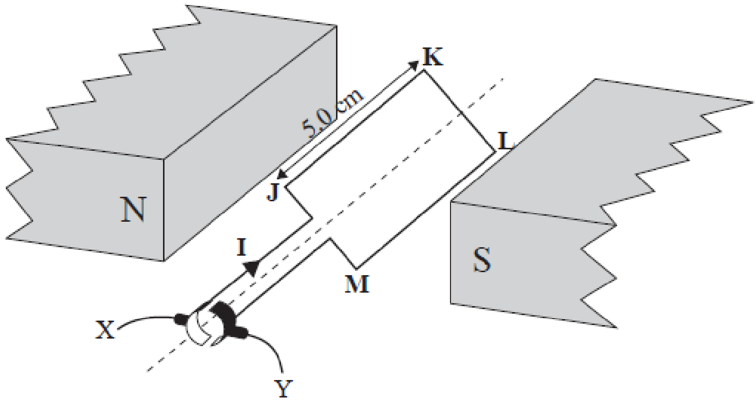
Multiple choice questions

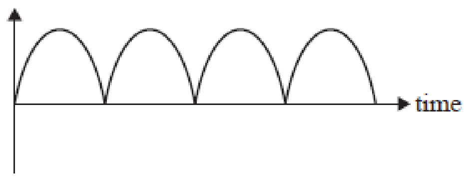


Coil JKLM is turned by hand at a constant speed. Points X and Y are now connected to an oscilloscope.

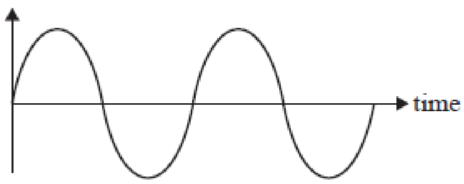
Example 1 (2011 Question 6, 2 marks)

Which of the following graphs best shows the shape of the voltage-time display on the oscilloscope?

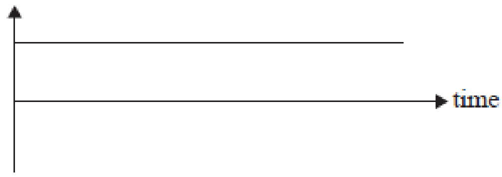
A.



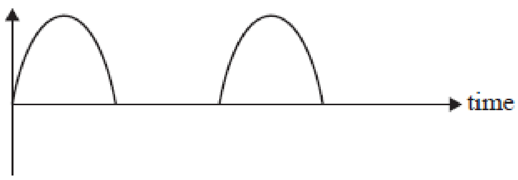
B.



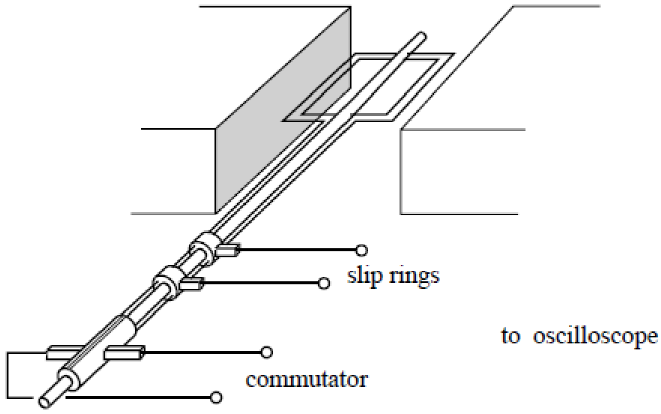
C.

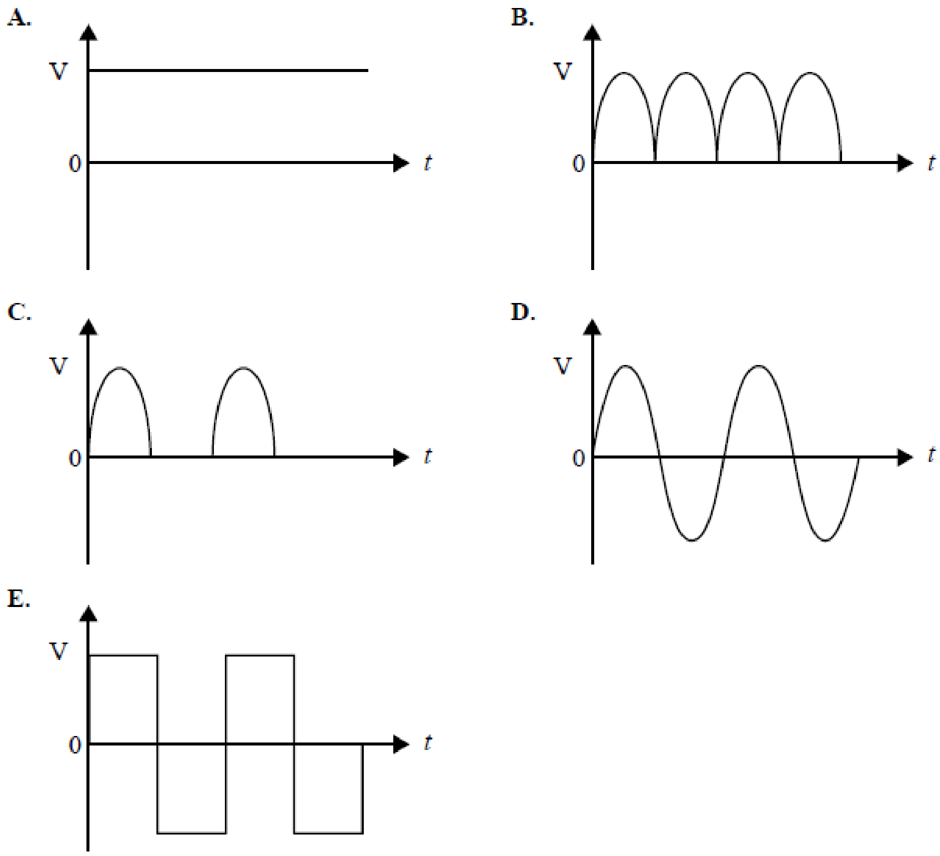


D.



A group of students is studying DC generators and AC alternators. They use a coil which rotates at a constant speed in the magnetic field as shown below.
The apparatus has slip rings **and** a commutator. Either the slip rings or the commutator can be connected to an oscilloscope to observe the output voltage.





Example 2 (2008 Question 5, 2 marks)

The oscilloscope is connected to the commutator. Which one of the graphs **(A – E)** best shows the shape of the output as observed on the oscilloscope?

Example 3 2008 Question 6, 2 marks

The oscilloscope is next connected to the slip rings. Which one of the graphs **(A – E)** best shows the shape of the output as observed on the oscilloscope?

A group of students is studying electromagnetic induction. The apparatus the students use is shown in Figure 4a below.
The apparatus consists of a square magnet and a square loop that can move. The magnet, of sides 8.0 cm, has a uniform magnetic field strength of 4.0×10^{-3} T between the poles. The field can be considered zero outside the poles. The loop is square of side 2.0 cm. The loop moves through the magnet at a constant speed of 2.0 cm s^{-1}.

Figure 4b shows the situation as seen from above.

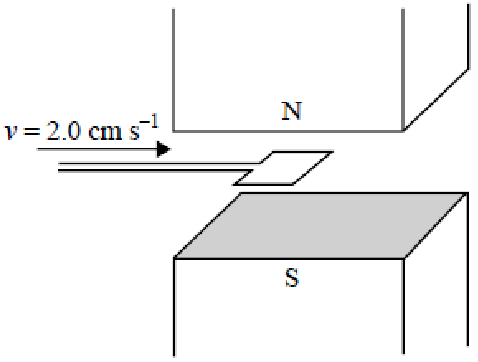


Figure 4a

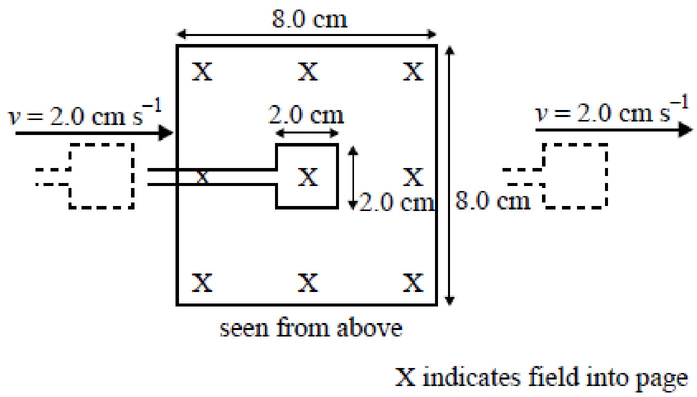
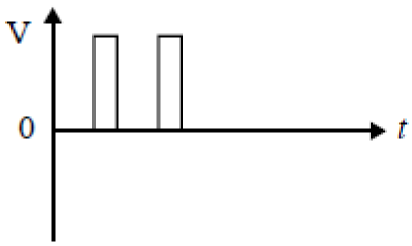


Figure 4b

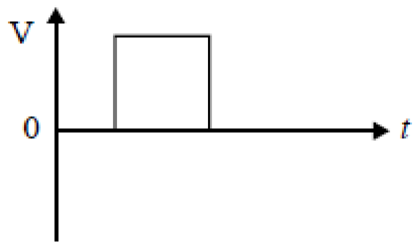
Example 4 2008 Question 8, 2 marks

Which of the following diagrams (**A – F**) best shows the shape of the output emf (voltage) induced in the loop as a function of time as the loop moves from outside the field at left to outside the field at right as shown in Figure 4b?

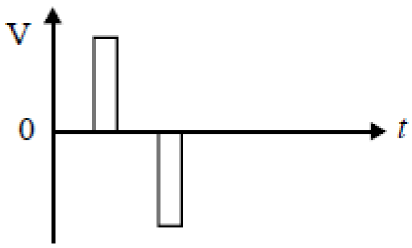
A.



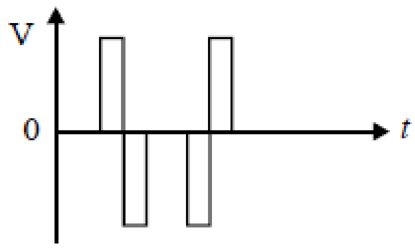
B.



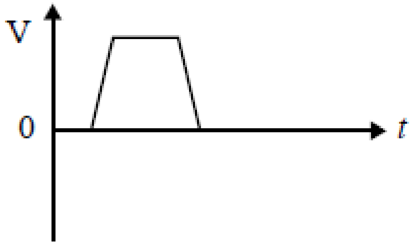
C.



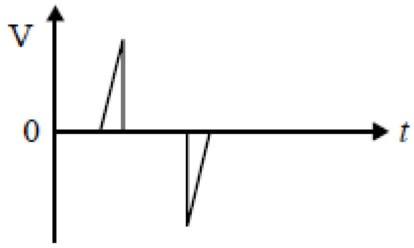
D.



