

Name: \_\_\_\_\_

DISC: \_\_\_\_\_

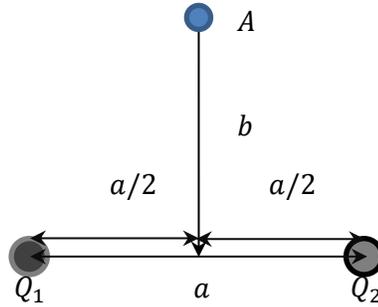
Score: \_\_\_\_ / 20

Instructions:

- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers

Q1	Q2	Q3	Q4
10	10	5	5

1. Consider the following situation ( $Q_1, Q_2$  are fixed):



$a$	$b$	$Q_1$	$Q_2$	$k$	ELECTRIC FIELD	FORCE
$4\text{ m}$	$2\text{ m}$	$+5.0\ \mu\text{C}$	$-2.5\ \mu\text{C}$	$9 \times 10^9\text{ N m}^2/\text{C}^2$	$E(r) = \frac{kq}{r^2}$	$F(r) = \frac{kq_1q_2}{r^2} = qE(r)$

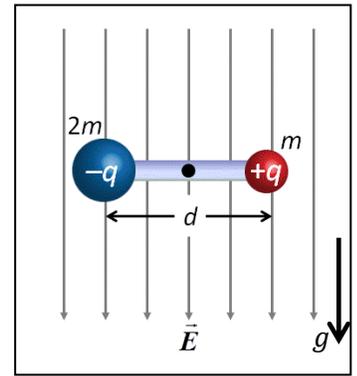
a. Using the information in the table, find the electric field (magnitude and direction) at point A.

Potential (5 pts):

b. What force (magnitude and direction) would a charge  $q = 1.5\ \mu\text{C}$  experience at point A?

Work (5 pts):

2. An electric dipole sits perpendicular to an downward-directed electric field, as shown. Gravity also acts downward on the dipole as shown in the diagram. The dipole can rotate about a frictionless axis located a distance  $d/2$  from each charge.
- a. What is the electric dipole moment  $\vec{p}$  of this dipole? Does it depend on the mass of the charges?



Dipole moment (1 pts):  
Mass dependence (1pt.):

- b. Using the information in the table, find the torque on the dipole due only to the electric field.

Mechanical Torque	$\tau_M = rF \sin \theta$
Electric Dipole Torque due to Field	$\tau_d = pE \sin \theta$
Charge $ q $	$4 \mu C$
Separation Distance $d$	$0.5 \text{ cm}$
Electric Field $E$	$1200 \text{ N/C}$
Mass $m$	$5 \text{ g}$

Dipole Torque (2 pts):

- c. Find the mechanical torque on this dipole due to gravity alone.

Dipole Torque (2 pts):

- d. Does the dipole rotate in this electric field? What field strength would be required to prevent the rotation? (use page 3 to show your work—make sure your answer is clear).

Rotate (1 pts):  
New Field (3 pts):

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