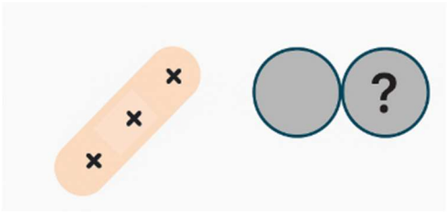
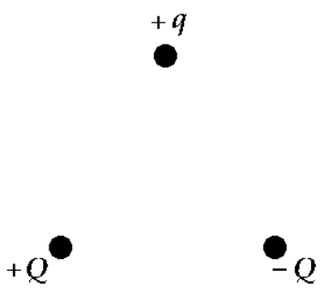
1. Two conductive spheres are touching each other. A **positively charged** plastic rod approaches the spheres without touching them. In this situation, the net charge on the **right** sphere is _____. Circle the best response.



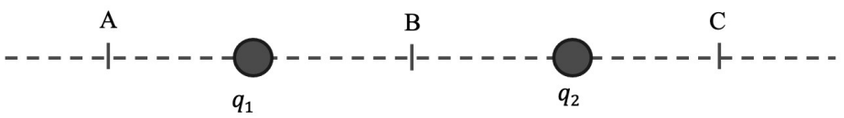
A. Zero
B. Positive
C. Negative
D. Either positive or negative.

2. Three point charges are located at the vertices of an **equilateral** triangle. In which quadrant is the **net force** exerted on $-Q$? Circle the best response



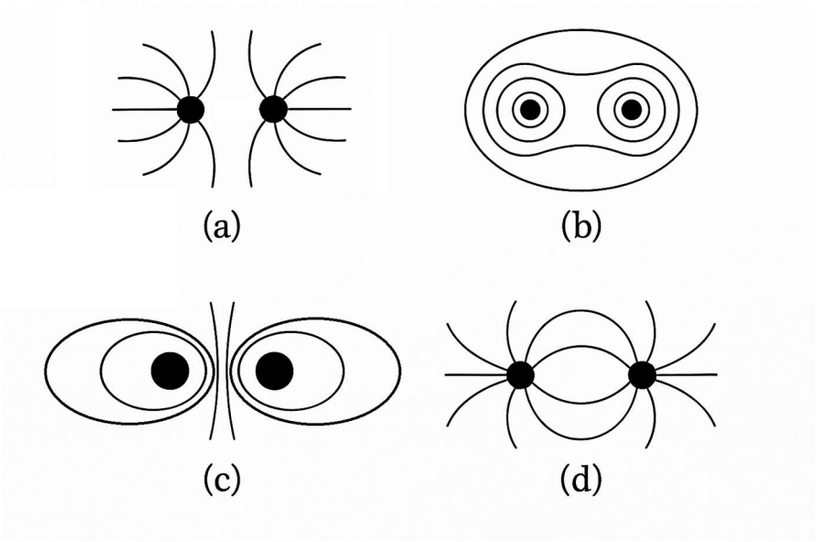
A. Quadrant I
B. Quadrant II
C. Quadrant III
D. Quadrant IV

3. Two charges of equal magnitude and sign, $q_1 = q_2$, are placed at a certain distance from each other. In which region(s) could the **electric field produced by the two charges be equal to zero?** Circle the best response(s).



