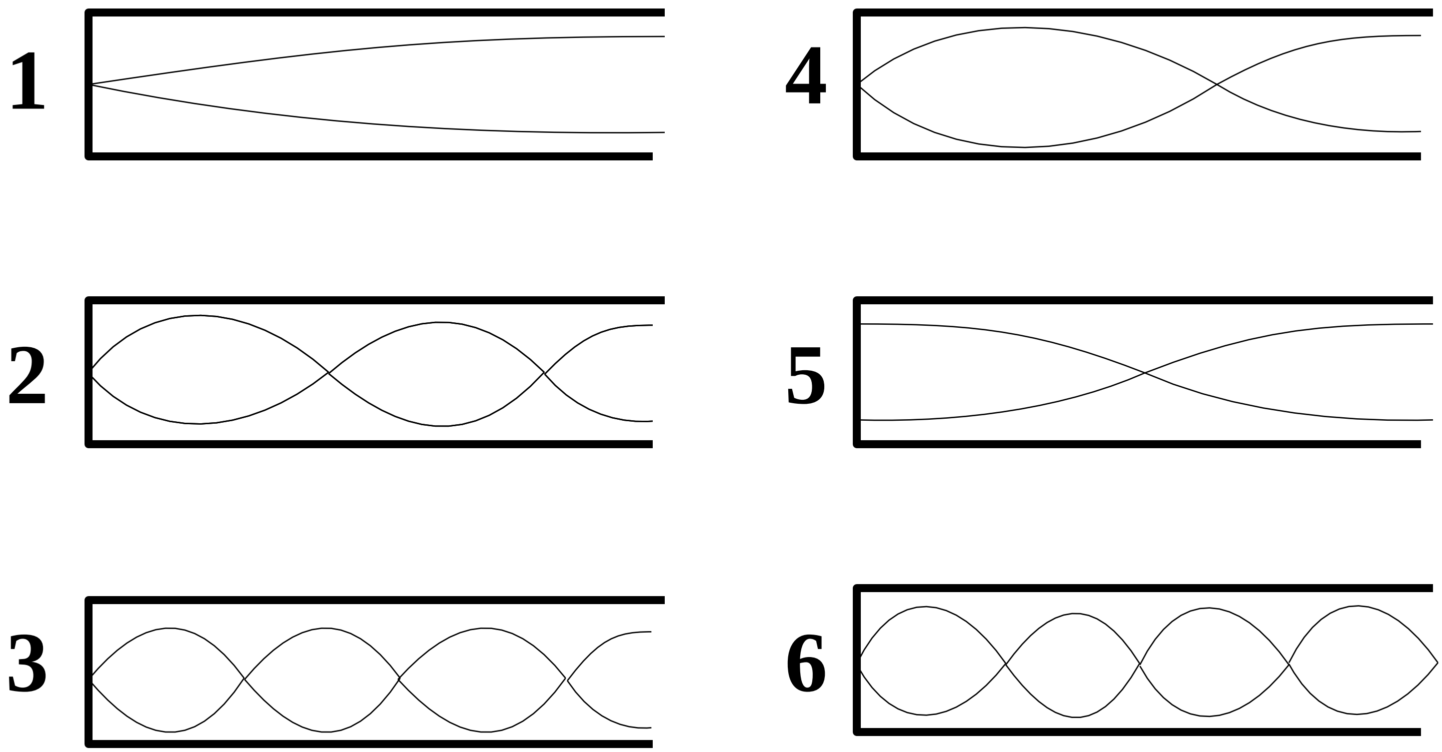
The figures show standing waves of sound in six organ pipes of the same length. Each pipe has one end open and the other end closed. **Warning:** some of the figures show situations that are not possible.



Which one of the pipes emits sound with the lowest frequency?

A: 1　　B: 2　　C: 4　　D: 5

Which one of the pipes emits sound with the next lowest frequency?

A: 1　　B: 2　　C: 4　　D: 5

Which one of the pipes emits sound with the highest frequency?

A: 2　　B: 3　　C: 4　　D: 6

Compared with the sound you hear from the siren of a stationary fire engine, the sound you hear when the fire engine approaches you has an increased

A. speed.

B. frequency.

C. Both of these.

D. Neither of these.

The electric field cannot exist in a vacumm

A. True.

B. False.

Complete the following statement: A simple series circuit contains a resistance *R* and an ideal battery. If a second resistor is connected in parallel with *R*,

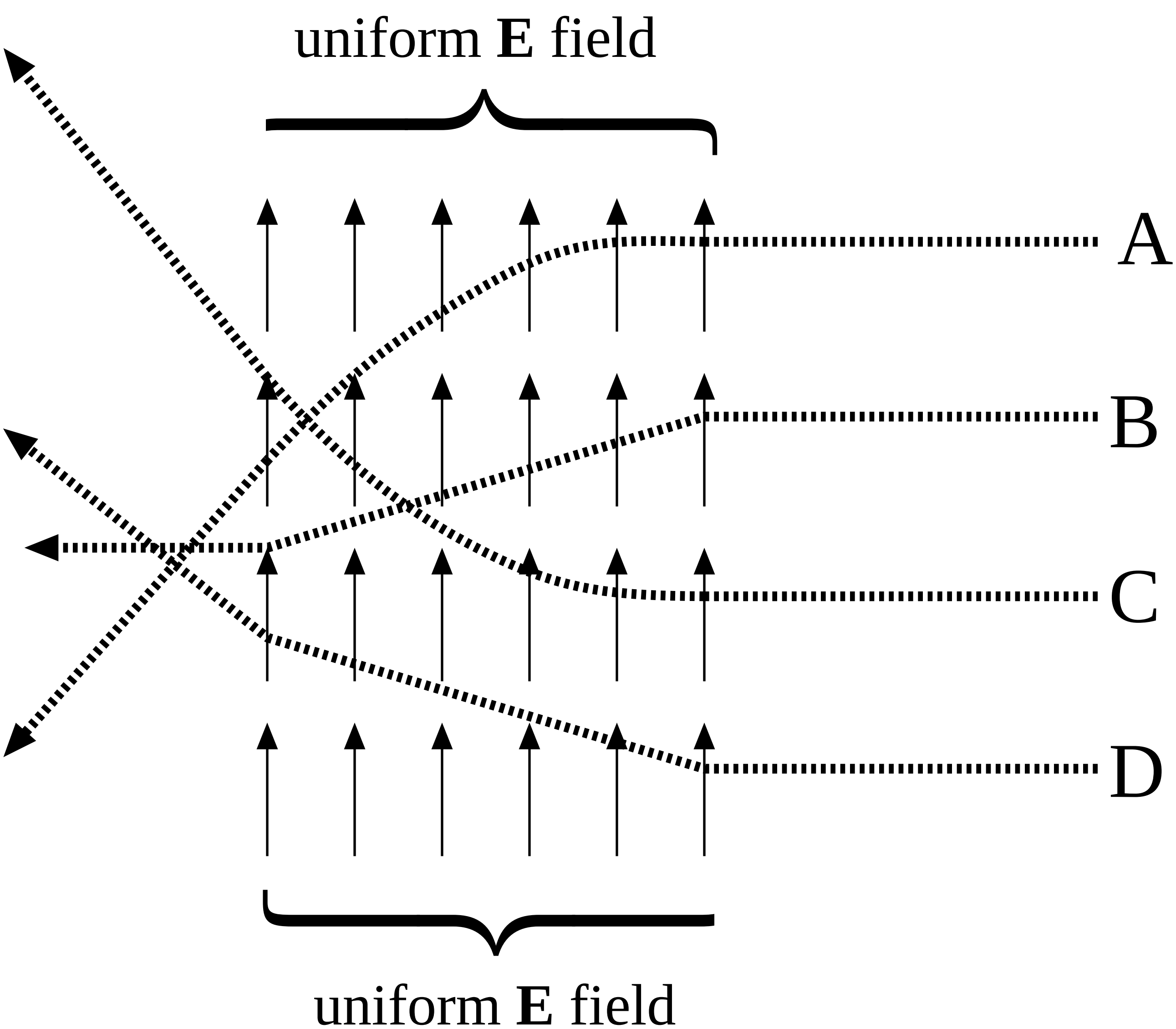
A) the voltage across *R* will decrease.

B) the current through *R* will decrease.

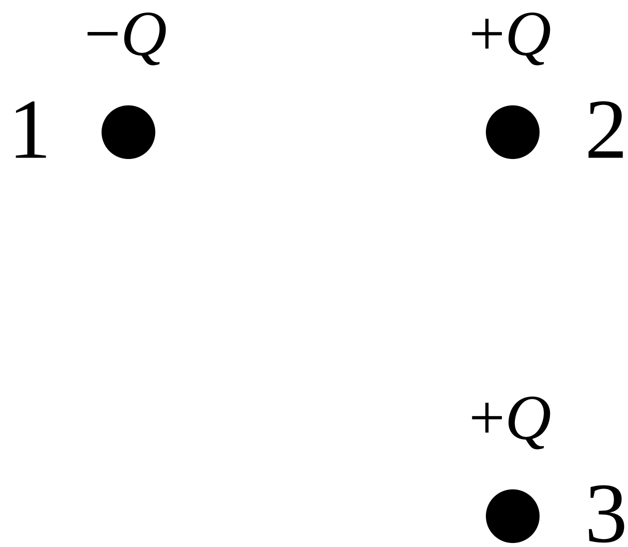
C) the total current through the battery will increase.

D) the equivalent resistance of the circuit will increase.

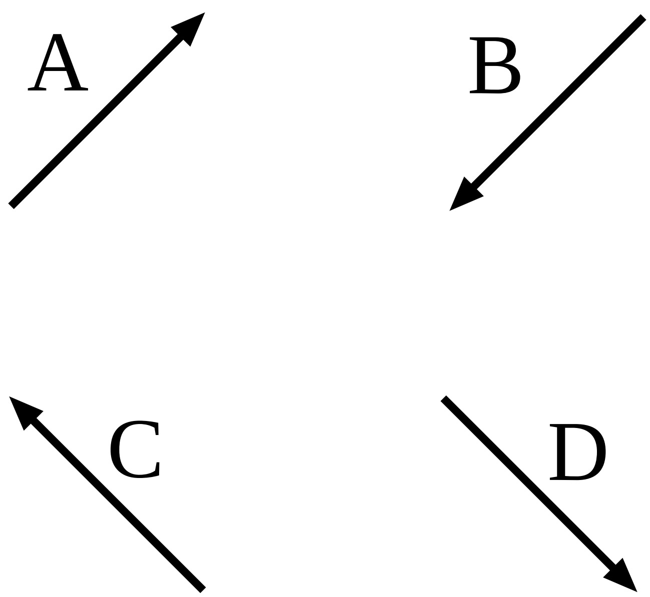
An electron is moving at high speed through a field-free region. In enters (and soon exits) a region in which the electric field points up. Which path best represents the path of the electron?



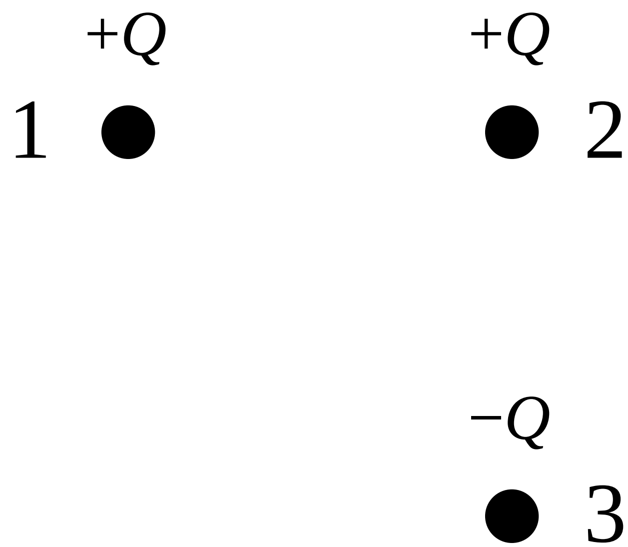
Three charges all carry the same magnitude of charge Q, but with different signs as shown below.



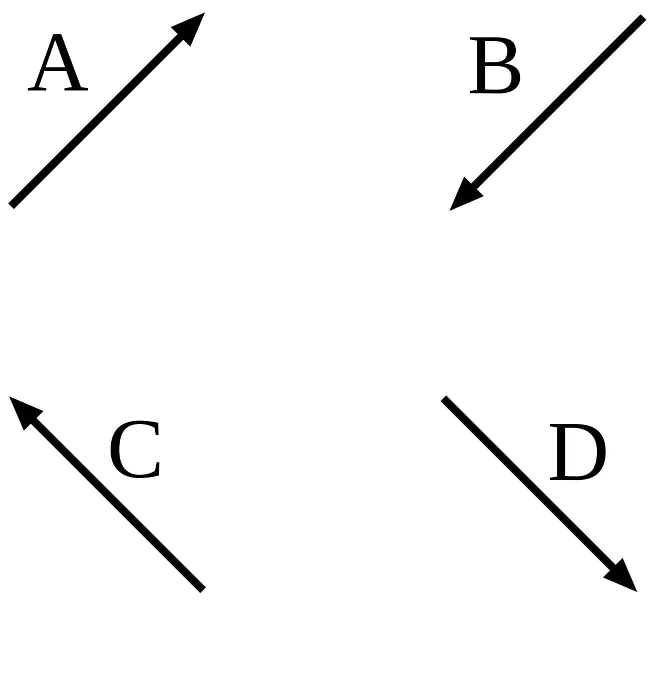
Which of the arrows is in the direction of the net force on charge 2?



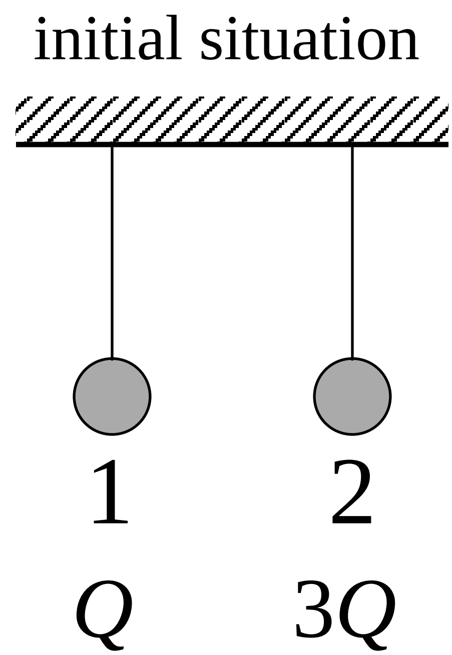
Three charges all carry the same magnitude of charge Q, but with different signs as shown below.



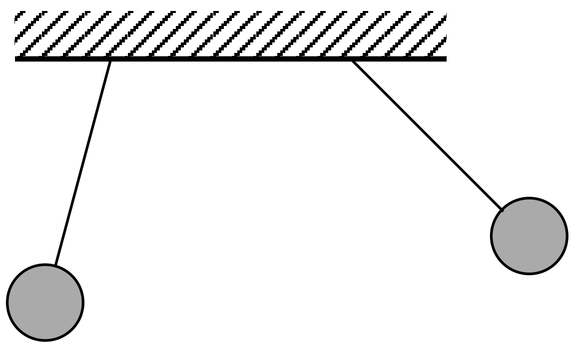
Which of the arrows is in the direction of the net force on charge 2?



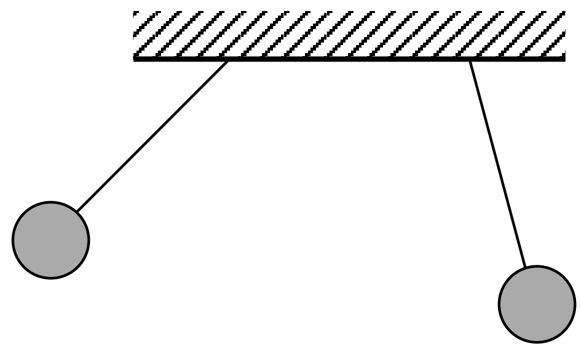
Two pith balls of identical mass and shape are suspended from the ceiling by nonconducting strings. Ball 1 is given a charge of q_1=Q and ball 2 is given a charge q_2=3Q. Which of the below pictures best displays the final positions of these balls?



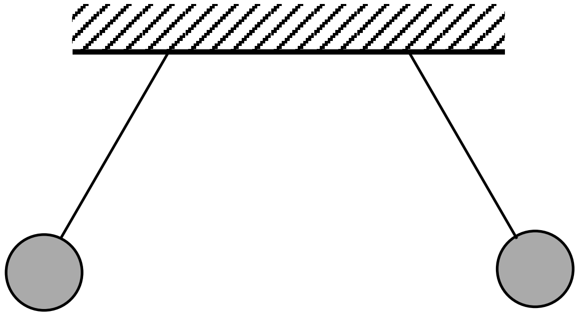
A



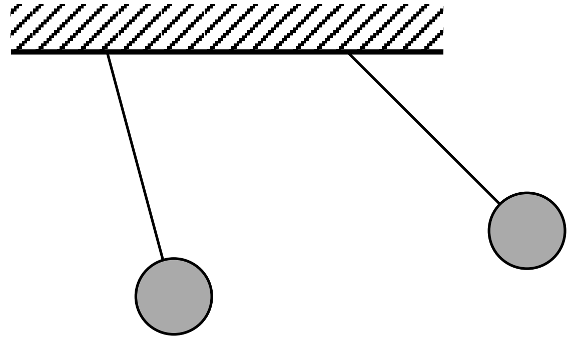
B



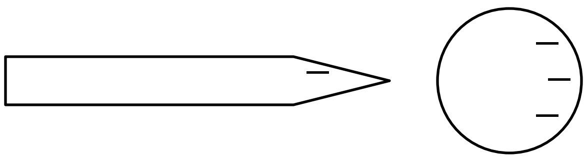
C



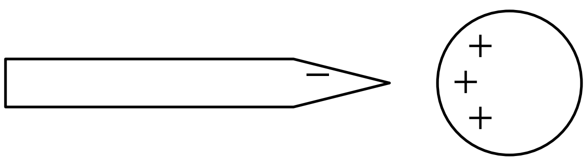
D



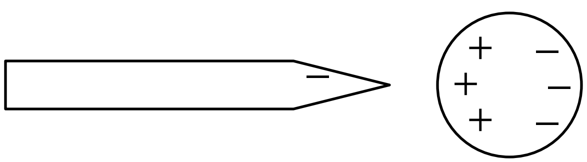
A negatively charged rod approaches a previously neutral conducting sphere. Which picture best displays the arrangement of the surface charges on the sphere?



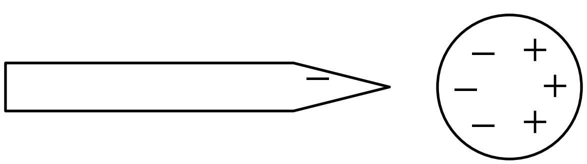
A



B

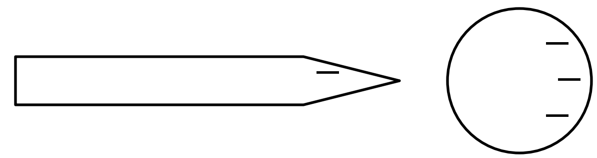


C

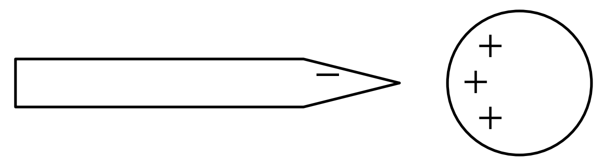


D

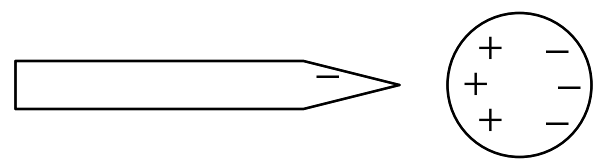
While the charged rod remains in place, the sphere is grounded. Which picture now best displays the arrangement of the surface charges on the sphere?