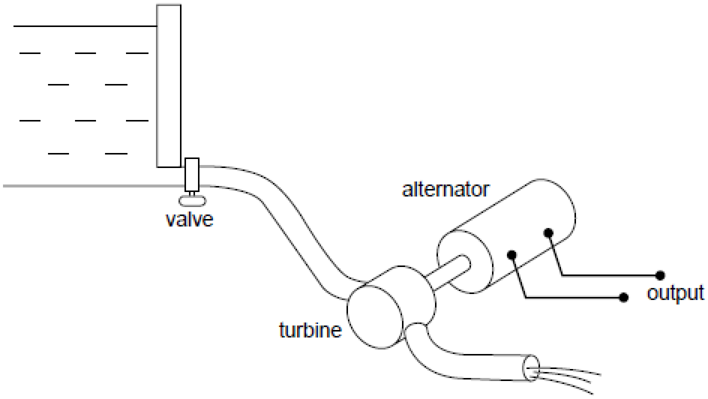
E.



F.



An alternator is driven by a water turbine, as shown below.

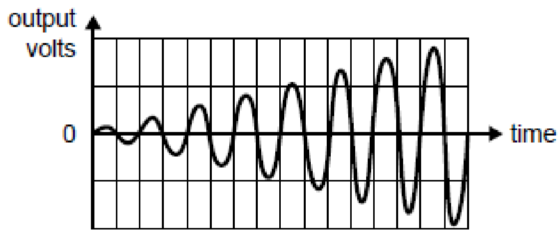


When the valve is opened, water begins to flow and the alternator gradually speeds up from stationary.

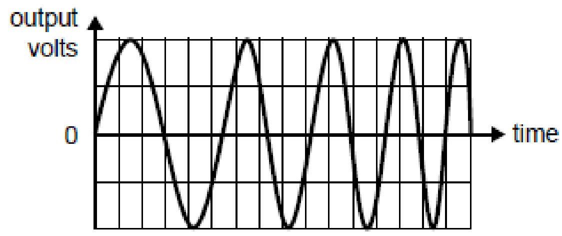
Example 5 (2007 Question 10, 2 marks)

Which one of the following graphs **(A. – D.)** best represents the shape of the output voltage as the alternator speeds up from rest?

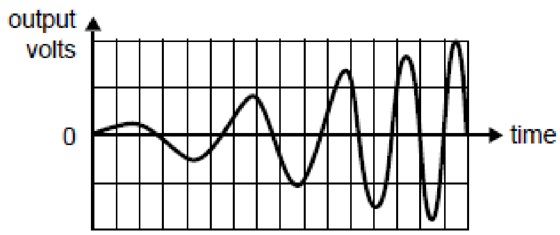
A.



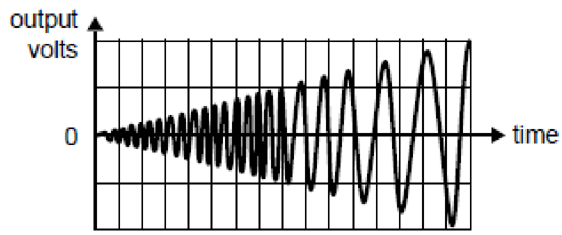
B.



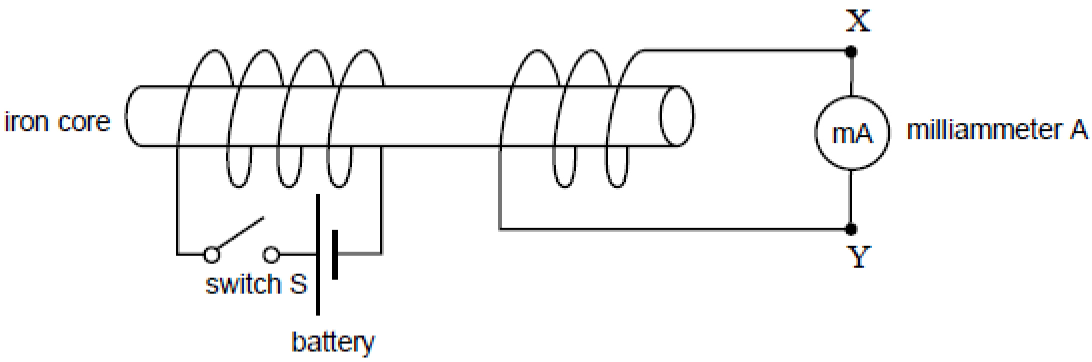
C.



D.



To study Lenz's law, students set up the following experiment using the circuit shown below.



Example 6 (2007 Question 14, 2 marks)

Initially switch S is open.
Which one of the following **(A.D)** will best describe the current through the milli-ammeter A, when the switch S is closed?

A. current flows momentarily in the direction X to Y

B. current flows momentarily in the direction Y to X

C. current flows continuously in the direction X to Y

D. current flows continuously in the direction Y to X

A loop of wire in the form of a 2.0 cm square is moved through a uniform magnetic field at a constant speed of 4.0 cm s^{-1}. This is shown in Figure 4a.
Figure 4b shows an end-on view of the loop as it passes across the face of the north pole of the magnet. Current flowing through the loop is measured by a micro-ammeter (μA).
You may assume the magnetic field exists **only** in the region between the north and south poles.

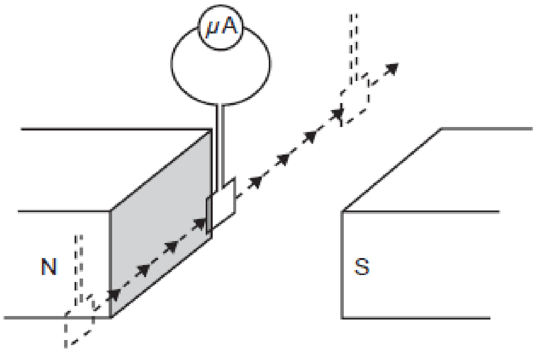


Figure 4a

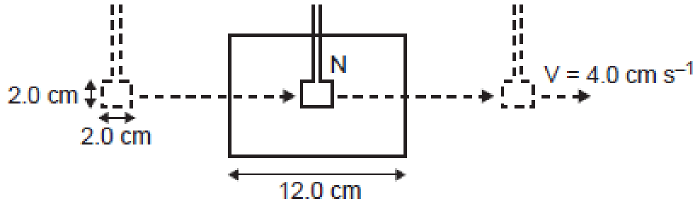


Figure 4b

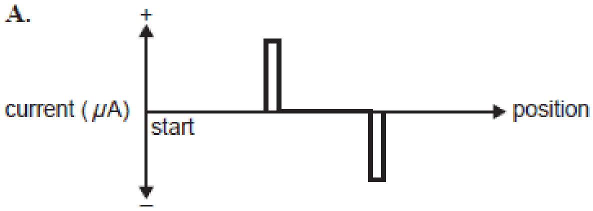
Figure 4c

Initially, the loop is placed well outside of the magnetic field and the micro-ammeter confirms that no current is flowing through the loop. The loop is now moved at a constant rate through the magnetic field, as shown in Figure 4b. Figure 4c shows the flux through the loop as a function of position of the leading edge of the loop.

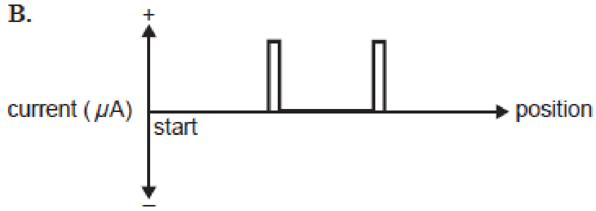
Example 7 (2006 Question 7, 2 marks)

Which one of the following (**A. – D.** below) best describes the current in the loop as it passes through the magnetic field?

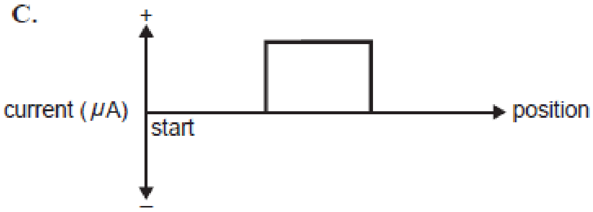
A.



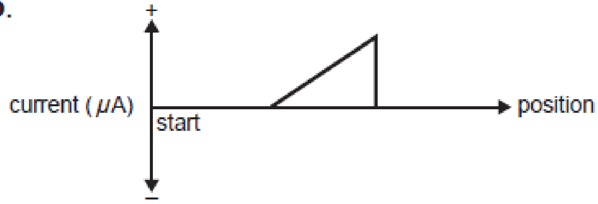
B.



C.



D.

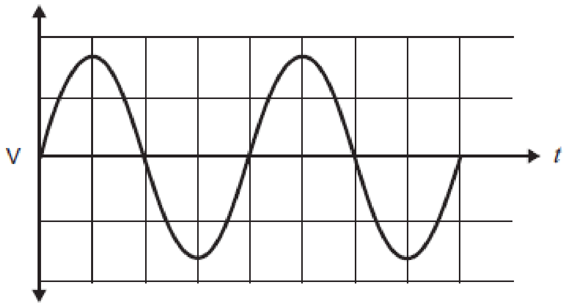


Pat and Kris are discussing **DC generators**. Pat says that slip rings are used in a DC generator. Kris disagrees, and says that DC generators cannot use slip rings because they must produce DC, and therefore a commutator is essential.

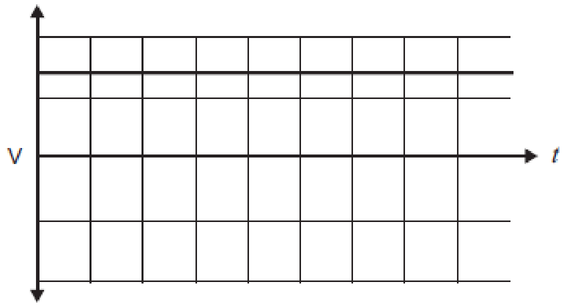
Example 8 2005 Question 8, 2 marks

Which one of the following diagrams **(A. - D.)** best describes the output of a DC generator?

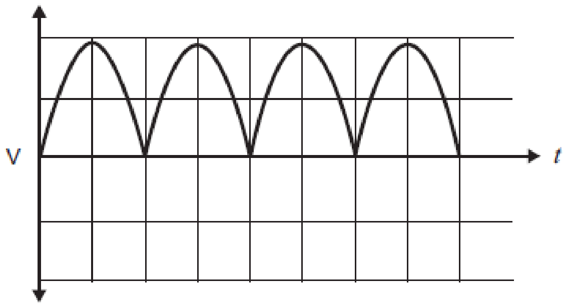
A.



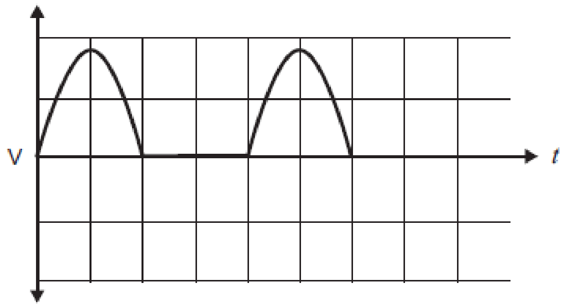
B.



