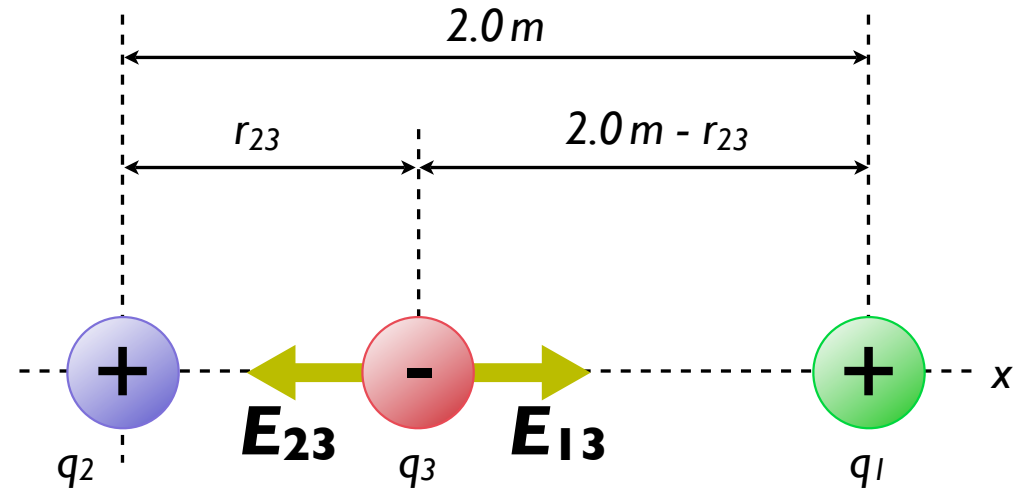
Table 3.2: *Approximate electric field values, in [N/C]*

Source	$ \vec{\mathbf{E}} $	Source	$ \vec{\mathbf{E}} $
Fluorescent lighting tube	10	Atmosphere (fair weather)	10^2
Balloon rubbed on hair	10^3	Atmosphere (under thundercloud)	10^4
Photocopier	10^5	Spark in air	10^6
Across a transistor gate dielectric	10^9	Near electron in hydrogen atom	10^{11}

2. Three point charges lie along the x axis, as shown at left. A positive charge $q_1 = 15 \mu\text{C}$ is at $x = 2 \text{ m}$, and a positive charge of $q_2 = 6 \mu\text{C}$ is at the origin. Where must a *negative* charge q_3 be placed on the x -axis **between the two positive charges** such that the resulting electric force on it is zero?



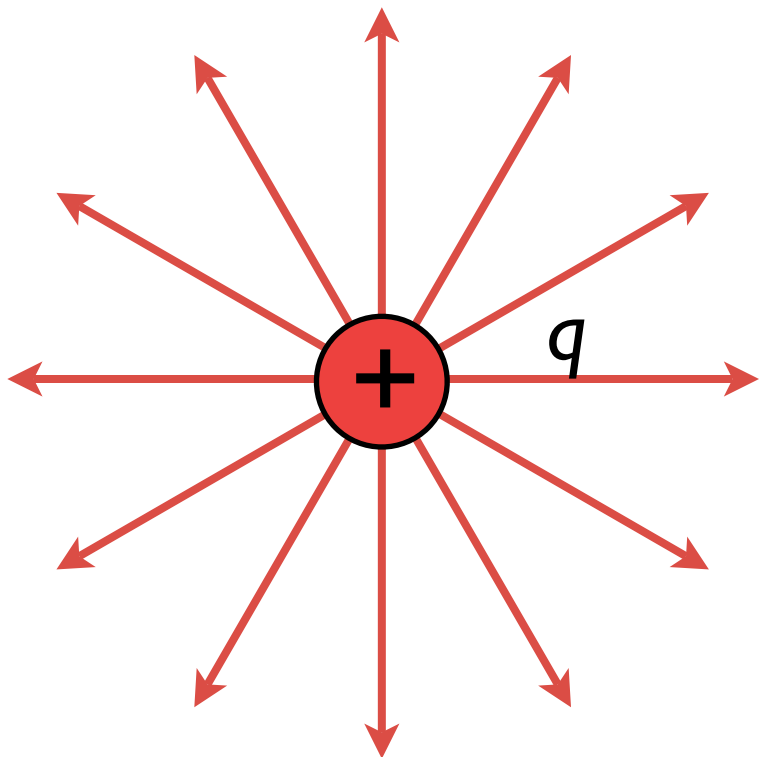
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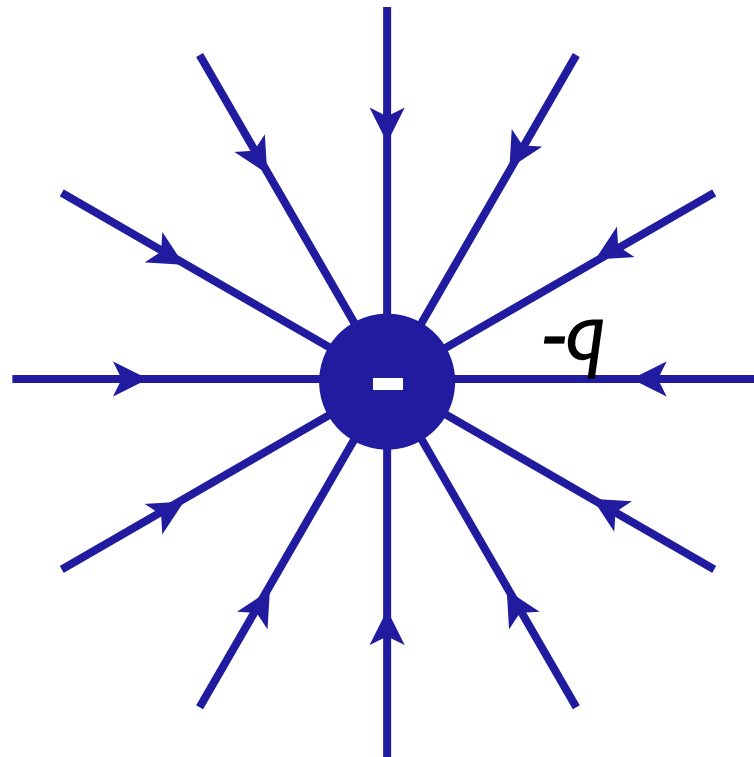
$\sim 0.77 \text{ m}$ from q_2

or

$\sim 1.23 \text{ m}$ from q_1

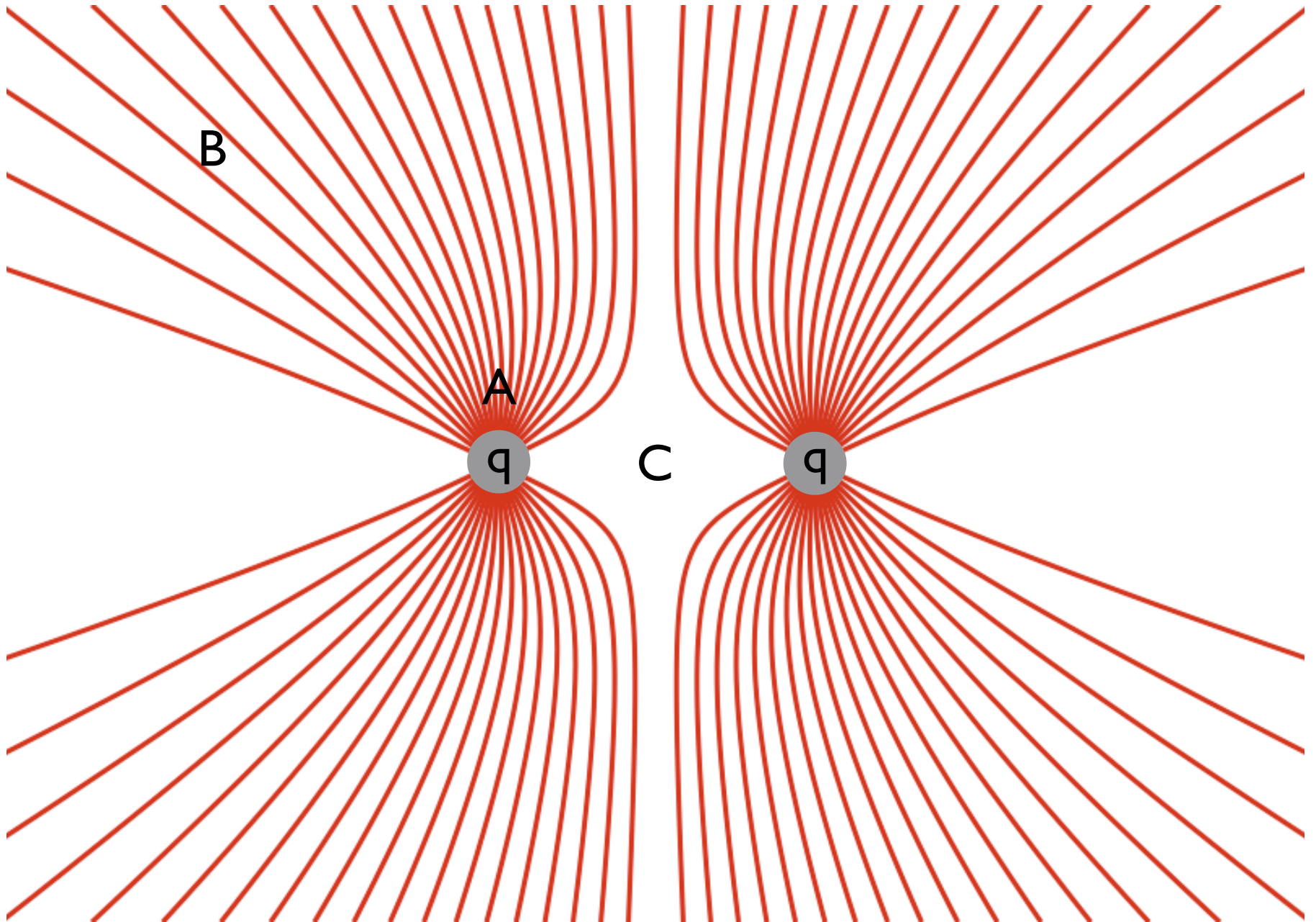


(a)