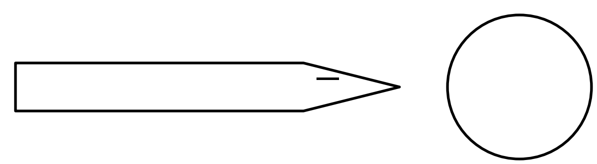
A



B

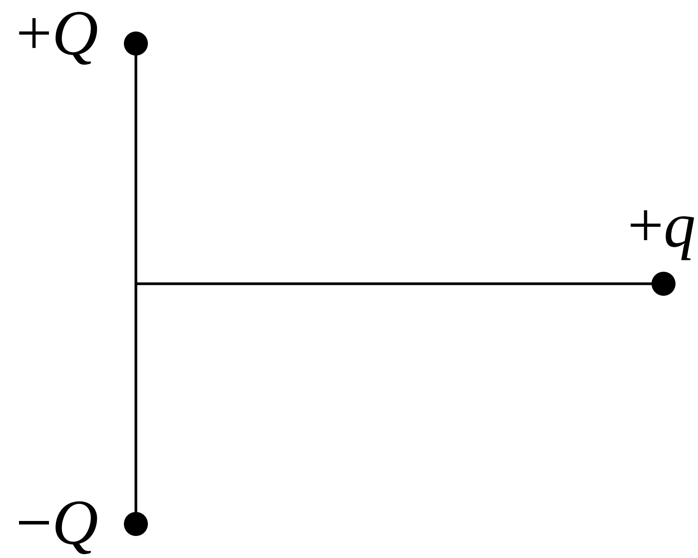


C

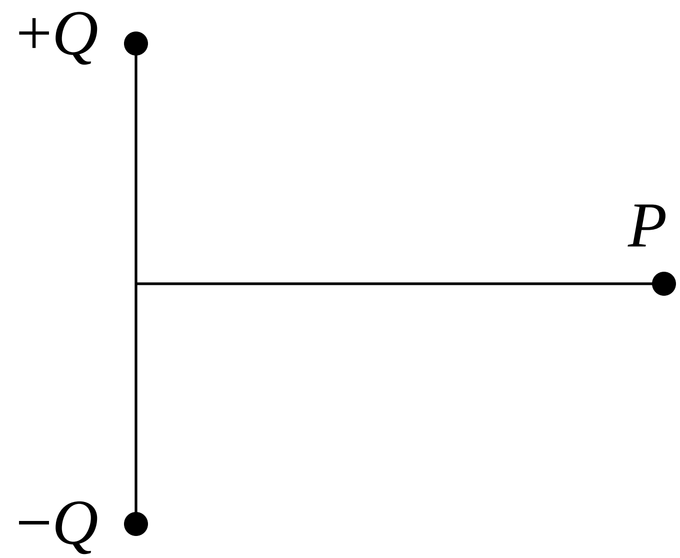


D

A charge $-Q$ lies directly below a charge $+Q$, while a third charge $+q$ lies on the perpendicular bisector of the line joining $+Q$ and $-Q$. What is the direction of the force on q?

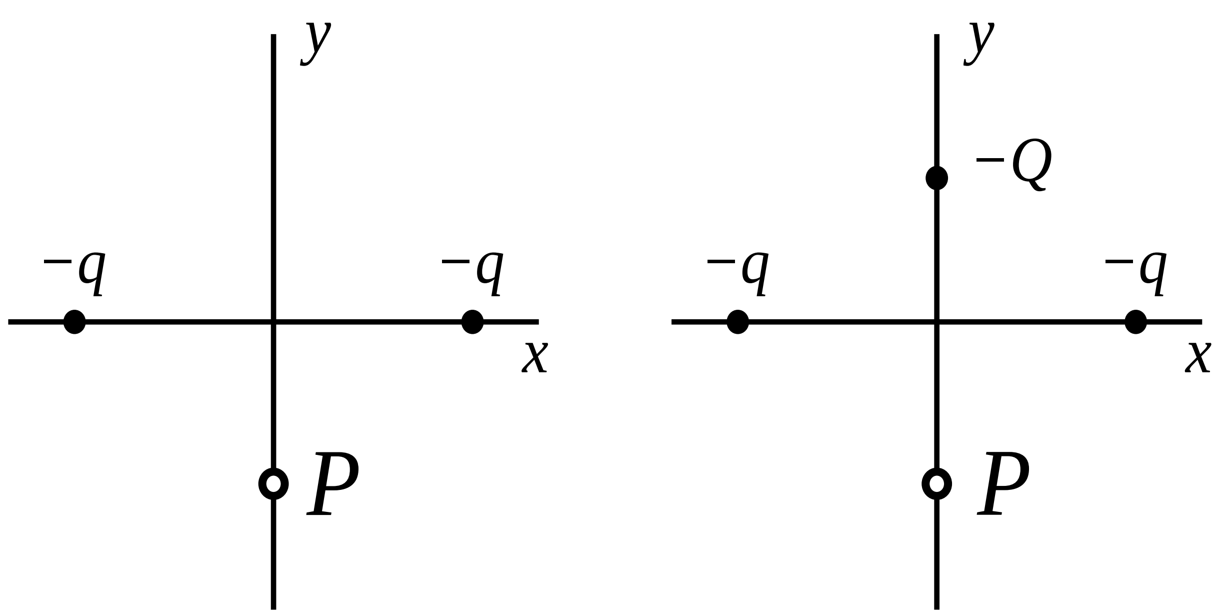


A charge $-Q$ lies directly below a charge $+Q$. The point P lies on the perpendicular bisector of the line joining $+Q$ and $-Q$. What is the direction of the electric field at P?



A	B	C	D
↓	↑	→	zero field

In the figure below, identical negative charges $-q$ are placed symmetrically around the origin on the x-axis and as a result the electric field at point P is directed upward along the y-axis. If a negative charge $-Q$ is now added at a point on the positive y-axis, what happens to the field at P? (All of the charges are fixed in position.)



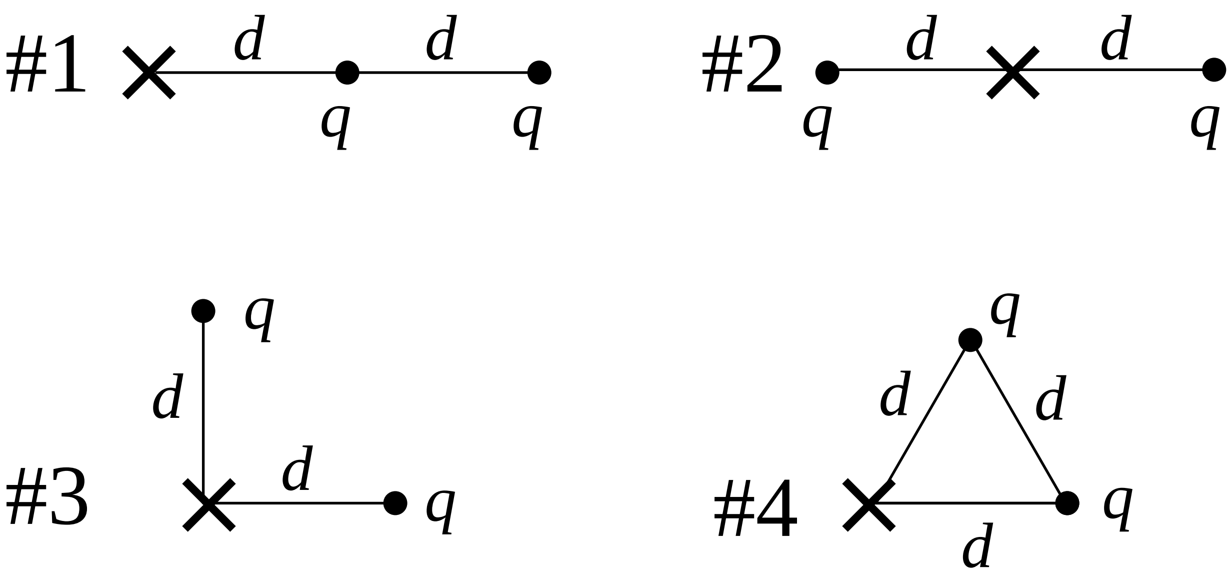
A. Nothing since $-Q$ is on the y-axis.

B. Strength will increase because $-Q$ is negative.

C. Strength will decrease and direction may change because of the interactions between $-Q$ and the two $-q$'s.

D. Cannot determine without knowing the forces exerted between particles.

Consider the electric field at the point marked × due to two particles, each with charge q and separated by distance d in any of the four configurations shown below. Rank the configurations according to the magnitude of the electric field at ×, least to greatest.

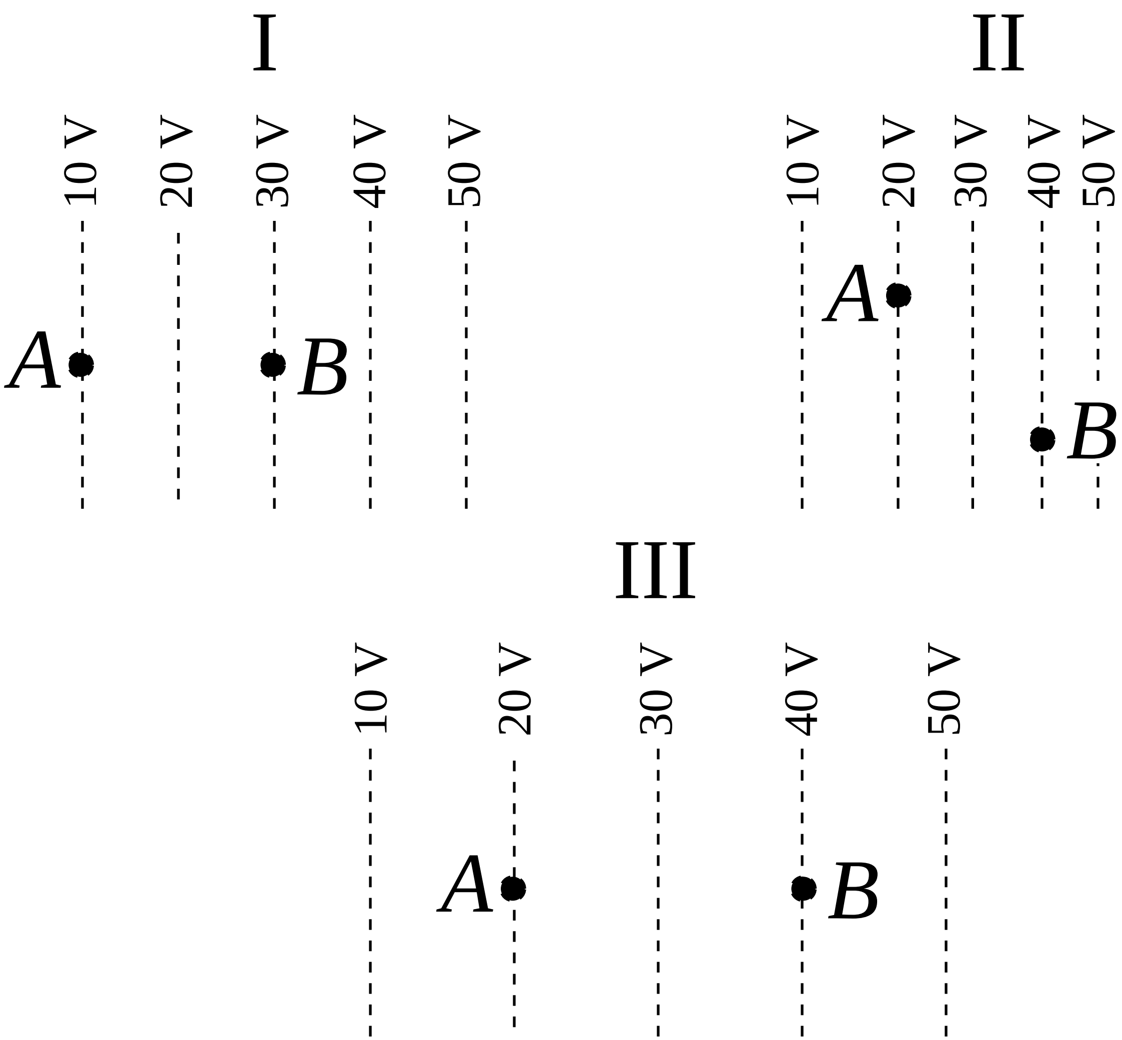


A. $E_1 < E_2 < E_3 < E_4$

B. $E_2 < E_1 < E_3 < E_4$

C. $E_2 < E_1 < E_4 < E_3$

D. $E_2 < E_3 < E_4 < E_1$



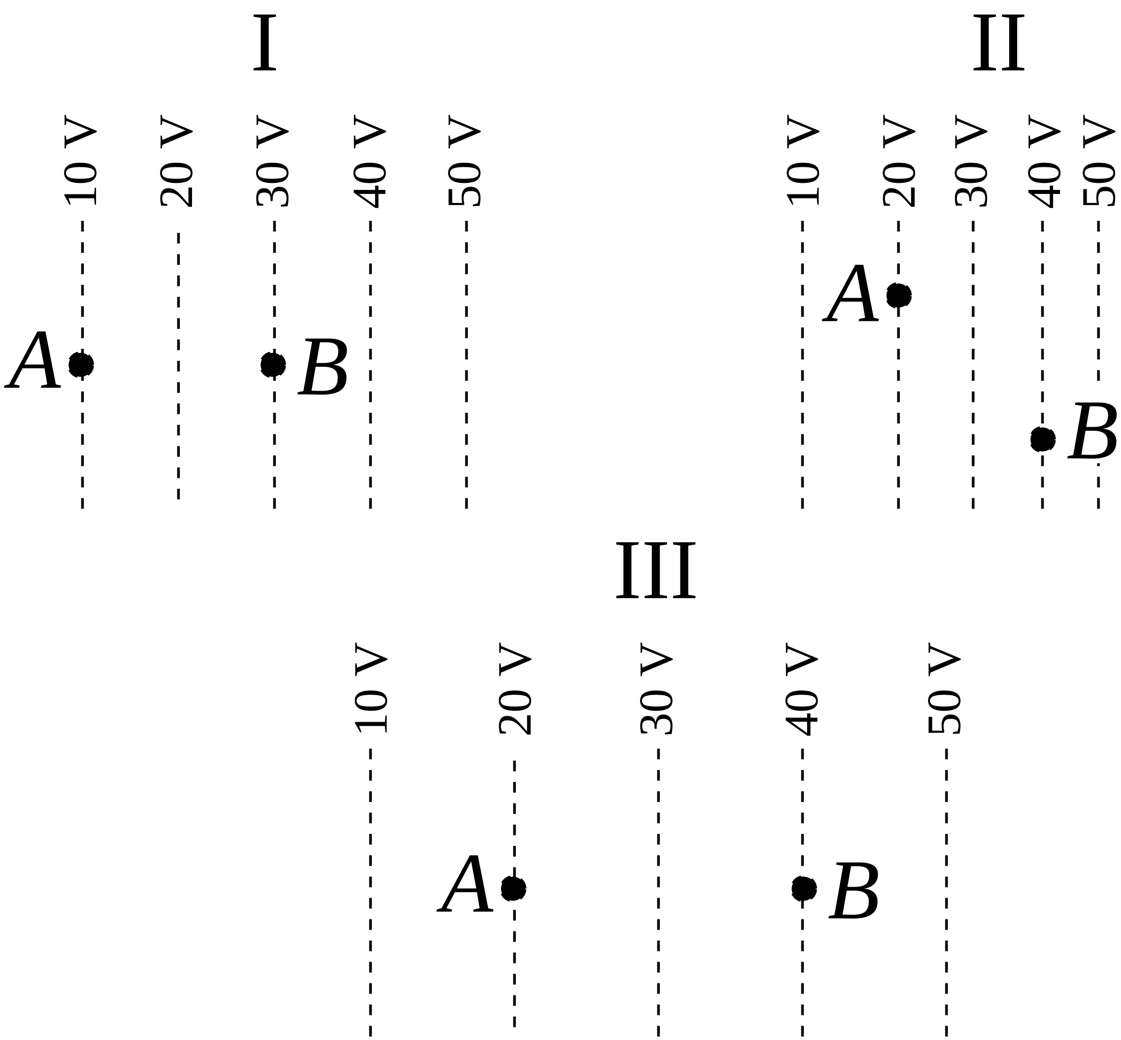
A. The smallest work is required in I.

B. The largest work is required in II.

C. The largest work is required in III.

D. All three would require the same amount of work.

The above shows the location of equipotential lines (displayed as the dotted lines with corresponding voltages). In each case, an object with charge +1μC is moved from *A* to *B*. In this problem we consider the work required to make these moves.



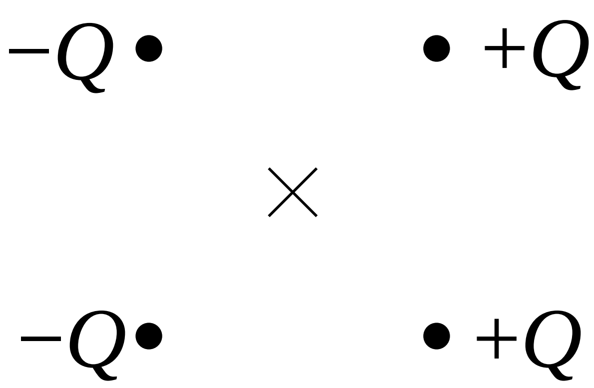
A. $E_{III} > E_{II} > E_{I}$

B. $E_{I} > E_{III} > E_{II}$

C. $E_{II} > E_{I} > E_{III}$

D. $E_{I} = E_{II} > E_{III}$

The above shows the location of equipotential lines (displayed as the dotted lines with corresponding voltages). In this problem we consider the magnitude of the electric field at the point *B* in the three cases.



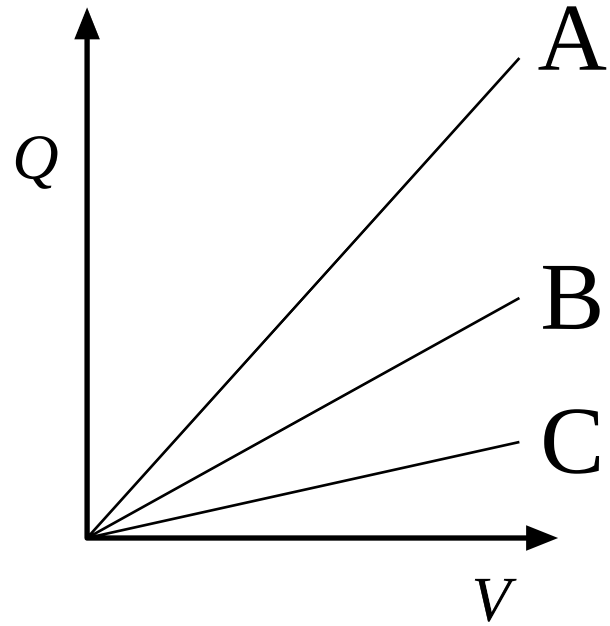
Consider four charges all of equal magnitude, but two are positive and two are negative. They are arranged as shown in a square. The voltage at the center of the square (marked with X) is:

A. zero

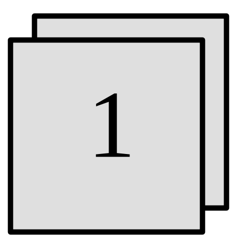
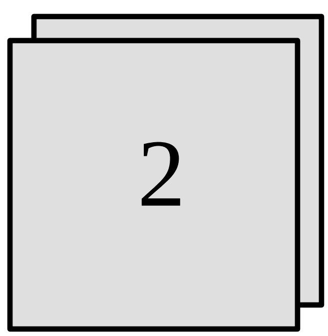
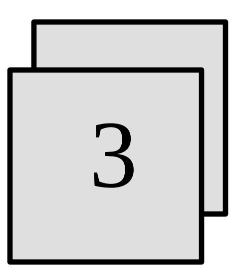
B. points up

C. points right

D. point to the left



Plots of charge Q vs. potential difference V for three different capacitors are displayed below along with the area and plate separation of these three capacitors. Which plot goes with which capacitor?

	area	plate separation
	A	d
	$2A$	d
	A	$2d$

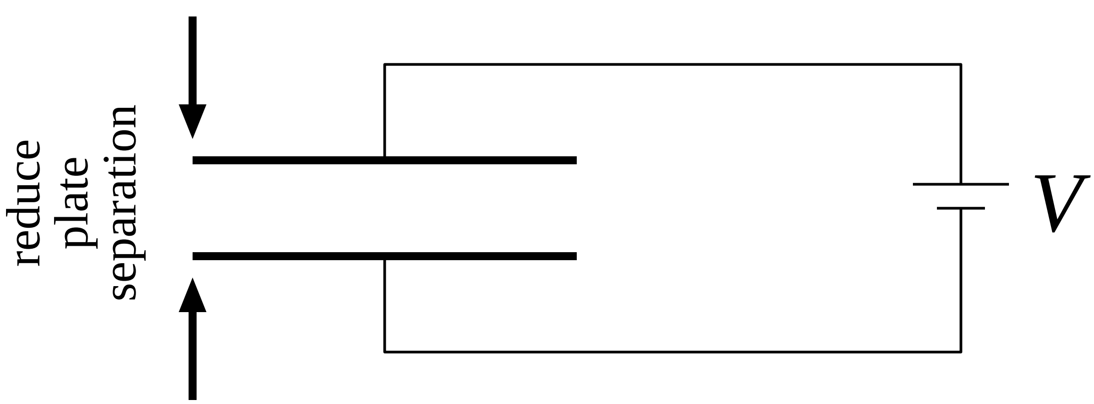
A parallel-plate capacitor is connected to a battery of electric potential difference *V*. If the plate separation is then decreased do these quantities:

A: increase

B: decrease

C: stay the same

1. capacitance
2. potential difference between plates
3. charge on a plate
4. energy stored
5. electric field between plates
6. energy density between plates



