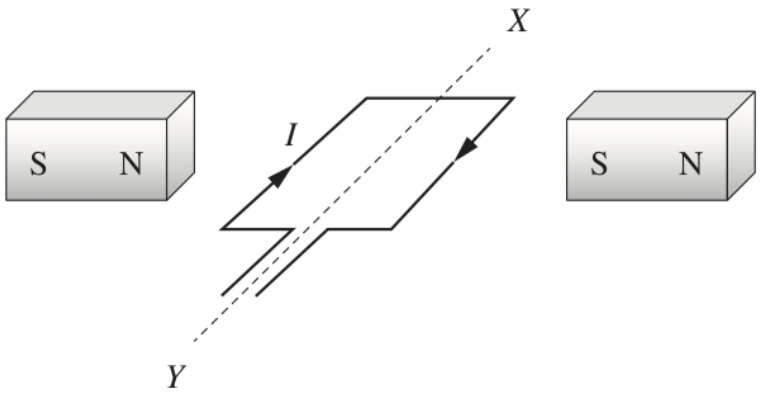
New Syllabus NESA Questions:

1)

A rectangular loop of wire passes between two magnets as shown and is free to rotate about *XY*. The loop has a current flowing through it.



Without changing the current, which of the following would result in the greatest increase in torque?

A. Increase the thickness of the wire in the loop.

B. Decrease the thickness of the wire in the loop.

C. Extend the length of the loop in the *XY* direction.

D. Extend the width of the loop towards the magnets.

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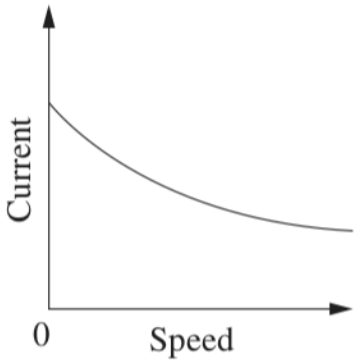
2)

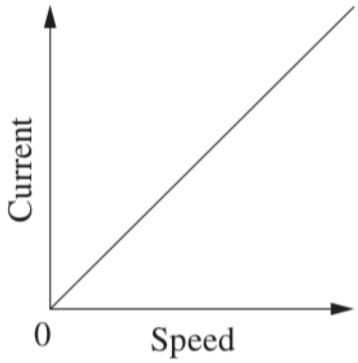
An electric motor is connected to a power supply of constant voltage. The motor runs at different speeds by adjusting a brake.

Which graph best shows the relationship between the current through the motor and its speed?

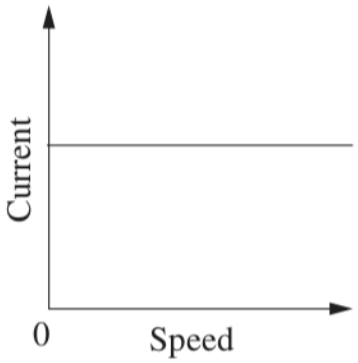
A.



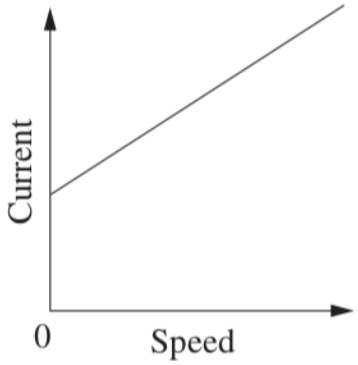
B.



C.



D.



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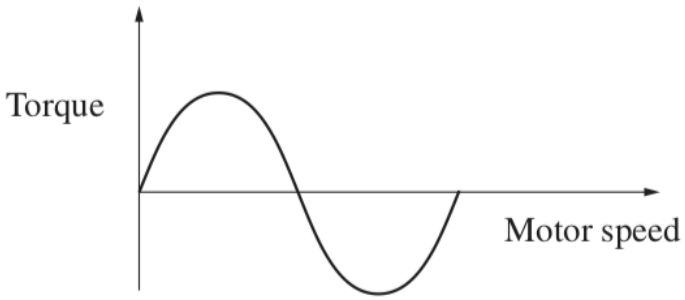
3)

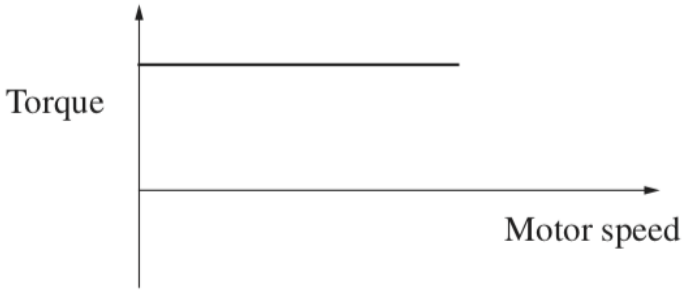
An experiment was carried out to investigate the change in torque for a DC motor with a radial magnetic field. The data from start up to operating speed were graphed.