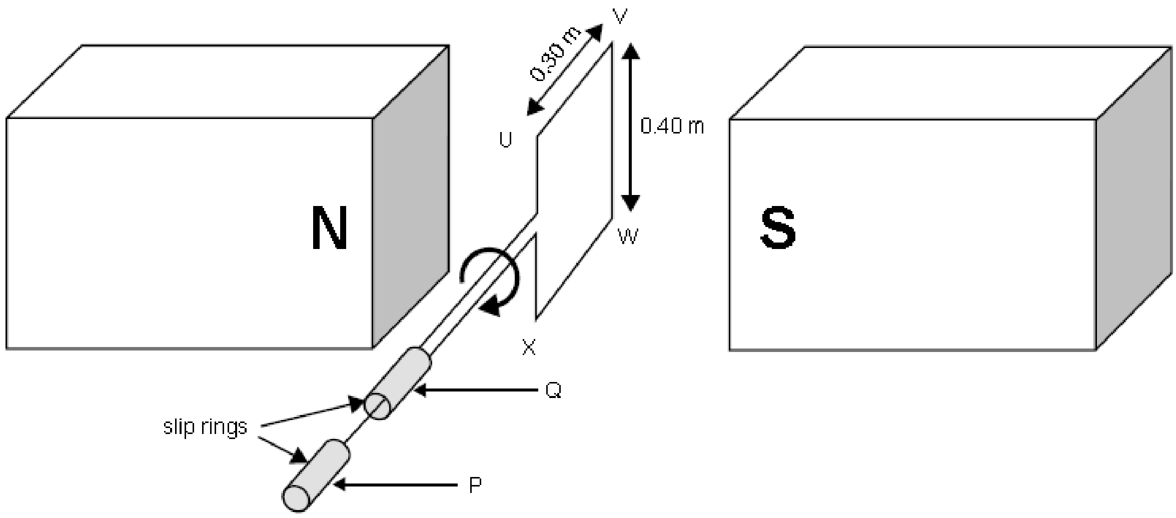
C.



D.



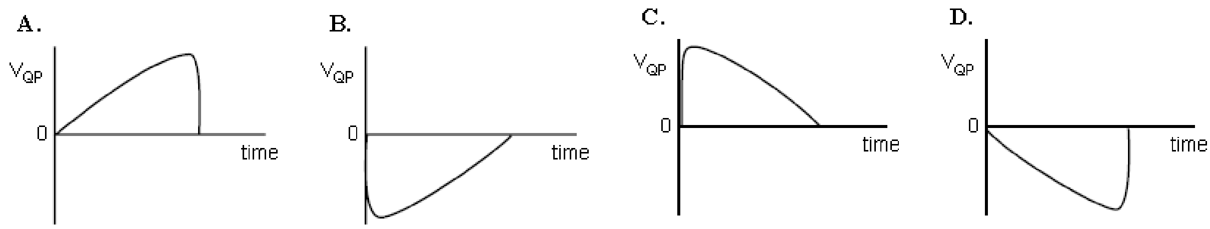
Mary and Shin have constructed a simple alternator. It consists of a single rectangular coil of wire, 0.40 m × 0.30 m, which is connected to slip rings, as shown below. The coil is in a uniform magnetic field of 0.12 T, and can be turned in the direction as shown below.



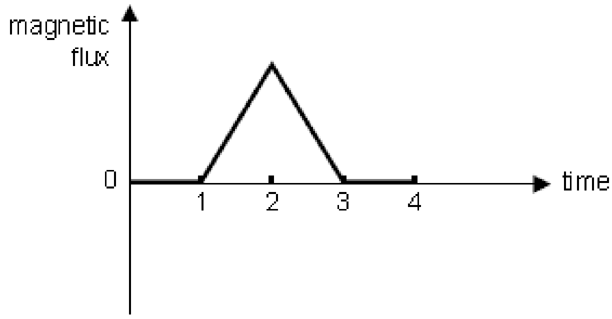
As a test, Shin rotates the coil at a constant rate in a time of 0.15 s through an angle of 90° from the orientation shown above. Mary observes the voltage on an oscilloscope.

Example 9 (2004 Question10, 2 marks)

Which of the graphs below best represents the variation as a function of time of the voltage at point Q relative to point P (V_{QP})?



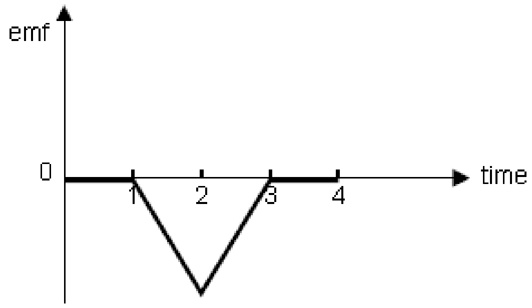
The magnetic flux through the coil as it moves from position (a), through position (b), to position (c) is shown below.



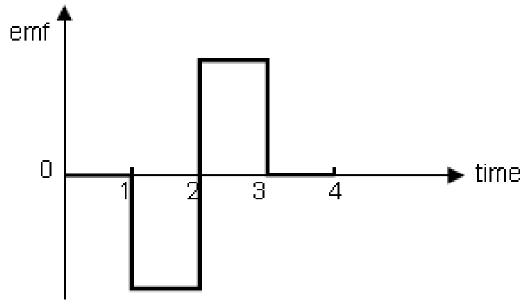
Example 10 (1999 Question 9, 2 marks)

Circle the letter (**A–D**) of the graph below that best shows the emf induced in the coil as a function of time.

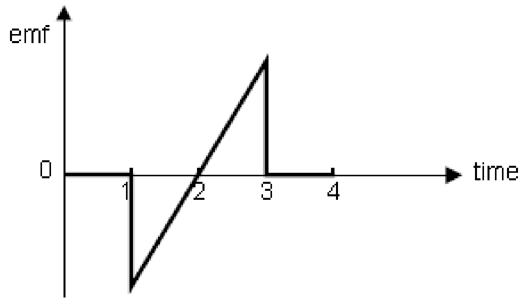
A.



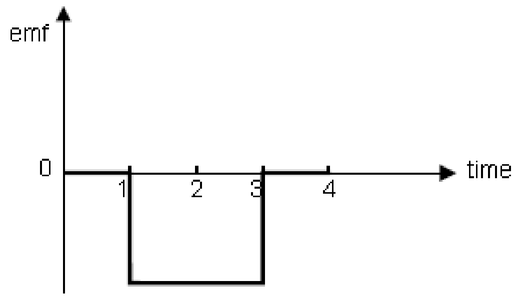
B.



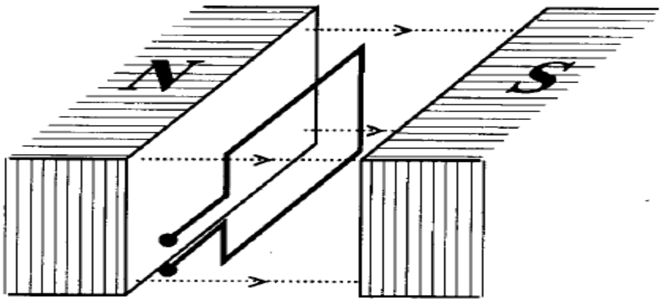
C.



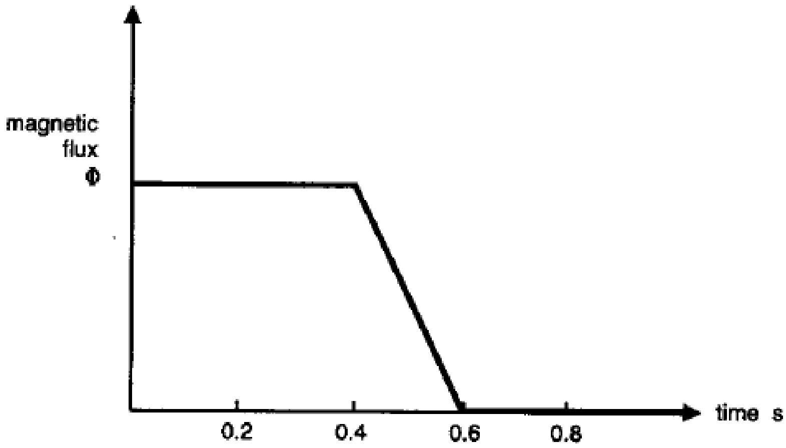
D.



To investigate electromagnetic induction, a student uses the equipment shown below

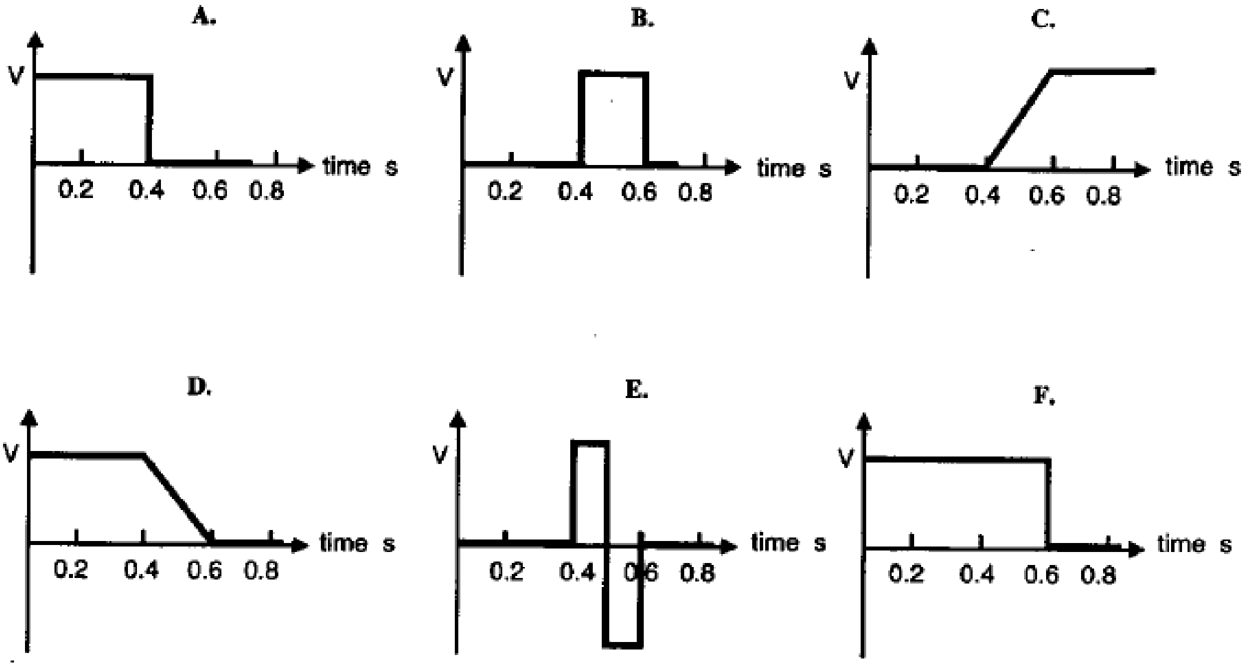


It consists of a magnet which provides a uniform magnetic field, and a rectangular coil. The voltage across the ends of the coil is measured using a cathode ray oscilloscope (C.R.O.).
The student moves the coil vertically out of the field at a constant speed. The entire coil is within the field from t=0untilt=0.4s. It leaves the field between t= 0.4s and t= 0.6s. The graph below shows how the magnetic flux though the coil varies with time.