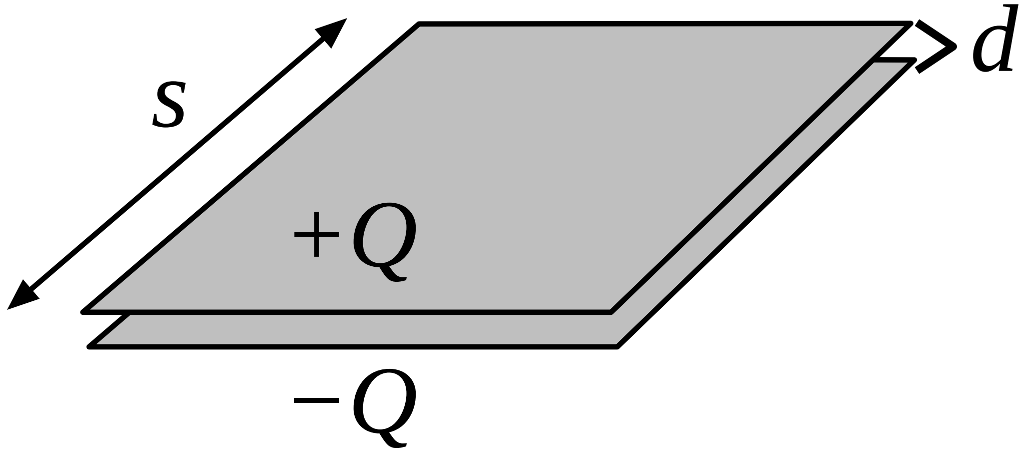
A square (side *s*) parallel-plate capacitor carries a charge *Q*, but is otherwise isolated (disconnected). If the plate size *s* is increased (with other parameters unchanged) do these quantities:

A: increase

B: decrease

C: stay the same

1. capacitance
2. electric field between plates
3. potential difference between plates
4. energy stored
5. energy density between plates



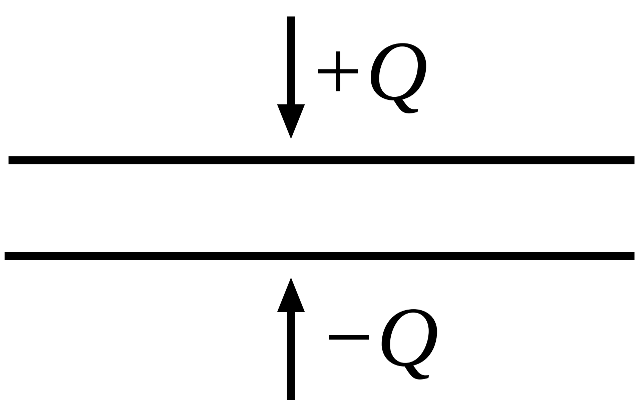
A parallel-plate capacitor carries a charge Q, but is otherwise isolated (disconnected). If the charge Q is then increased do these quantities:

A: increase

B: decrease

C: stay the same

1. capacitance
2. potential difference between plates
3. electric field between plates
4. energy stored
5. energy density between plates



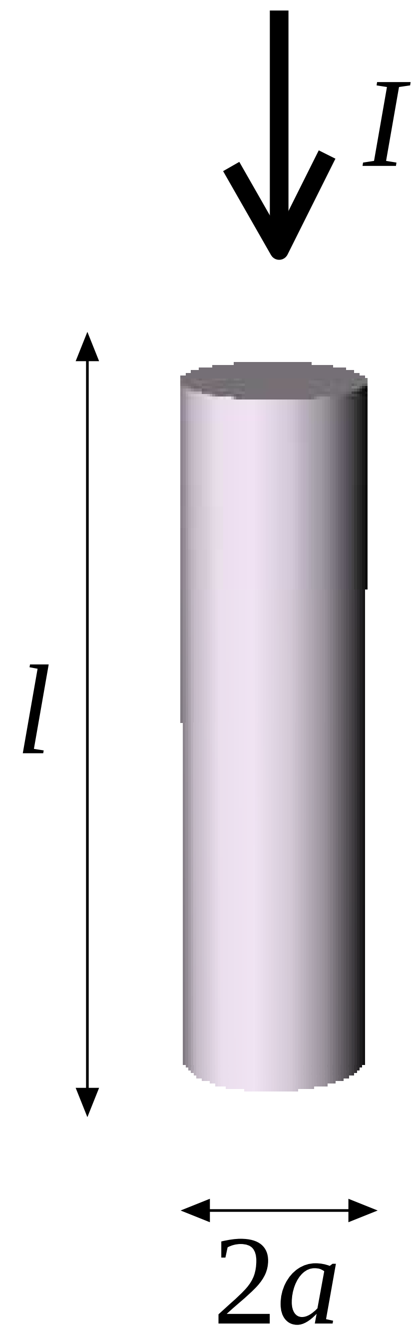
A resistor consists of a long cylinder of carbon (radius *a*, length *l*) and carries a current *I*. If the current *I* is then increased do these quantities:

A: increase

B: decrease

C: stay the same

1. resistance
2. potential difference
3. electric field
4. resistivity
5. power
6. current density
7. drift velocity



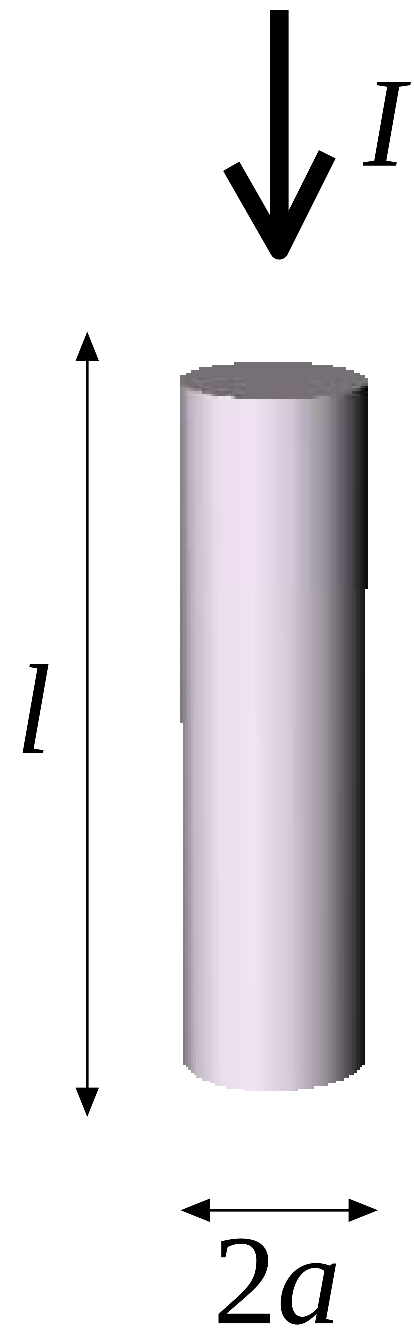
A resistor consists of a long cylinder of carbon (radius *a*, length *l*) and carries a current *I*. If the radius *a* is then increased do these quantities:

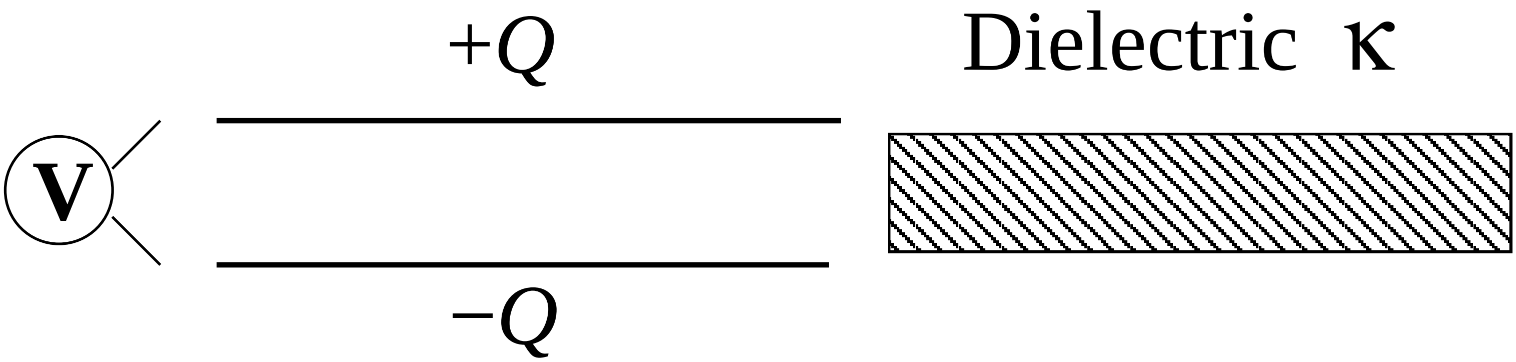
A: increase

B: decrease

C: stay the same

1. resistance
2. potential difference
3. electric field
4. resistivity
5. power
6. current density
7. drift velocity





An isolated parallel plate capacitor holds a charge Q. A dielectric slab (dielectric constant $\kappa > 1$) can exactly fit between the plates. If the dielectric is inserted

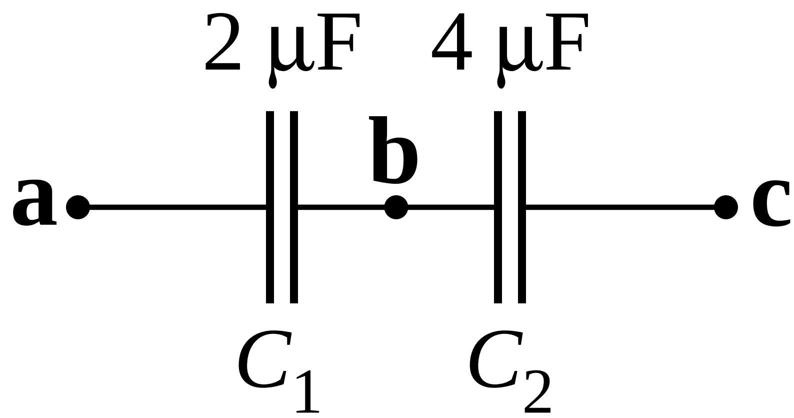
A. the charge on the plates and the voltage will increase.

B. the capacitance will increase and the voltage will decrease.

C. the electric field between the plates will increase.

D. the capacitance and the electric field between the plates will decrease.

A 2 μF capacitor (C_1) and a 4 μF capacitor (C_2) are connected in series and I attach a 6 V battery between points **a** and **c**



How does the charge Q_1 stored on C_1 compare to the charge Q_2 stored on C_2 ?

A. $Q_1 < Q_2$ **B.** $Q_1 > Q_2$ **C.** $Q_1 = Q_2$

How does the voltage drop across C_1 : ΔV(**ab**) compare to the voltage drop across C_2 : ΔV(**bc**) ?

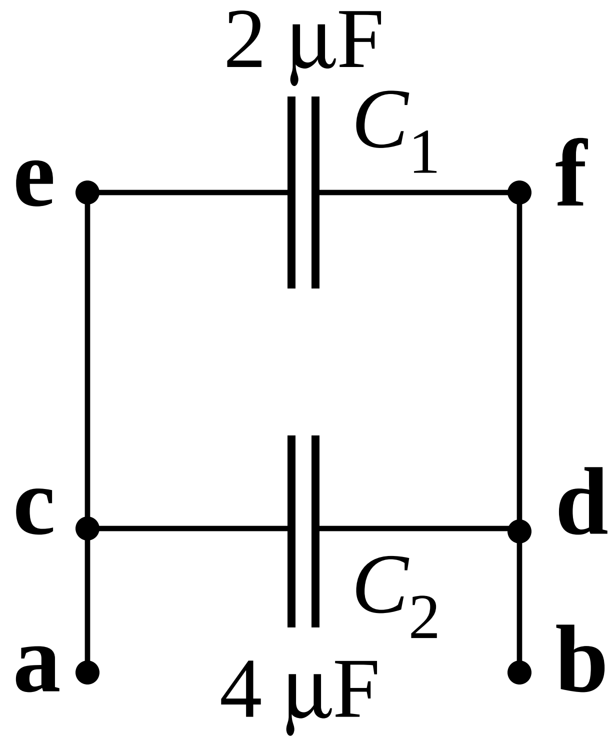
A. ΔV(**ab**)=2ΔV(**bc**)

B. 2ΔV(**ab**)=ΔV(**bc**)

C. ΔV(**ab**)=ΔV(**bc**)

D. None of the above

A 2 μF capacitor (C_1) and a 4 μF capacitor (C_2) are connected in parallel and I attach a 6 V battery between points **a** and **b**



How do the voltages at **a, c,** and **e** compare ?

A. $V_a < V_c < V_e$

B. $V_a > V_c > V_e$

C. $V_a = V_c = V_e$

D. None of the above

How does the voltage drop across C_1 : $\Delta V(\mathbf{ef})$ compare to the voltage drop across C_2 : $\Delta V(\mathbf{cd})$?

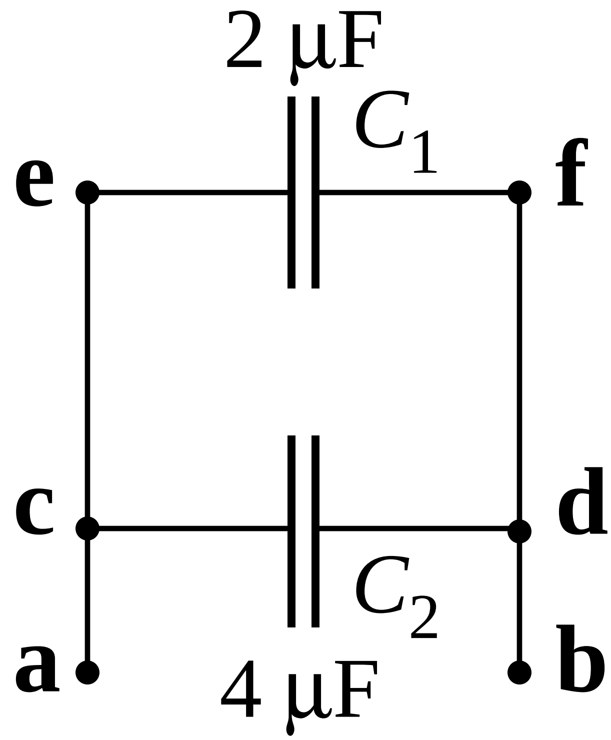
A. $\Delta V(\mathbf{cd})=2\Delta V(\mathbf{ef})$

B. $2\Delta V(\mathbf{cd})=\Delta V(\mathbf{ef})$

C. $\Delta V(\mathbf{cd})=\Delta V(\mathbf{ef})$

D. None of the above

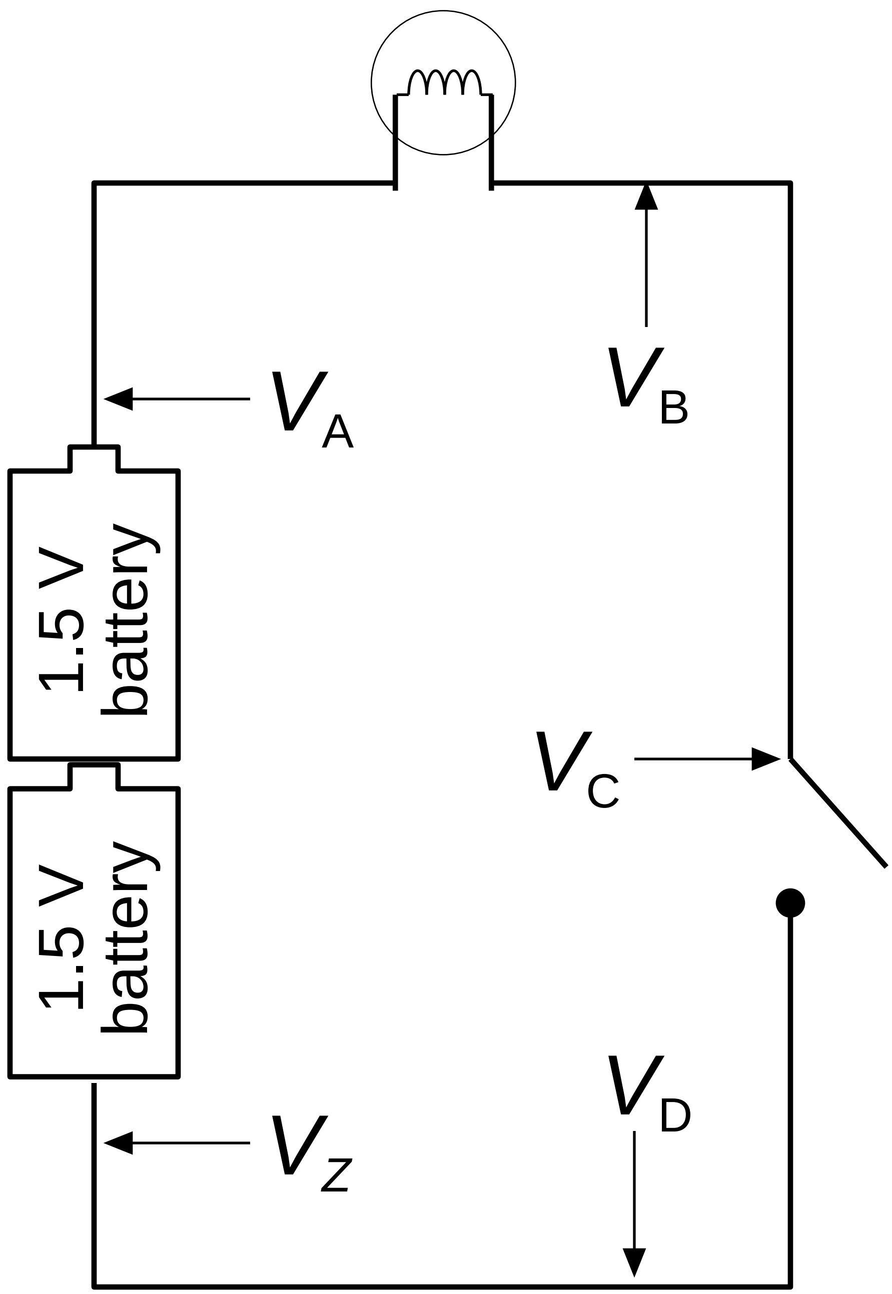
A 2 μF capacitor (C_1) and a 4 μF capacitor (C_2) are connected in parallel and I attach a 6 V battery between points **a** and **b**



How does the charge Q_1 stored on C_1 compare to the charge Q_2 stored on C_2 ?