A. A
B. B
C. C
D. The field is never zero except at infinity.

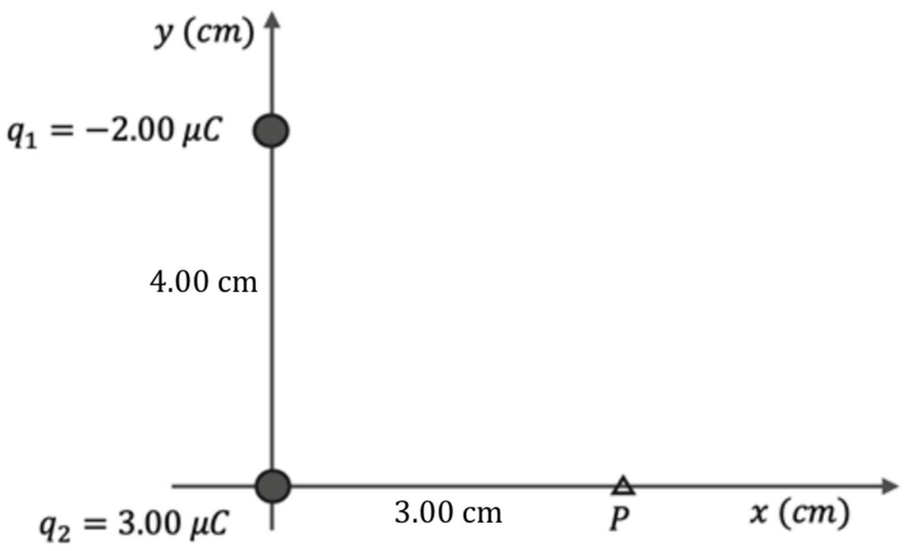
The following situation applies to the next two questions (4 & 5): Two charges of **equal magnitude** but **opposite sign**, $q_1 = -q_2$, are separated by a certain distance.



4. Which figure represents the electric **field** produced by these charges? **Answer:** ___

5. Which figure represents the **equipotential lines** produced by these charges? **Answer:** ___

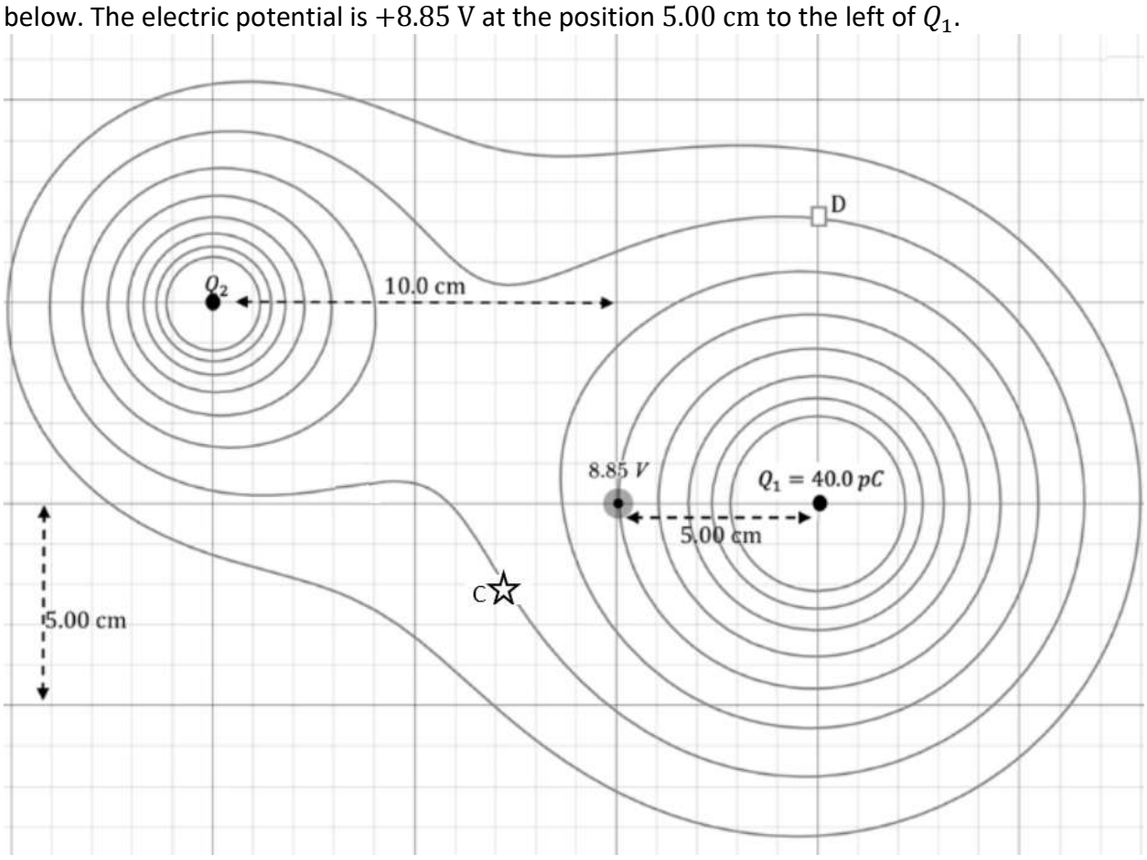
6. Two point charges $q_1 = -2.00\ \mu\text{C}$ and $q_2 = 3.00\ \mu\text{C}$ have this configuration:



   A. What is the electric field (magnitude and direction) at point P ?

   B. A third charge $q_3 = 5.00\ \mu\text{C}$ with a mass $m = 1.50 \times 10^{-9}\ \text{kg}$ is positioned at point P and then released. Determine its velocity when it is located at infinity.

7. A known charge $Q_1 = 40.0$ pC and an unknown charge Q_2 are placed as shown in the figure below. The electric potential is $+8.85$ V at the position 5.00 cm to the left of Q_1.



A. Determine the **magnitude** and **sign** of Q_2.

B. Draw at least 8 **electric field lines** for this set of charges.

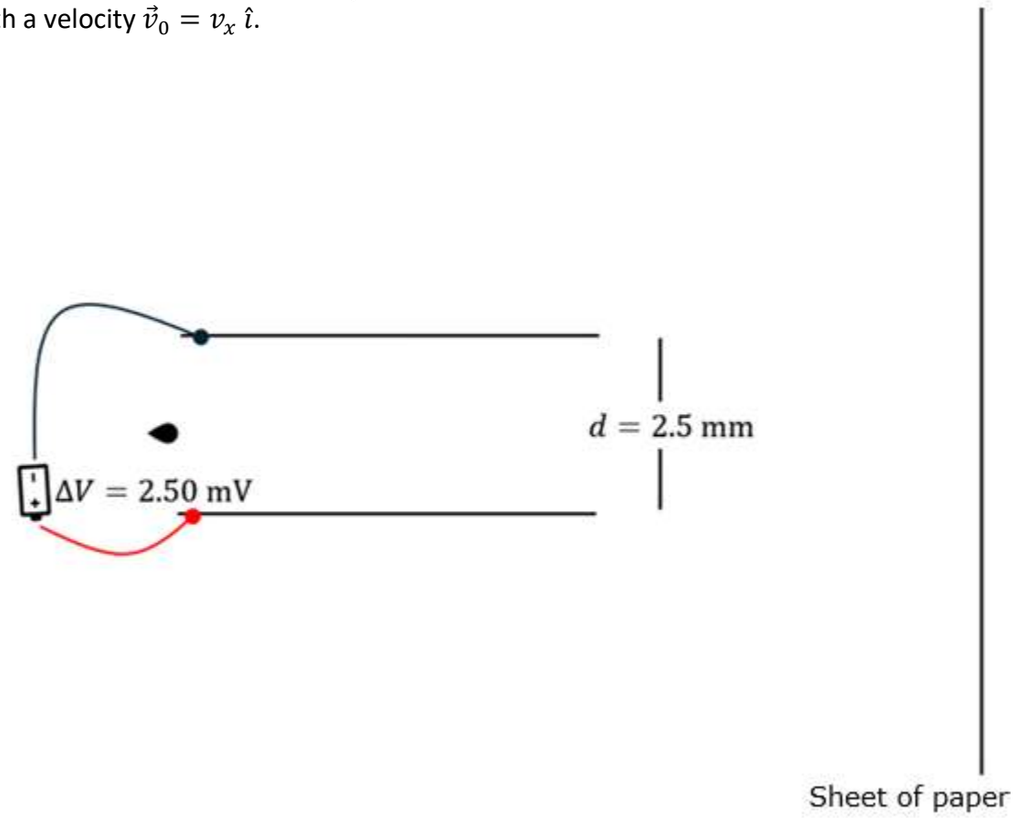
C. A negative charge is placed at position C, marked by a star. On the figure, indicate the direction of the **force** that would act on this charge.

