JEE 2025

COMPETENCY BASED QUESTIONS

1. A proton (e) approaches a short fixed electric dipole (p) moving along the dipole axis as shown in the figure. At a large distance from the dipole, the kinetic energy of the proton was K_0 = 400 eV.

The graph below shows the variation of kinetic energy (K) of the proton at points close to the dipole. Find the value of r_0 (r_0>> length of the dipole).

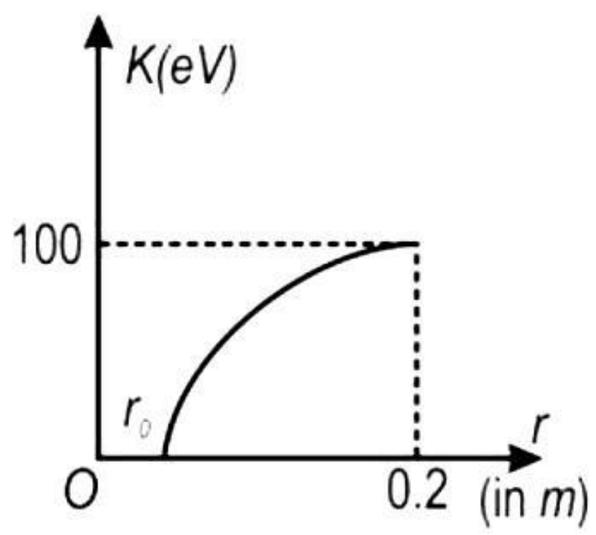
In the graph r is the distance from the centre of the dipole.

(a) $\sqrt{3}/5$

(b) $\sqrt{3}/10$

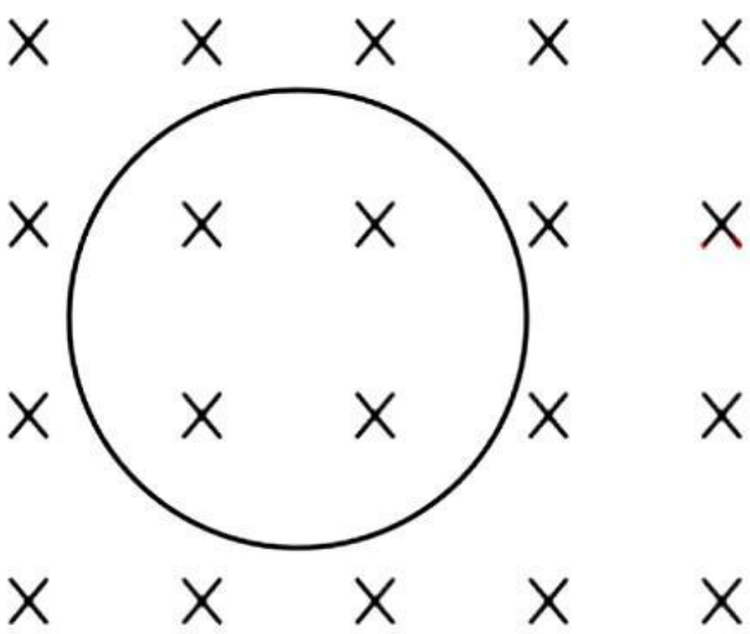
(c) $1/\sqrt{5}$

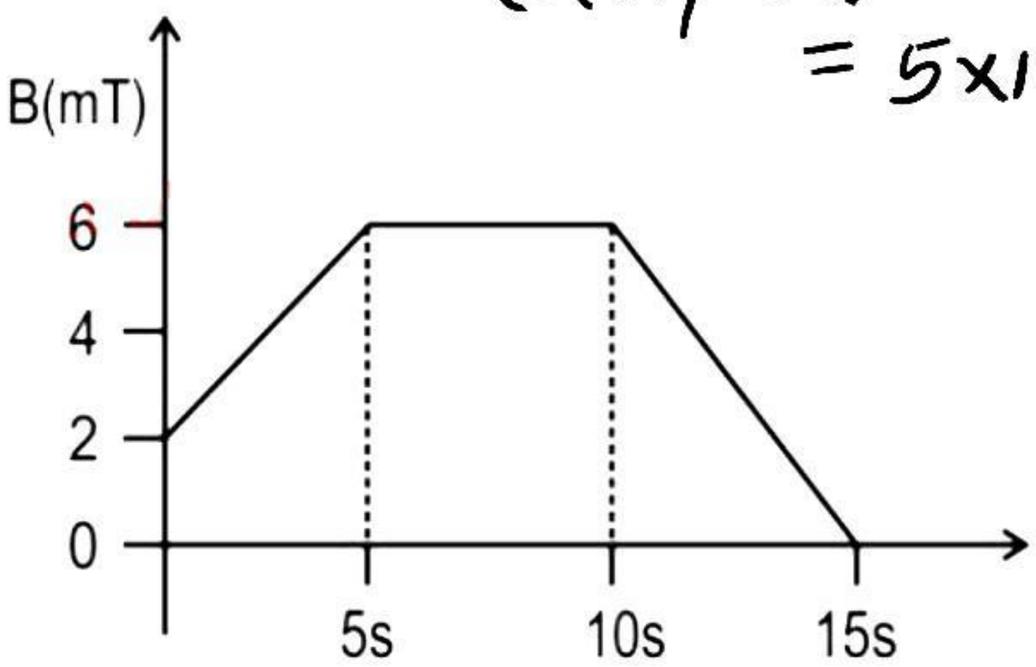
(d) $1/\sqrt{10}$



2.

A circular loop of conducting wire is placed in a time-varying magnetic field such that the plane of the loop is perpendicular to the magnetic field. The graph below represents the variation of the magnetic field with time. (Loop Area $= 5 \times 10^{-4} m^2$)