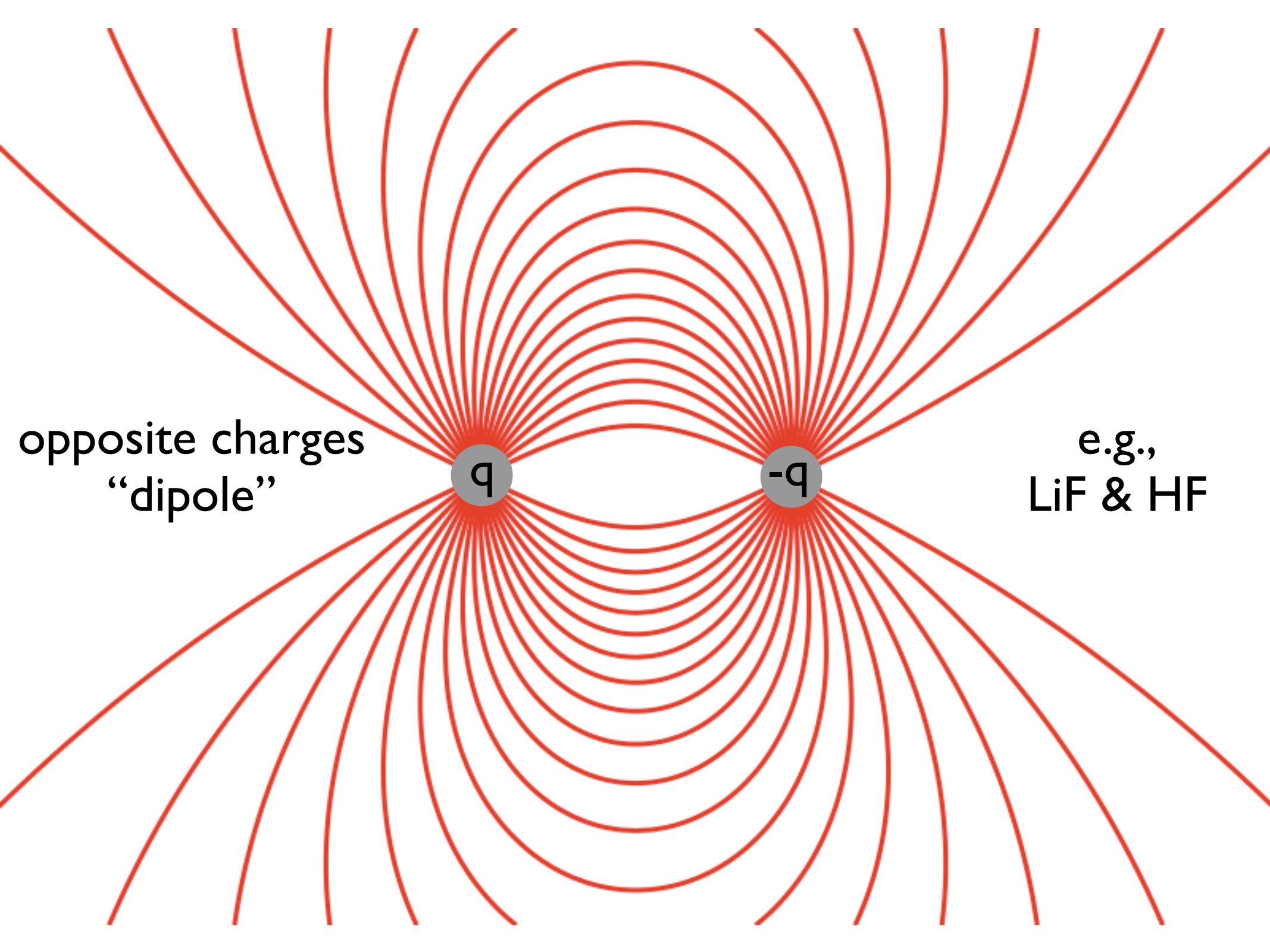


(b)

equal charges

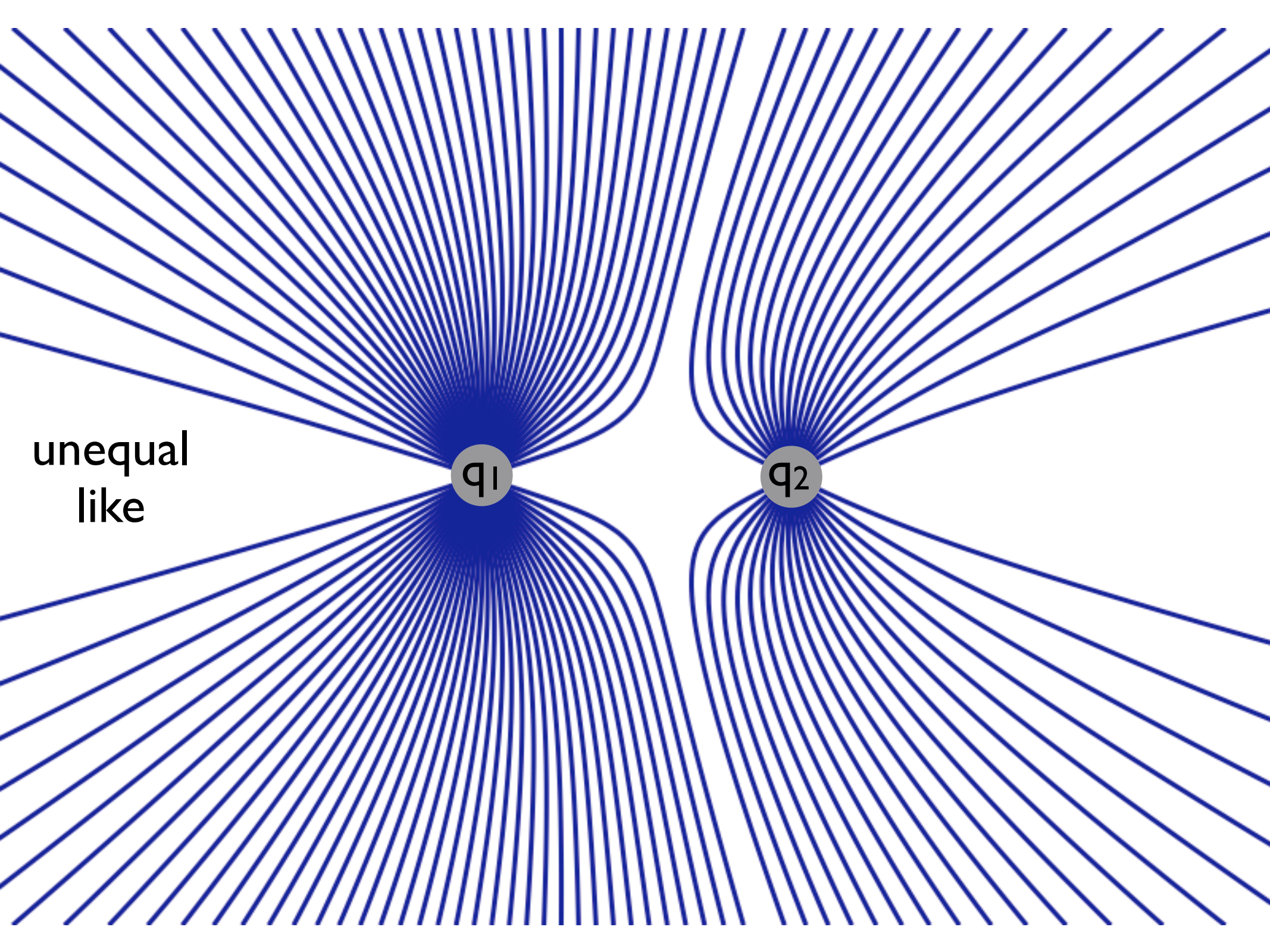


field: $A > B > C$



opposite charges
“dipole”

e.g.,
LiF & HF

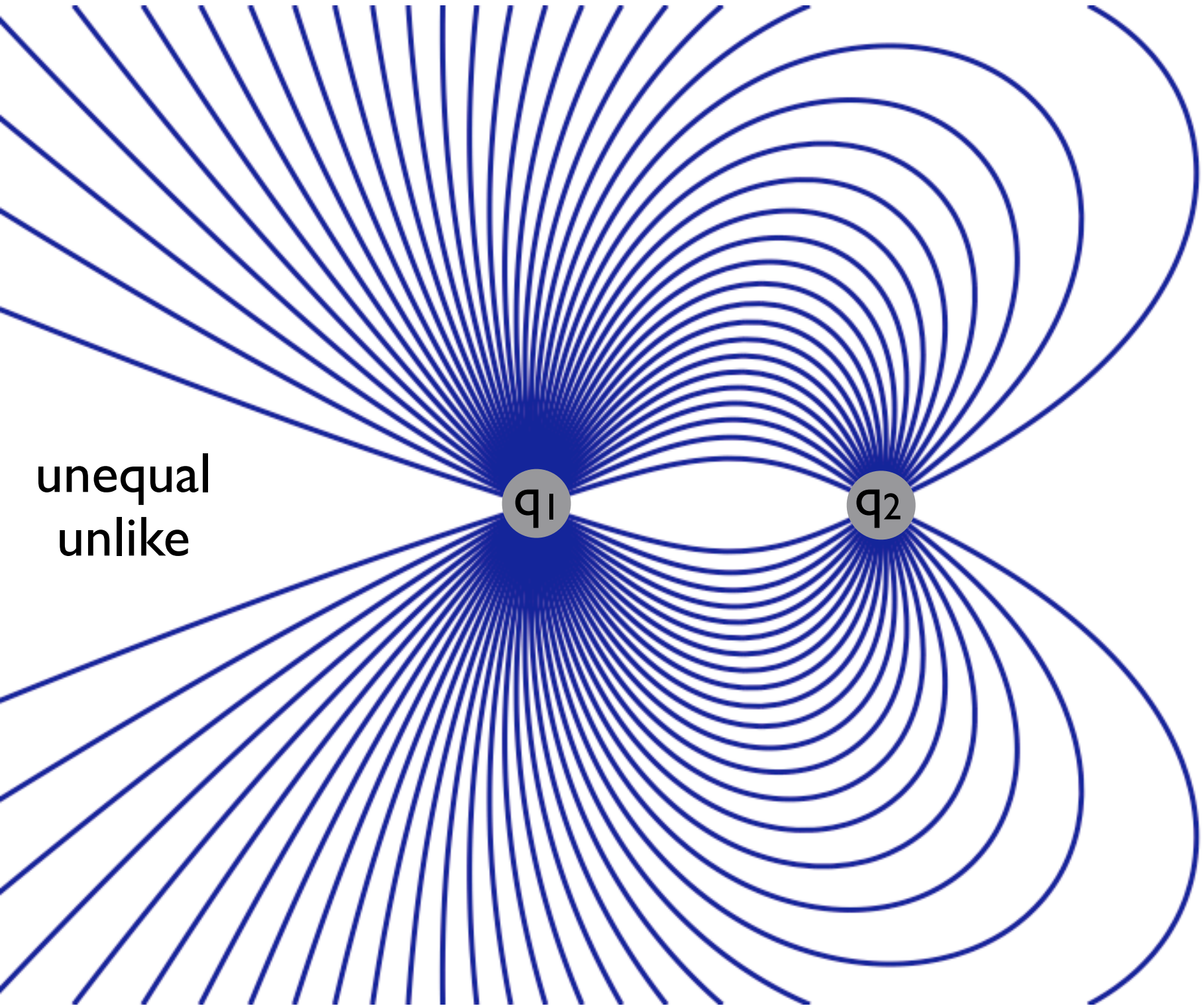


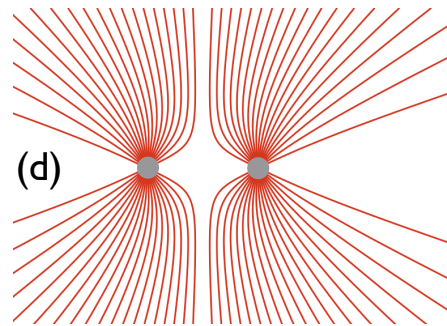
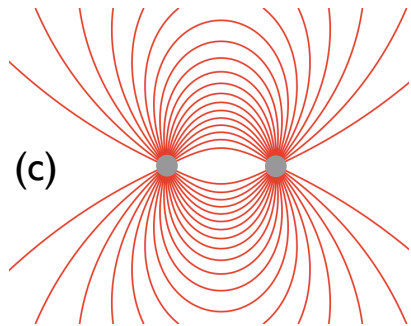
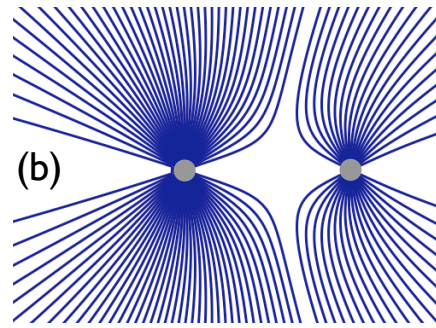
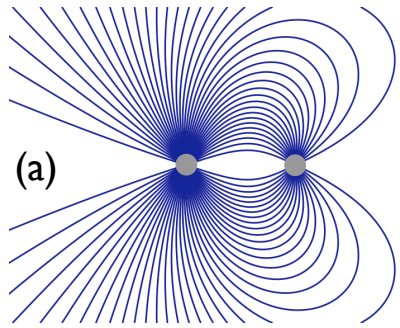
unequal
like