D. **Label the following 3 statements as true (T) or false (F),** corresponding to what will happen to the system as the negative charge moves from position C to D.

____ The electric potential energy increases.
____ The kinetic energy increases.
____ The energy doesn't change.

E. On the figure, indicate where the **net electric field is zero by marking it with an X.** If there is no other place than infinity, put an X in this blank____. To receive marks for this question, you must also explain your reasoning below.

8. In inkjet printers, charged droplets of ink are deflected between two parallel plates where there is a uniform electric field $\vec{E} = E_y\hat{j}$. A droplet with mass m and charge $+q$ enters the field with a velocity $\vec{v}_0 = v_x\,\hat{\imath}$.



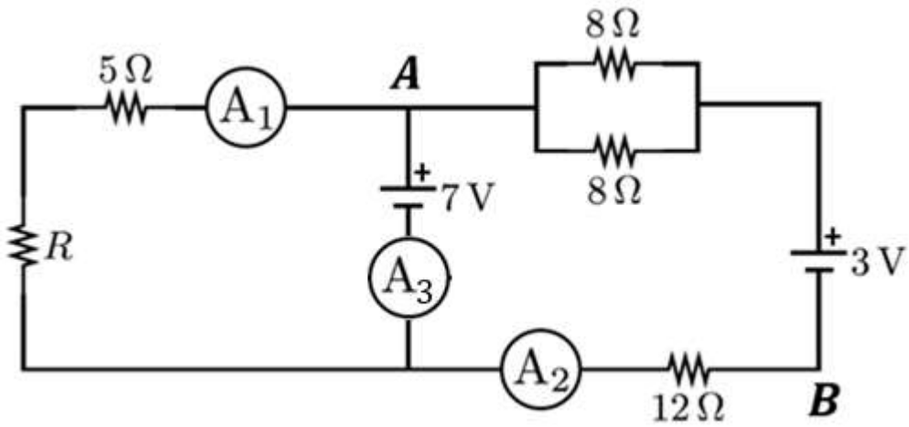
A. Trace the droplet's trajectory on the diagram.

B. What is the magnitude of the electric field between the two parallel plates?

C. What is the expression for the acceleration experienced by the droplet as it passes through the parallel plates?

D. Describe two ways to increase the total vertical deflection of the droplets, clearly explaining how each has the desired result.

9. Answer the following questions for the circuit shown below.

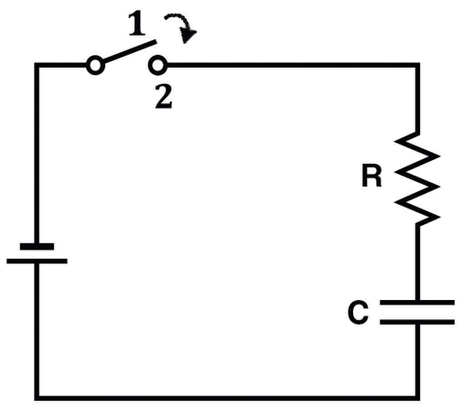


A. Ammeter A3 reads 0.75 A, directed upwards. Determine the current measured by A_1, the current measured by A_2, and the resistance R .

B. What is the potential difference from A to B: ΔV_{AB} ?

C. What is the power dissipated by the $12\ \Omega$ resistor?

10. In the following circuit, the capacitor is initially empty. At $t = 0$ s , the switch is set to position 2.



How do the following parameters change (increase, decrease, or remain constant)?