A. $2Q_1 = Q_2$ **B.** $Q_1 = 2Q_2$ **C.** $Q_1 = Q_2$

D. None of the above

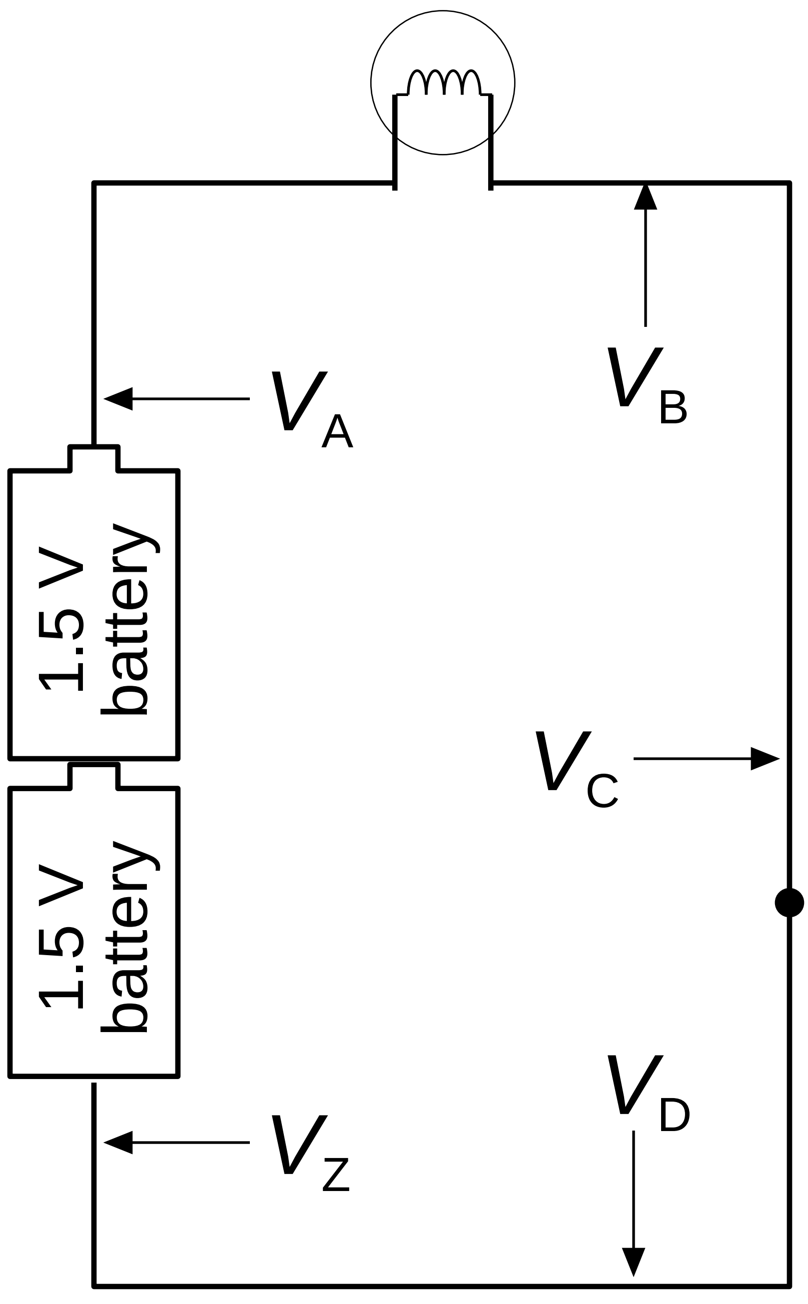


1. V_A?
2. V_B?
3. V_C?
4. V_D?

V_Z is defined to be 0 Volts

A: 3 V **B:** 1.5 V **C:** 0 V

D: none of the above



1. V_A?

2. V_B?

3. V_C?

4. V_D?

V_Z is defined to be 0 Volts

A: 3 V **B:** 1.5 V **C:** 0 V

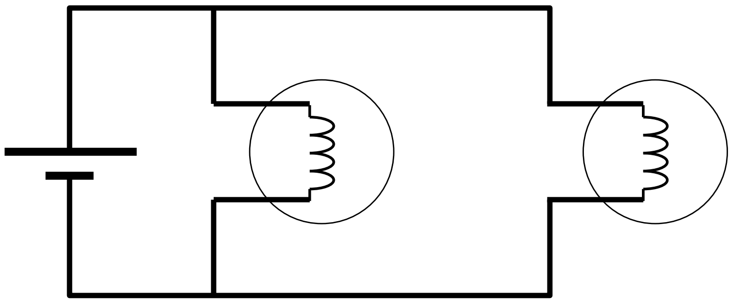
D: none of the above

1. Which bulb has the greater resistance?

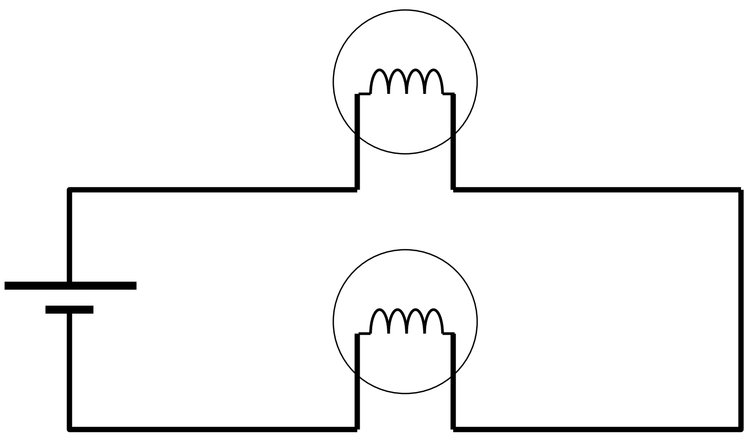
2. Which bulb will shine brighter

A. 25 W
B. 40 W
C. Same

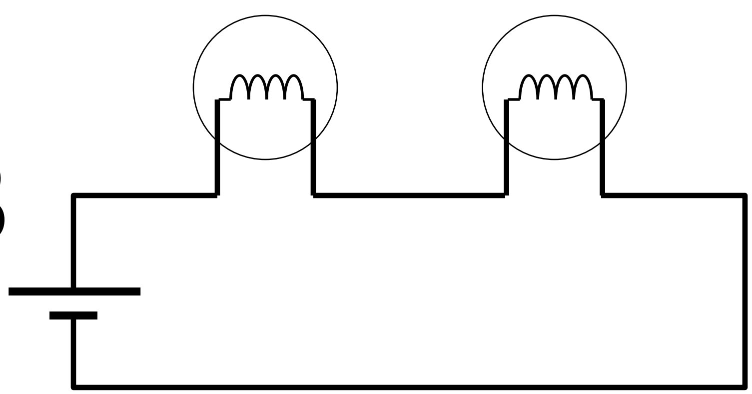
#1



#2



#3



Identical batteries power identical light bulbs in the three circuits. Which circuit produces the most total light?

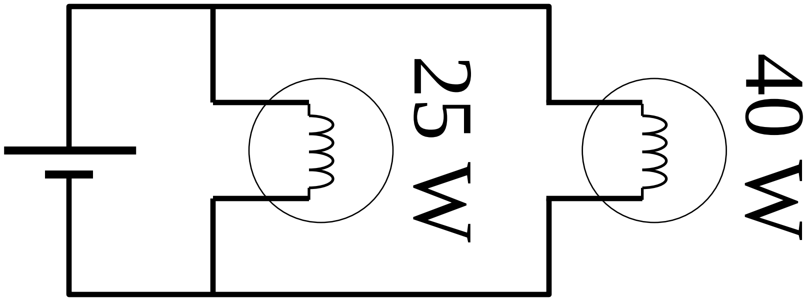
A. Circuit #1

B. Circuit #2

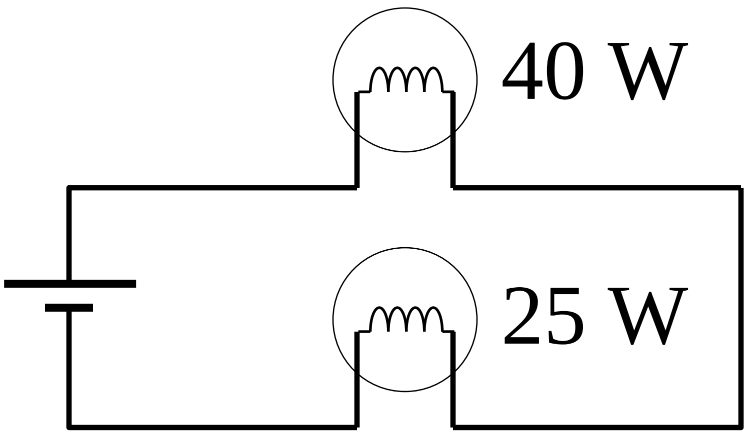
C. Circuit #3

D. #1 and #2 produce the same total light

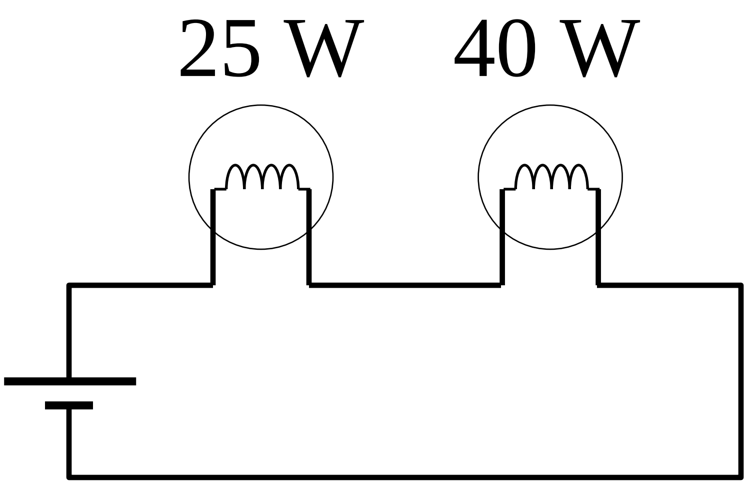
#1



#2



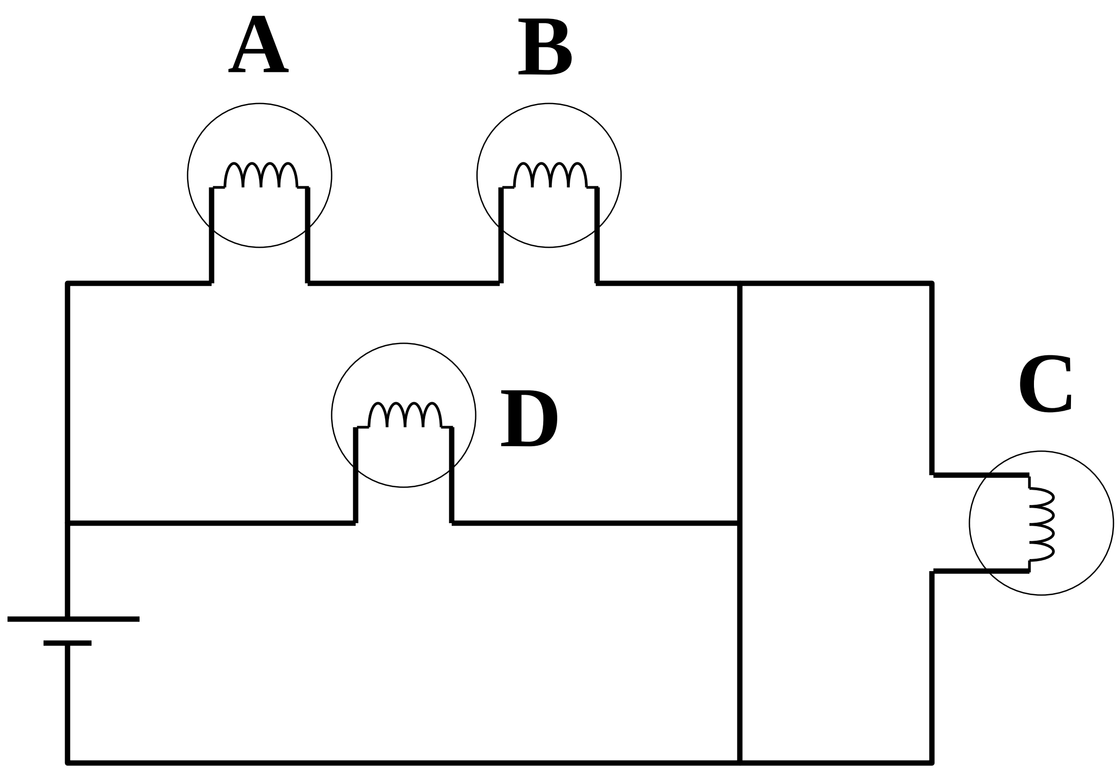
#3

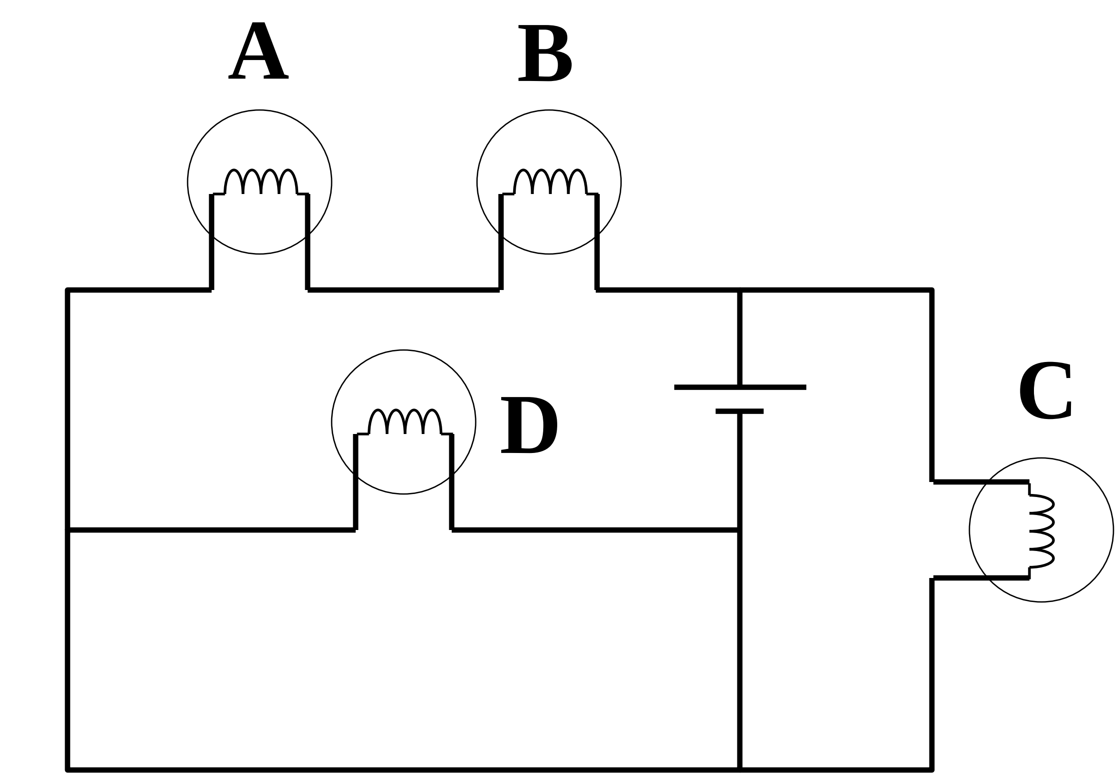


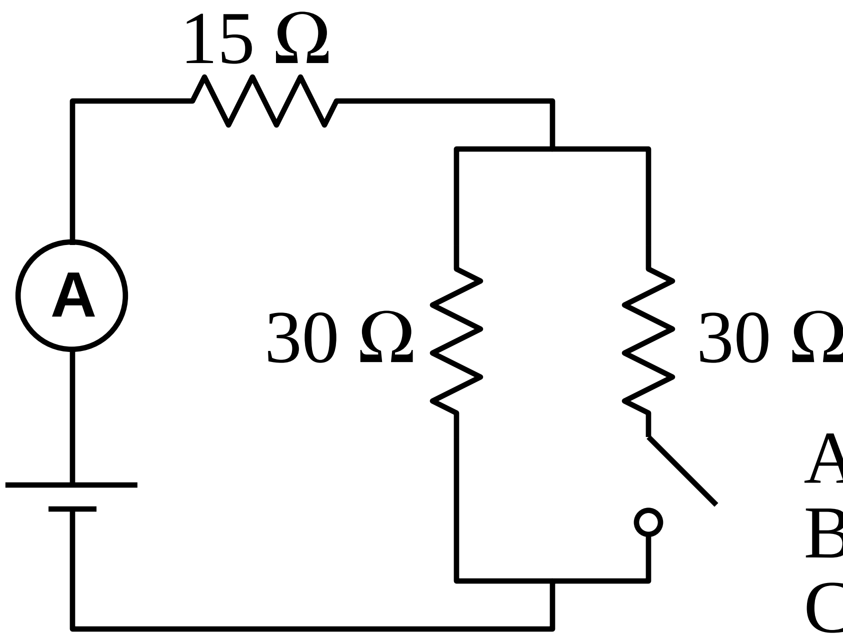
Which bulb is brighter?

A. 25 W
B. 40 W
C. Equally bright

Which bulb will shine the brightest?

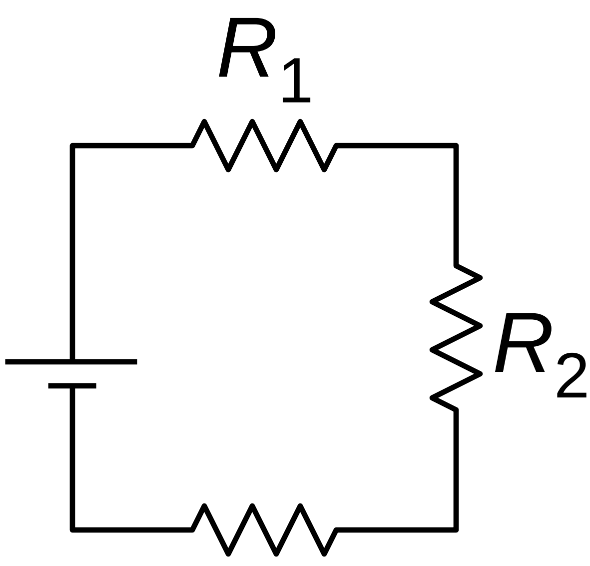






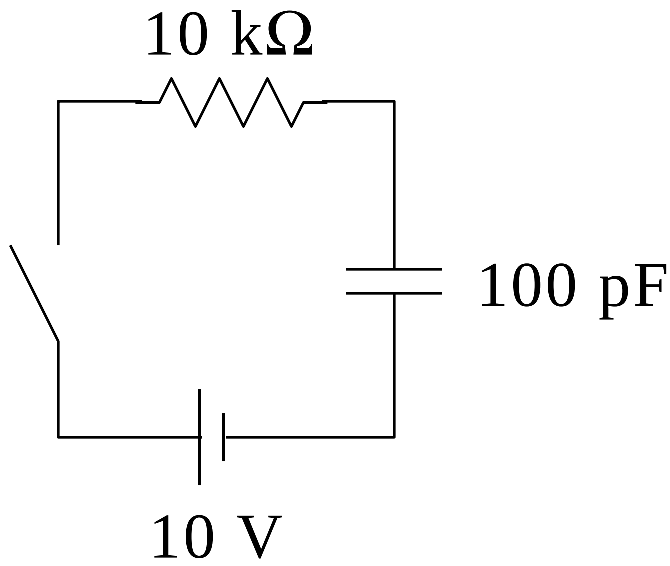
With the switch as shown (open) the ammeter reads 1 A. When the switch is closed, the current:

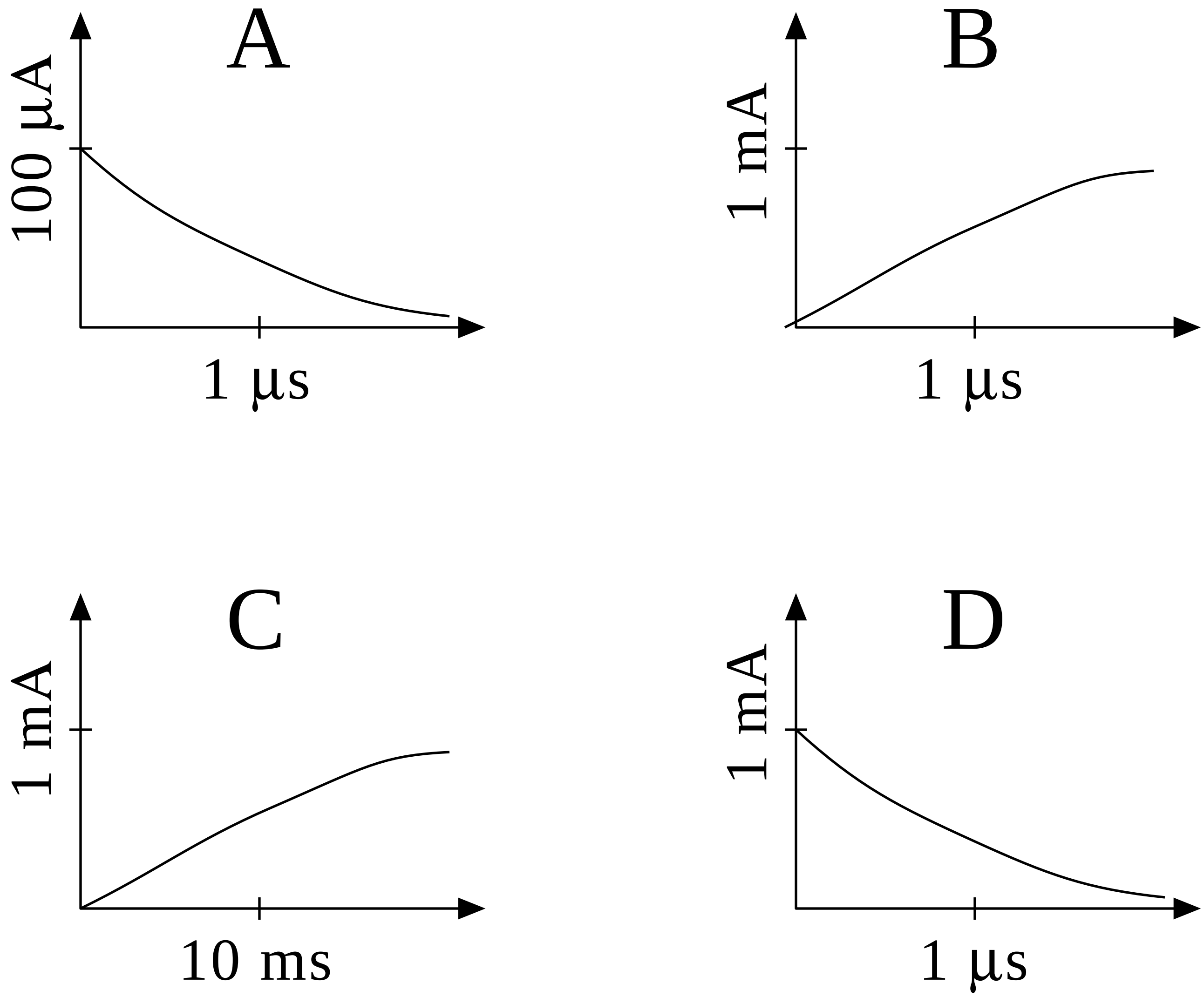
A. increases slightly
B. decreases slightly
C. remains the same
D. doubles