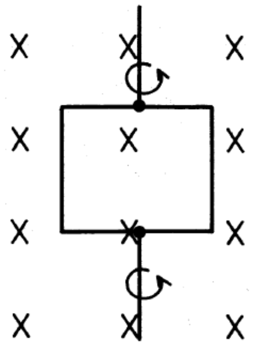


Example 11 (1994 Question 5, 3 marks)

Which of the following graphs best shows the variation with time of the voltage across the ends of the coil? Justify your choice by referring to the diagram above.



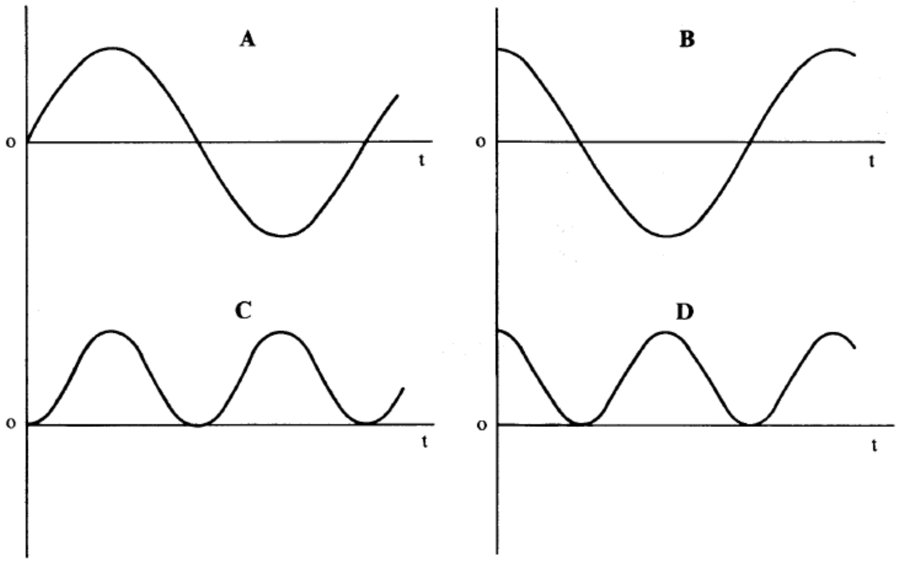
The figure below shows a single loop of wire placed completely within a region of uniform magnetic field ($B = 10^{-2}$ T) directed into the page. The loop of wire has an area of 10 cm^2; and is mounted so that it can be turned about the vertical axis as shown.



The loop rotates at a constant rate of 10 turns during each second.

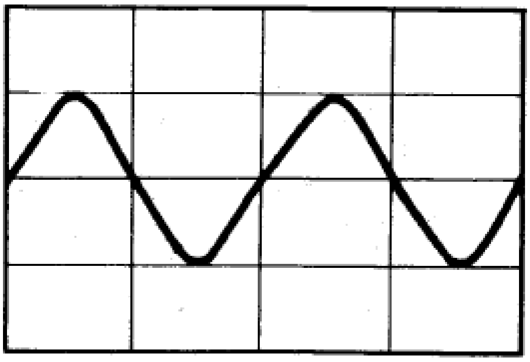
Example 12 (1984 Question 71, 1 mark)

Which diagram below best represents the magnetic flux through the coil as a function of time if the figure above shows the situation at time t = 0?



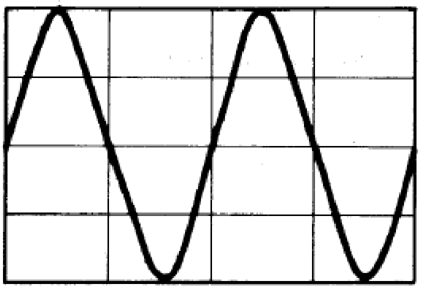
Example 13 (1981 Question 70, 1 mark)

The output of a simple alternator can be fed into an oscilloscope; the visual display represents a graph of the output-EMF against time. The figure below represents the display for an alternator rotating at a rate of ‘f’ revolutions per second.

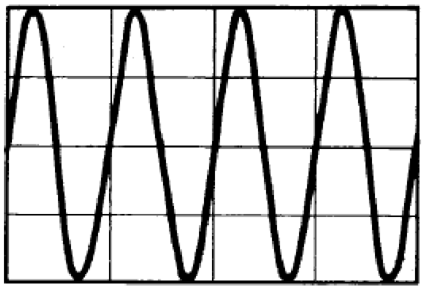


The alternator is now made to rotate at ‘2f’ revolutions per second. Which of the following best represents the new display on the oscilloscope?

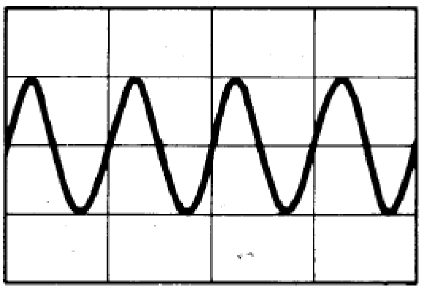
(A)



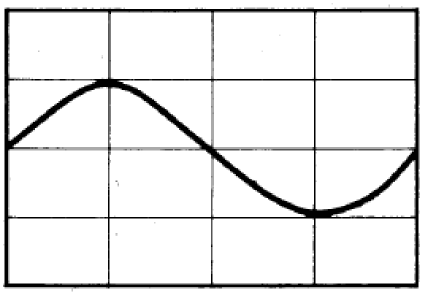
(B)



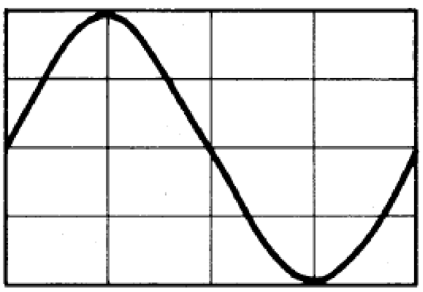
(C)

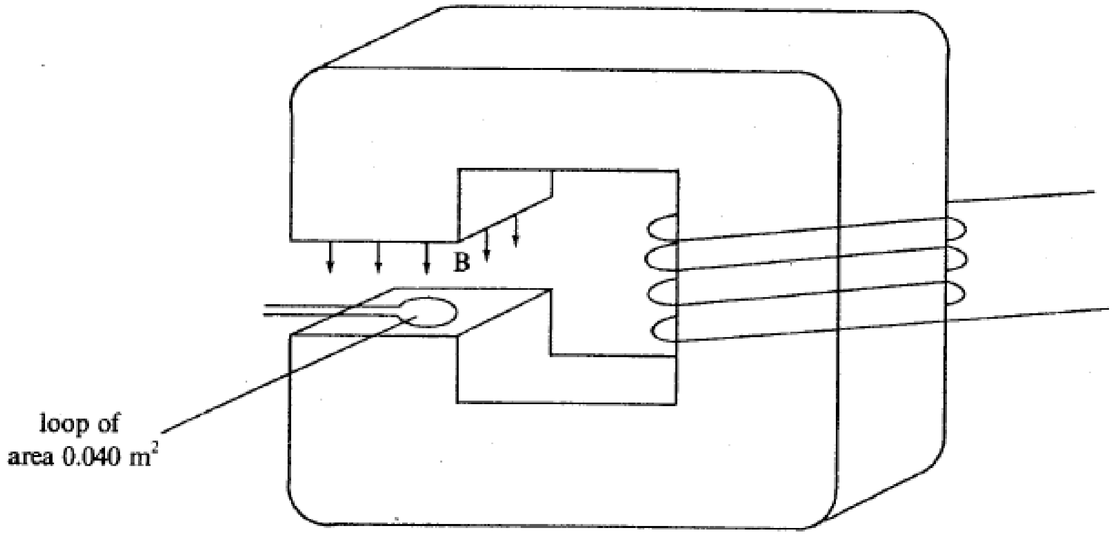


(D)

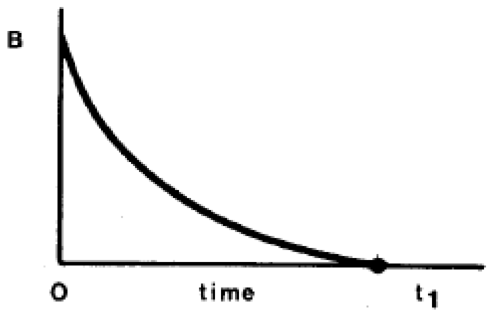


(E)



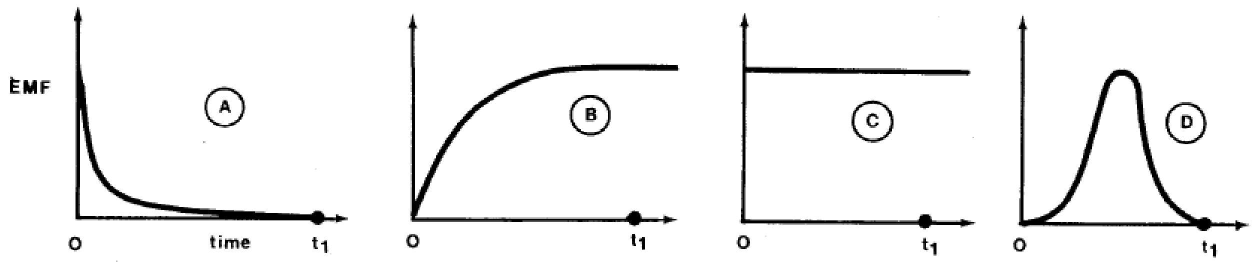


The diagram shows a flexible loop of wire between the poles of an electromagnet which provides a uniform field B in the region of the loop.
At time t = 0, the current through the electromagnet is turned off, and the field B then falls to zero at time t_1 as shown.



Example 14 (1981 Question 68, 1 mark)

Which diagram best represents the EMF across the ends of the loop as a function of time?

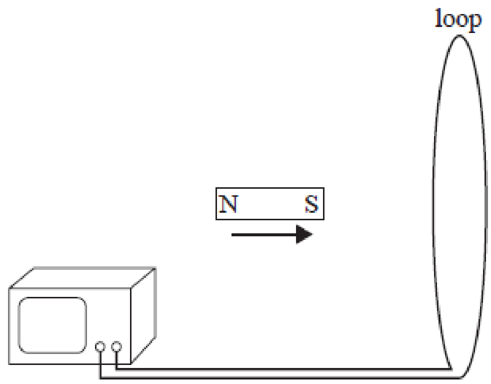


Extended response

Example 15 (2011 Question 10, 2 marks)

Use the following information to answer Questions 10 – 12

A small bar magnet is moved through a circular wire loop, as shown below. The magnet moves with constant speed through the centre of theloop, in the direction shown by the arrow. An emf is generated in the wire loop. The wire loop is connected to an oscilloscope, as shown below.



Explain why an emf is generated in the wire loop.

