

APOLLO

Induction

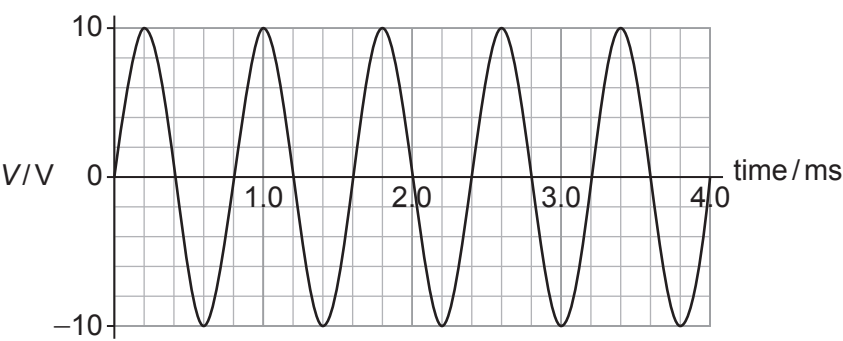
HL

Physics

First assessment 2025

10 questions | questions

31. A coil of wire rotates at a constant angular speed ω in a uniform magnetic field.
- The variation with time of the emf in the coil is shown.



The angular speed is changed to $\frac{3\omega}{4}$.

What is the amplitude of the emf and the time period for the variation of the emf in the coil after the change?

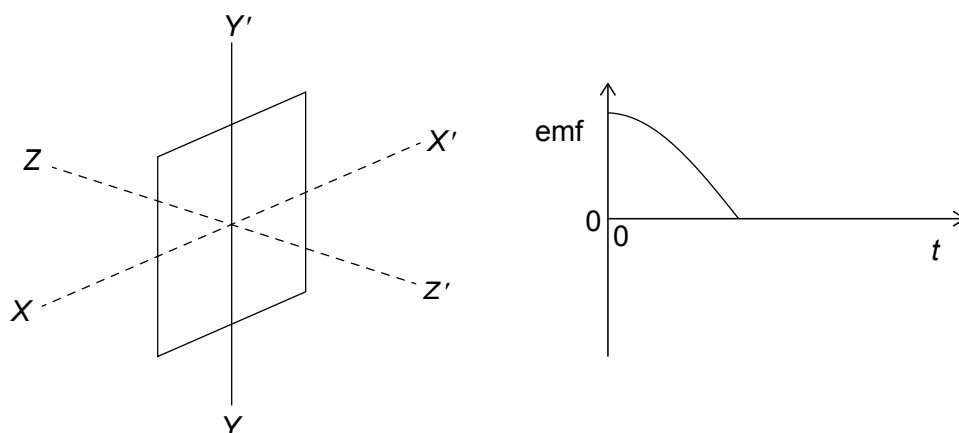
	Amplitude of emf/V	Time period/ms
A.	13	0.60
B.	13	1.1
C.	7.5	0.60
D.	7.5	1.1

- 28.** A horizontal conducting ring is perpendicular to a uniform vertical magnetic field. When the ring is rotated through 180° about the horizontal axis, an average emf of $2.0\,\mu\text{V}$ is induced in the ring. The area enclosed by the ring is 4.0 cm^2 and the rotation takes 2.0 s .

What is the magnetic field?

- A. 2.5 mT
- B. 5.0 mT
- C. 10.0 mT
- D. 20.0 mT

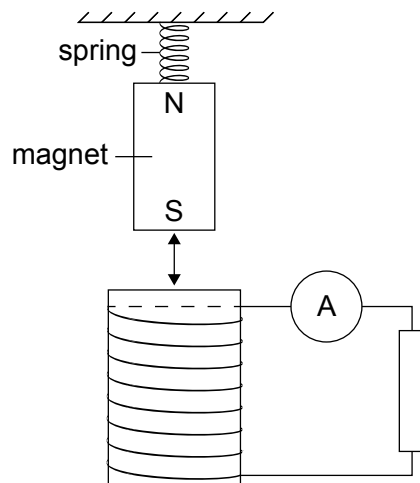
29. A rectangular coil rotates at a constant angular velocity. At the instant shown, the plane of the coil is at right angles to the line ZZ' . A uniform magnetic field acts in the direction YY' . The variation of emf with time t is shown.