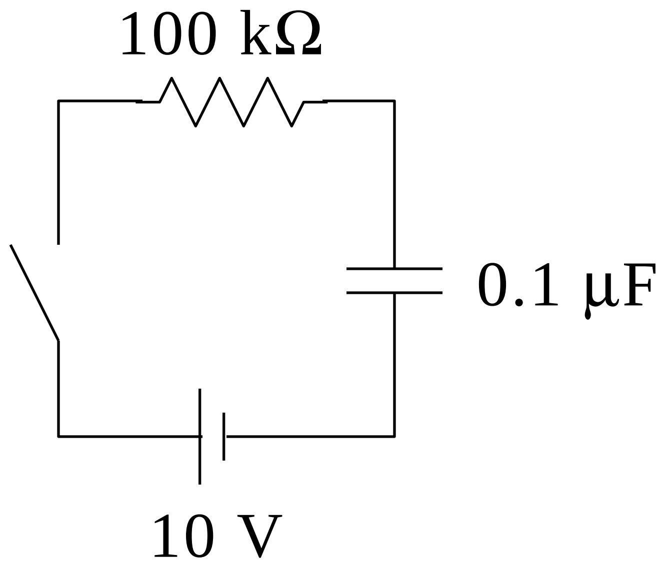


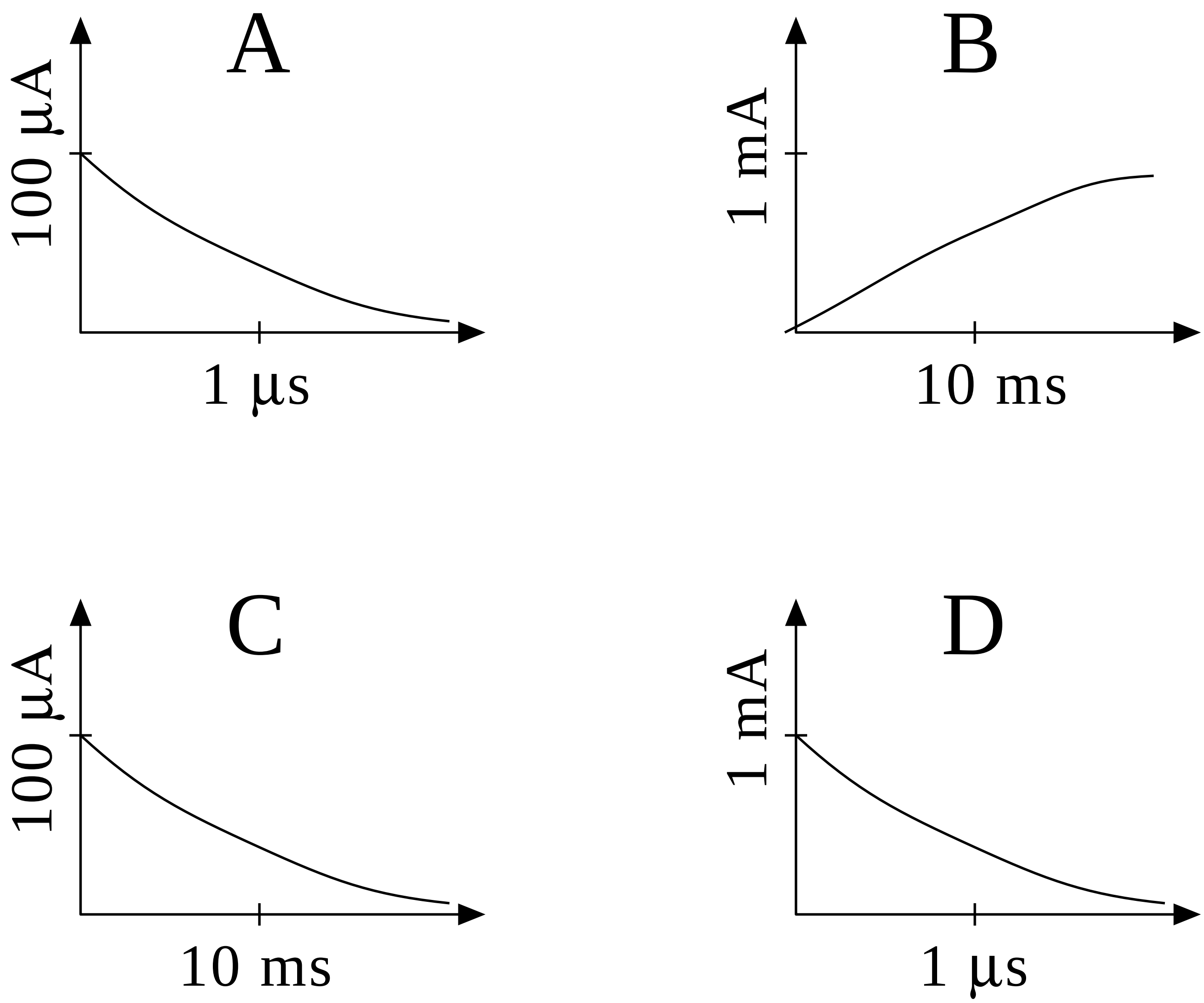
$R_1 > R_2 > R_3$
Rank the current in the resistors.

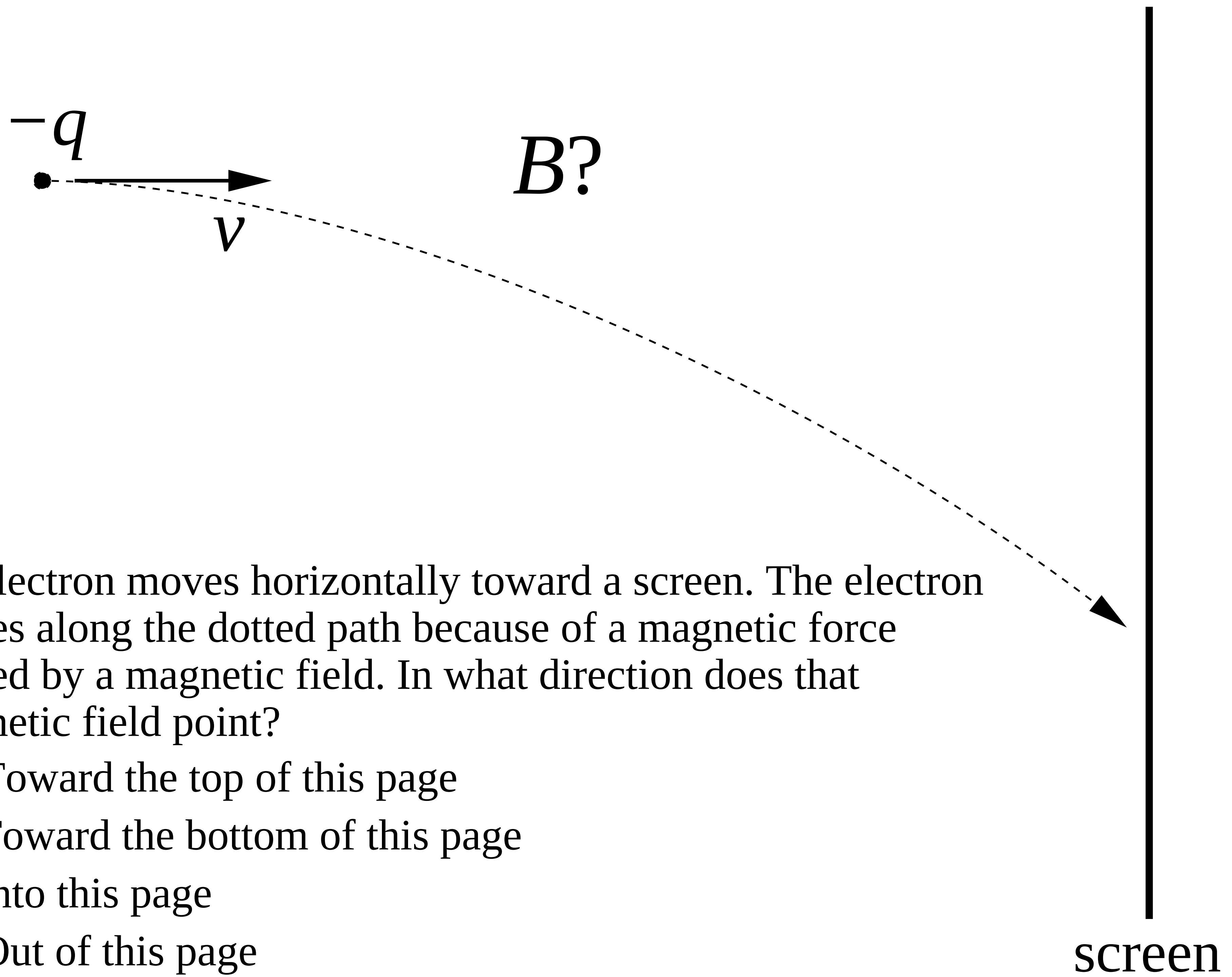
A. $I_1 > I_2 > I_3$
B. $I_1 < I_2 < I_3$
C. $I_1 = I_2 = I_3$
D. none of the above


10 kΩ
100 pF
10 V


A
100 μA
1 μs
B
1 mA
1 μs
C
1 mA
10 ms
D
1 mA
1 μs


100 kΩ
0.1 μF
10 V


A
100 μA
1 μs
B
1 mA
10 ms
C
100 μA
10 ms
D
1 mA
1 μs



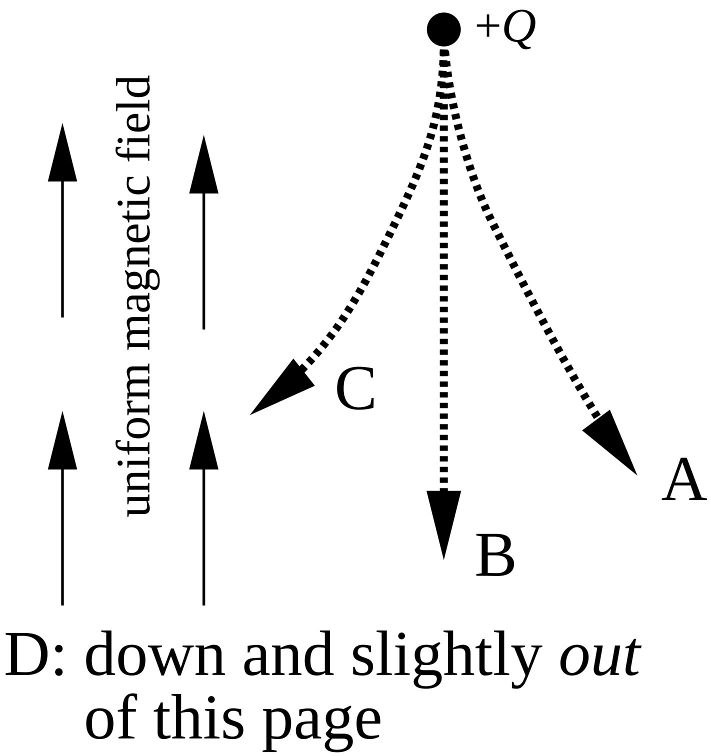
An electron moves horizontally toward a screen. The electron moves along the dotted path because of a magnetic force caused by a magnetic field. In what direction does that magnetic field point?

A. Toward the top of this page

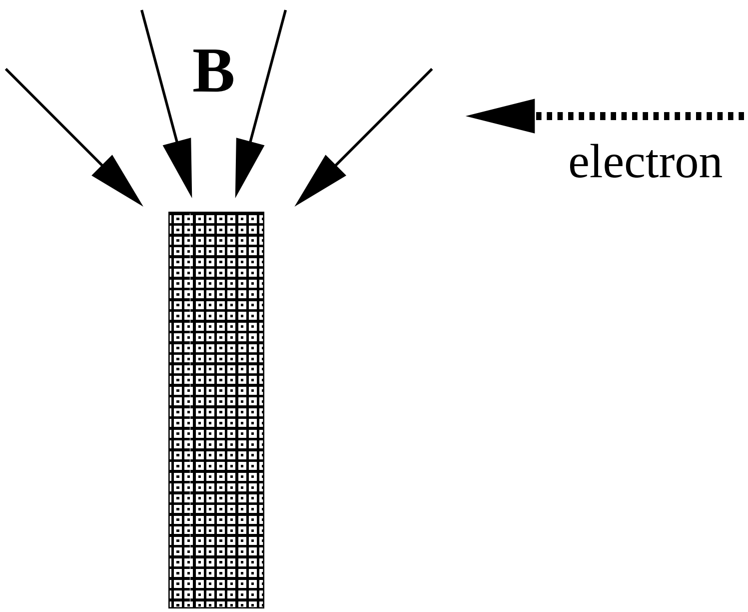
B. Toward the bottom of this page

C. Into this page

D. Out of this page



A uniform magnetic field points straight up in a laboratory on Earth. A positively charged ball is dropped in this field, and gravity makes it fall (at least initially) straight down. Which of the following best show its path?



An electron approaches the pole of bar magnet at high speed. The arrows on this diagram show the direction of the magnetic field and the direction of the electron's initial velocity. What type of pole (N or S) is the electron approaching and in which direction will the electron move?

A. S, into page
B. S, out of page
C. N, into page
D. N, out of page

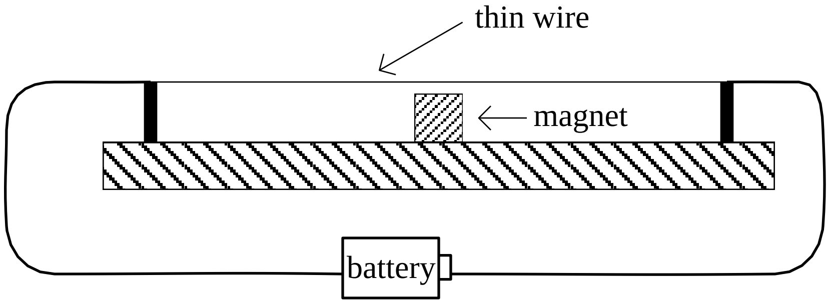
What happens to a positive charge that is placed at rest in a uniform magnetic field? (A uniform field is one whose strength and direction are the same at all points.)

A. It moves with a constant velocity since the force has a constant magnitude.

B. It moves with a constant acceleration since the force has a constant magnitude.

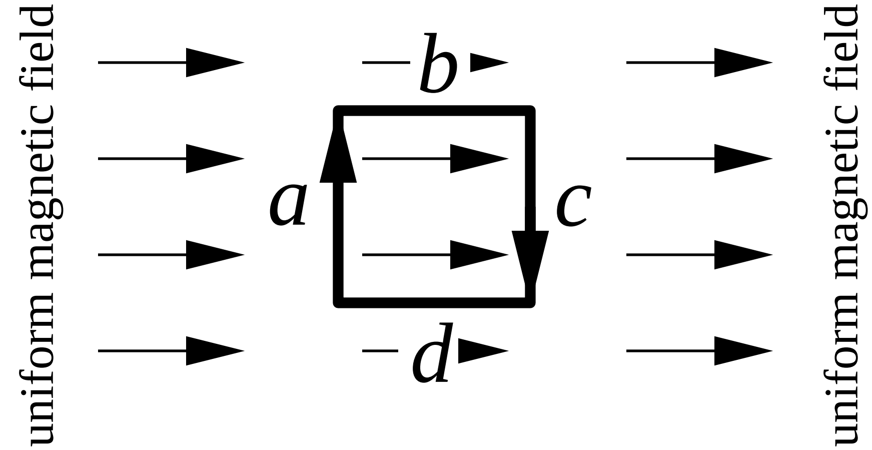
C. It moves in a circle at a constant speed since the force is always perpendicular to the velocity.

D. It remains at rest since the force and the initial velocity are zero.



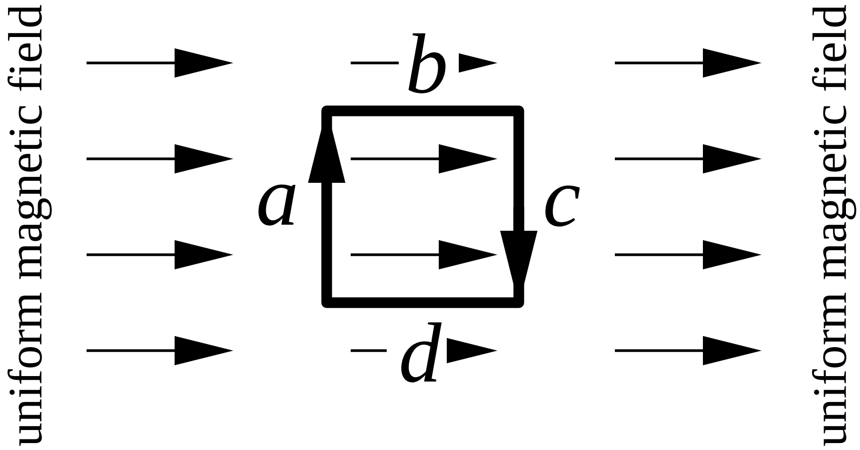
The picture above shows a device very similar to one used in class. A battery drives a current through a thin wire which is suspended above a magnet. When the battery is connected the thin wire moves into the page. What sort of pole is the top of the magnet?

A. N B. E
C. S D. W

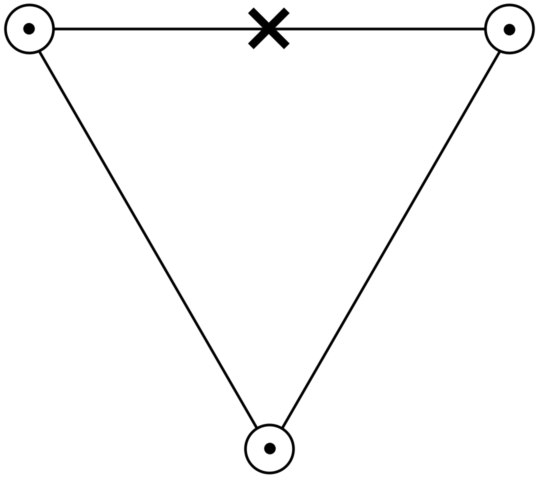


There is a current flowing clockwise around a square loop which is surrounded with a uniform magnetic field pointing to the right. The torque on this loop will try to rotate the loop so:

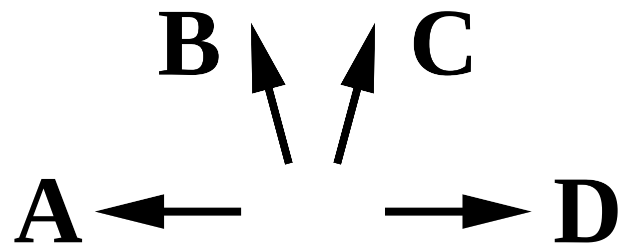
A. side *a* moves out of the page
B. side *b* moves out of the page
C. side *c* moves out of the page
D. side *d* moves out of the page

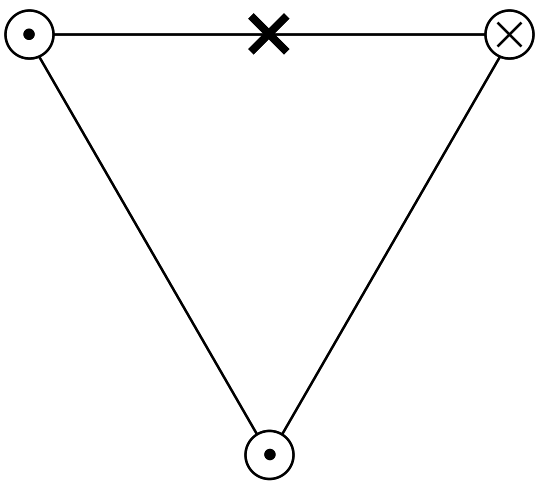


A. wire *a* moves out of the page
B. wire *b* moves out of the page
C. wire *c* moves out of the page
D. wire *d* moves out of the page

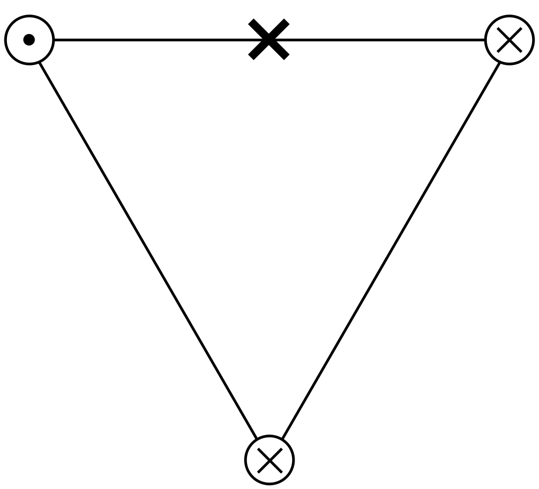


Long straight wires, carrying equal currents, are placed at the corners of an equilateral triangle. Which vector best displays the direction of the magnetic field at X?