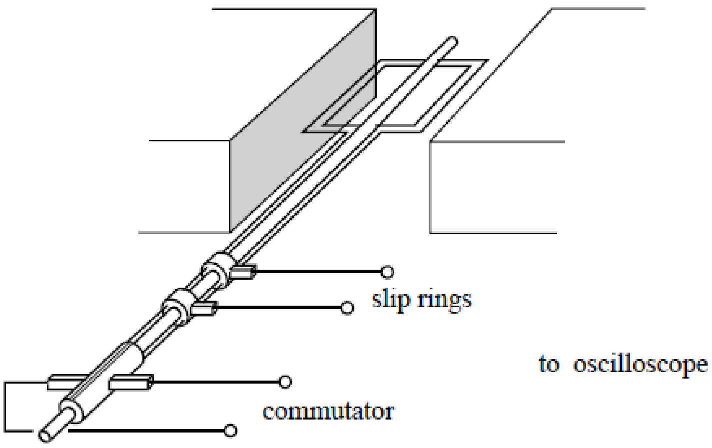
Example 16 (2011 Question 11, 3 marks)

On the graph axes below, sketch the variation of emf with time, from when the magnet is a long way to the left of the loop, through the loop, to when it is a long way to the right of the loop. Note that you can take either upwards or downwards as positive.

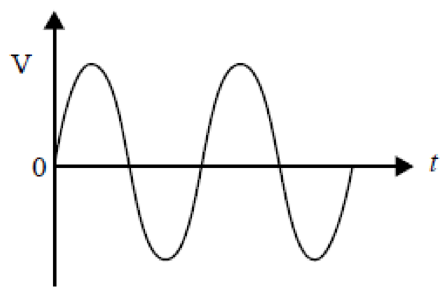
Example 17 (2011 Question 12, 3 marks)

After the magnet has passed through the wire loop, and is moving away from the loop. Current flows around the loop in an **anticlockwise** direction, as viewed from the left of the figure.
Use Lenz's law to explain why the current flows in an **anticlockwise** direction.

A group of students is studying DC generators and AC alternators. They use a coil which rotates at a constant speed in the magnetic field as shown below.
The apparatus has slip rings **and** a commutator. Either the slip rings or the commutator can be connected to an oscilloscope to observe the output voltage.



D.



Example 18 (2008 Question 7, 2 marks)

In diagram **D.**, the peak-to-peak voltage is observed to be 8.0 V. What will the RMS voltage be? Show working.

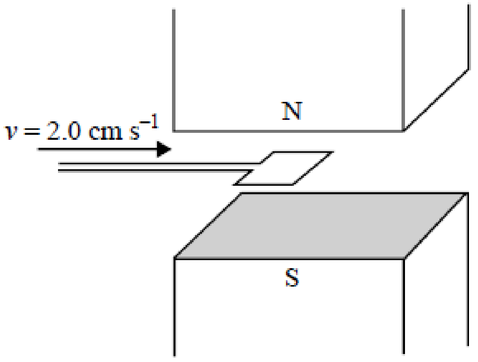


Figure 4a

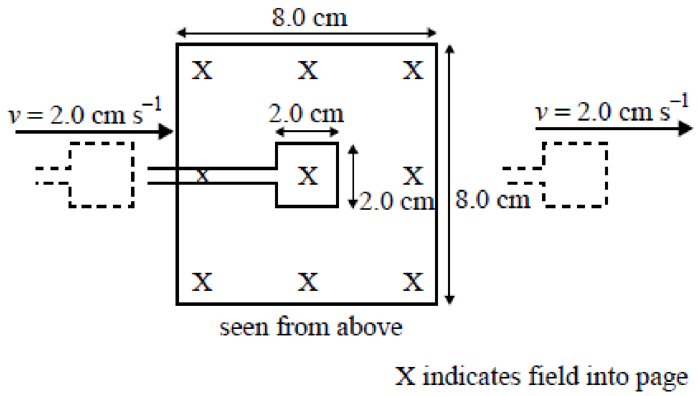
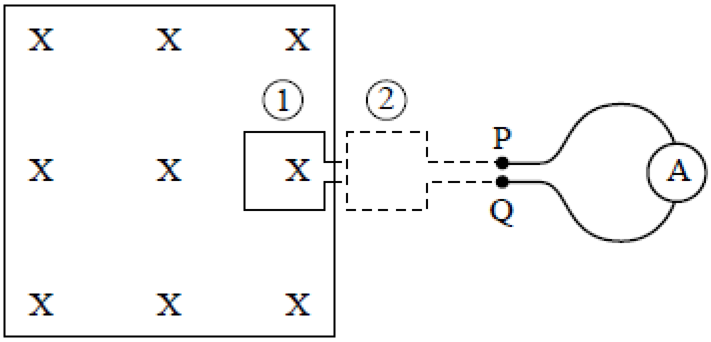


Figure 4b

Example 19 (2008 Question 9, 3 marks)

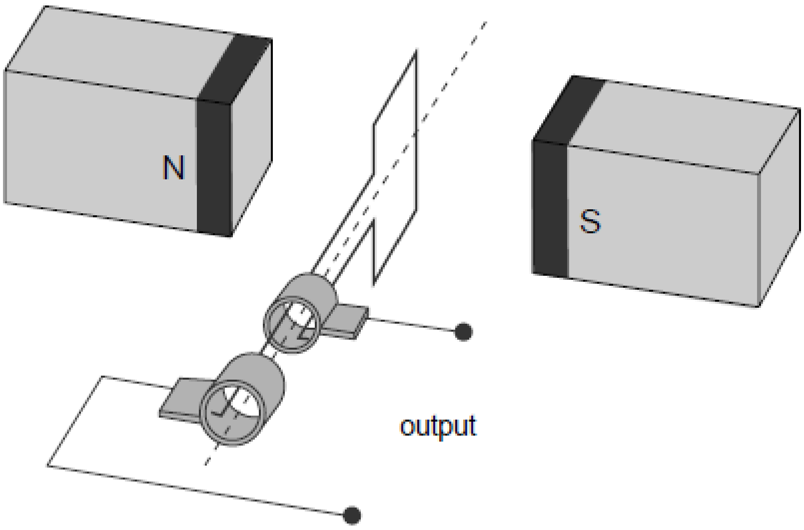
The square loop moves from position 1 (just inside the magnetic field) to position 2 (just outside the magnetic field) as shown in Figure 4d (seen from above). What is the average emf (voltage) induced?
Show working.



Example 20 (2008 Question 10, 4 marks)

Will the current due to the induced voltage flow from P to Q **or** Q to P **through the square loop** as it moves from position 1 to position 2? Explain your answer in terms of Lenz's law.

The figure shows an alternator consisting of a rectangular coil with sides of 0.20 m × 0.30 m, and 1000 turns rotating in a uniform magnetic field. The magnetic flux through the coil in the position shown is 3.0×10^{-4} Wb.



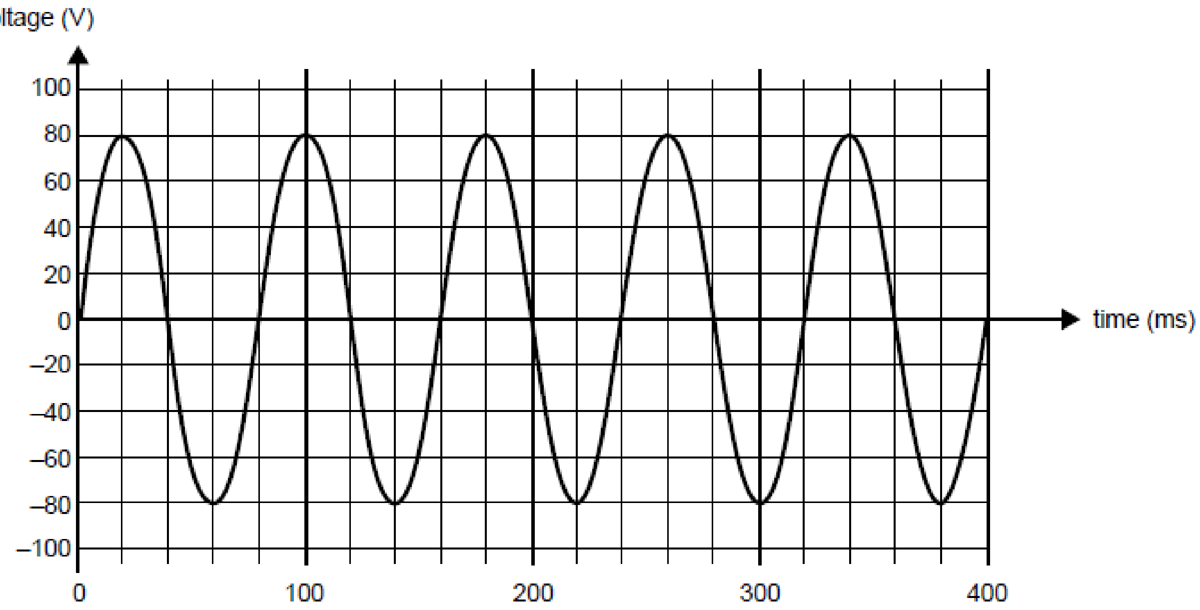
Example 21 (2007 Question 6, 3 marks)

What is the magnitude of the magnetic field? Include a unit.

Example 22 (2007 Question 7, 3 marks)

The coil rotates a quarter of a revolution in 0.01 s from the starting position shown above.
Calculate the magnitude of the average induced emf in the coil in this time.
You must show your working.

At a particular speed of rotation, the output of another alternator is as shown below.



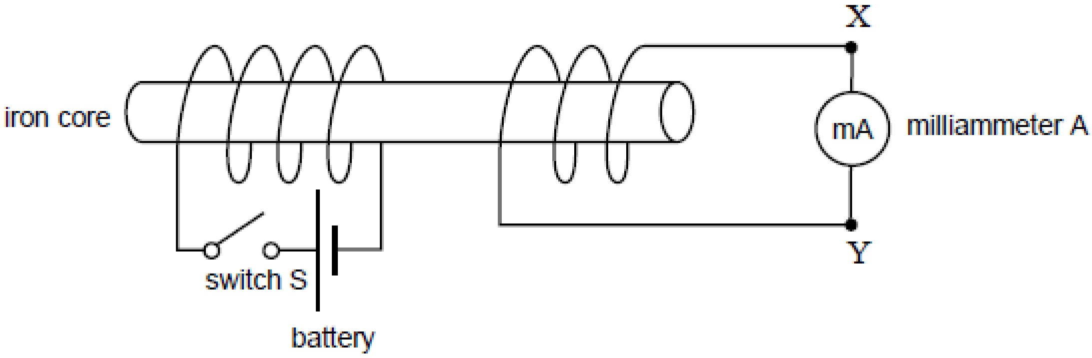
Example 23 (2007 Question 8, 3 marks)

What is the frequency of rotation of the alternator?

Example 24 (2007 Question 9, 2 marks)

What is the RMS value of the output voltage?

To study Lenz's law, students set up the following experiment using the circuit shown below.



Example 25 (2007 Question 15, 3 marks)

Explain how Lenz's law enables you to determine the direction of the current flow in this experiment.

Jo and Effie have found a design for a small electric motor, shown below. It consists of two large permanent magnets, a coil of wire and a commutator. They plan to build the motor as part of their Physics experiment. The area of the coil is 5.0 cm^2 and the magnetic field strength (which can be assumed to be uniform) between the poles is 2.0×10^{-4} T (Wb m^{-2}).