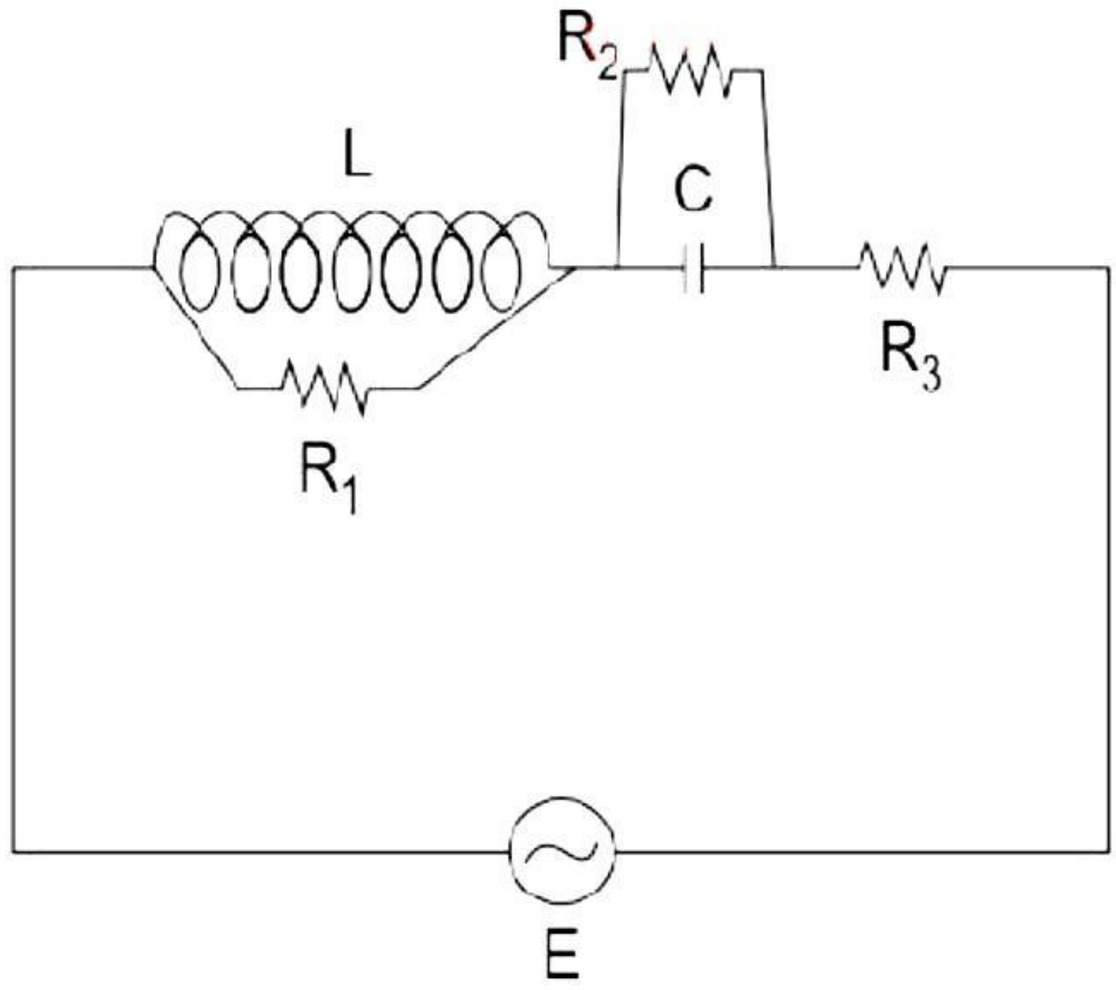
(a) In which time interval will the current induced in the coil be in the clockwise direction? Give reason.

(b) Emf induced in interval 10s — 15s is

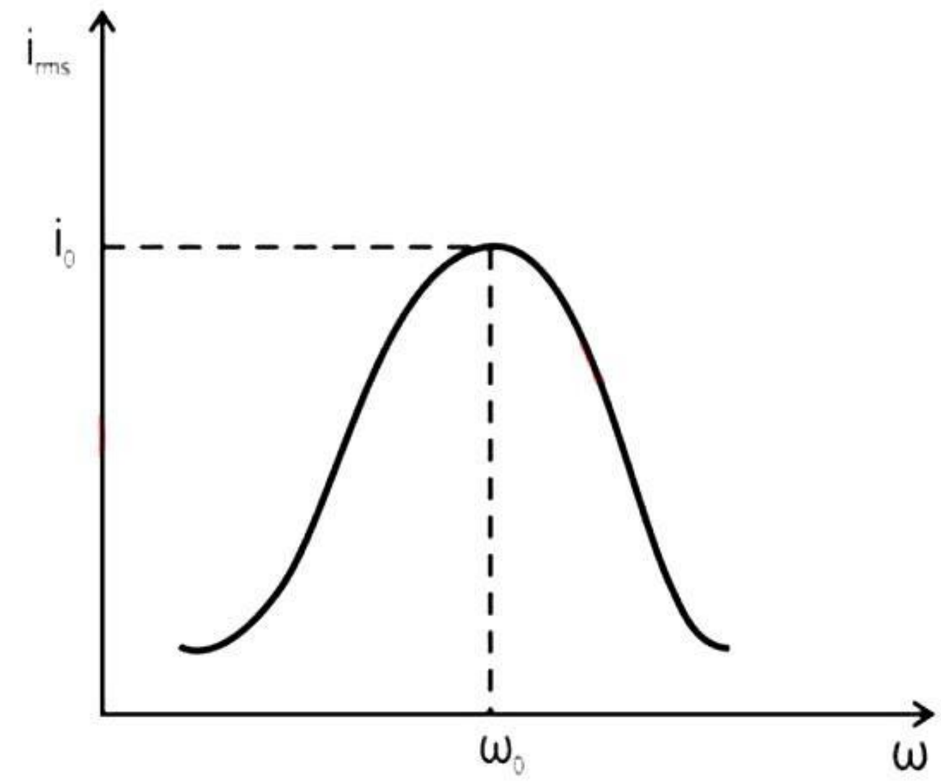
— $\times 10^{-7}$ V

3.

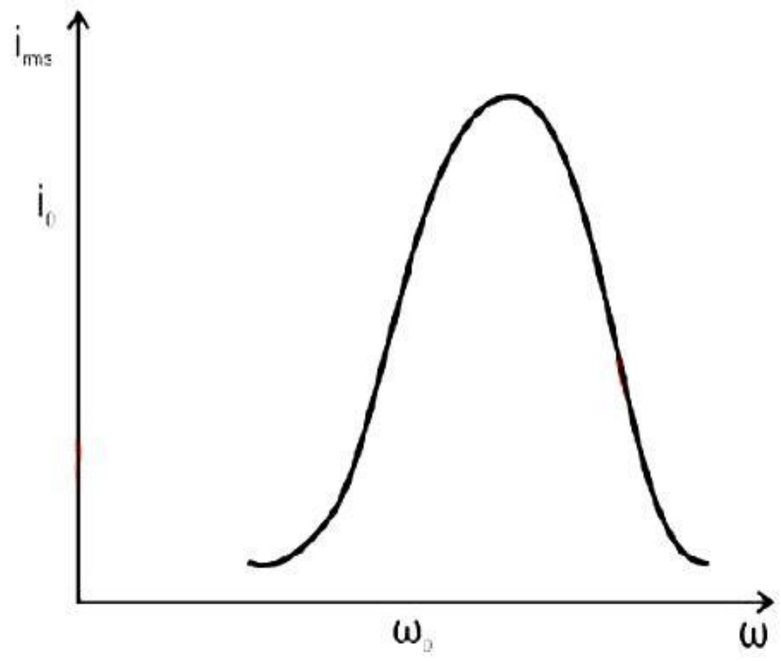
A very high frequency AC source of peak EMF 200 V is connected across a circuit as shown in the figure. The components of the circuit are L = 1 mH, C = 1 μF, R_1=10 ohm, R_2 = 40 ohm, R_3 = 30 ohm. What is the approximate value of the peak current flowing through this circuit?