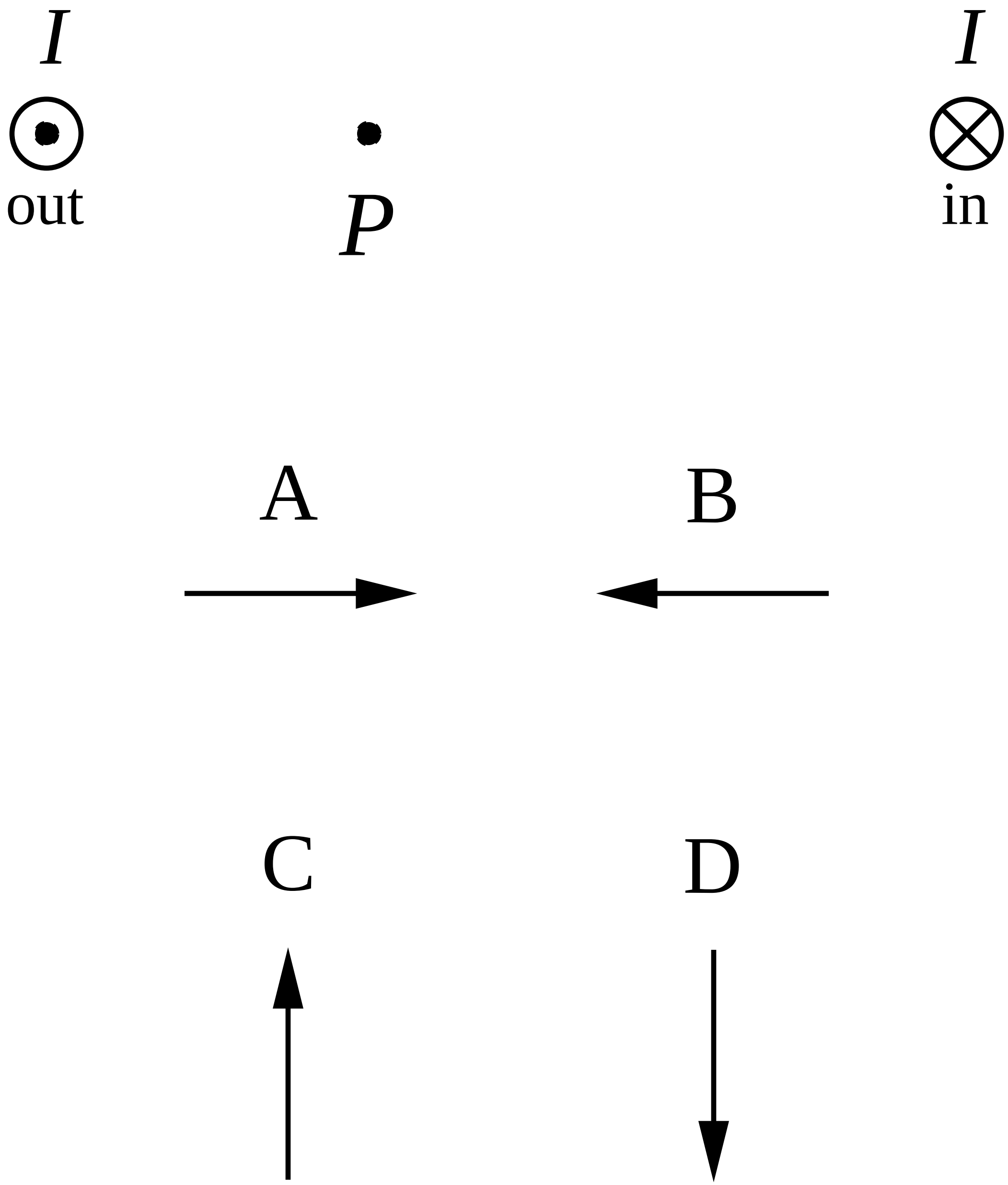




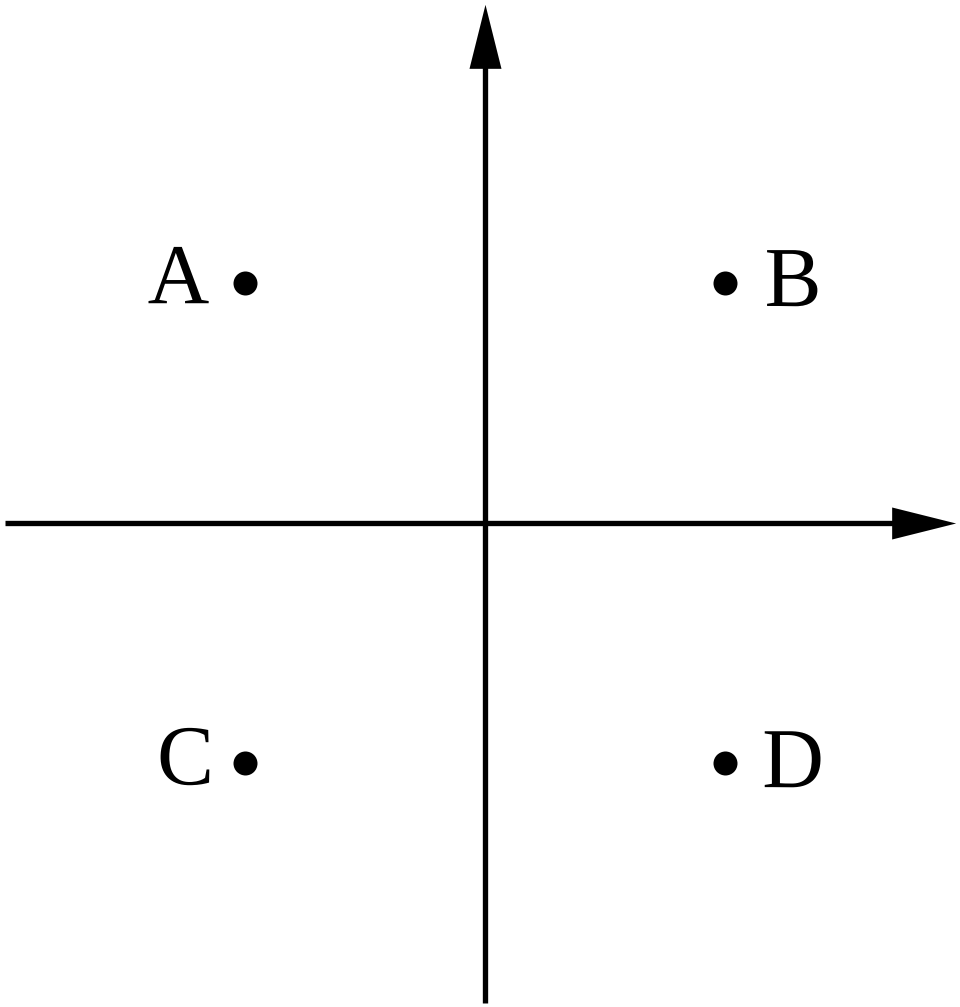
One current is now reversed...



Another current is reversed...



Wire 1 has a large current I flowing out of the page (⊙), as shown in the diagram. Wire 2 has the same current I, but flowing into the page (⊗).
In what direction does the magnetic field point at position P?

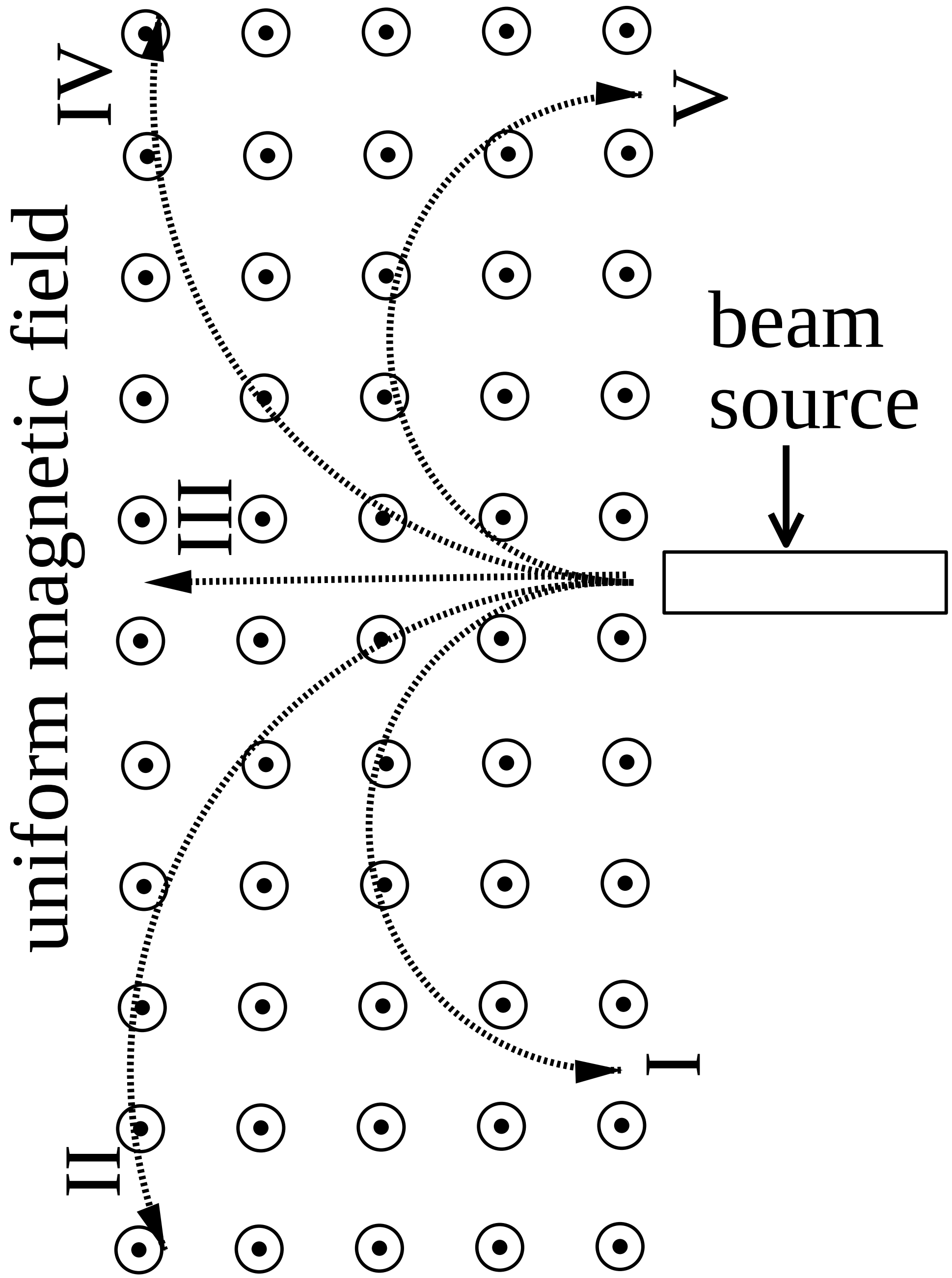


Crossed wires each carry the same current I.

Which point has a magnetic field pointing out of the page?

Into the page?

Zero?



In this case the particles all have the same *speed*, Which of the below statements properly assigns particles with paths?

A. I=electron; V=proton

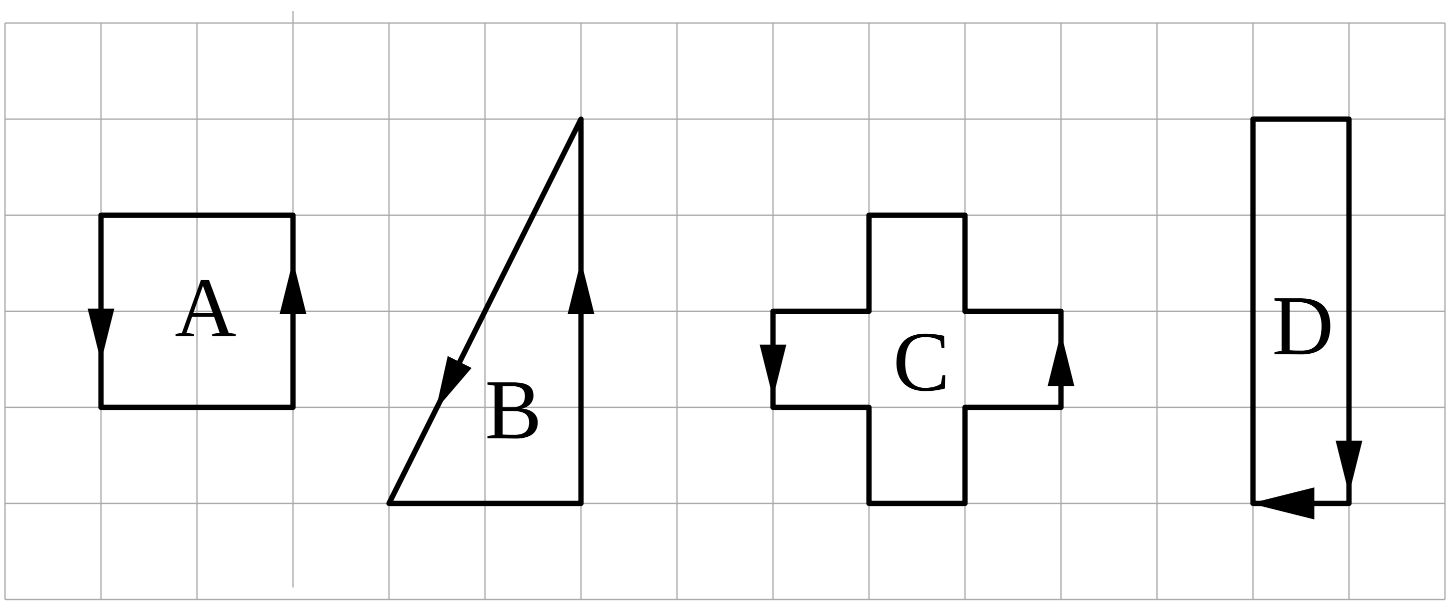
B. IV=deuteron and α; V=proton

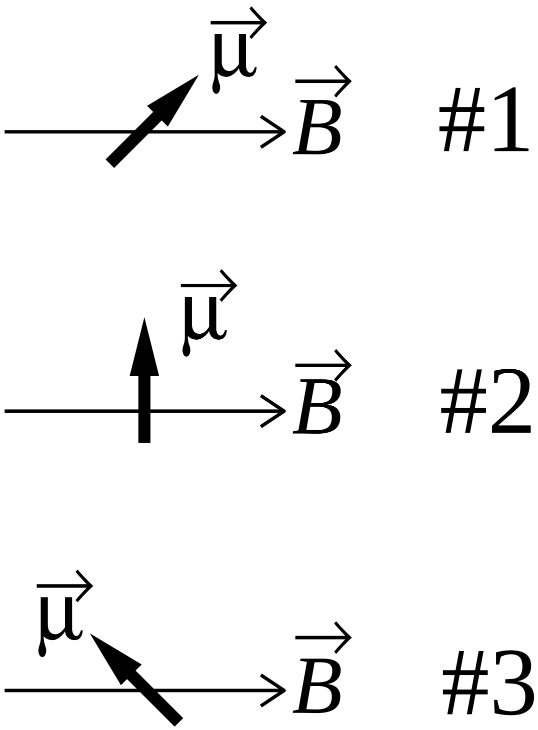
C. I=proton; II=deuteron

D. I=electron; III=α; IV=deuteron

Each of the below loops carries a current I. Which has the biggest magnetic dipole moment?

Smallest?





The figure shows three different configurations of a magnetic dipole μ placed in a uniform magnetic field *B*. Which of the below options best describes the relationship between the magnitude of the torque experienced by the dipole in these configurations. (τ_1 denotes the magnitude of the torque in configuration #1, etc.)

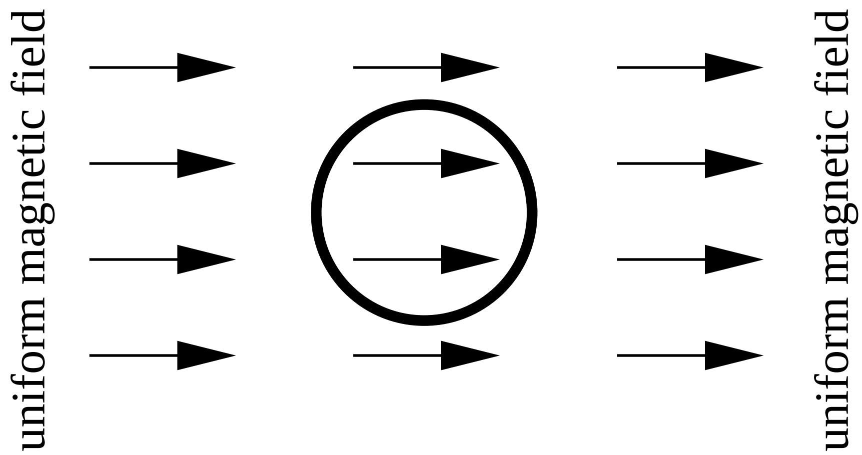
A. $\tau_1 > \tau_2 > \tau_3$ **B.** $\tau_1 < \tau_2 < \tau_3$

C. $\tau_1 = \tau_2 = \tau_3$ **D.** $\tau_1 = \tau_3 < \tau_2$

Consider the potential energy of the magnetic dipole in the uniform magnetic field of the previous problem. Which of the below options best describes the relationship between the potential energy of the dipole in these configurations. (U_1 denotes the potential energy in configuration #1, etc.)

A. $U_1 > U_2 > U_3$ **B.** $U_1 < U_2 < U_3$

C. $U_1 = U_2 = U_3$ **D.** $U_1 = U_3 < U_2$



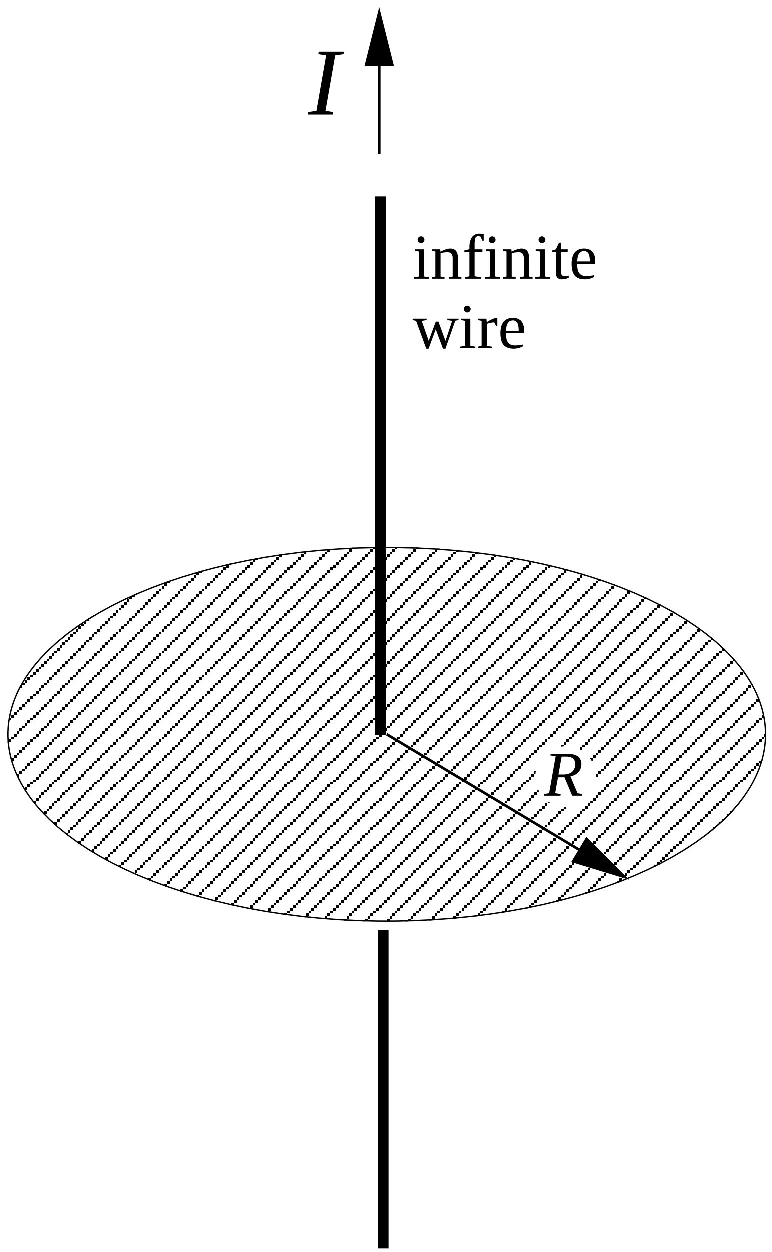
The magnetic field and the circular loop lie in the plane of this page. The magnetic flux through the loop is:

A $+\pi r^2 B$

B $-\pi r^2 B$

C $+2\pi r B$

D zero



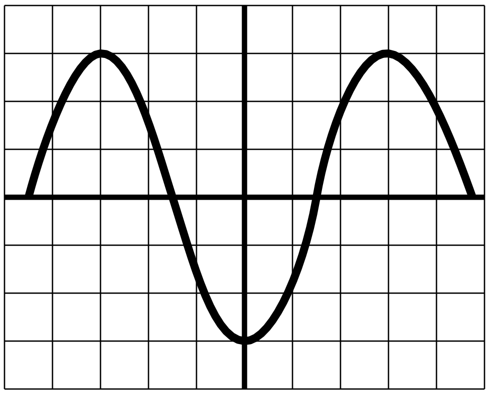
Consider the case of an infinite wire, carrying a current I sitting on the z axis. The magnetic flux through a disk of radius R, sitting in the xy plane and centered on the origin is:

A. $2 \pi R B$

B. $+ \pi R^2 B$

C. $- \pi R^2 B$

D. 0



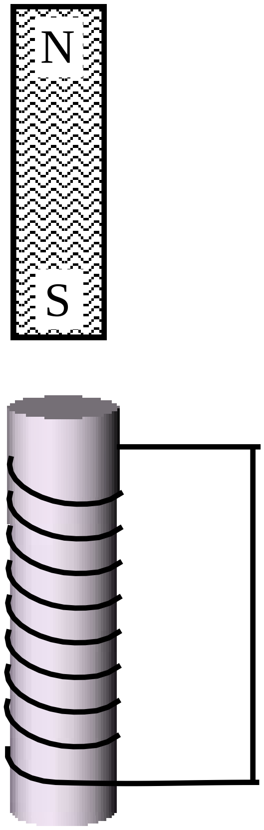
In this oscilloscope trace the vertical scale is 1V/div and the horizontal scale is 2ms/div.