q_1

q_2

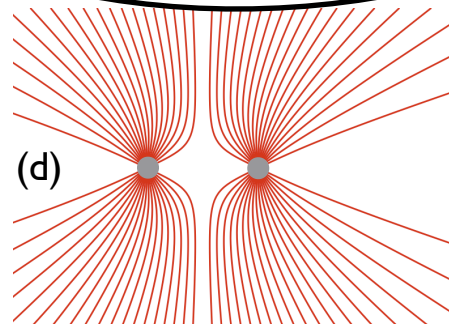
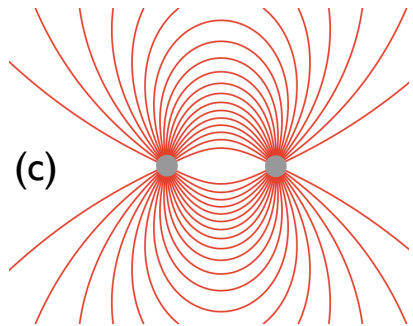
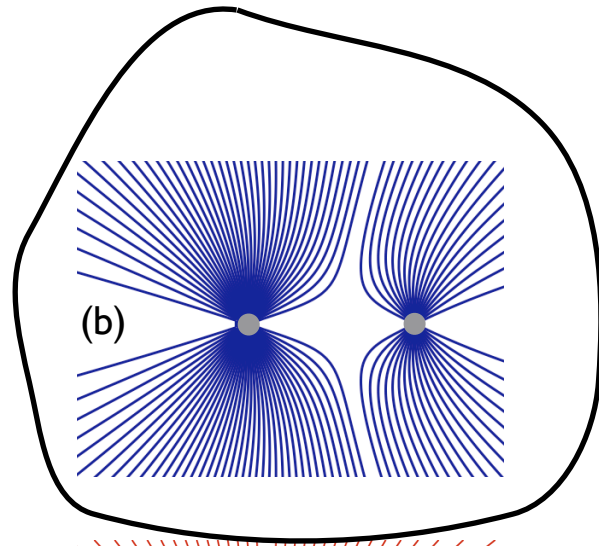
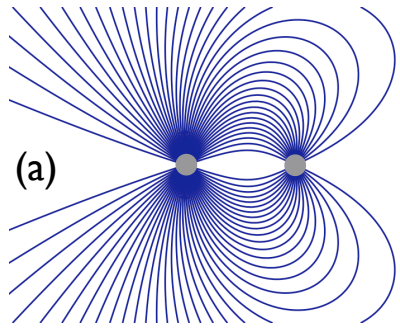
unequal
unlike





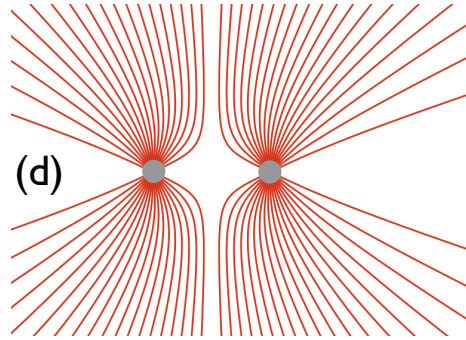
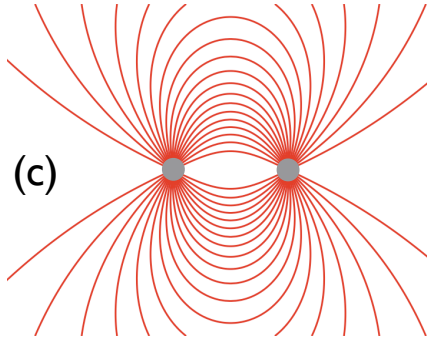
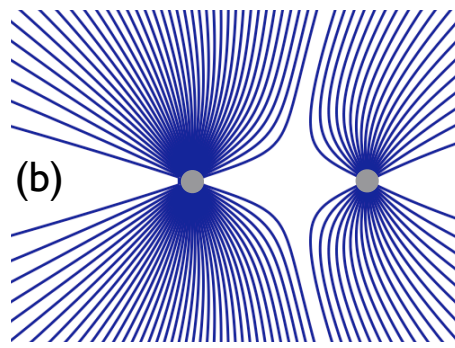
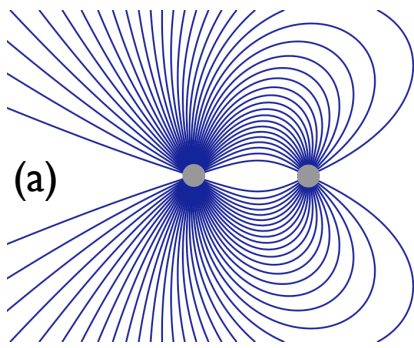
9. Which set of electric field lines could represent the electric field near two charges of the same sign, but *different magnitudes*?

- a
- b
- c
- d



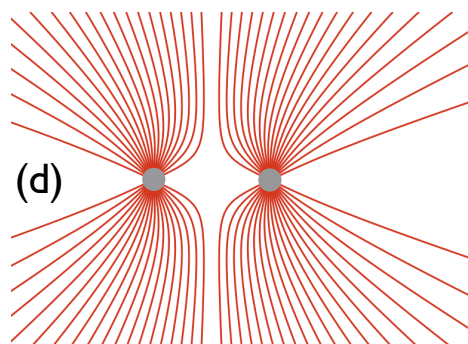
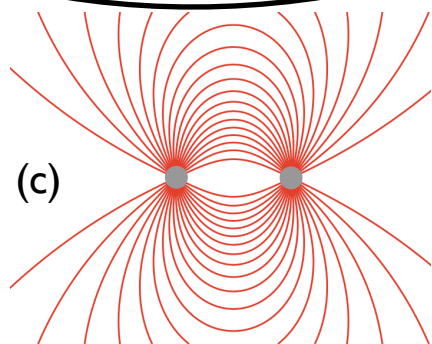
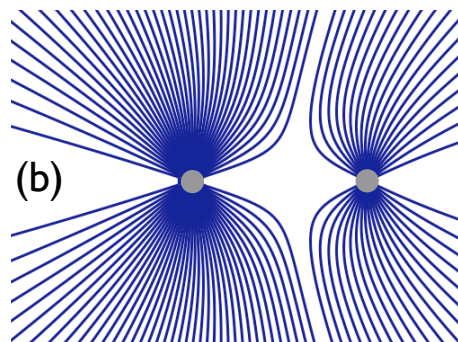
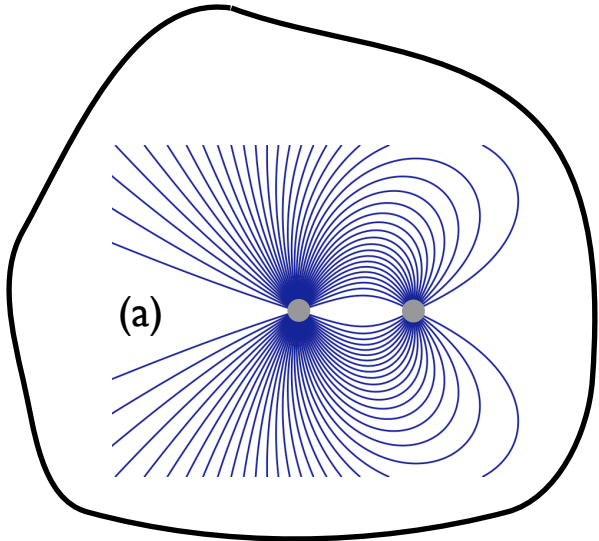
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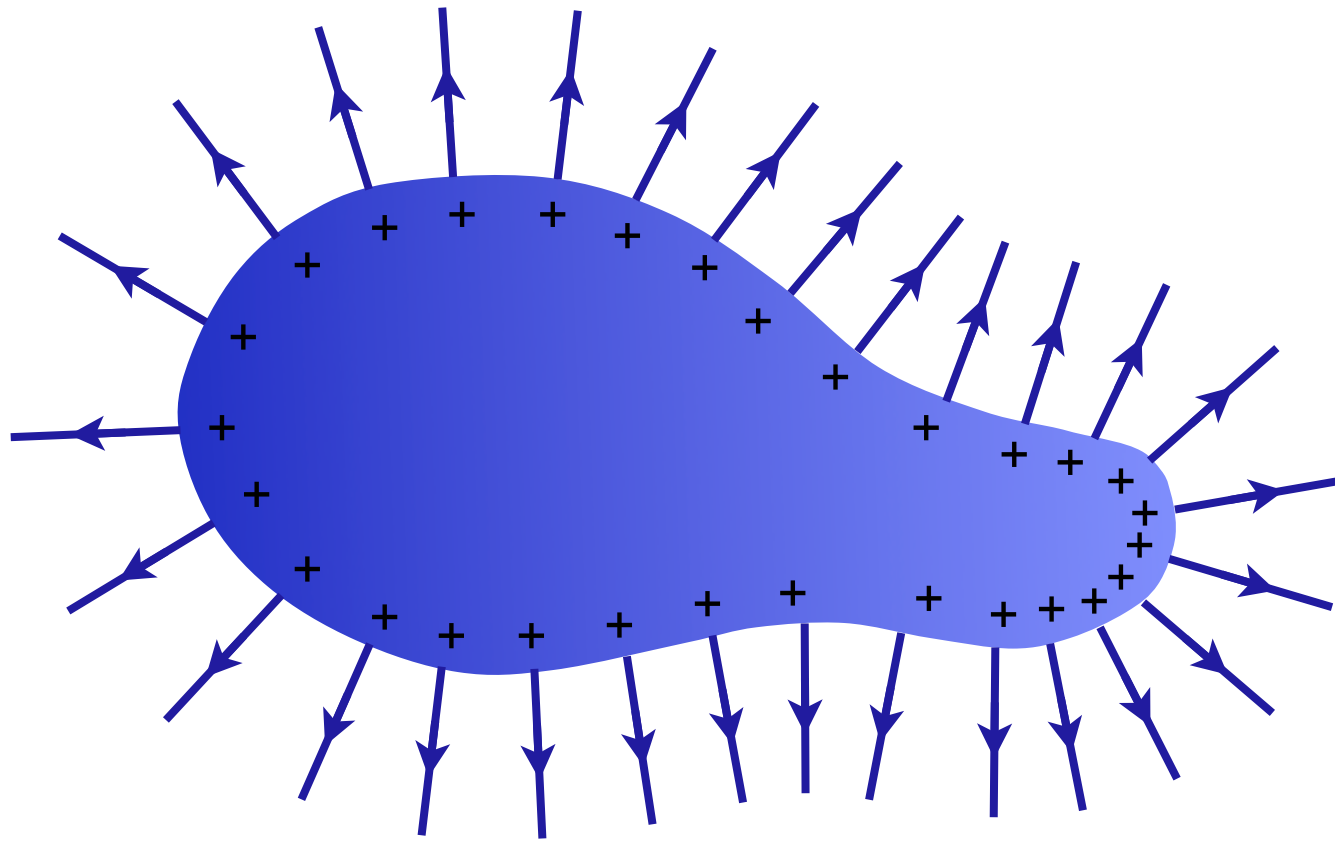
10. Referring again to the figure above, which set of electric field lines could represent the electric field near two charges of *opposite sign* and *different magnitudes*?