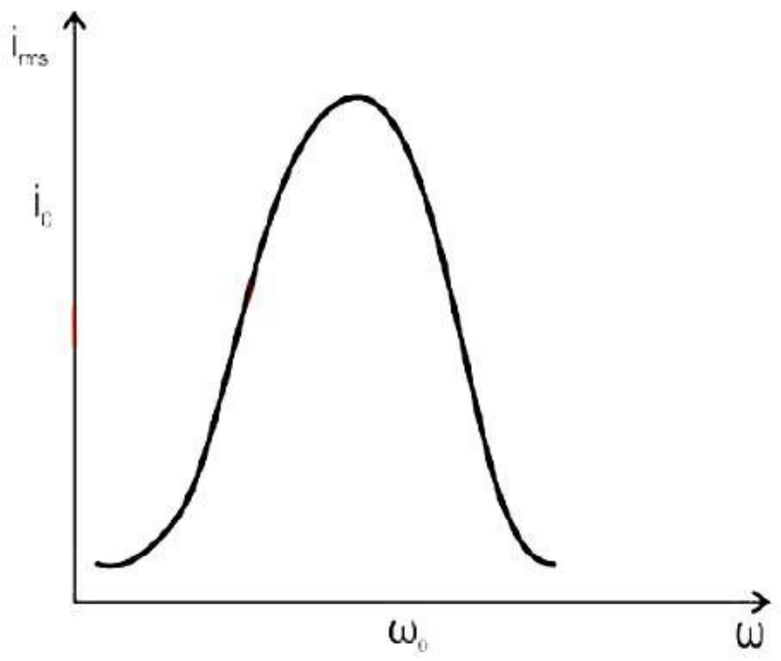
4. The graph below shows the frequency response of an LCR circuit when connected to an AC source.



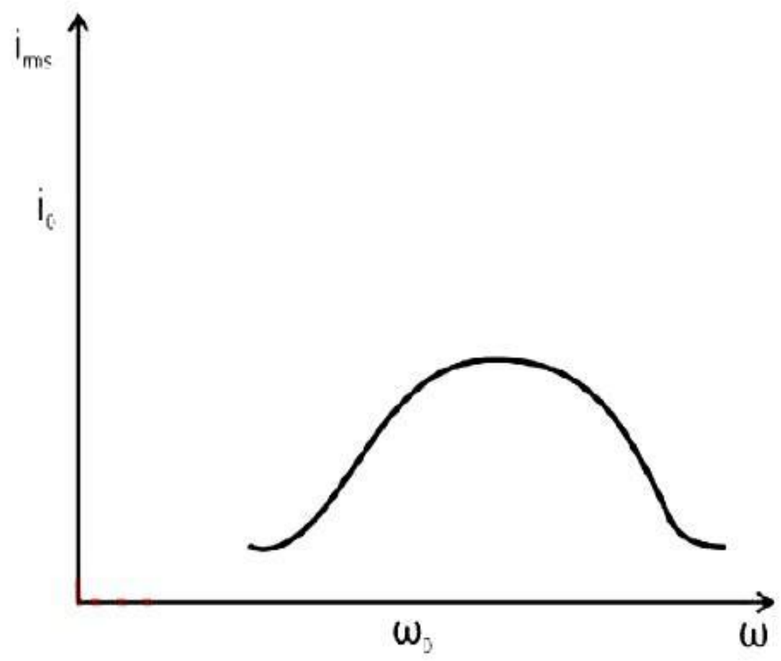
Which of the following graphs CORRECTLY represents the change in the frequency response of the LCR circuit if the capacitance and the inductance of the circuit are increased and resistance is decreased?