V_{rms} is most nearly?

A:3 **B**:2 **C**:1 **D**:0

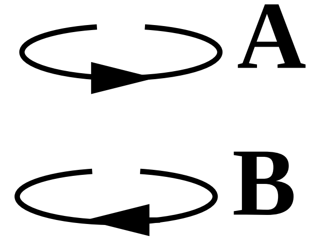
The period is most nearly:

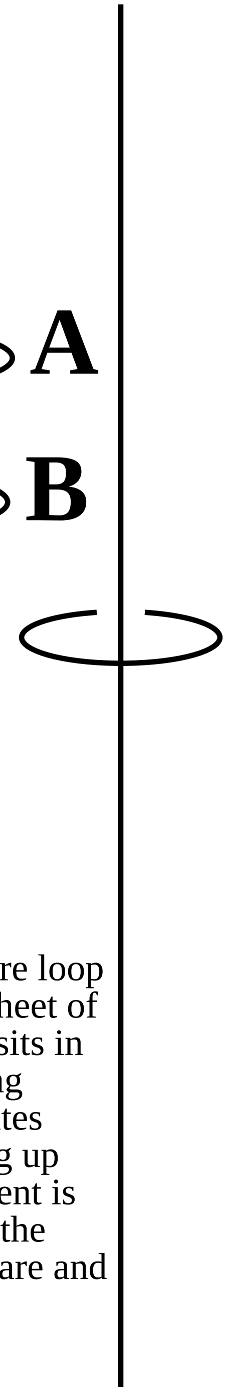
A:12ms **B:**8ms **C:**6ms **D:**2ms

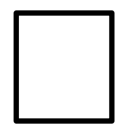


The south pole of a bar magnet has been sitting near the end of a solenoid. The bar magnet is now moved vertically towards the solenoid. Which way will the current flow in the straight section?

A. Up
B. Down

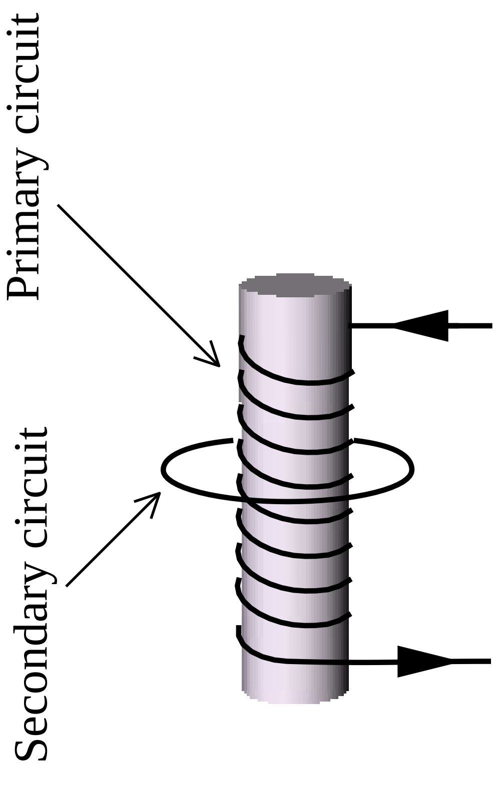




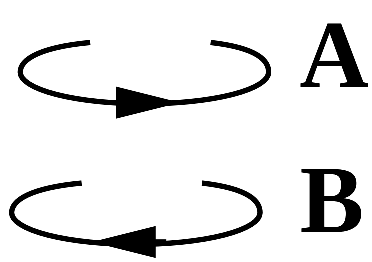


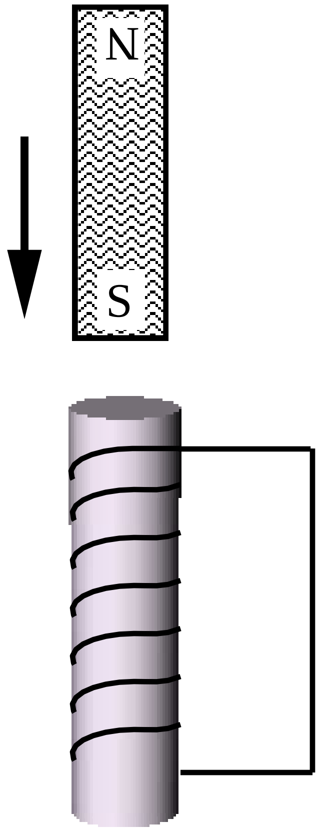
A. Clockwise
B. Counter Clockwise

A long straight wire and a square loop of wire sit in the plane of this sheet of paper. A circular loop of wire sits in a plane perpendicular to the long straight wire. For several minutes there has been a current flowing up the long straight wire; that current is now reduced. Which way will the induced current flow in the square and the circle?



A current has been flowing through the primary circuit in the direction indicated. This current is now reduced to zero. What is the direction of the current induced in the secondary circuit



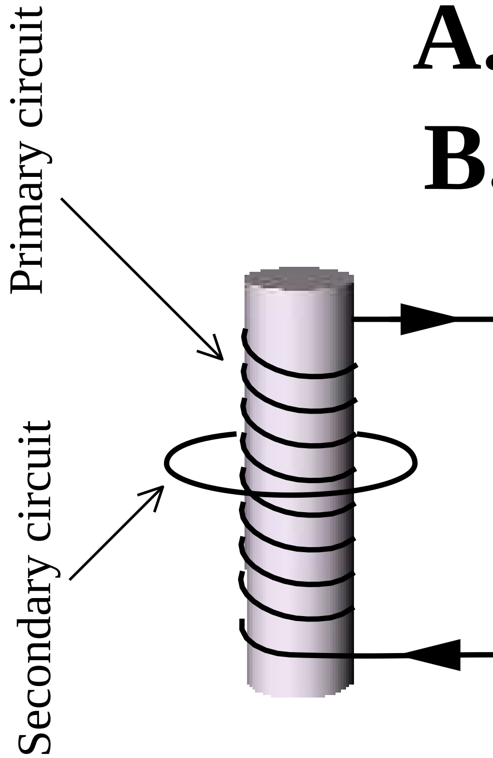


The south pole of a bar magnet is approaching the solenoid

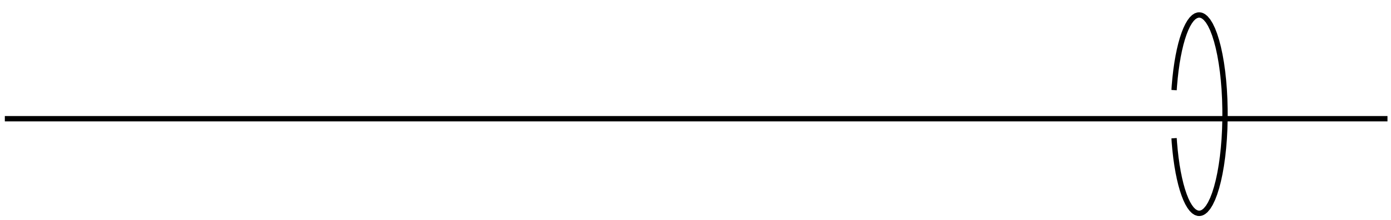
A. Up **B.** Down

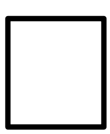
A. Left

B. Right



The current shown flowing through the primary circuit is increasing

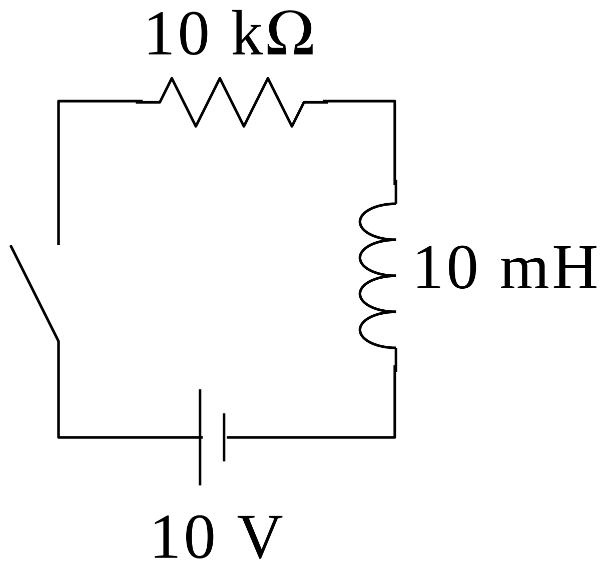


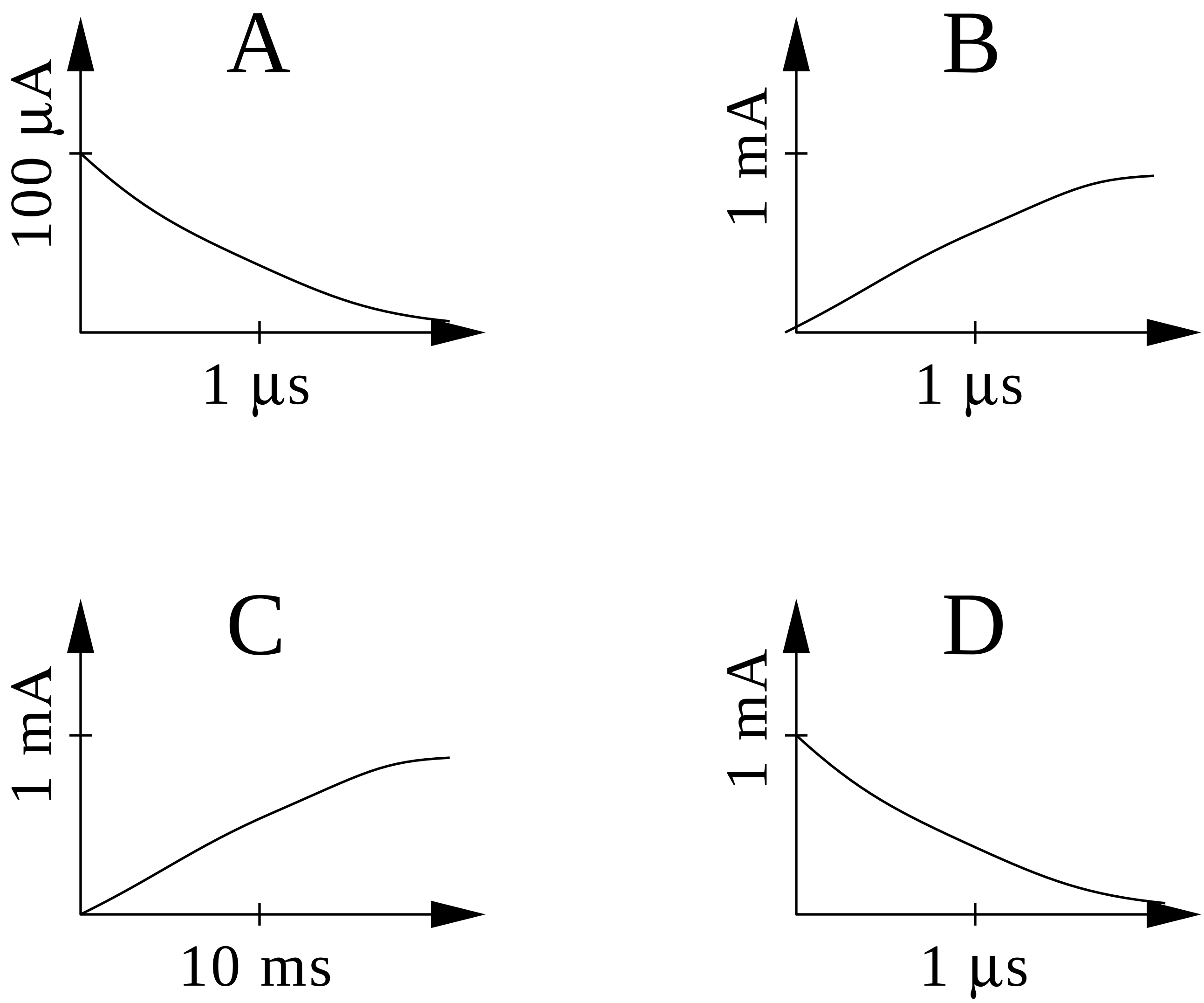


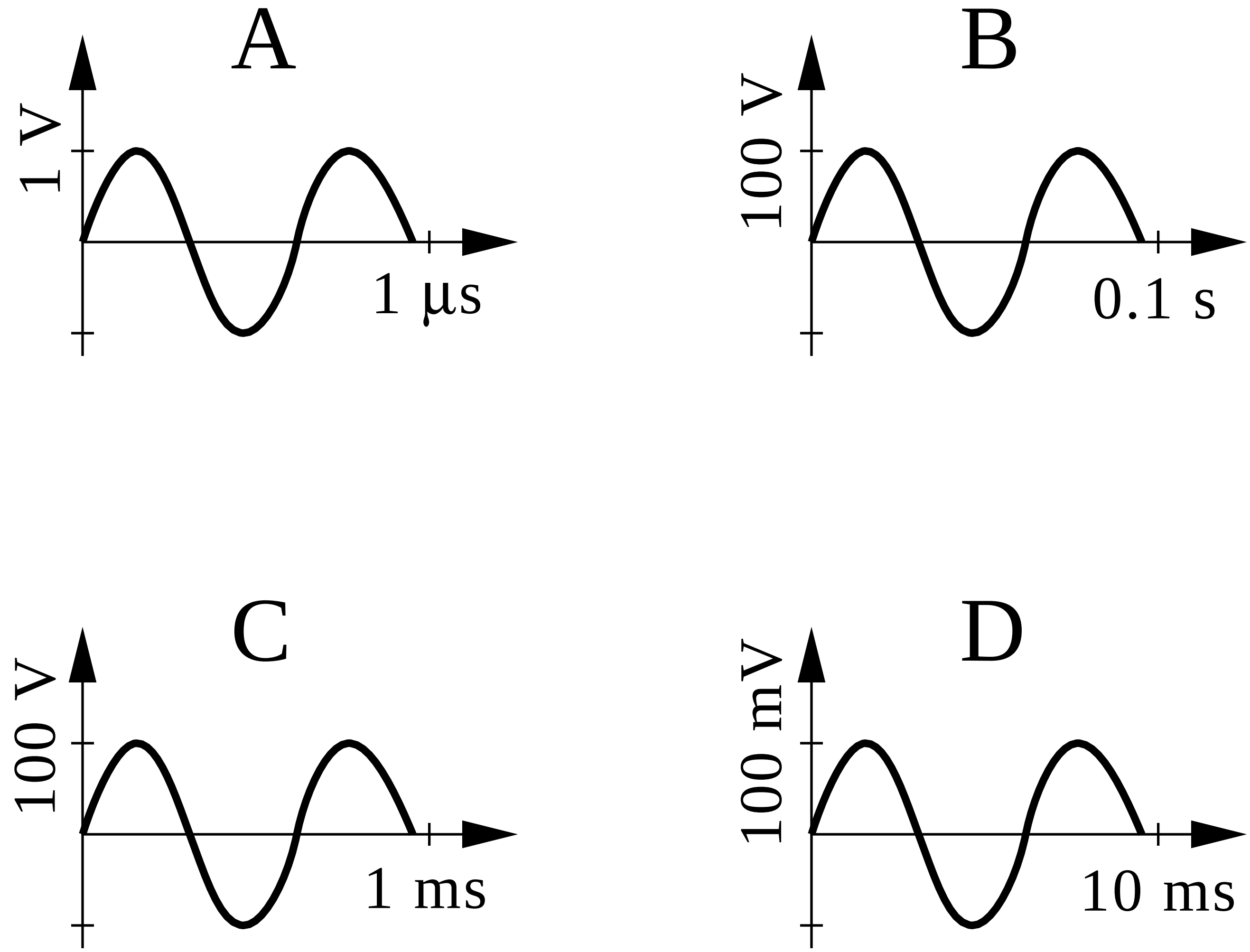
A long straight wire and a square loop of wire sit in the plane of this sheet of paper. A circular loop of wire is centered on the long wire, but sits in a plane perpendicular to this sheet of paper. For several minutes there has been no current flowing in any wire. A battery (not shown) is connected and a current starts to flow to the right through the long straight wire.

A. Clockwise

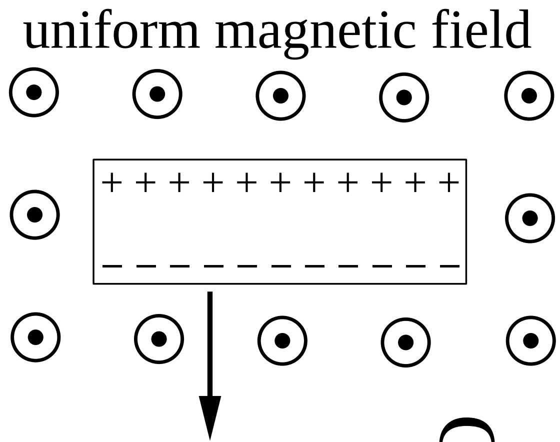
B. CCW


10 kΩ
10 mH
10 V

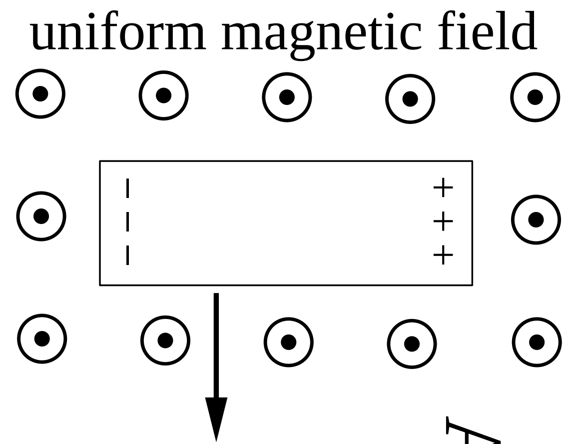

A
100 μA
1 μs
B
1 mA
1 μs
C
1 mA
10 ms
D
1 mA
1 μs



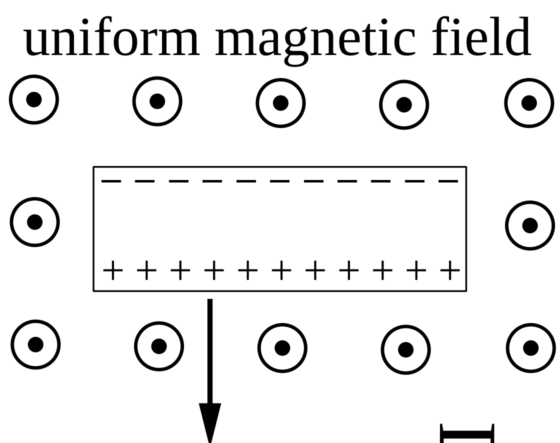
A generator has 10,000 turns around a square loop with side 1cm and is spinning at ω=100rad/s. What does is the output voltage?