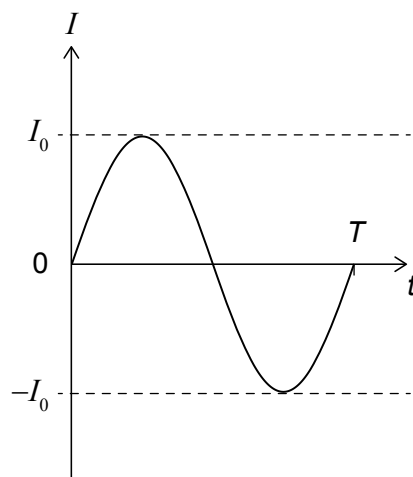
What coil rotation about the axis specified produces this graph?

- A. Through $\frac{\pi}{2}$ about XX'
- B. Through π about XX'
- C. Through $\frac{\pi}{2}$ about YY'
- D. Through π about YY'

- 30.** A magnet attached to a spring oscillates above a coil as shown. The period of the oscillation is T .



The graph shows the variation with time t of the current I in the coil.



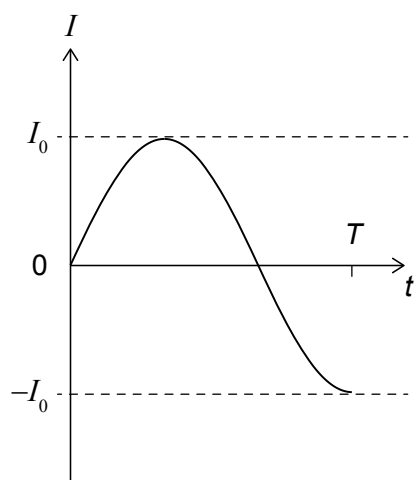
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(Question 30 continued)

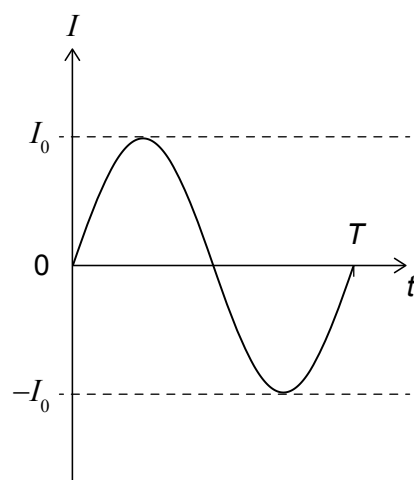
The amplitude of the magnet's oscillation is now decreased.

What is the new variation of I with t ?

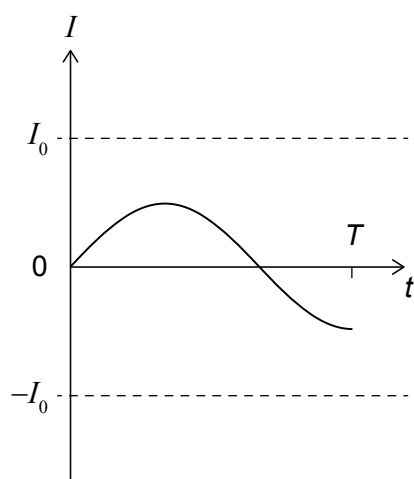
A.



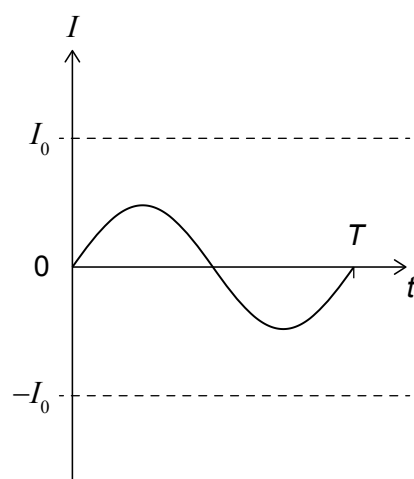
B.