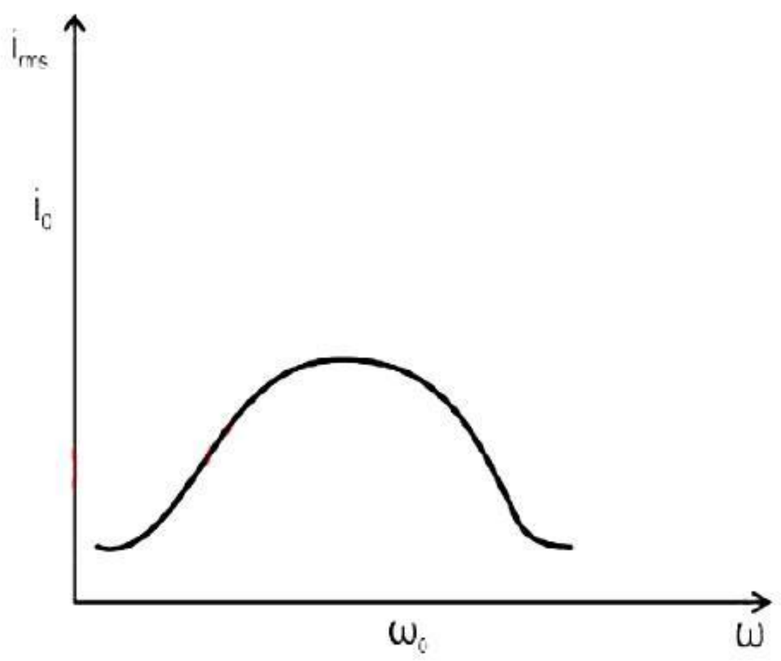
A



B



C



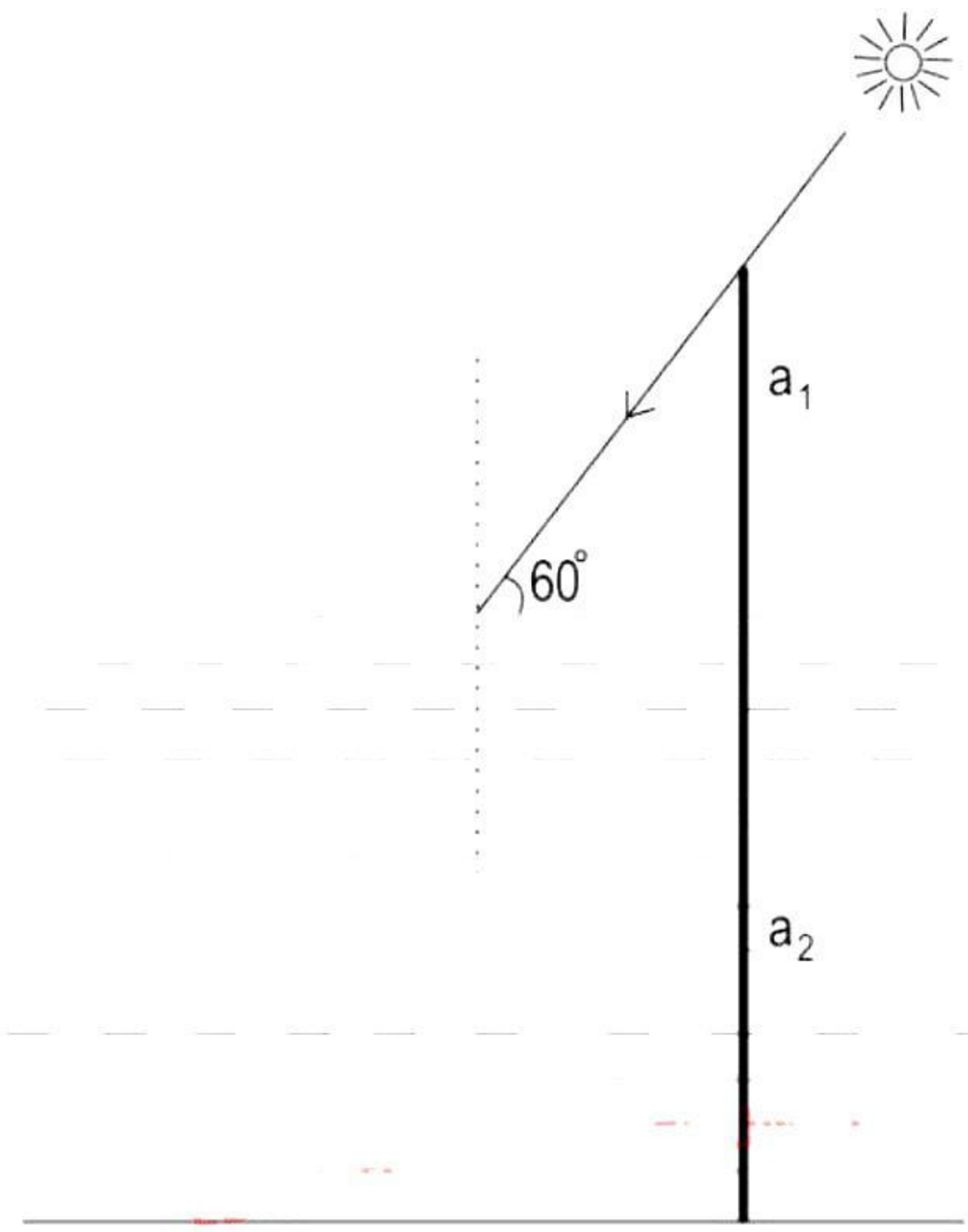
D

A. A
B. B
C. C
D. D

5.

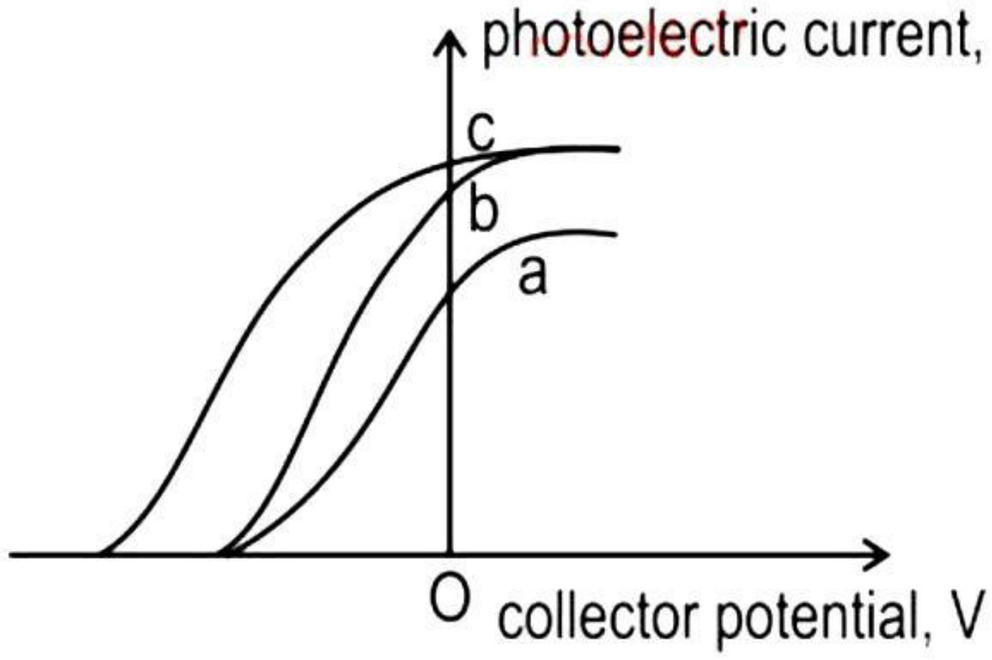
A pole stands in a pool of water such that the sun shines at an angle as shown in the diagram. The ratio of the height of the pole above the water, a_1 to that inside the water, a_2 is √3/ √55.

$n = 4/3$



The ratio of length of shadow of pole on water Surface to that at the bottom of pool in 1/x, find x

6. Study the following graphs between photoelectric current (i) vs. collector potential (V) for three different radiations a, b, and c of frequencies f_a, f_b, f_c respectively with corresponding intensities I_a, I_b, and I_c respectively falling on a given photosensitive surface.



Select the correct option.

A. $f_a \neq f_b$; $I_a = I_b$
B. $f_b = f_c$; $I_b = I_c$
C. $f_a = f_b$; $I_a \neq I_c$
D. $f_b \neq f_c$; $I_b \neq I_c$

7. Assertion (A): The mass of a nucleus is less than the mass of the constituent particles.

Reason (R): Energy is absorbed when the nucleons are bound together to form the nucleus.