uniform magnetic field

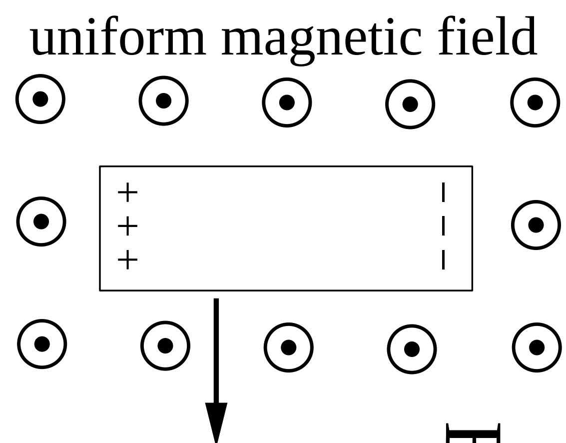
C


uniform magnetic field

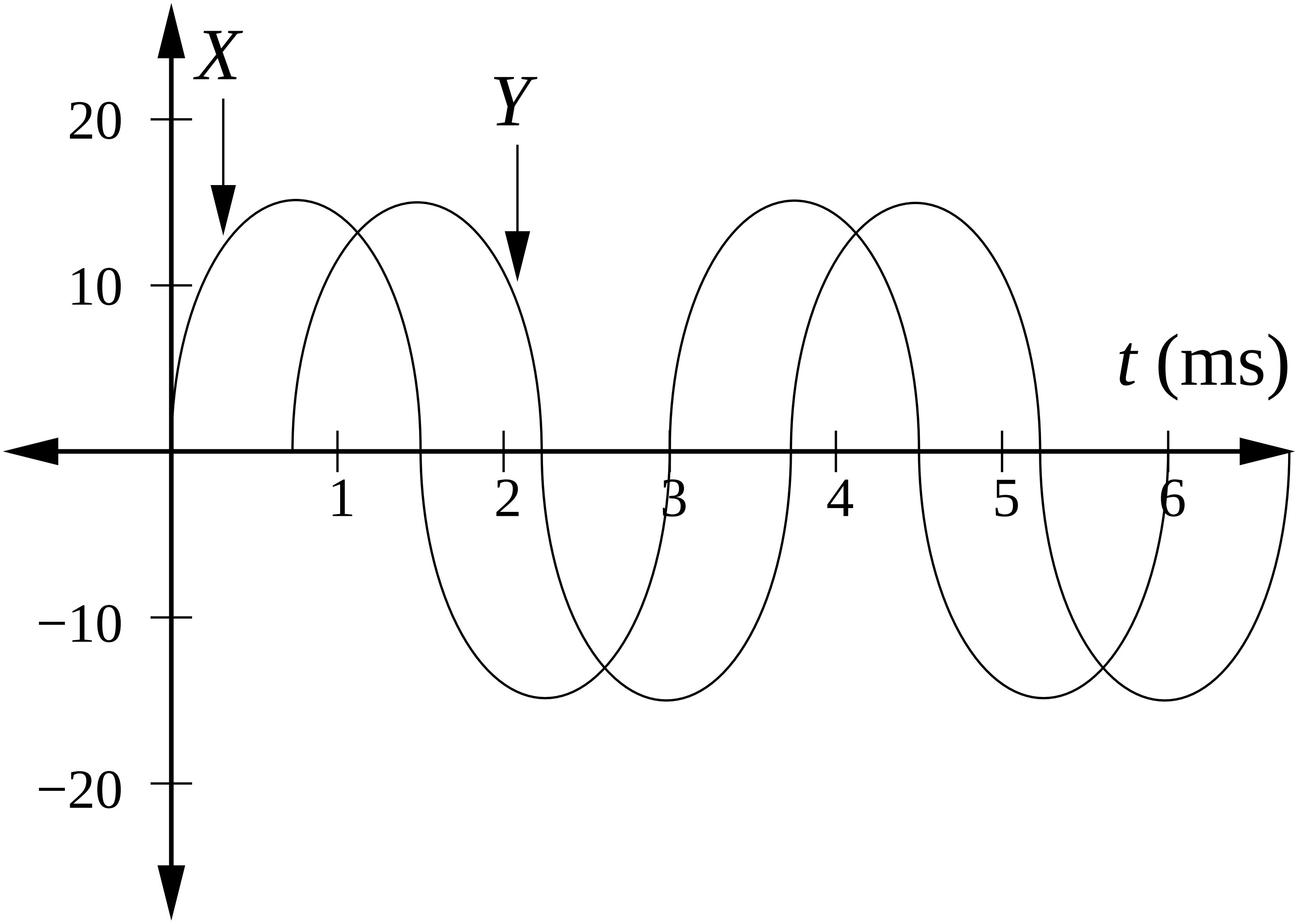
A


uniform magnetic field

D


uniform magnetic field

B



A. X leads Y

B. Y leads X

C. X lags Y

D. Y lags X

If this is an *L*...

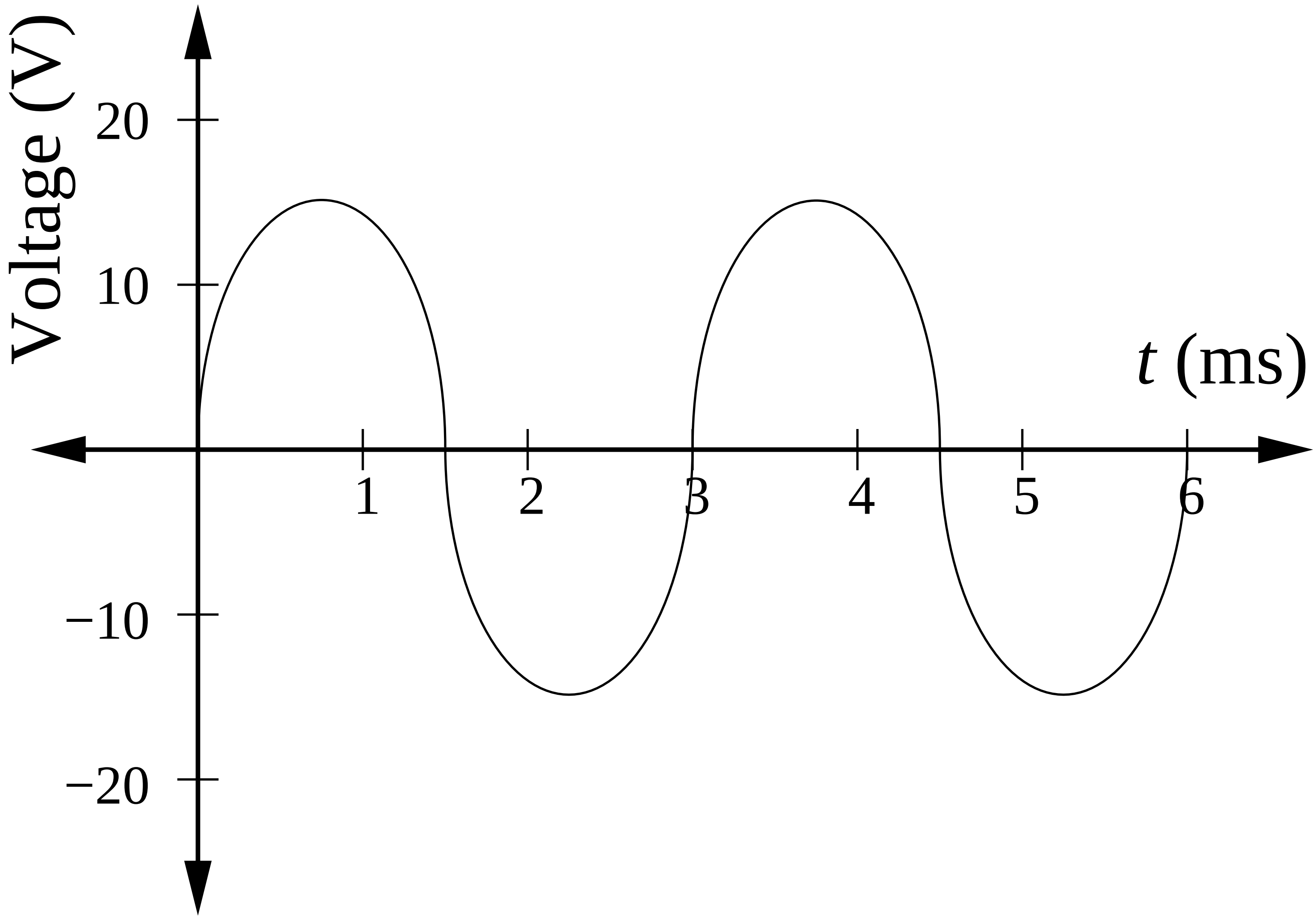
A. X is *I*, Y is *V*

B. X is *V*, Y is *I*

If this is a *C*...

A. X is *I*, Y is *V*

B. X is *V*, Y is *I*



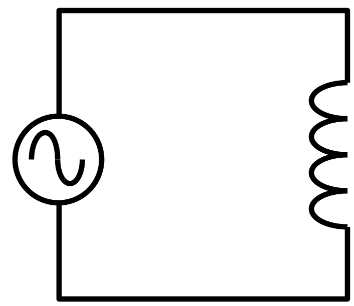
A. 10 V
B. 14 V
C. 28 V
D. −14 V

1. V_{rms}
2. V_m or V_p
3. $V_{p\text{-}p}$

A. .0015
B. .003
C. 333
D. 2000

4. T
5. f
6. ω

The ac generator in this circuit has a fixed voltage (V) and frequency (f). We seek to maximize the current through a particular coil with inductance L. Compared to the simple circuit shown, the current through the coil could be increased by:

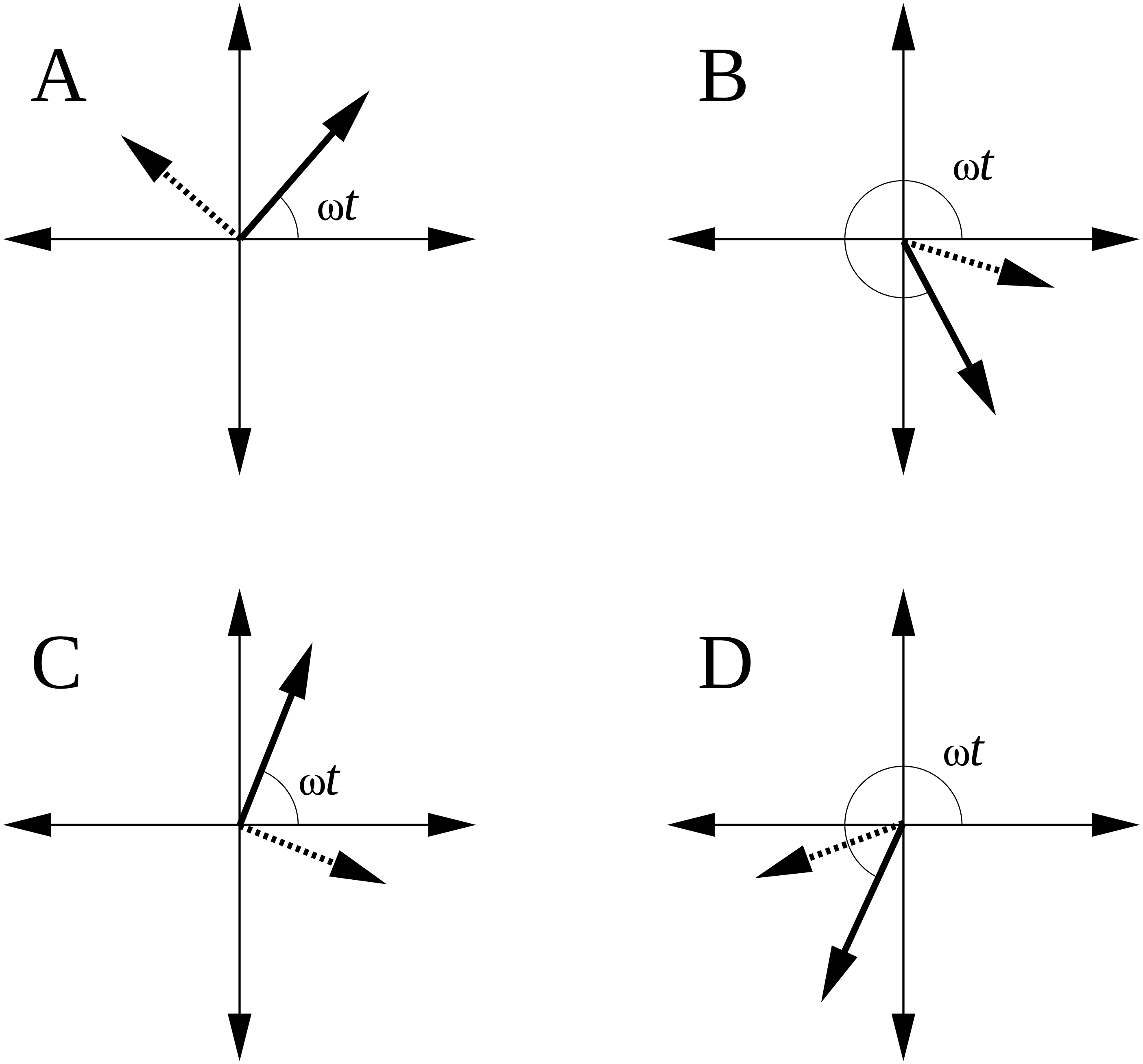


A. Adding a resistor in parallel to L

B. Adding a capacitor in series with L

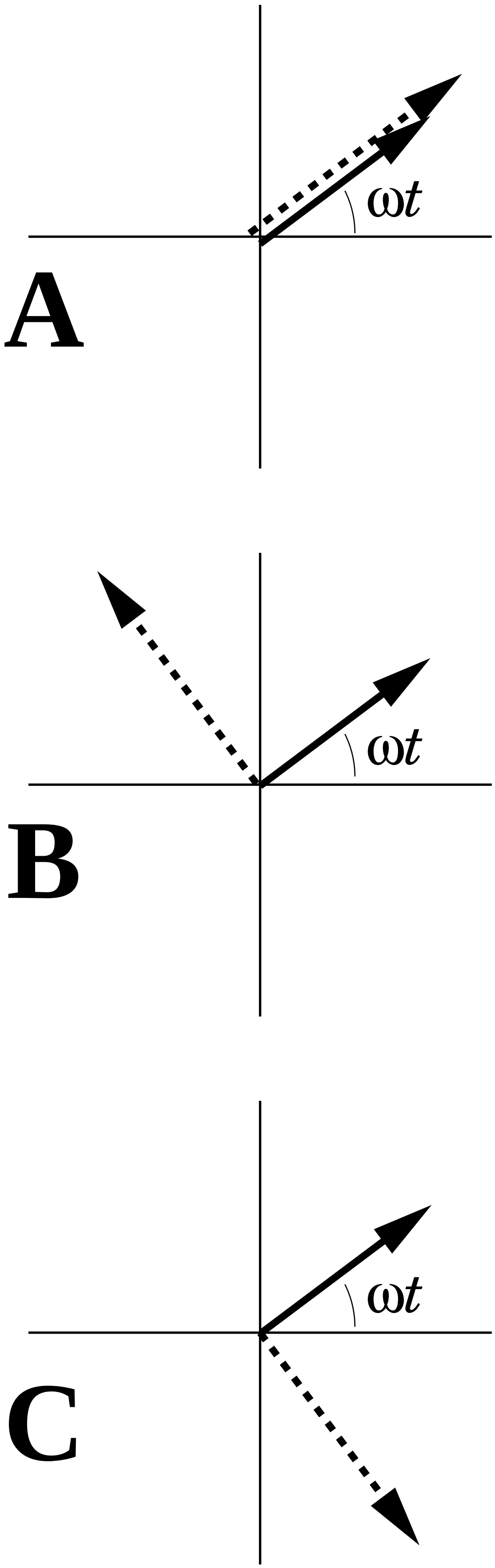
C. Adding an inductor in parallel with L

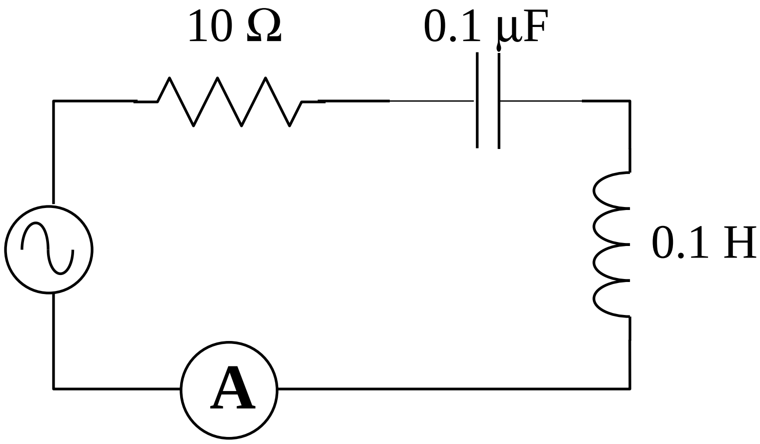
D. It is not possible to increase the current through the coil by adding components.


A
ωt
B
ωt
C
ωt
D
ωt

If the solid arrow represents the phasor for V_R which case shows:

V_L?
V_C?



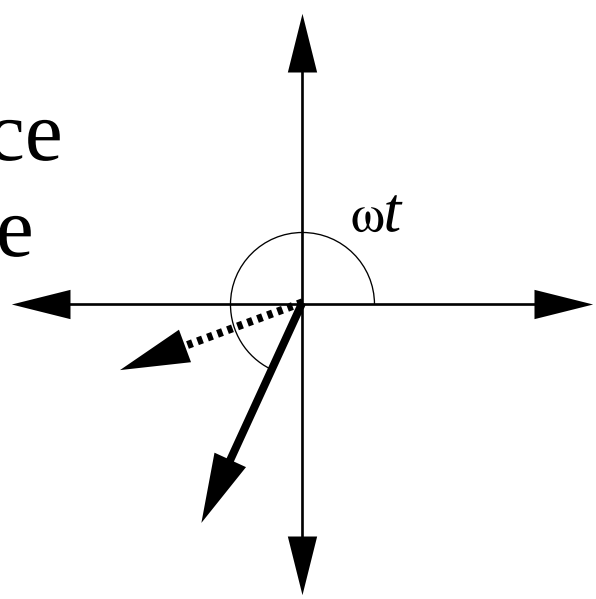


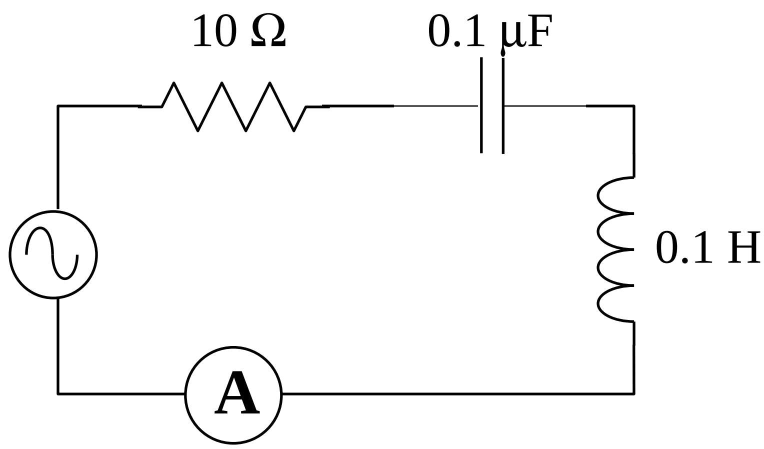
What value of ω would maximize the current?

A:10^5 **B**:10^4 **C**:10^3 **D**:10^2

If the phasor diagram is as shown, ω is

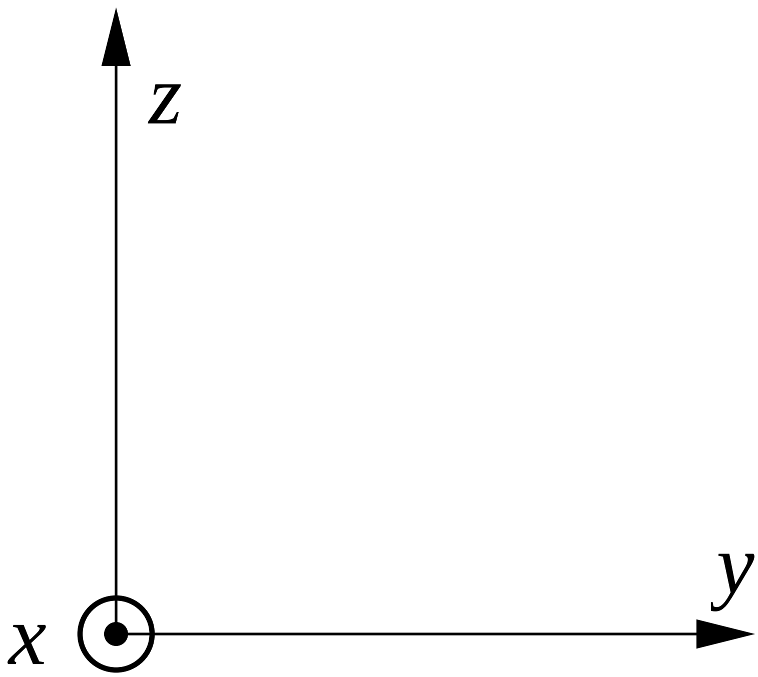
A. higher than resonance
B. lower than resonance
C. at resonance





If $R < X_L < X_C$, which component will heat the most?

A: *R* **B:** *L* **C:** *C*



If light is moving out of the page (+x direction), and the electric field is in the +y direction, the magnetic field is in:

A. +z direction
B. −z direction
C. +y direction
D. none of the above