C.



D.



Turn over

8. A rod, R, lies perpendicular to a uniform magnetic field B of strength 0.50 T directed into the plane of the page. R is connected to a circuit and the electric current I_R is 2.0 A .

(a) (i) Calculate the magnitude of the force per unit length on R.

[2]

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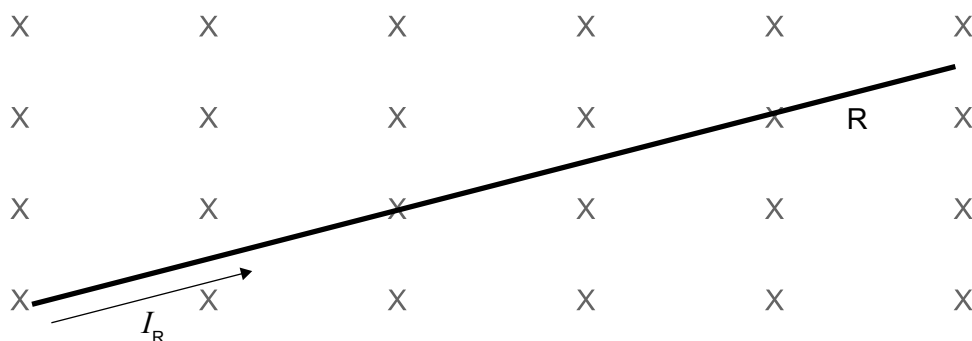
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(ii) Identify on the diagram the direction of the force on R.

[1]

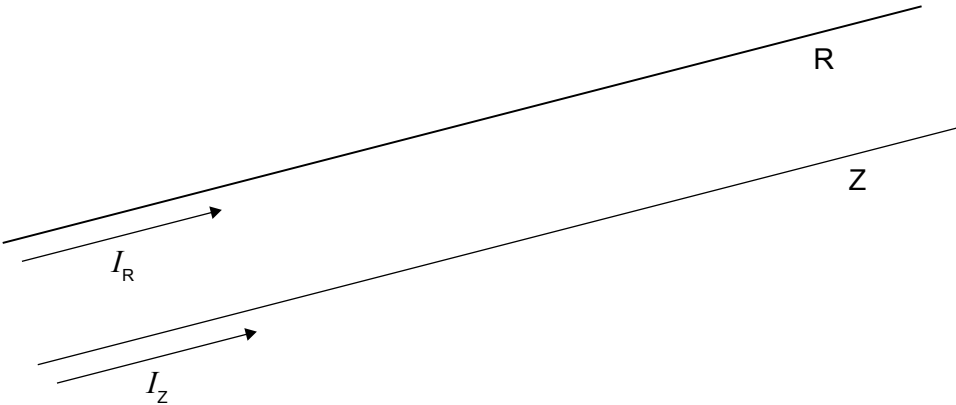


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(Question 8 continued)

(b) B is removed and a wire Z, carrying a current I_Z , is placed parallel to R.



(i) Show that the magnetic field strength B_R due to R at a point on Z is

$$B_R = \frac{\mu_0 I_R}{2\pi r}$$

where r is the distance between R and Z. [2]

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(ii) Derive the units of μ_0 in SI fundamental units. [1]