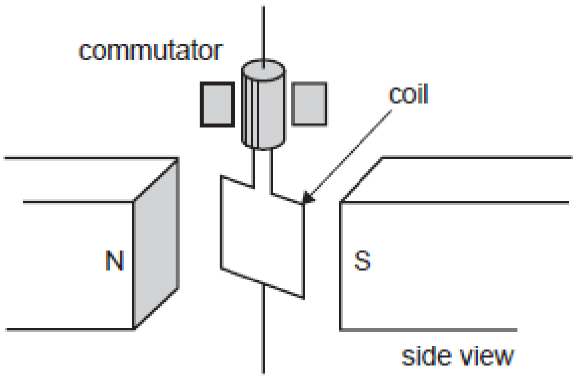


Figure 3a

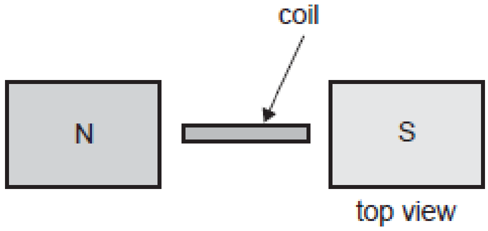


Figure 3b

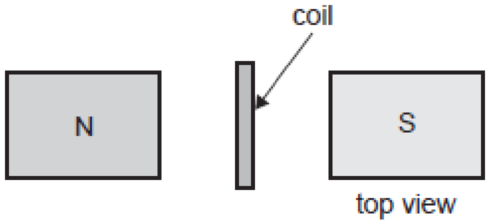


Figure 3c

Example 26 (2006 Question 4, 2 marks)

What is the magnetic flux, Φ_B, threading the loop when the face of the coil is aligned as shown in Figure 3b? Include the unit.

Example 27 (2006 Question 5, 2 marks)

What is the magnetic flux, Φ_B, threading the loop when the face of the coil is aligned as shown in Figure 3c? Include the unit.

Jo tests the motor using a 6.0 V battery as a power source and it turns very slowly. Effie suggests that they should replace the commutator with slip rings to make it turn faster.

Example 28 (2006 Question 6, 3 marks)

What is the role of the commutator? Can Effie's idea work? Explain your answer.

A loop of wire in the form of a 2.0 cm square is moved through a uniform magnetic field at a constant speed of 4.0 cm s^{-1}. This is shown in Figure 4a.
Figure 4b shows an end-on view of the loop as it passes across the face of the north pole of the magnet. Current flowing through the loop is measured by a micro-ammeter (μA).
You may assume the magnetic field exists **only** in the region between the north and south poles.

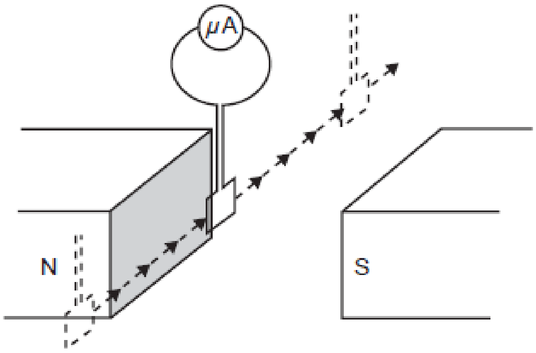


Figure 4a

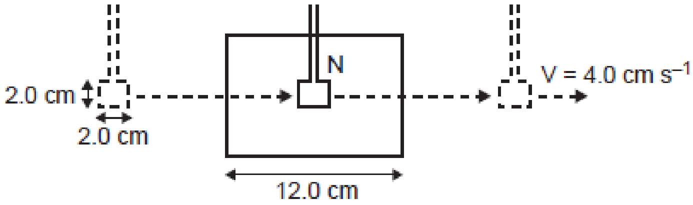


Figure 4b

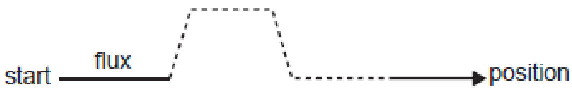


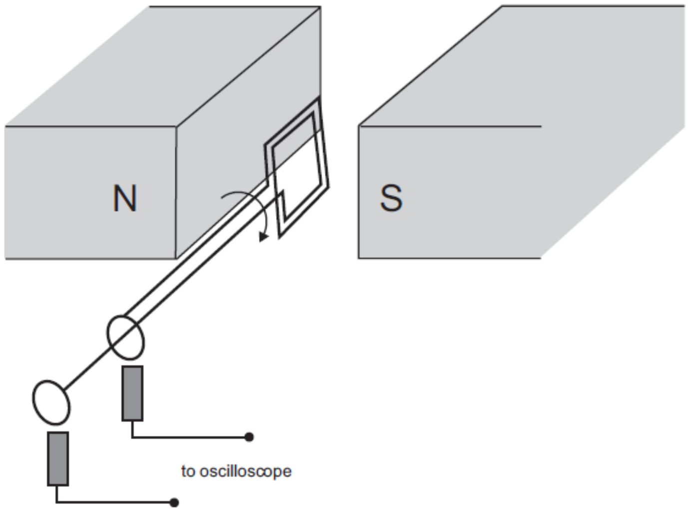
Figure 4c

Initially, the loop is placed well outside of the magnetic field and the micro-ammeter confirms that no current is flowing through the loop. The loop is now moved at a constant rate through the magnetic field, as shown in Figure 4b. Figure 4c shows the flux through the loop as a function of position of the leading edge of the loop.
The field strength between the poles is 3.7×10^{-3} T (Wb m^{-2}).

Example 29 (2006 Question 8, 4 marks)

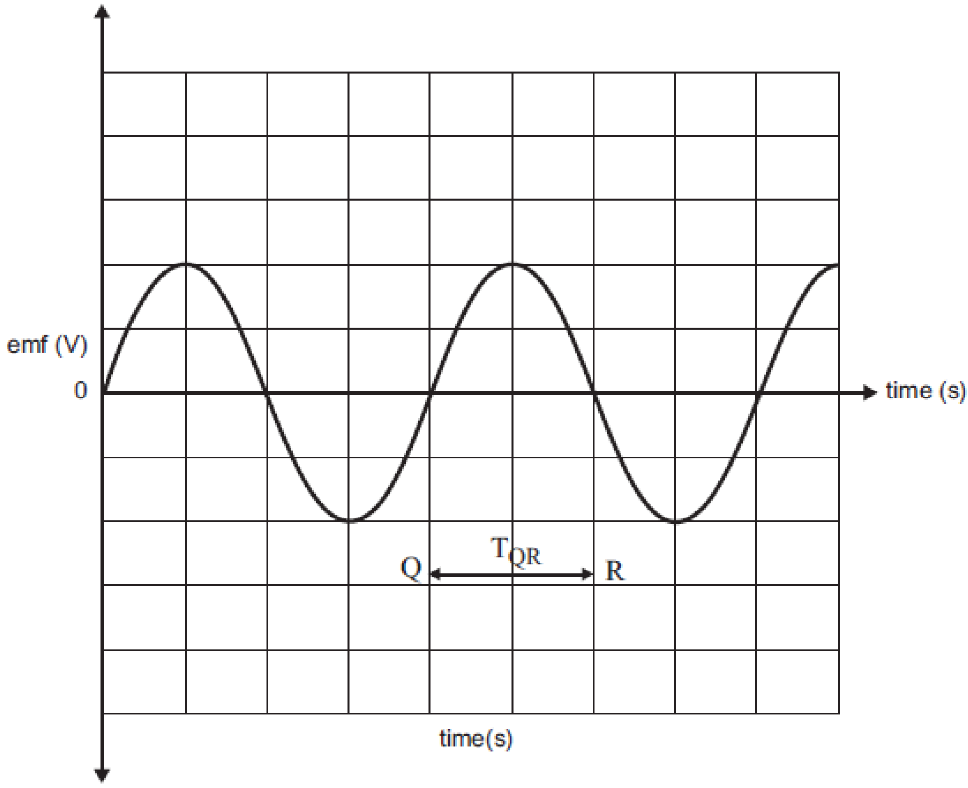
Calculate the maximum induced voltage in the loop.

Some students are studying the emf induced by a magnetic field in a coil of wire. Their experimental apparatus consists of a coil of 100 turns of wire in a magnetic field of 2.0×10^{-2} T as shown below.



Example 30 (2005 Question 2, 2 marks)

With the coil vertical as shown, the flux through the coil is 8×10^{-6} Wb. What is the area of the coil?



The coil is rotated at a rate of 10 revolutions per second, and the output is observed on an oscilloscope (CRO), as shown above.

Example 31 (2005 Question 3, 2 marks)

What is the time interval, T_{QR}, between Q and R?

Example 32 (2005 Question 4, 3 marks)

Calculate the **average** emf observed over the time interval T_{QR}.

The rotation speed of the coil is increased to 20 revolutions per second.

Example 33 (2005 Question 5, 3 marks)

On the figure above, sketch the output from the oscilloscope that would be observed now.

Pat and Kris are discussing **DC generators**. Pat says that slip rings are used in a DC generator. Kris disagrees, and says that DC generators cannot use slip rings because they must produce DC, and therefore a commutator is essential.

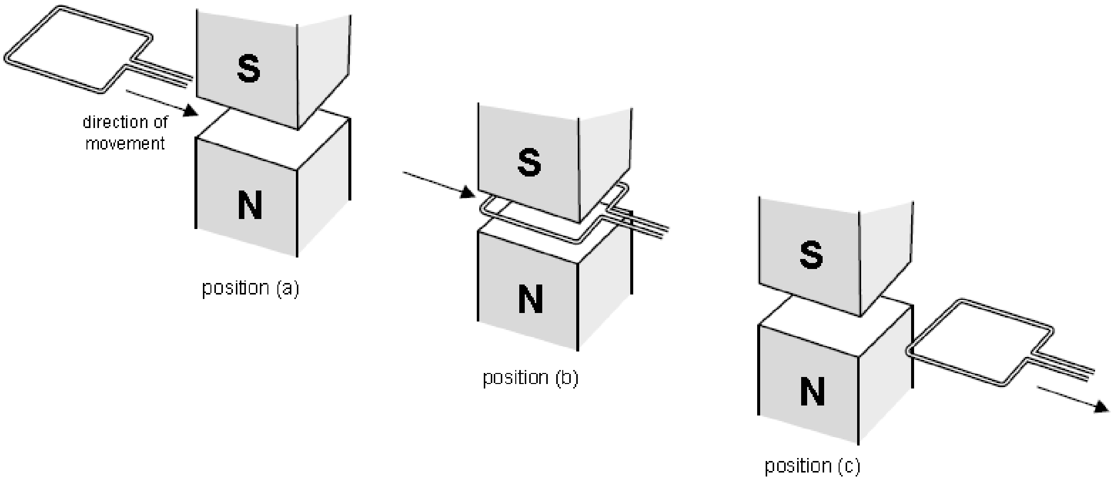
Example 34 (2005 Question 6, 1 mark)

Who is correct?