- a
- b
- c
- d

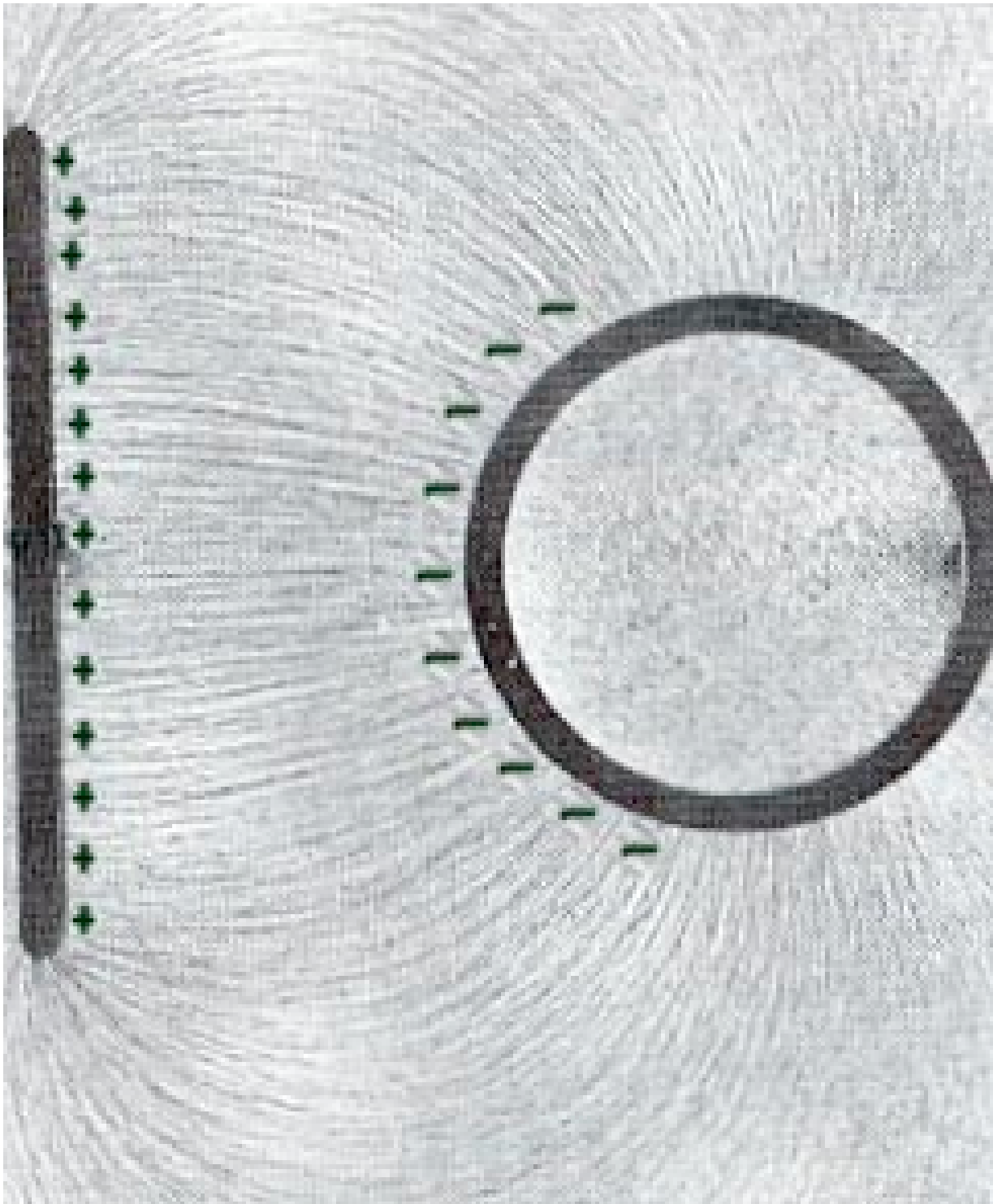


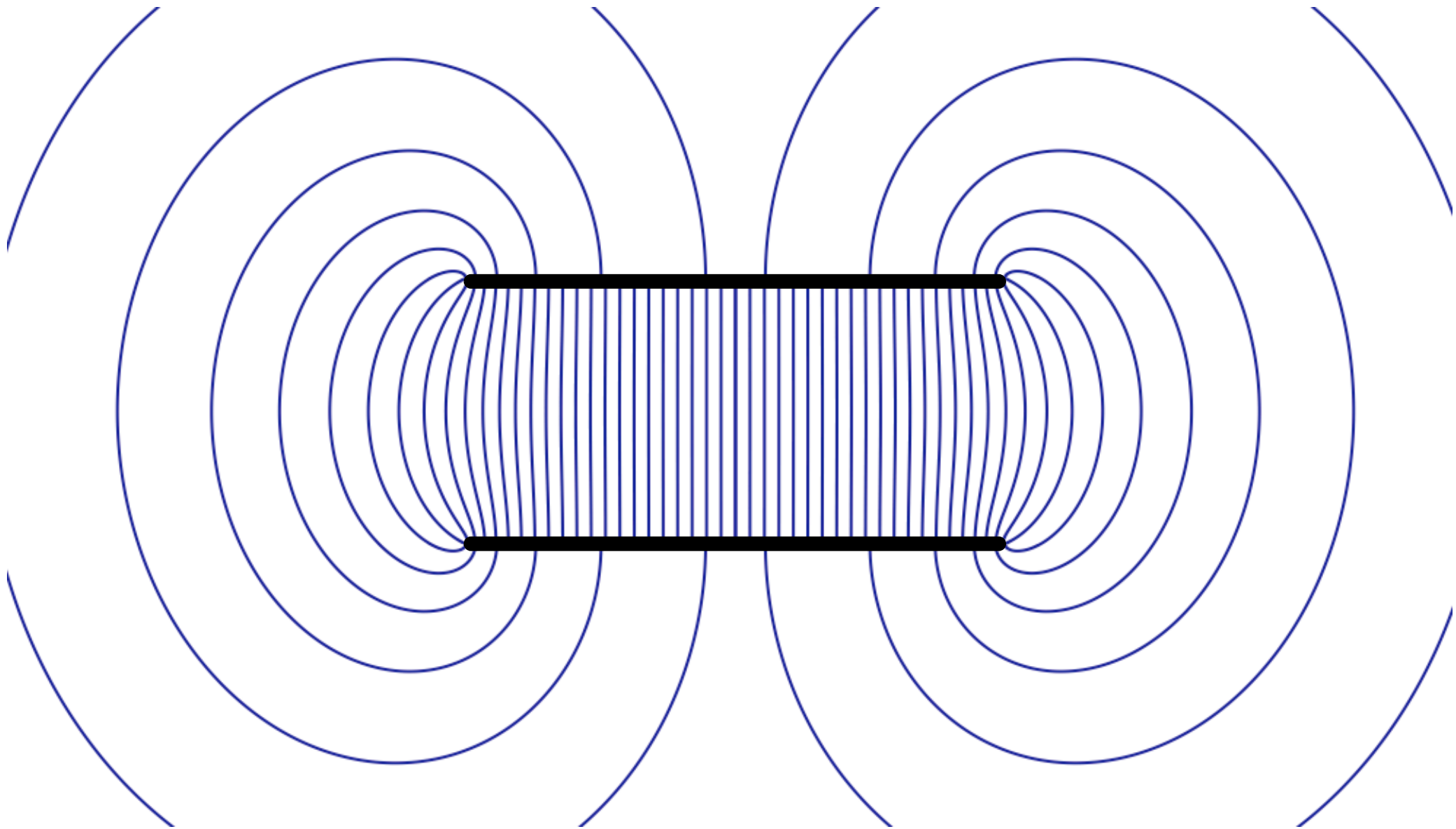
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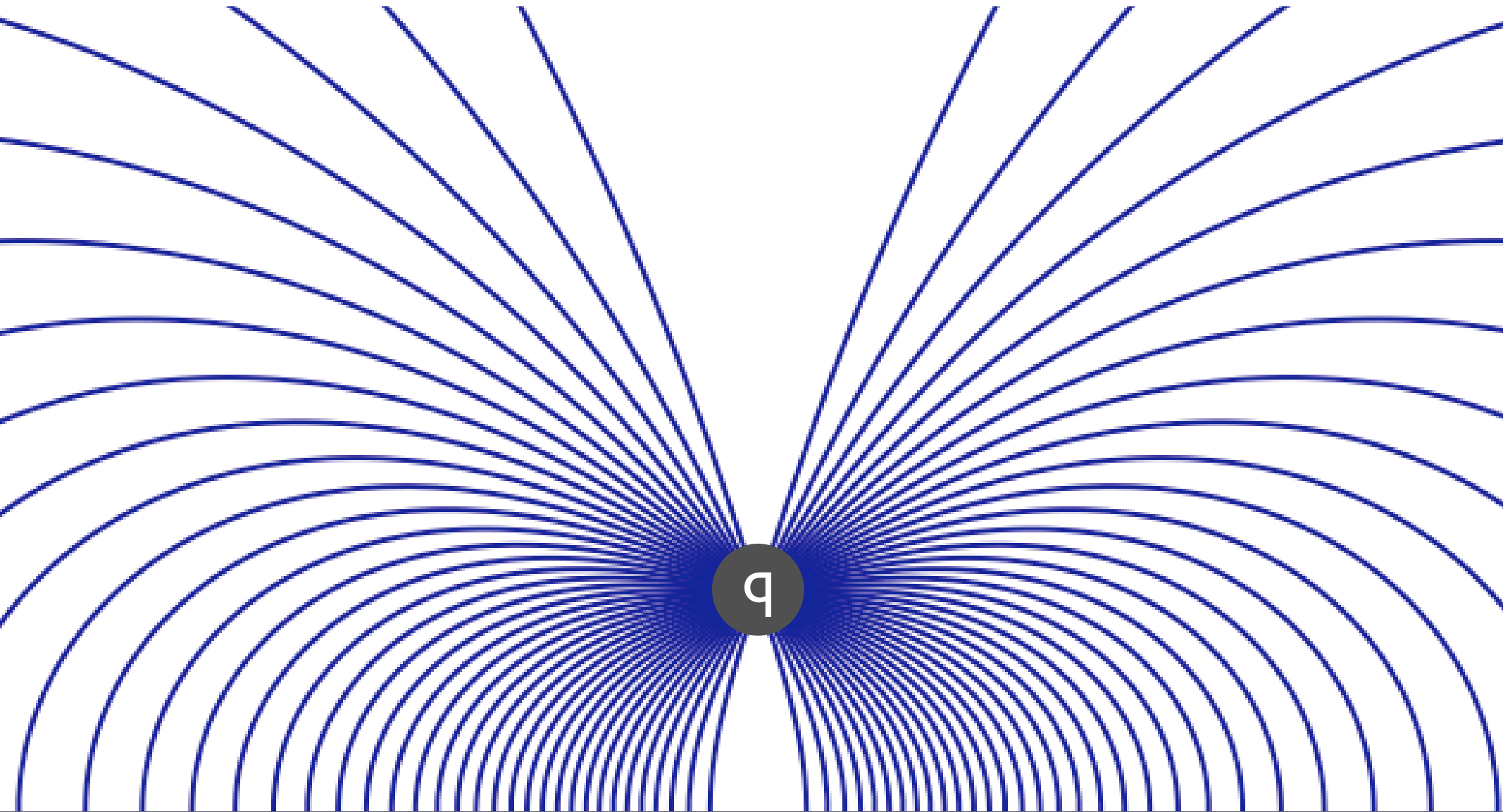
- a
- b
- c
- d