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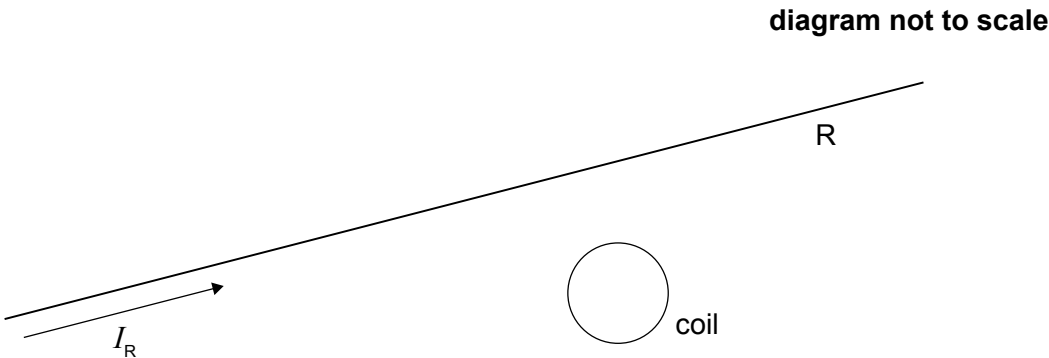
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Turn over

(Question 8 continued)

- (c) A small coil of wire of radius 2.0 cm and 20 turns is now located with its centre 10.0 cm from R. The current in R is kept constant at 2.0 A.



- (i) Explain why there is no current induced in the coil. [2]

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- (ii) The current in R increases at a constant rate from 2.0 A to 10.0 A in 0.5 seconds.

Calculate the emf induced in the coil. [3]

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(Question 8 continued)

(iii) Deduce the direction of the current induced in (c)(ii). [2]

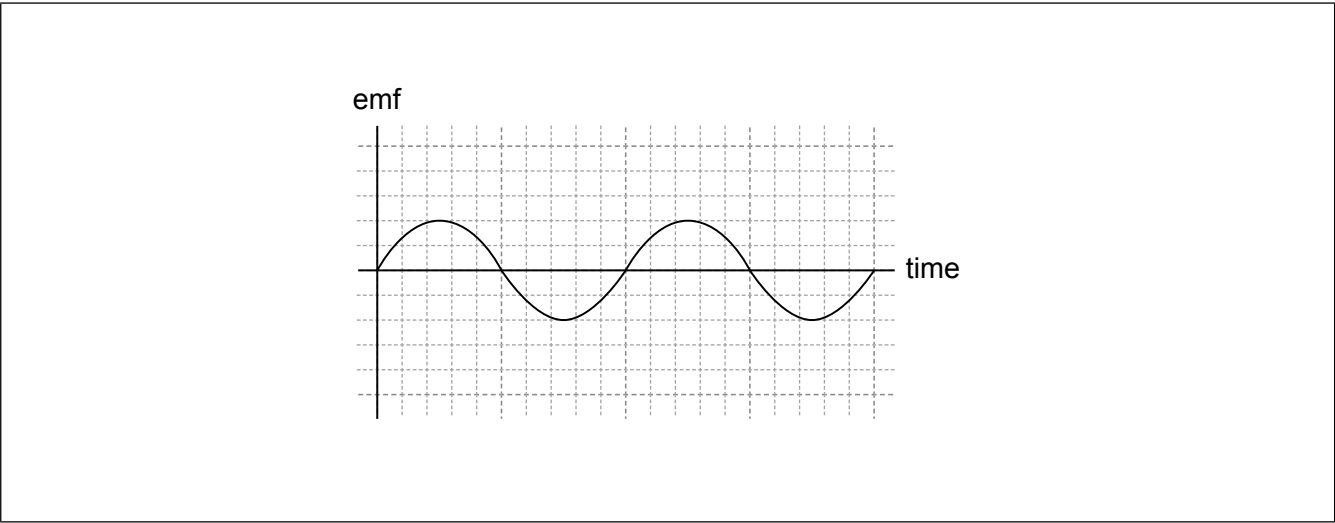
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Turn over

(Question 8 continued)

- (d) The coil is made to rotate such that an emf is induced. The graph shows the variation with time of the emf induced in the coil.



The frequency of rotation is doubled. Draw on the graph the variation with time of the new emf induced.