A. Both assertion and reason are true and reason is the correct explanation for assertion.
B. Both assertion and reason are true but reason is not the correct explanation of assertion.
C. Assertion is true but reason is false.
D. Both assertion and reason are false.

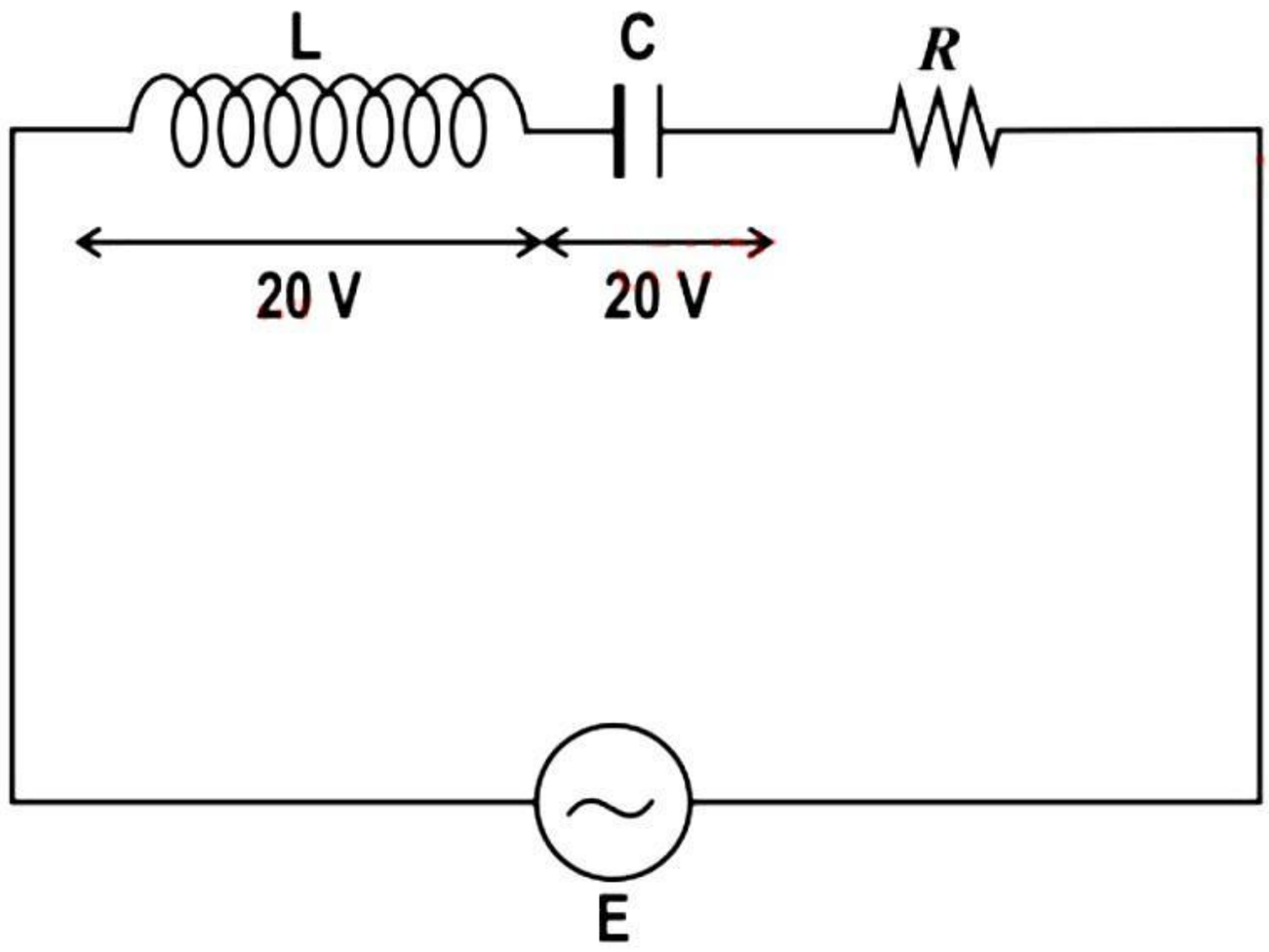
8.

In a Geiger Marsden experiment, an alpha particle of energy ½ mv^2 bombards the heavy target nucleus of charge Ze.

In the modified version of the Geiger Marsden experiment, a bombarding particle of 3 times the mass and 2 times the charge of the alpha particle moving with the same speed as earlier, is used as the bombarding particle, keeping the heavy target nucleus the same as earlier.

If the distance of closest approach in the first case is r_0, then distance of closest approach in modified case is $\frac{Nr_0}{3}$, find N

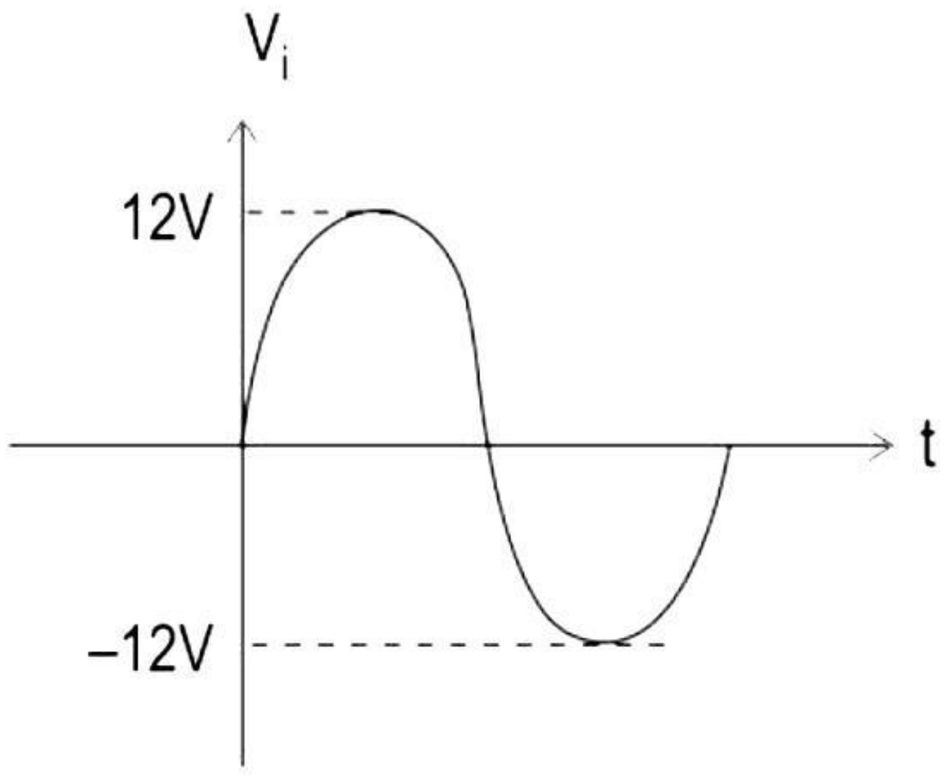
9. Shown below is a series LCR circuit connected to an ac source of emf E. The voltage drop across the inductor and the capacitor is 20 V.