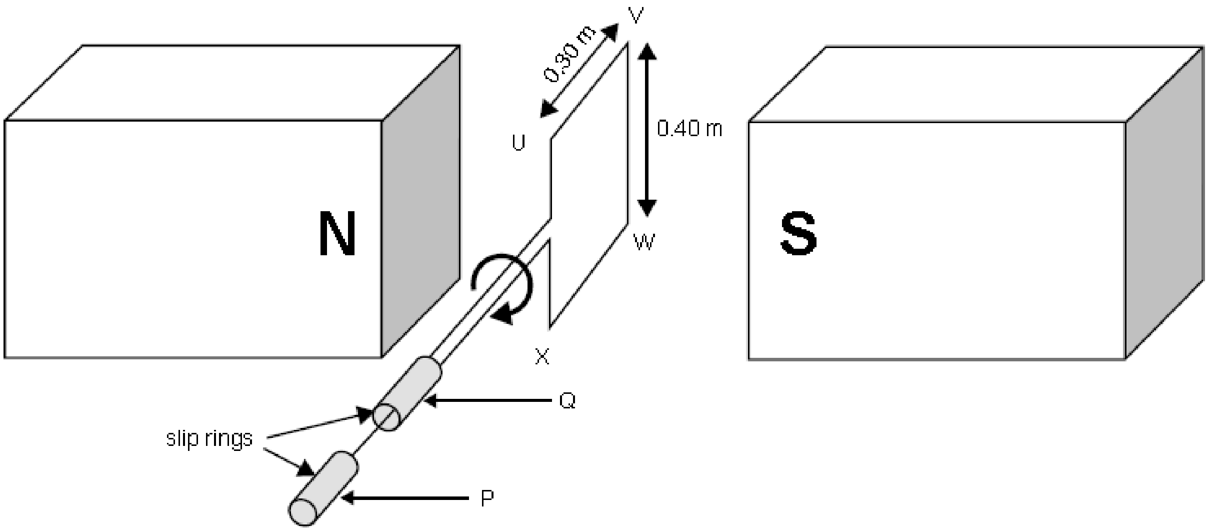
Example 35 (2005 Question 7, 2 marks)

Explain the operation of a commutator

Sofia and Max now move the coil through the magnetic field, as shown below.



Mary and Shin have constructed a simple alternator. It consists of a single rectangular coil of wire, 0.40 m × 0.30 m, which is connected to slip rings, as shown below. The coil is in a uniform magnetic field of 0.12 T, and can be turned in the direction as shown below.



Example 36 (2004 Question 9, 2 marks)

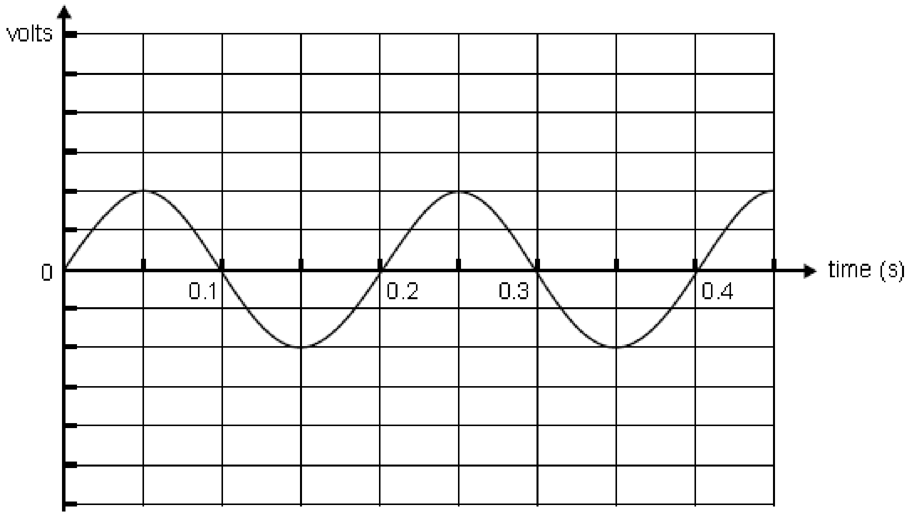
What is the magnitude of the flux through the coil when oriented as shown above?

Example 37 (2004 Question 11, 2 marks)

What is the average voltage measured between points Q and P due to this rotation?

Mary now rotates the coil at a constant rate of 5 revolutions per second, and the students observe that the voltage between points Q and P varies with time as shown in Figure 4 below.

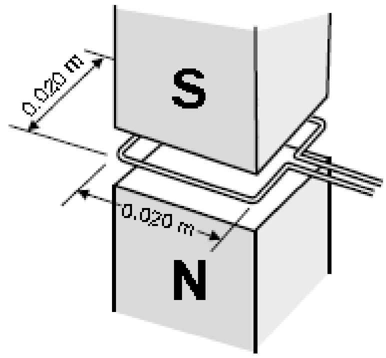
Shin decides to test the effect of rotation speed, and turns the coil at a rate of 10 revolutions per second.



Example 38 (2004 Question 12, 1 mark)

On the figure above, sketch a graph that shows the variation with time of the voltage between points Q and P that the students would now see.

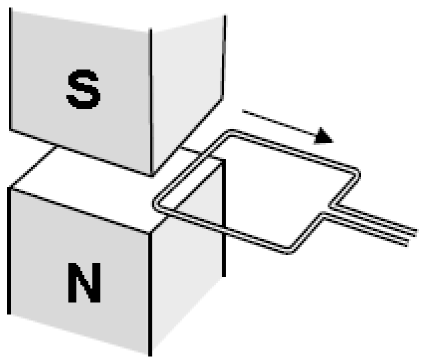
Sofia and Max are investigating electromagnetic induction using a square coil. They place the coil between the poles of a magnet as shown below. The sides of the coil are 0.020 m long. The uniform magnetic field between the poles is 5.0 x 10^{-2} T, and elsewhere in air it is assumed to be zero.



Example 39 (1999 Question 7, 1 mark)

Calculate the magnetic flux through the coil when it is entirely within the magnetic field, as shown above.

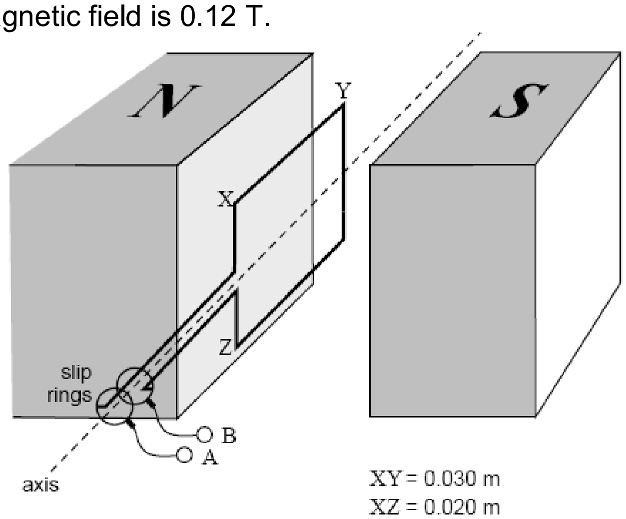
Sofia and Max now move the coil from the position shown above (entirely inside the magnetic field) to the position shown below (entirely outside the magnetic field). It takes 0.040 s to move the coil from the position shown above to the position shown below.



Example 40 (1999 Question 8, 2 marks)

What is the average emf induced in the coil as it moves from one position to the other?

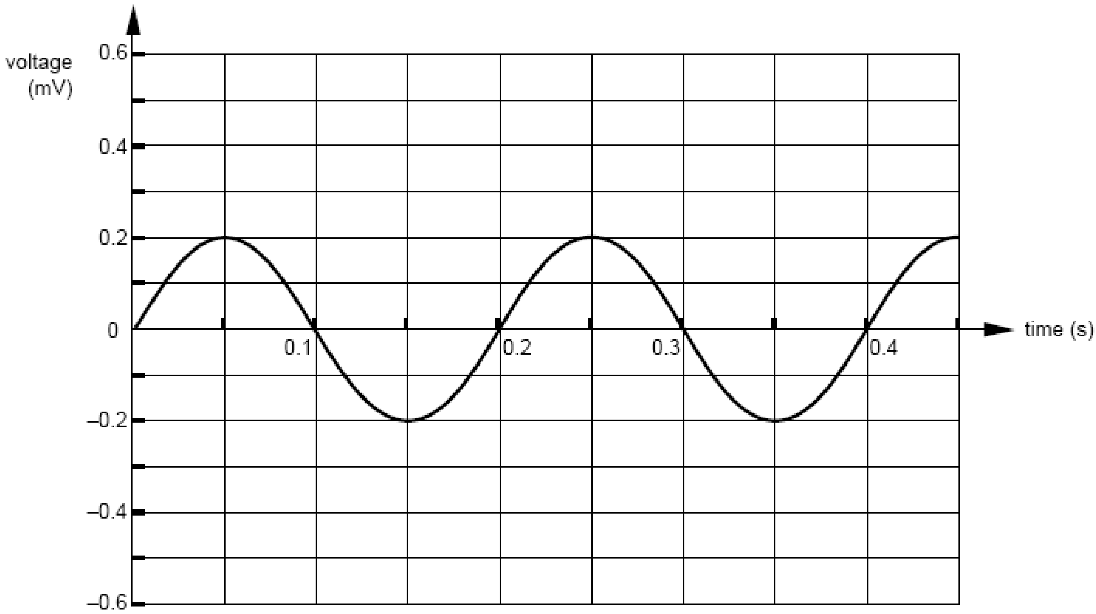
Gary and Kate are investigating electromagnetic induction. They have a single wire loop of dimensions 0.030 m long by 0.020 m wide which is placed in a uniform magnetic field. The loop can be rotated by hand about an axis as shown below. The ends of the loop slide within slip rings so that a measurement of the EMF between the ends of the loop can be made between terminals A and B. The uniform magnetic field is 0.12 T.



Example 41 (1998 Question 9, 2 marks)

What is the value of the magnetic flux through the loop when it is oriented as shown?

Gary now rotates the coil at a constant rate of 5 rotations per second. Using an oscilloscope they observe that the voltage between points A and B varies with time as shown below.

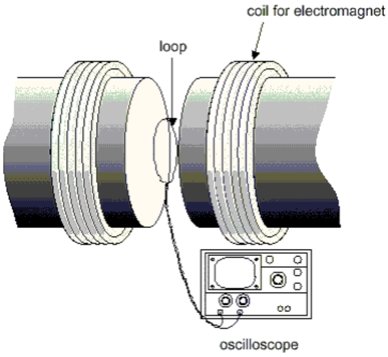


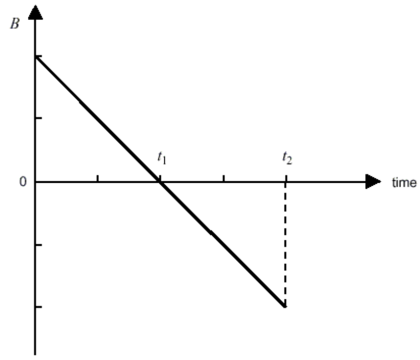
Kate decides to double the rate of rotation to 10 rotations per second.

Example 42 (1998 Question 10, 4 marks)

On the figure above, sketch a graph which shows the variation with time of the voltage between points A and B at this faster rate of rotation.

A student investigates electromagnetic induction using a single loop coil and an electromagnet as shown below. The loop is placed between the poles of the electromagnet, perpendicular to the magnetic field, and connected to an oscilloscope so that any voltage induced in the loop can be measured.