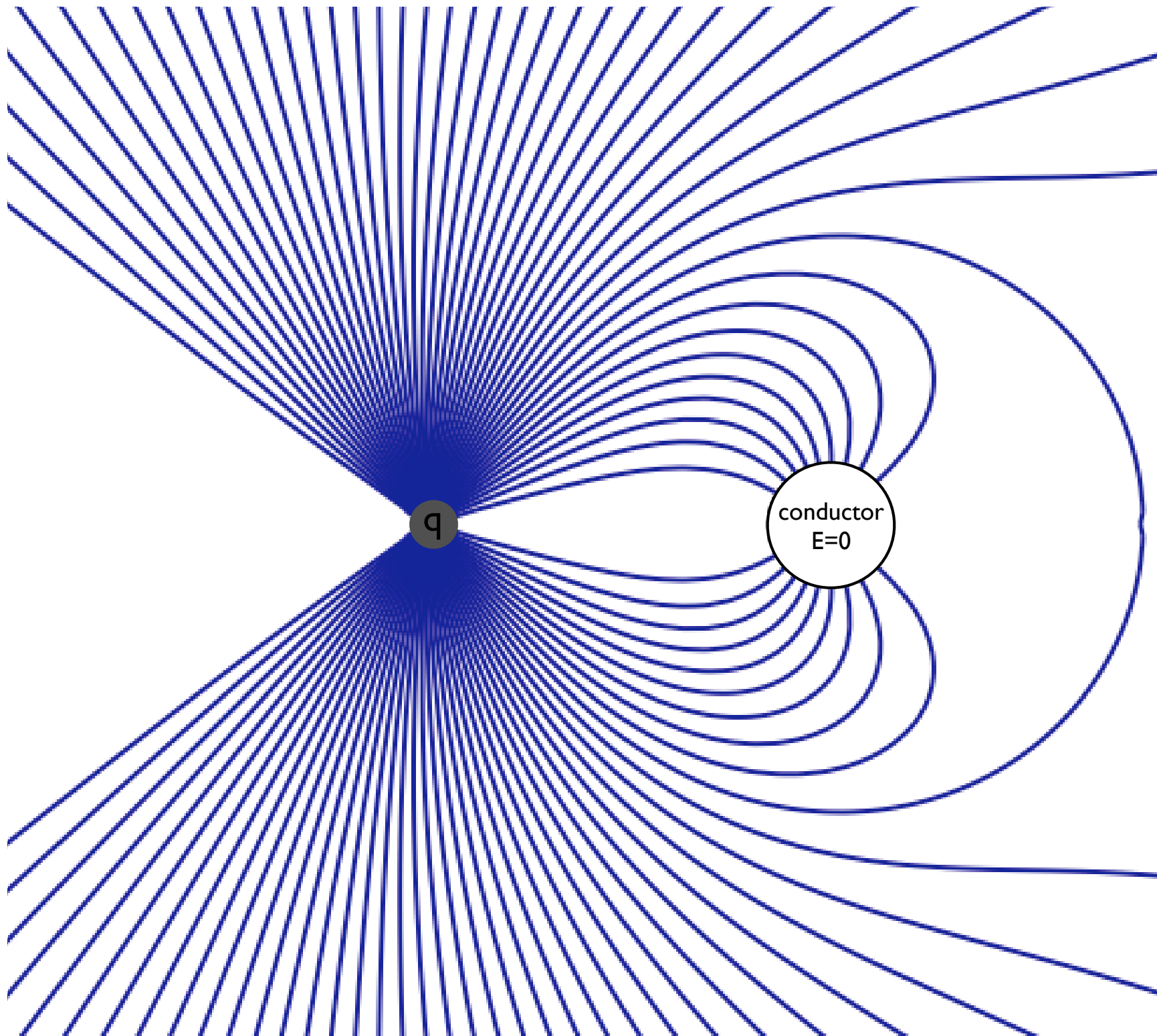


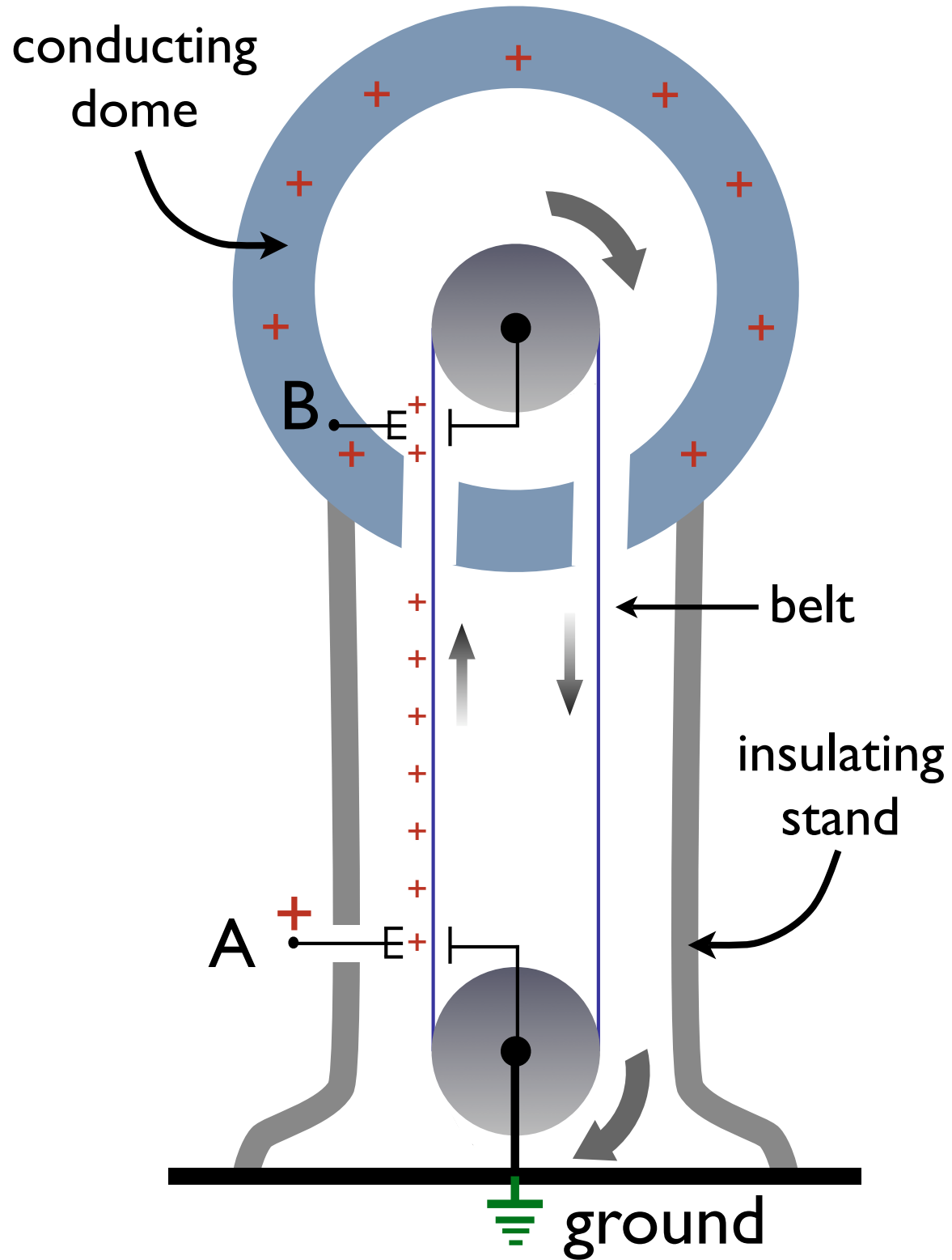
amoeba conductor

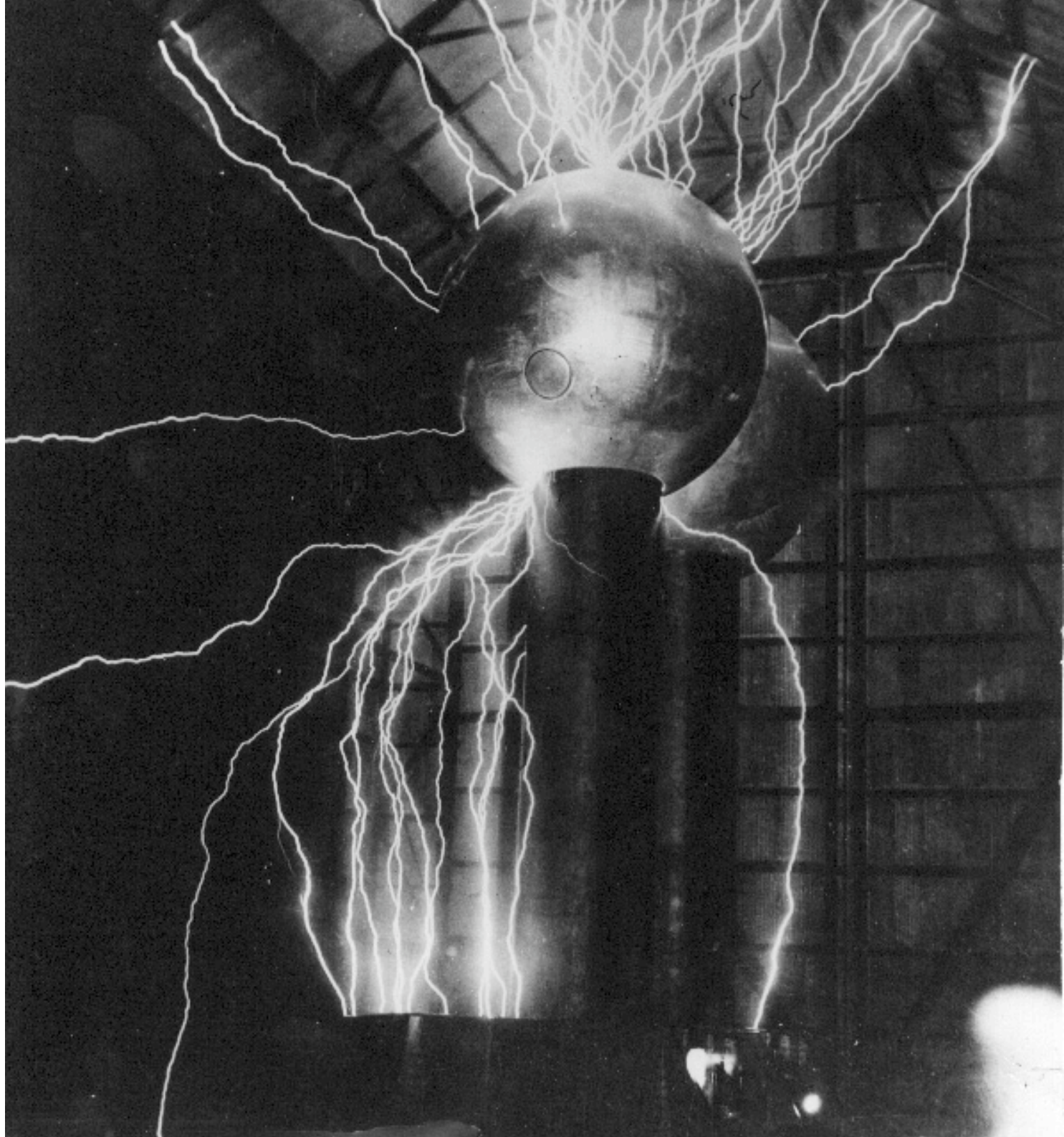