[2]

(This question continues on the following page)



(Question 8 continued)

(e) An electron is moving at constant velocity $v = 9.0 \times 10^5 \text{ m s}^{-1}$ parallel to a rod T, at a perpendicular distance d . T is connected to a cell via a switch. When the switch is closed the electron's path curves with initial radius r . The magnetic field strength at the position of the electron at d is $4.0 \times 10^{-6} \text{ T}$.

(i) Calculate the initial radius of the electron's path. [3]

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(ii) Explain the subsequent change in the radius of the electron's path. [2]

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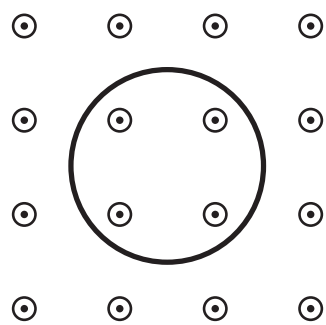


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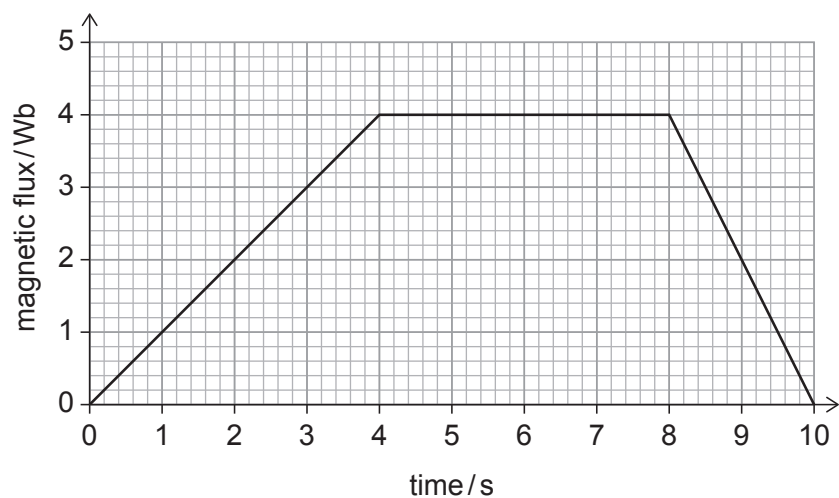
30. A conducting ring is perpendicular to a uniform magnetic field directed out of the page.



The magnitude of the magnetic field strength increases. What are the direction of the conventional current induced in the ring and the net magnetic force on the ring?

	Current induced in the ring	Magnetic force on the ring
A.	clockwise	zero
B.	counter-clockwise	zero
C.	clockwise	non-zero
D.	counter-clockwise	non-zero

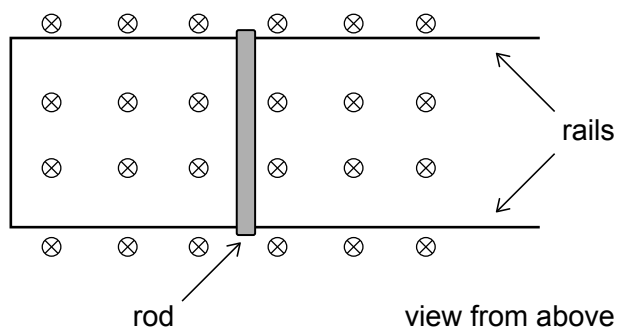
31. The graph shows how the magnetic flux linked through a conducting coil varies with time. The coil has only one turn.



What is the maximum emf induced in the coil?

- A. 0.40 V
- B. 1.0 V
- C. 2.0 V
- D. 4.0 V

8. (a) A conducting rod is placed on horizontal, conducting, frictionless rails.



A uniform magnetic field is directed into the plane of the page.

The rod begins to move to the right after it is given a short push. Explain why the rod will quickly stop moving.