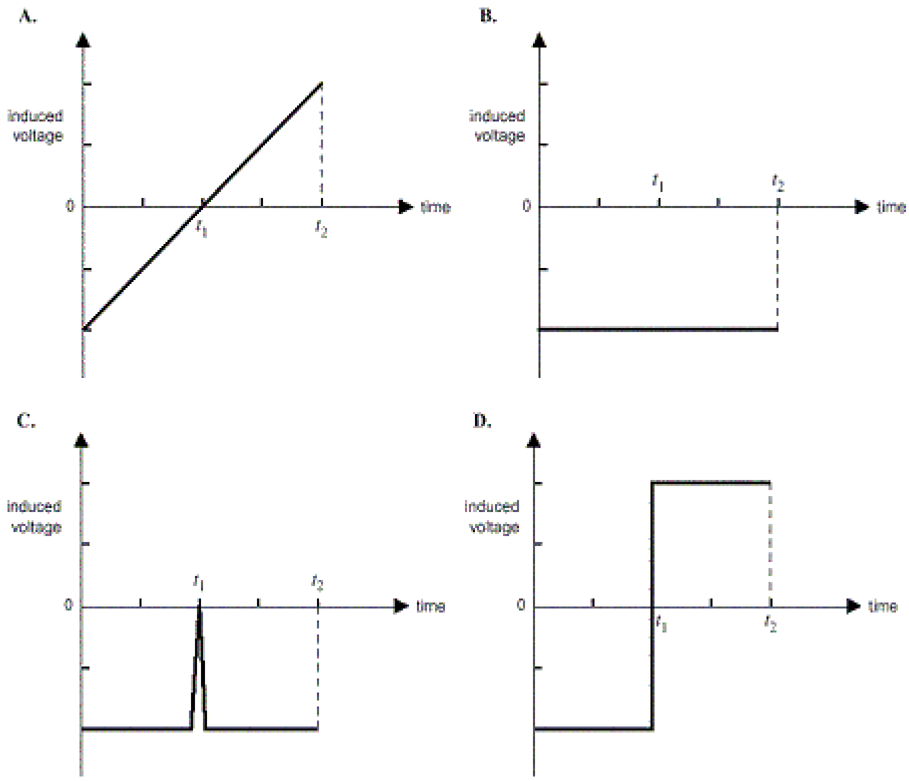




The current in the coils of the electromagnet is reduced to zero and then reversed so that the magnetic field, B, changes as shown above.

Example 43 (1997 Question 12, 2 marks)

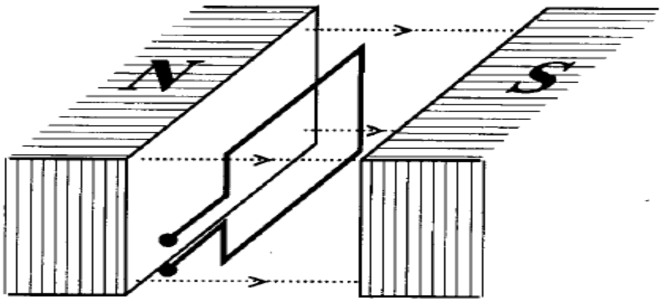
Which one of the options **(**A–D) shown below best represents the induced voltage measured on the oscilloscope?



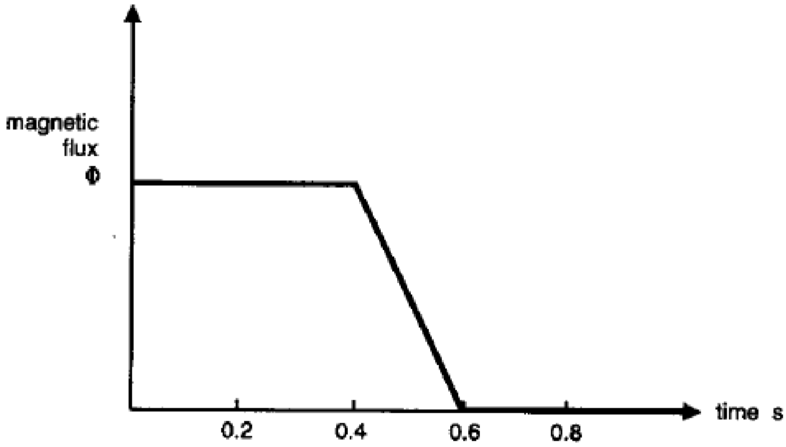
Example 44 (1997 Question 13, 2 marks)

Justify your answer to Question 12.

To investigate electromagnetic induction, a student uses the equipment shown below



It consists of a magnet which provides a uniform magnetic field, and a rectangular coil. The voltage across the ends of the coil is measured using a cathode ray oscilloscope (C.R.O.).
The student moves the coil vertically out of the field at a constant speed. The entire coil is within the field from t=0untilt=0.4s. It leaves the field between t= 0.4s and t= 0.6s. The graph below shows how the magnetic flux though the coil varies with time.

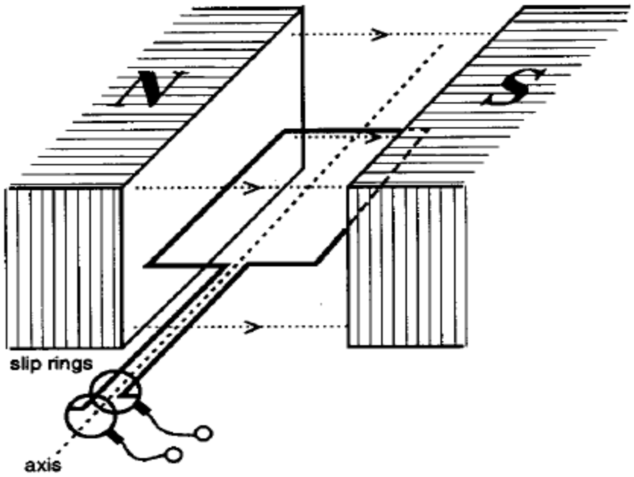


The coil has 200 turns and the area of each turn is 0.020m^2. The uniform magnetic field is 0.080T.

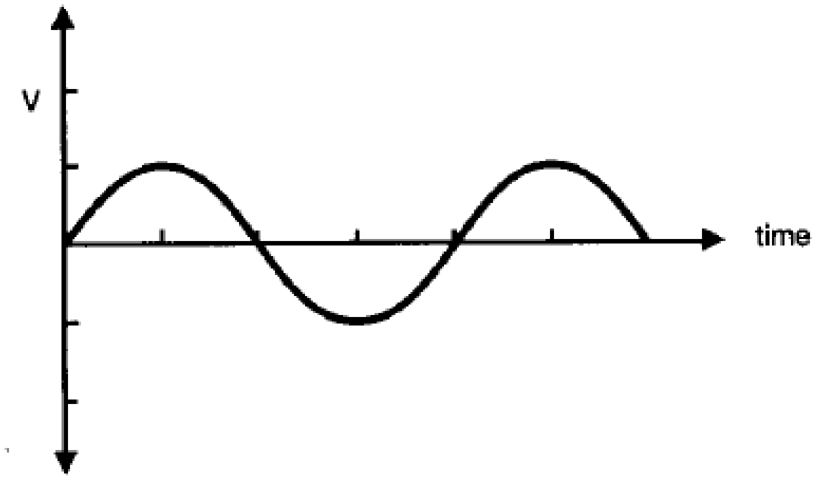
Example 45 (1994 Question 6, 1 mark)

What is the average voltage produced across the ends of the coil for the time interval from t = 0.4 s to t = 0.6s?

The student now arranges the same coil to make an AC generator as shown below



When the coil is rotated at constant speed the voltage varies with time as shown below.

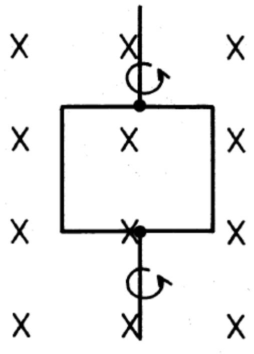


The student then increases the rate of rotation of the coil to twice the initial rate.

Example 46 (1994 Question 7, 2 marks)

Draw the variation of voltage with time which would be observed when the coil is turned at twice the initial rate.

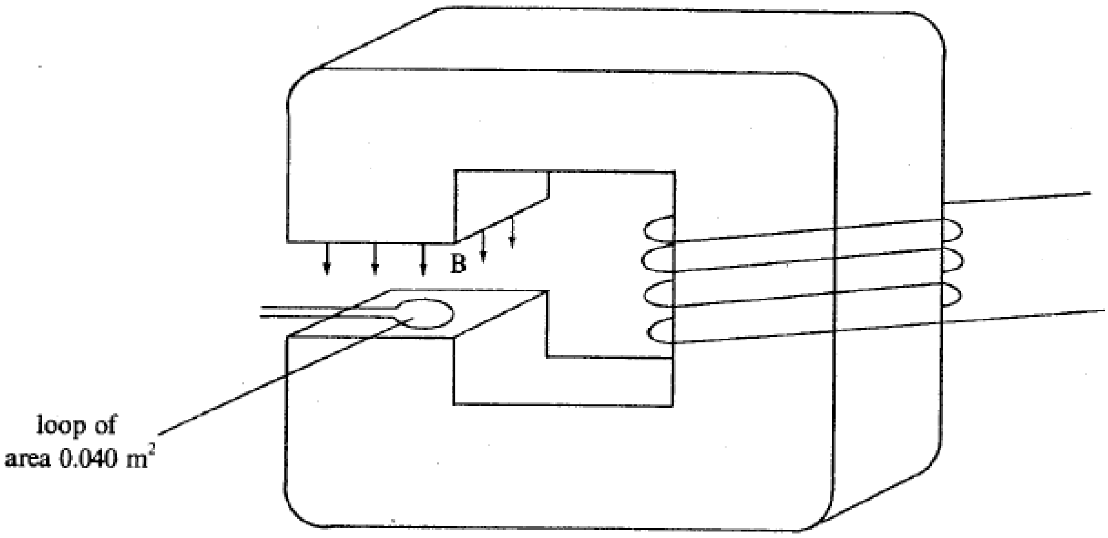
The figure below shows a single loop of wire placed completely within a region of uniform magnetic field ($B = 10^{-2}$ T) directed into the page. The loop of wire has an area of 10 cm^2; and is mounted so that it can be turned about the vertical axis as shown.



The loop rotates at a constant rate of 10 turns during each second.

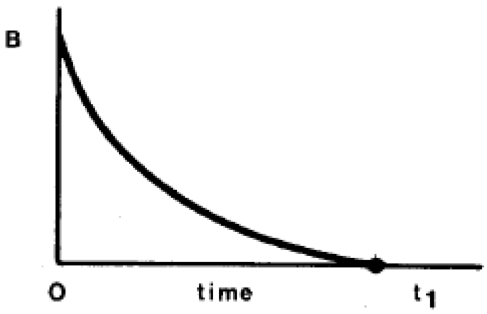
Example 47 (1984 Question 72, 1 mark)

What is the value of the emf induced in the loop at an instant when the plane of the loop is perpendicular to the direction of the magnetic field (as shown above).



The diagram shows a flexible loop of wire between the poles of an electromagnet which provides a uniform field B in the region of the loop.

At time t = 0, the current through the electromagnet is turned off, and the field B then falls to zero at time t_1 as shown.



Example 48 (1981 Question 69, 1 mark)

The loop has an area of 0.040 m^2. If the magnetic field falls from 0.60 Wb m^{-2} to zero over a period of 2.0 s, what is the average EMF produced?