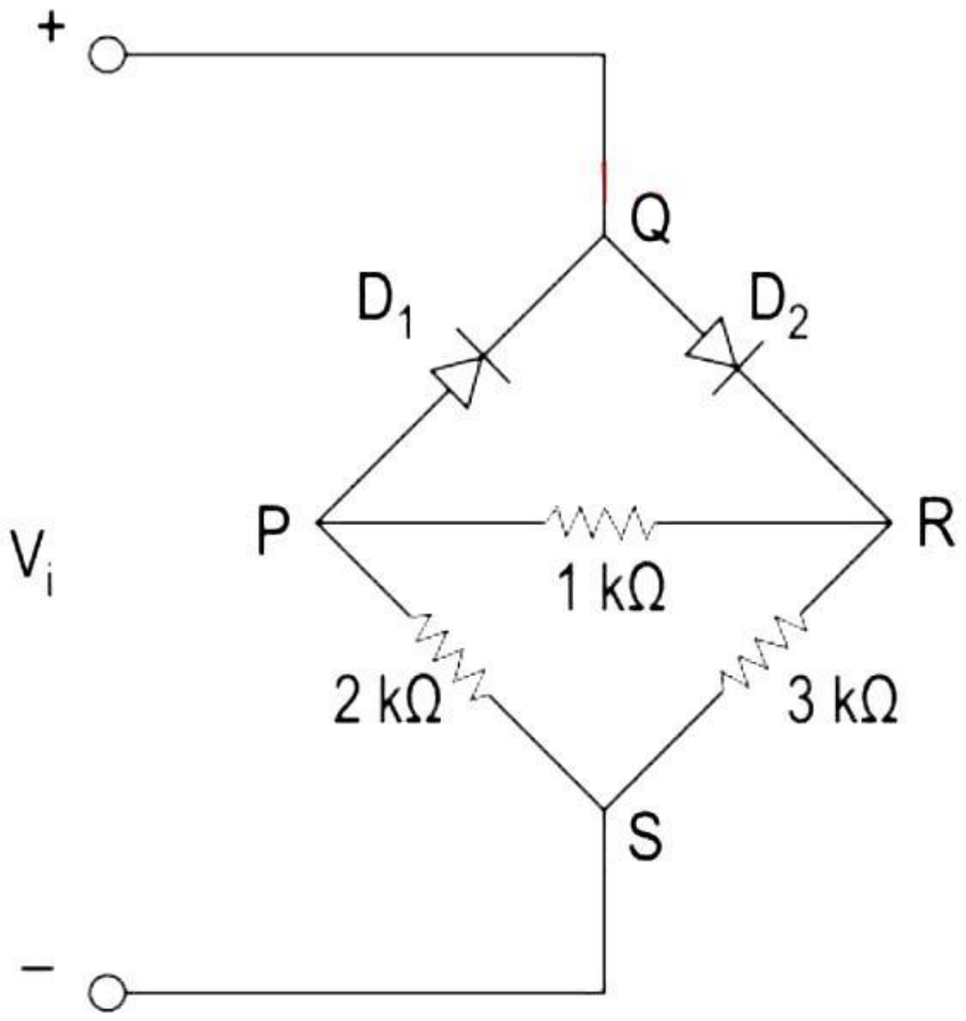


Which of the following will happen if the value of R is doubled?

A. The voltage across L will be doubled.
B. The voltage across C will remain the same.
C. The voltage across the LC combination will be halved.
D. The voltage across the LC combination will remain the same.

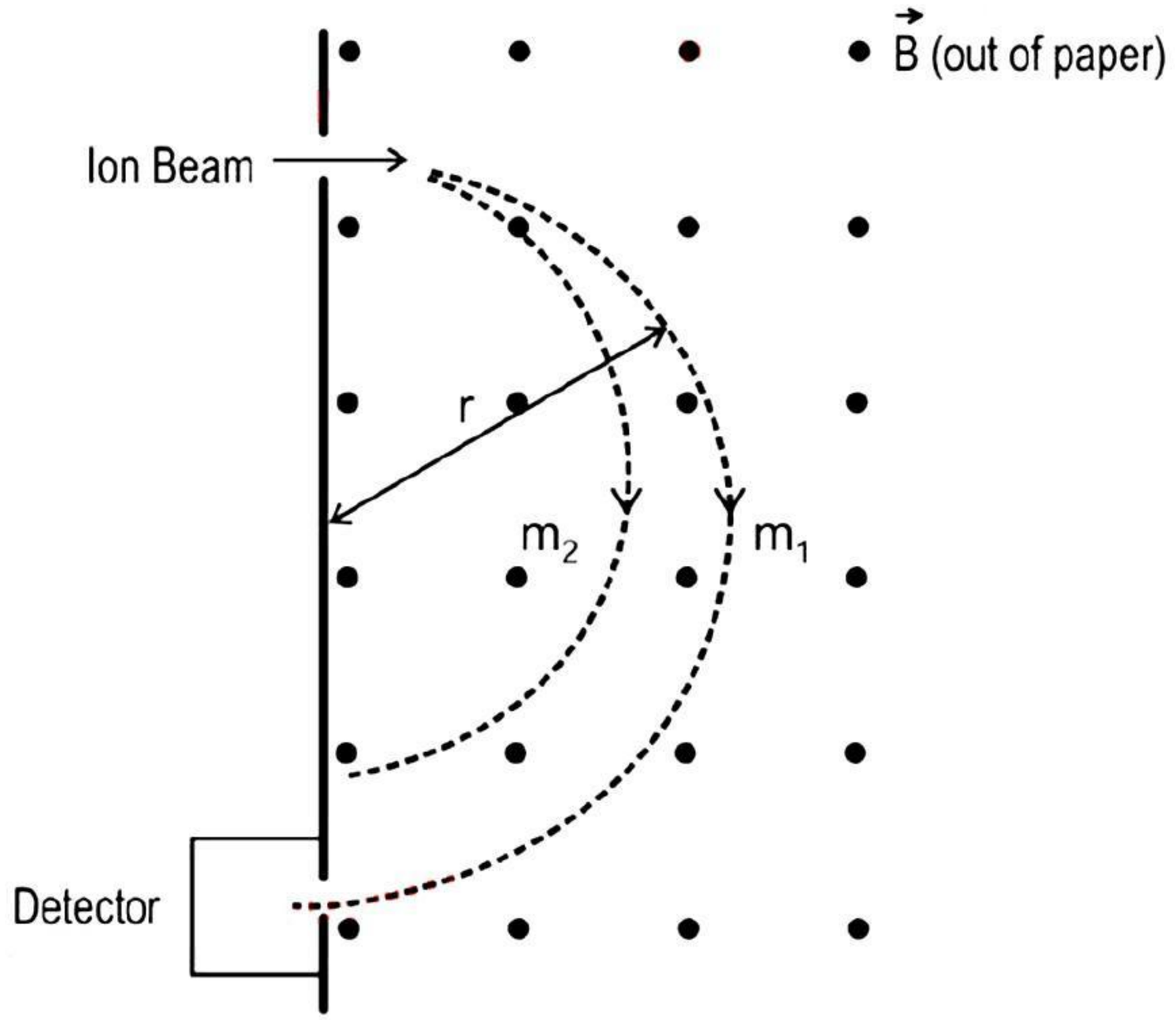
10. A sinusoidal input voltage V_i is applied across a network of 2 ideal diodes and the 3 resistors as shown below.