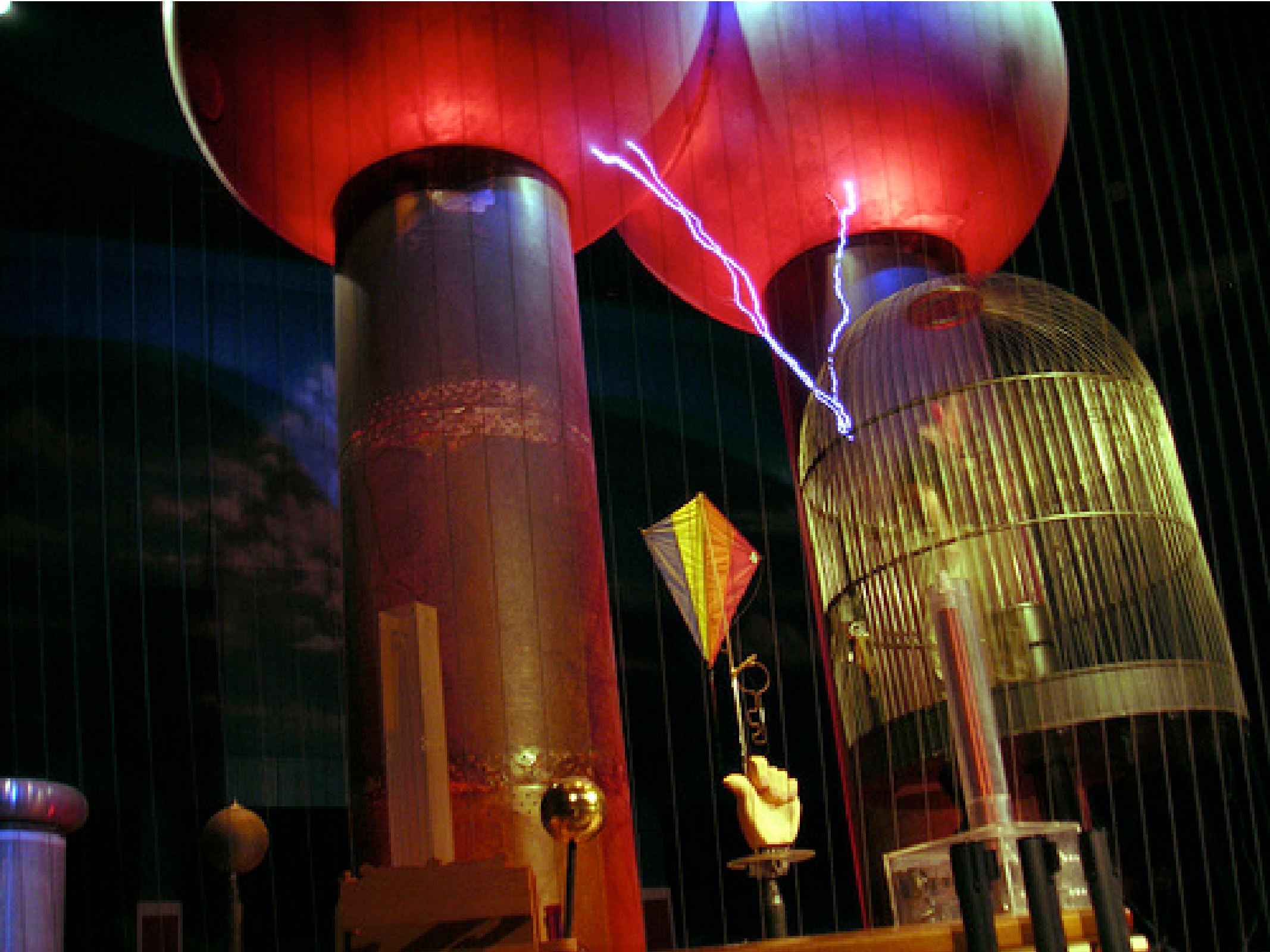


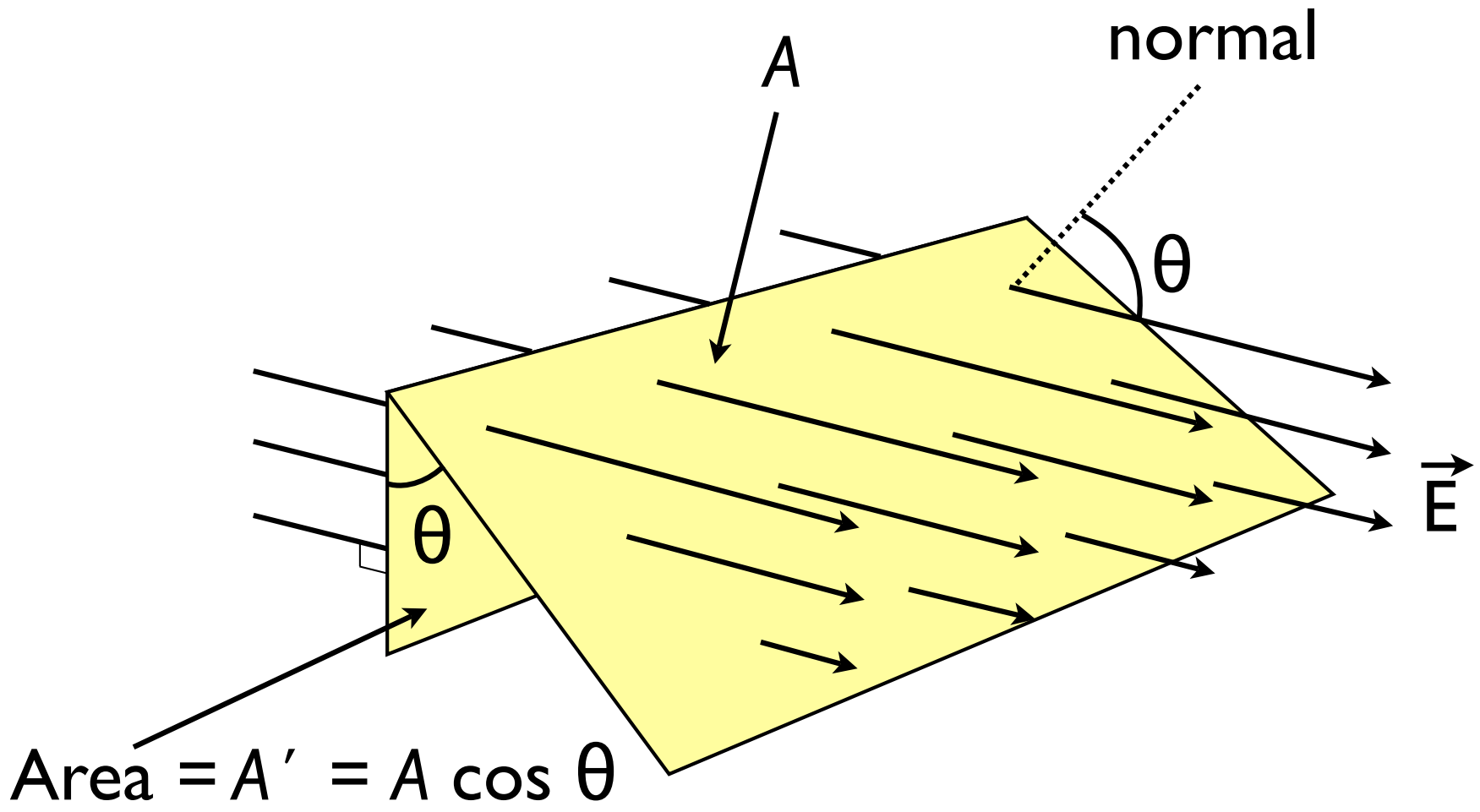






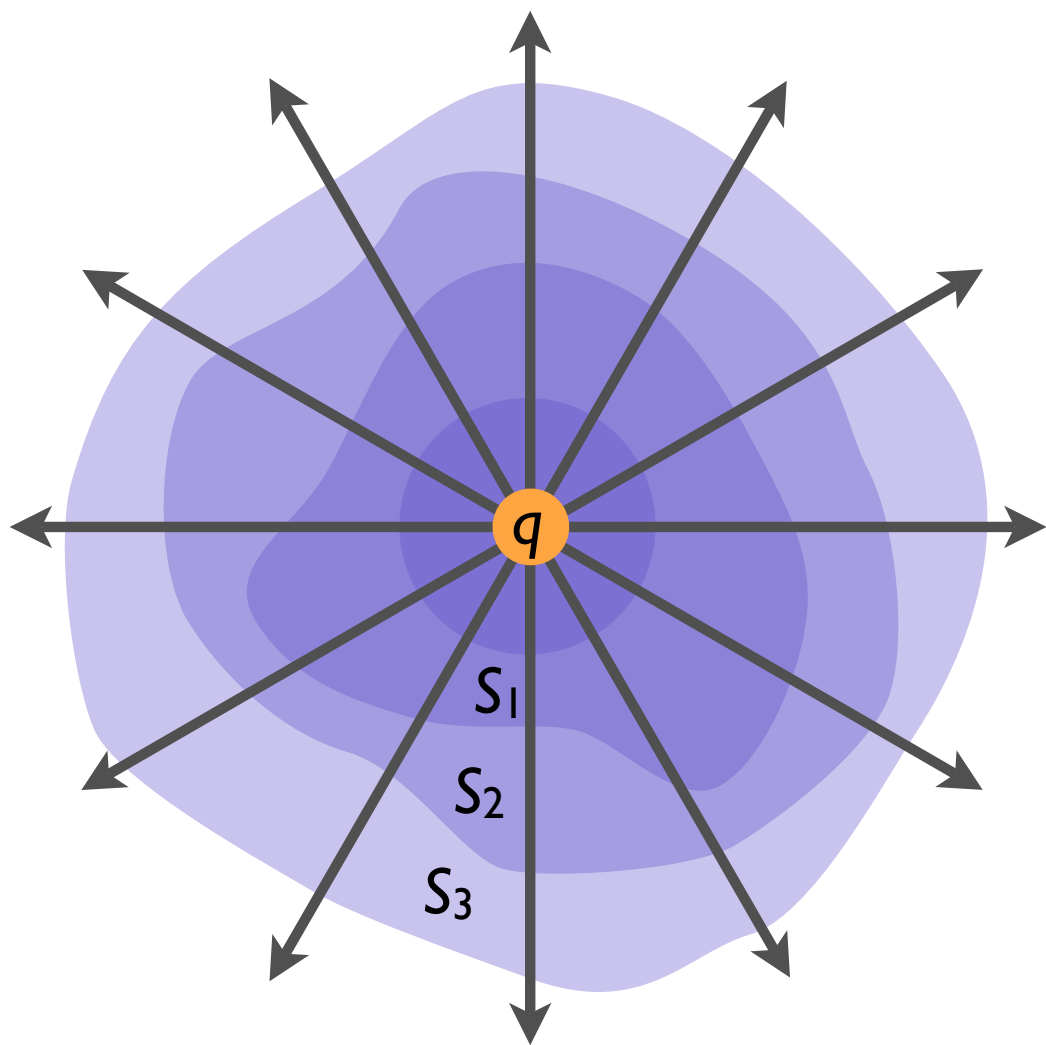




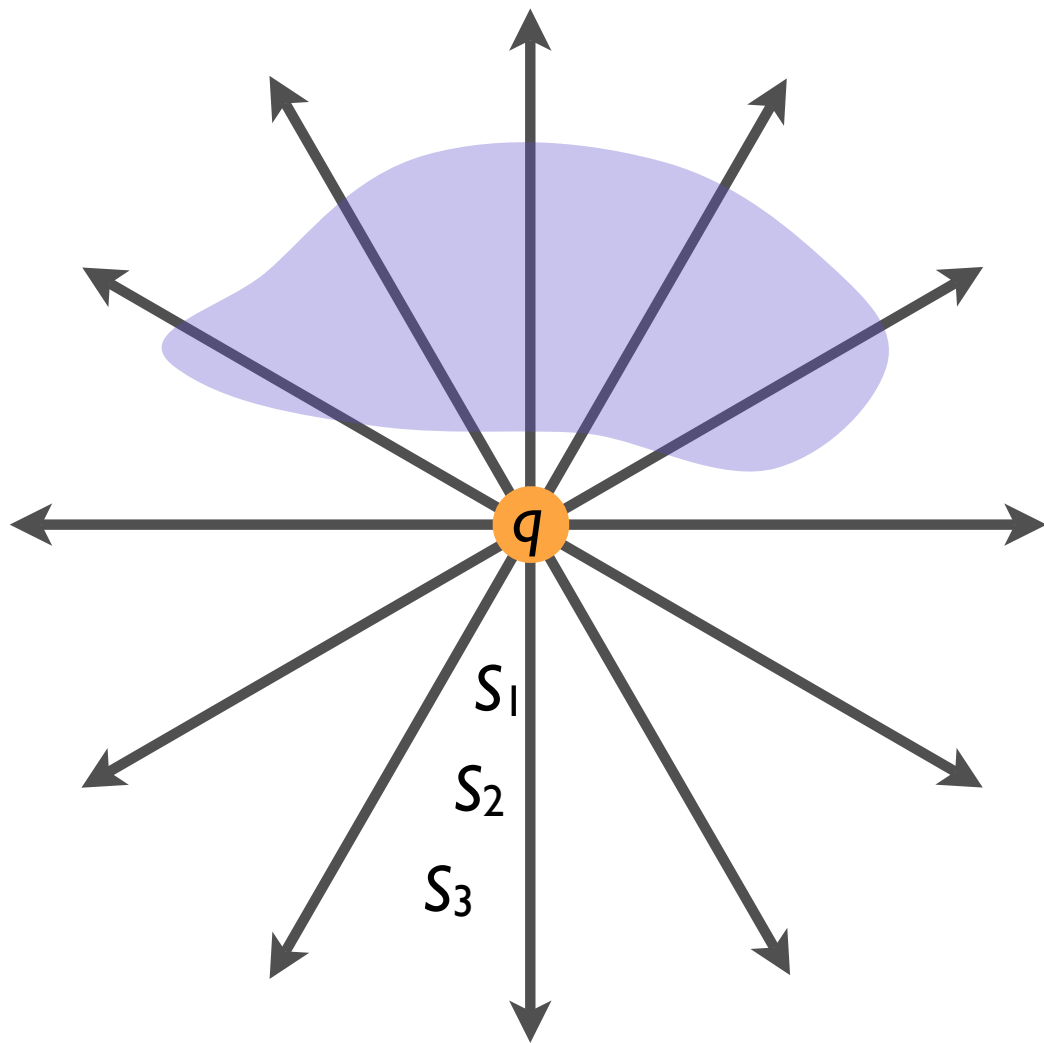