[3]

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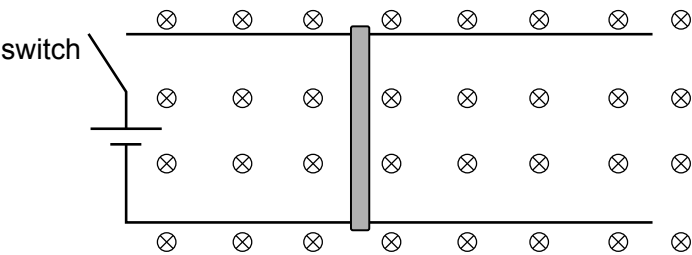
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(Question 8 continued)

- (b) In another experiment, the rod is at rest on the rails. A cell and a switch are inserted as shown.



The switch is closed.

- (i) Suggest what happens to the rod. [1]

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- (ii) Explain why the rod will eventually reach terminal speed. [2]

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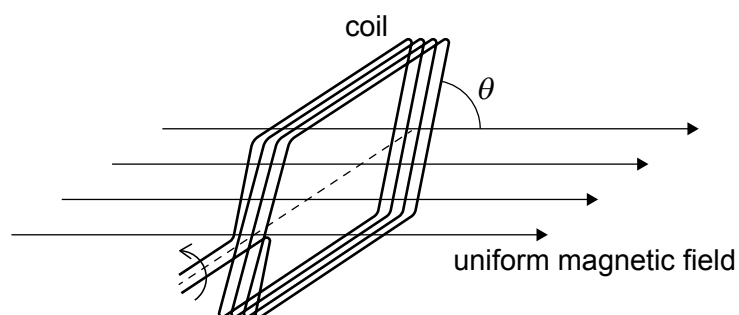
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29. A rectangular conducting coil rotates at a constant angular velocity in a uniform magnetic field. The rotation axis of the coil is perpendicular to the field.

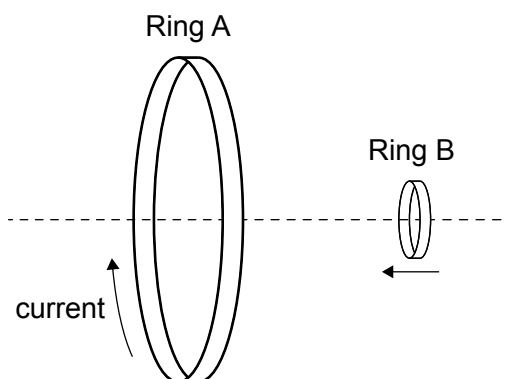


At one instant the plane of the coil is at an angle θ to the direction of the field.

The magnitude of the emf induced in the coil is

- A. never zero.
- B. at a maximum when $\theta = 0^\circ$ or 180° .
- C. at a maximum when $\theta = 45^\circ$ or 225° .
- D. at a maximum when $\theta = 90^\circ$ or 270° .

5. Two conducting rings, A and B, have their centres on the same line. The planes of A and B are parallel. There is a constant clockwise current in A. Ring A is stationary and ring B moves towards ring A at a constant speed.



- (a) Outline why the magnetic flux in ring B increases.

[1]

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- (b) State the direction of the induced current in ring B.

[1]

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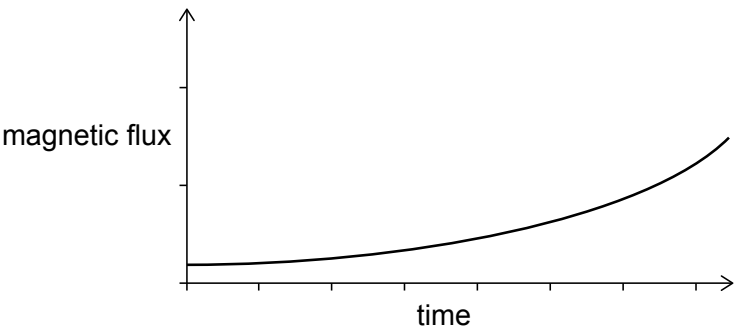
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(Question 5 continued)

(c) The graph shows how the magnetic flux in ring B varies with time.



Discuss the variation with time of the induced current in ring B. [3]

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(d) Outline why work must be done on ring B as it moves towards ring A at a constant speed. [2]

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