Voltage across PR is (when input voltage is 12V)

11. A stream of singly charged particles of mass $m_1 = 0.8 \times 10^{-26}$ kg accelerated through a potential difference V are projected into a uniform magnetic field $B_1 = 0.2$ T. The stream deflects along a curved path under the effect of the magnetic field and strikes the detector.

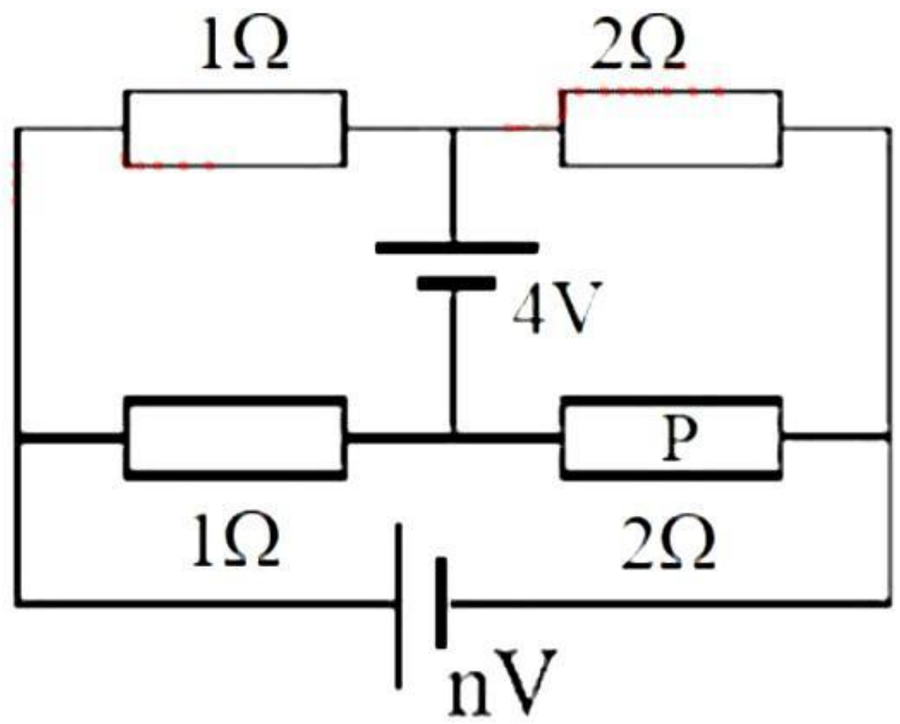


Another stream of singly charged particles of mass $m_2 = 0.2 \times 10^{-26}$ kg, projected through the same accelerating potential and into the same magnetic field B_1, fail to reach the detector.

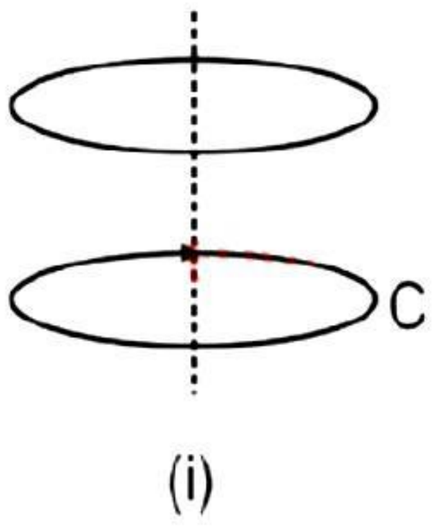
To what value should the magnetic field be changed so that this stream of particles strikes the detector?

(a) 0.7T (b) 0.1T (c) 0.5T (d) 0.4T

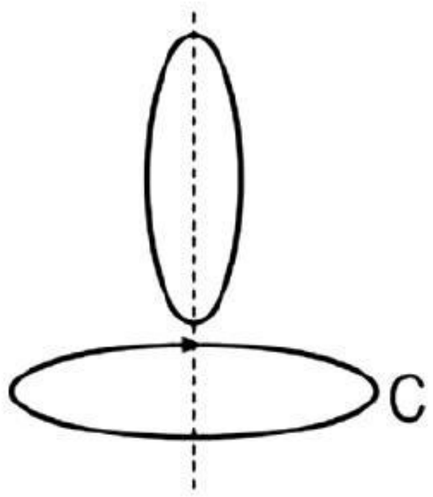
12. Four resistors and two ideal batteries are connected as shown in figure. Electromotive force of the batteries are 4 volt and n volt. If current through the 'P' resistor is zero then n is:



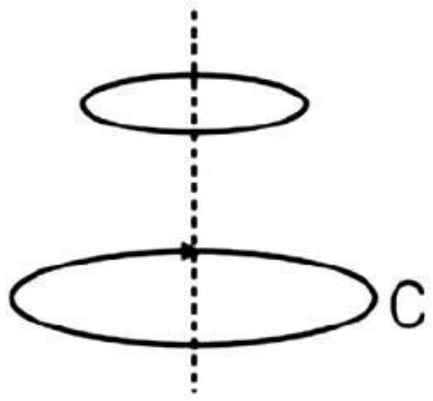
13. Coil C carries a steady current. A second coil is placed in close proximity to coil C in different configurations as shown.