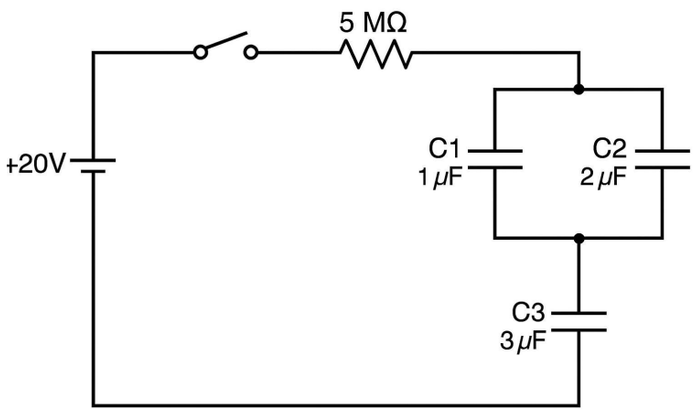
A. The charge stored on the plates: _____

B. The voltage across the capacitor: _____

C. The current: _____

D. The voltage across the resistor: _____

11. In the following RC circuit, the capacitors are initially uncharged. The switch is closed at t = 0 s.

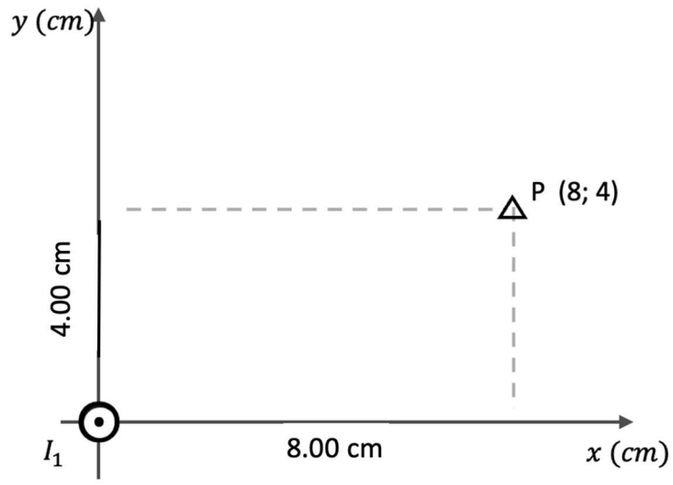


A. What is the time constant τ of the circuit?

B. What is the power being dissipated by the resistor at time $t = 15$ s?

C. At time $t \to \infty$, how much energy is stored in C_2?

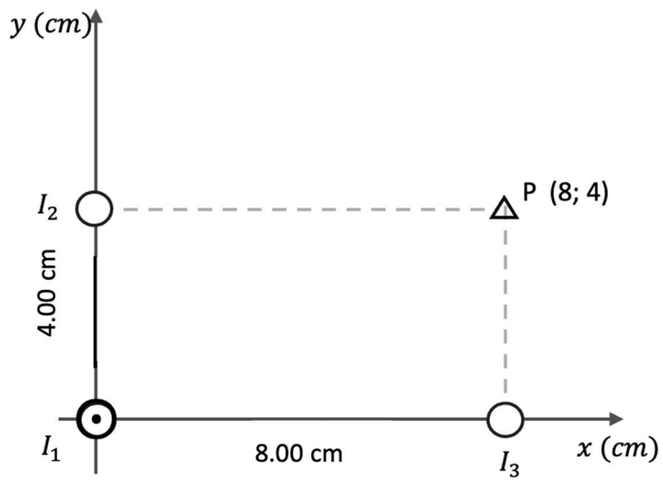
12. A long, straight wire carries a current of 4.00 A and is positioned as shown in the figure.