both surfaces have the same flux!

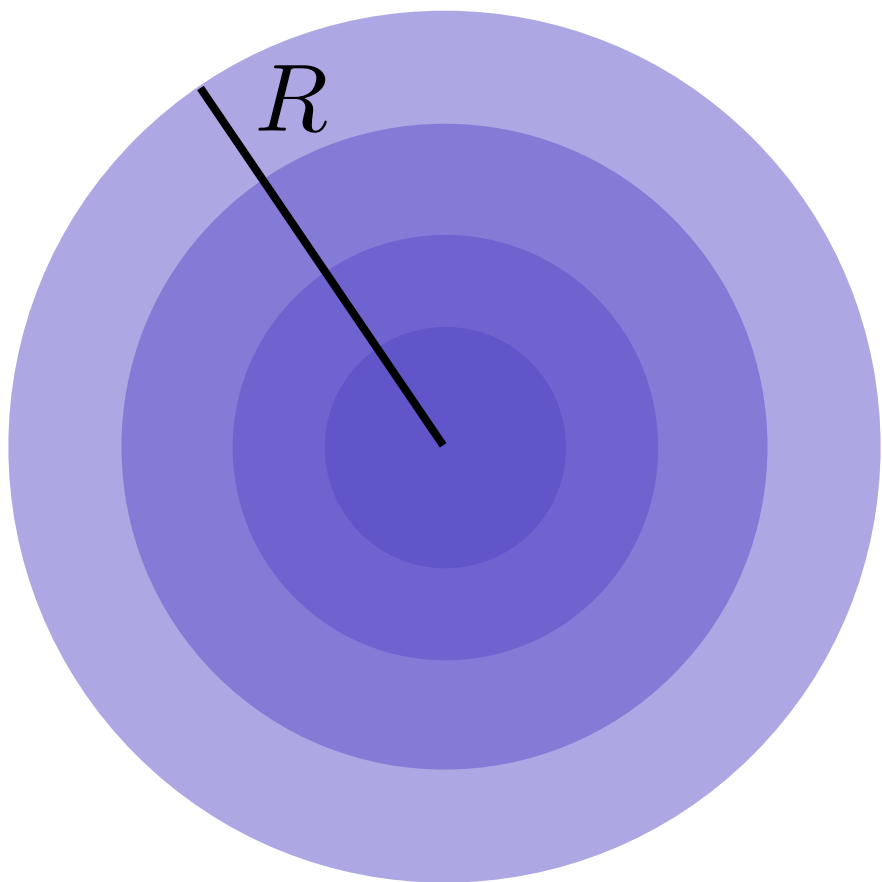
(a)



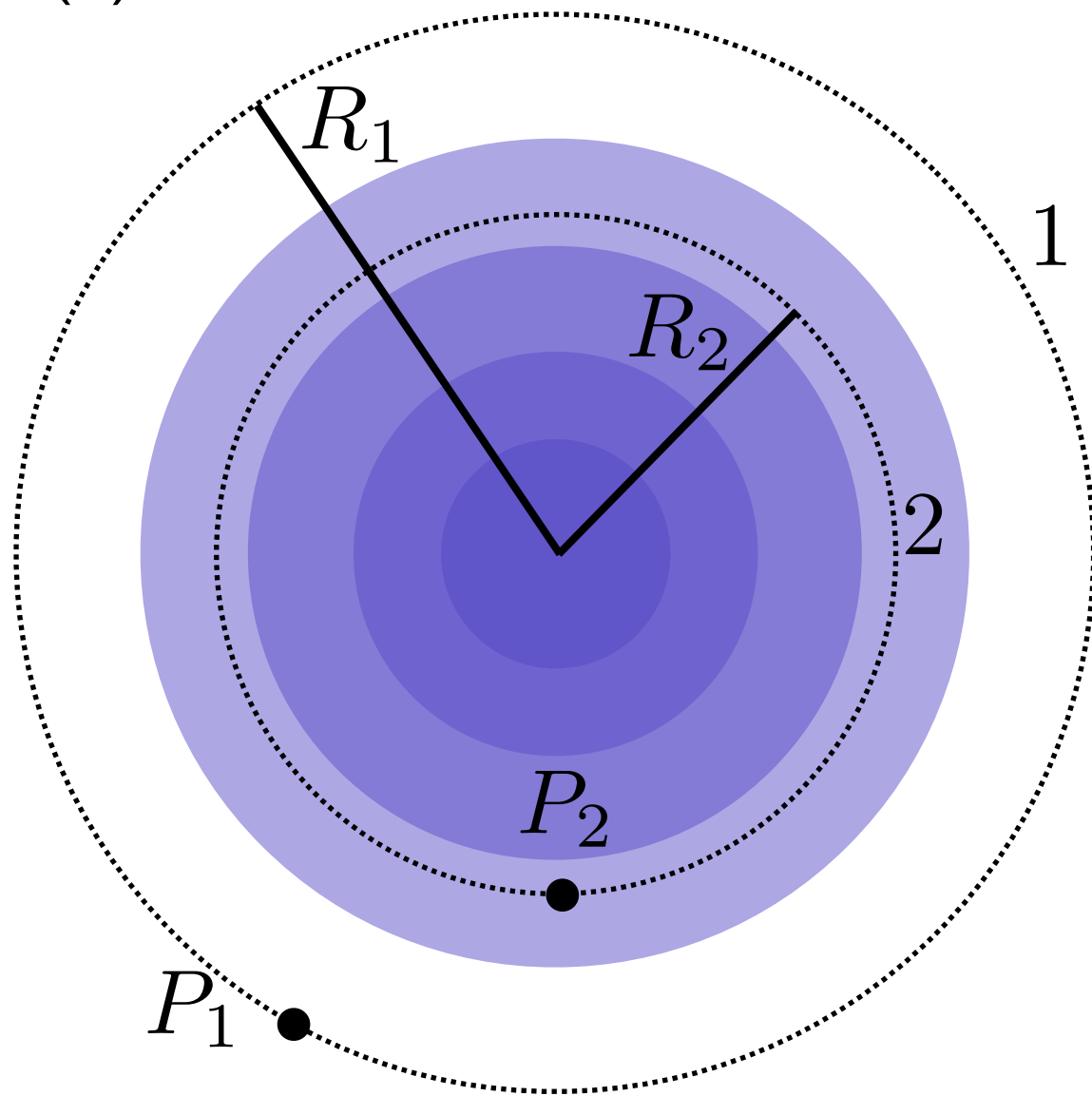
(b)