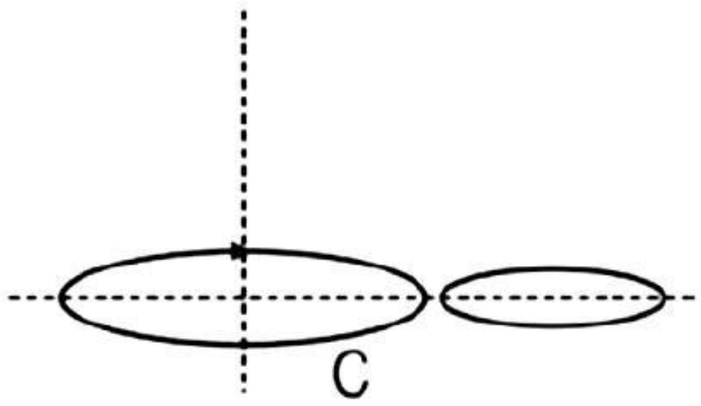
(i)



(ii)



(iii)



(iv)

Which of the following options represents the correct order of the mutual inductance values for the pair of coils in given configurations?

A. (i) > (iii) > (iv) > (ii)

C. (ii) > (iv) > (iii) > (i)

B. (iv) > (iii) > (i) > (ii)

D. (iii) > (i) > (ii) > (iv)

14. The diagrams below show the electric and magnetic field components of an electromagnetic wave at a certain time and location.

Which of these electromagnetic waves are travelling towards you?

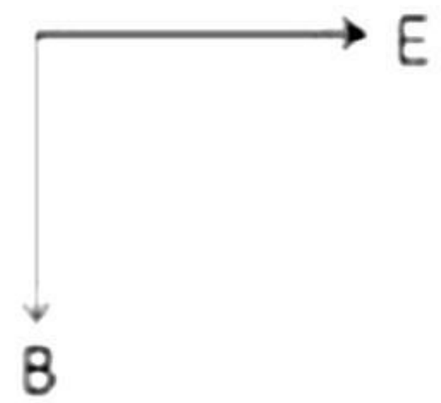


Fig I

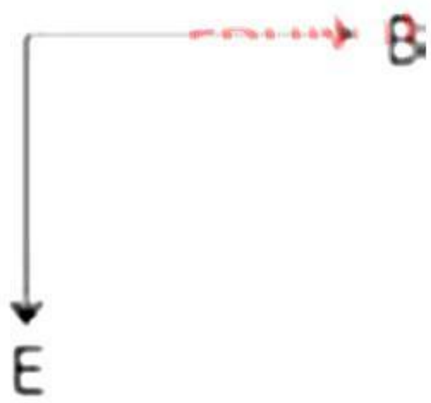


Fig II

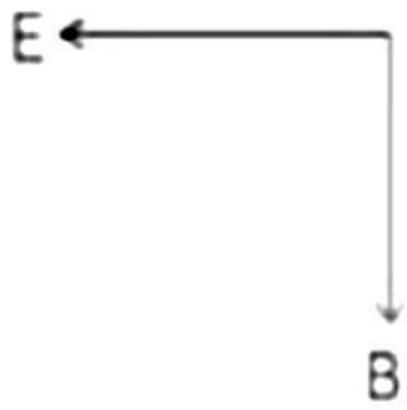


Fig III

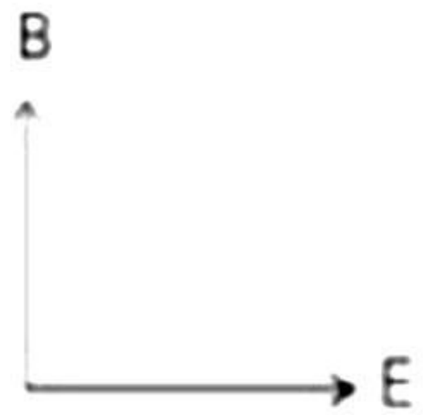


Fig IV

A. only the em wave in Fig I

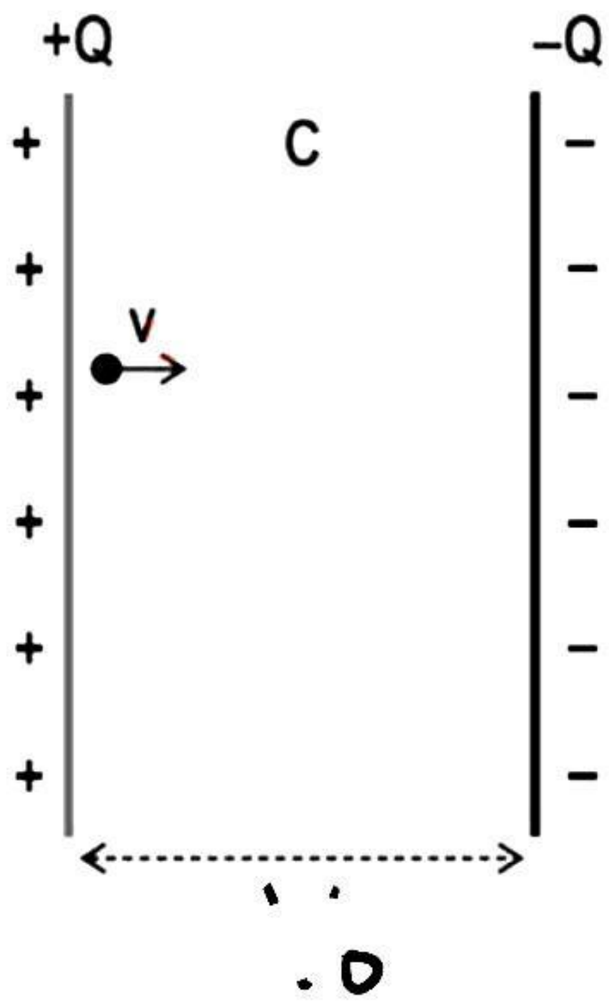
B. only the em wave in Fig I and II

C. only the em wave in Fig II and III

D. only the em wave in Fig II, III and IV

15. A small ball of mass 2×10^{-16} kg carrying a charge $q = -2\ \mu C$ is fired from the positive plate of the capacitor towards the negative plate with a speed of 3×10^{6} m/s.

(Ignore gravity)



Maximum value of V_0 for which ball strikes negative plate is — V.