A. Determine the magnetic field at point P.

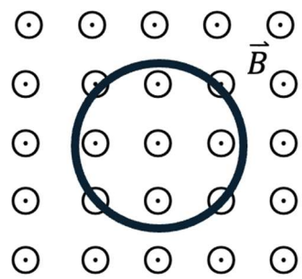
B. Determine the magnetic force acting on an electron, if its velocity is $\left(2.0 \times 10^6 \hat{\imath} - 3.0 \times 10^6 \hat{k}\right)$ m/s as it passes point P.

C. To make the net magnetic field be zero at point P, we add two other long, straight wires (I_2 and I_3) carrying current as shown in the figure below. Indicate the <u>direction</u> of their current on the figure.



13. A loop of wire is initially located in a uniform magnetic field as shown in the figure below.

A. Draw one possible “After” situation in which the magnetic flux has changed.

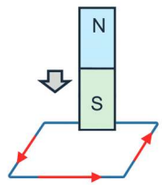
Before:	After:
	

B. Explain how your "after" situation causes the magnetic flux to change.

14. A square coil is located near a magnet. We observe that a current is induced in the coil in the direction shown below (counter-clockwise when viewed from above). **State whether each of the following situations could cause this induced current.**

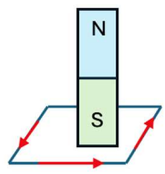
Could it cause the induced current shown? Yes or No?

A. The magnet is moving toward the coil.



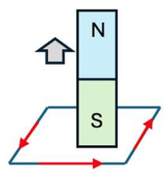
_____

B. The magnet is at rest.



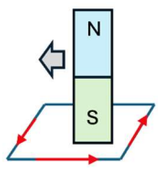
_____

C. The magnet is moving away from the coil.



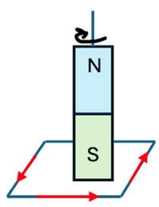
_____

D. The magnet is moving sideways.



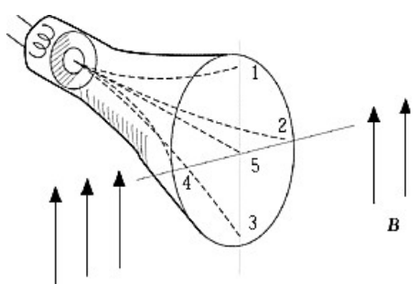
_____

E. The magnet is rotating on its axis.



_____

15. A tube is placed in a magnetic field, as shown in the figure. Which of the five trajectories shown, #1-5, corresponds to that of the electrons? **Answer: _____**



16. A pickup coil on an electric guitar converts the vibration of the strings into an electrical signal. It has 500 turns and produces a magnetic field of $12.0\ \mathrm{mT}$ near a metal string.

    The area subjected to the magnetic field is given by the function: $A(t) = 0.100\sin(600t)$.

    A. Calculate the magnetic flux at time $t = 0.750\ s$.

    B. What is the expression for the induced electromotive force as a function of time?

    C. What is the maximum value of the induced electric voltage?

17. A team of physics students are testing whether their theoretical model accurately describes how the phenomenon behaves in real life. Their model takes the form:

$$\frac{\boldsymbol{f - 3K}}{\boldsymbol{4h}} = \boldsymbol{2L}$$

Where: f & h are variables of interest
- f has units of V
- h has units of V/m

K & L are theoretical constants
- $K = 0.5\ \mathrm{V}$
- $L = 0.3\ \mathrm{m}$

Model's predictions: A graph of experimental values of f on the x-axis and h on the y-axis will:

1) be linear,
2) with a slope equal to _____,
3) and a y-intercept of _____.

Null hypothesis: The experimental results do not significantly differ from the model's predictions.

Alternative hypothesis: The experimental results significantly differ from the model's predictions.

A. Complete predictions #2 and #3 above by filling in the two blanks with values and units.

B. Why does the null hypothesis say, "the experimental results **do not significantly differ** from the model's predictions" rather than saying, "the experimental results **are the same** as the model's predictions?"