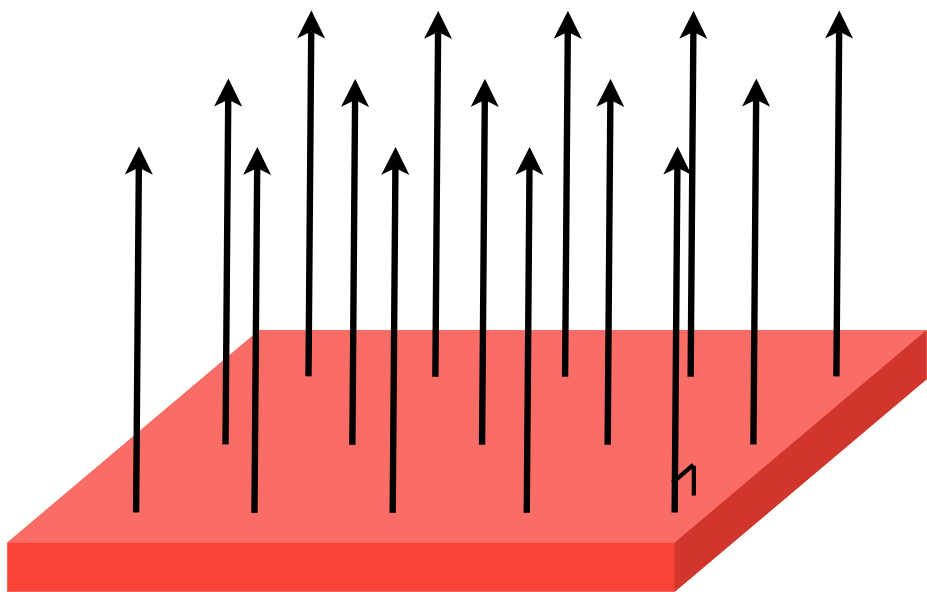
(a)



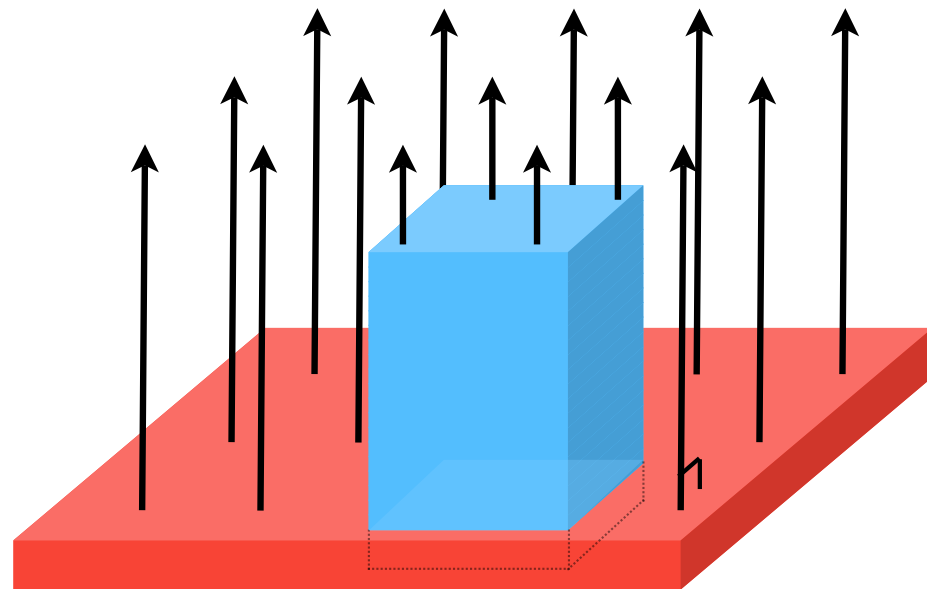
(b)



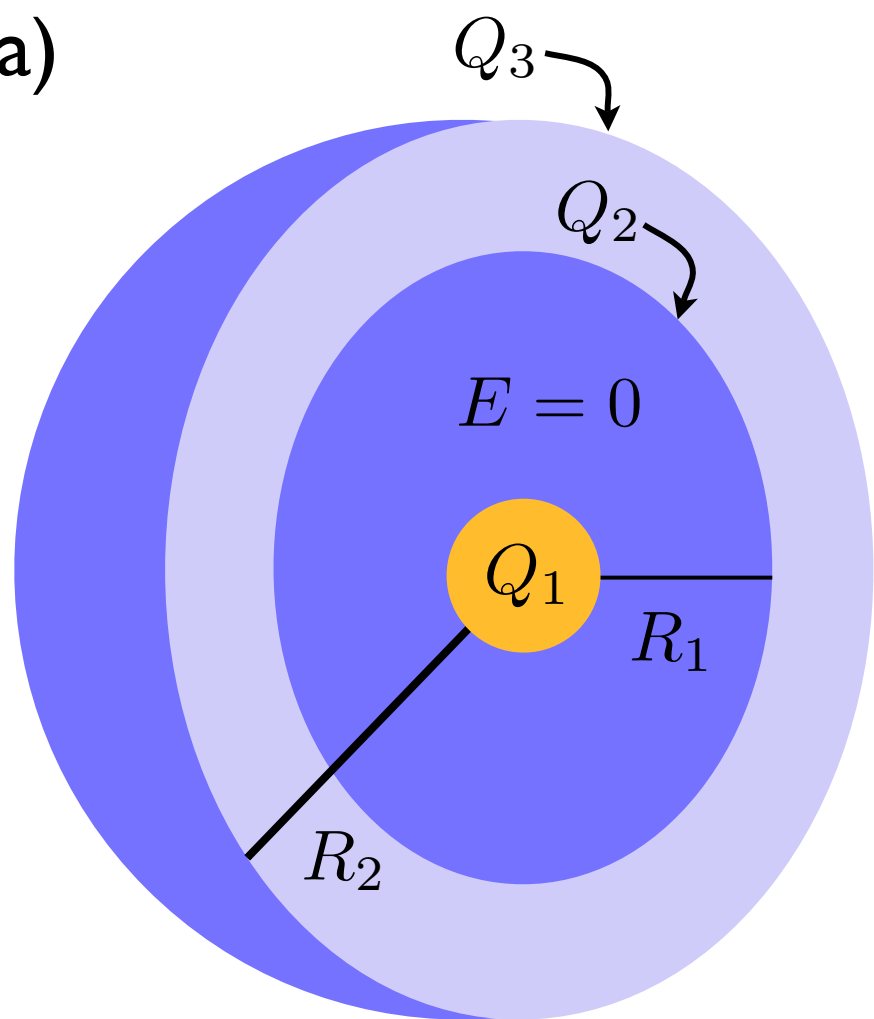
(a)



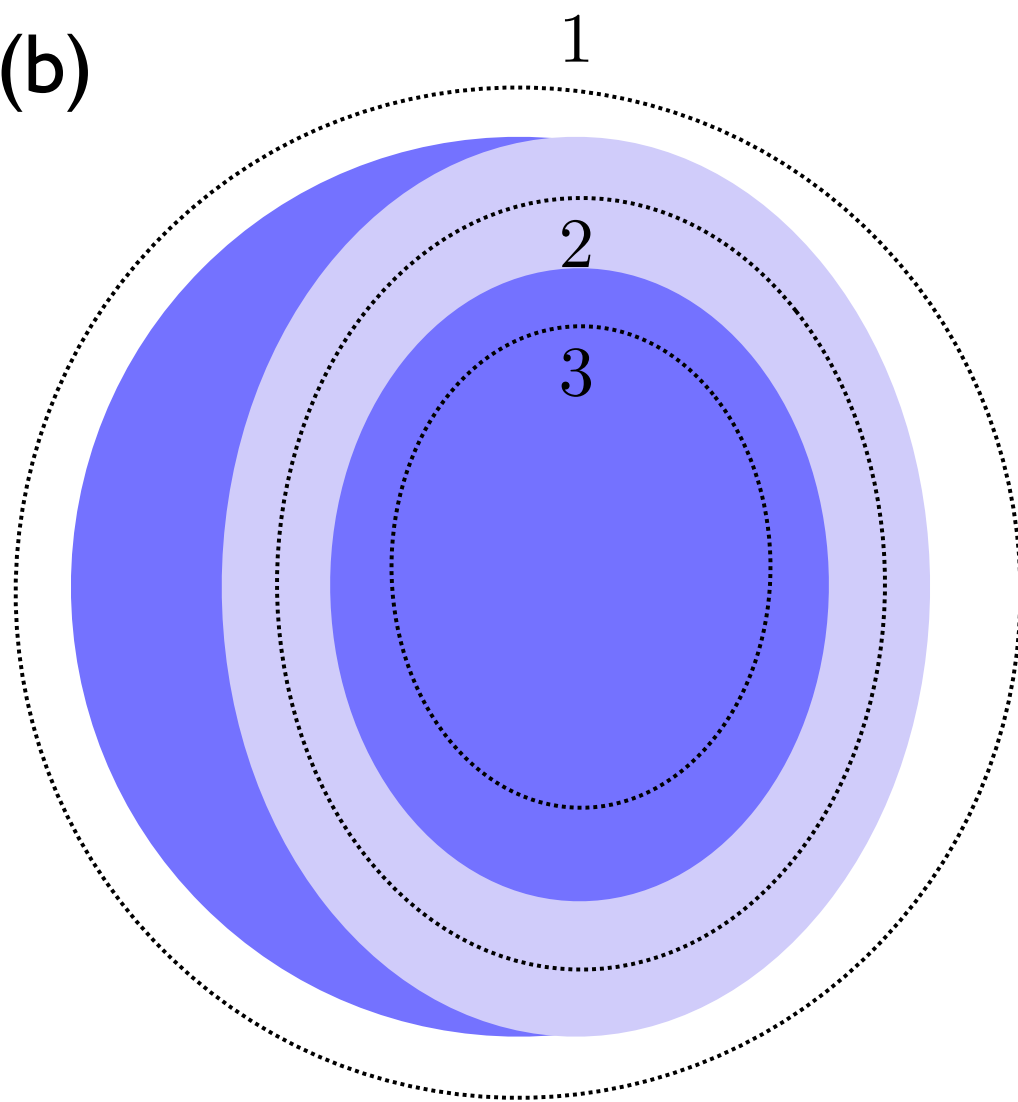
(b)



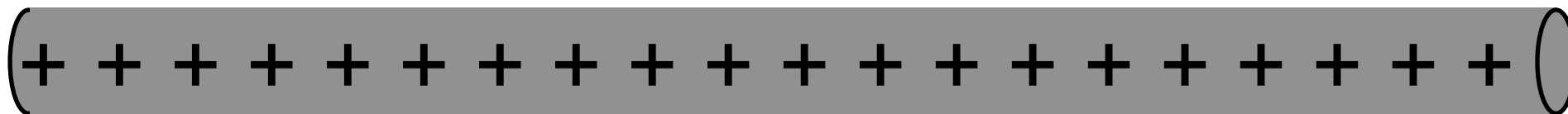
(a)



(b)



(a)



(b)