Which graph is most likely to represent this set of data?

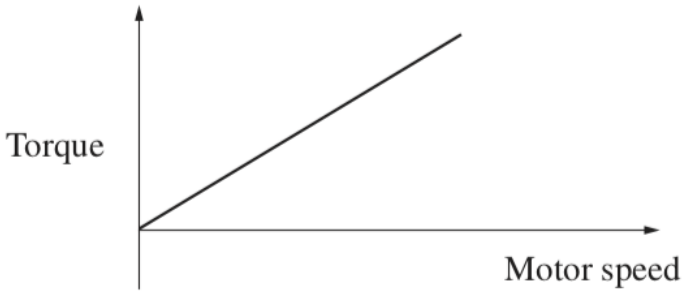
A.



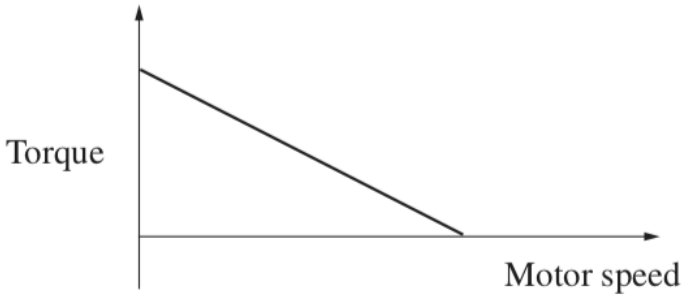
B.



C.

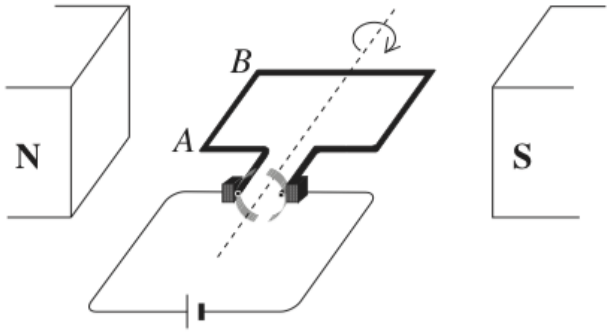


D.



4)

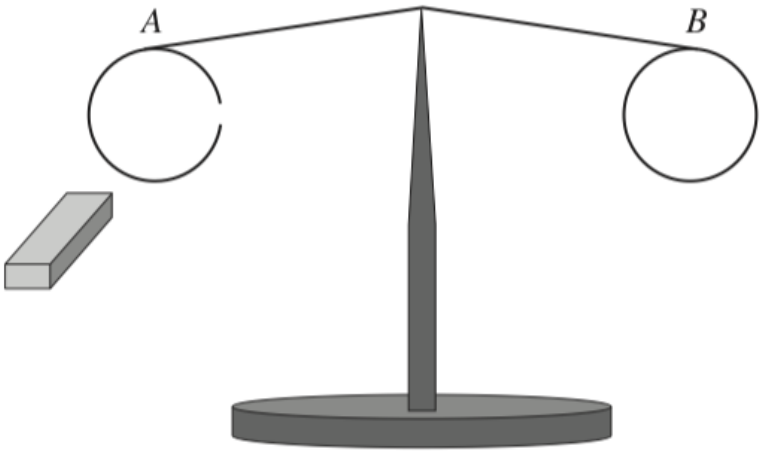
The diagram shows a DC motor with a constant current flowing to the rotor. **4**



Sketch graphs to compare the behaviour of the force F on wire AB and the torque τ on the rotor, as functions of time t.

5)

The diagram shows two rings *A* and *B*, connected to a balancing arm which swings freely on a pivot. Ring *A* has a split in it as shown. **5**



When a bar magnet is pushed into one of the rings, the whole balancing arm begins to rotate on the pivot. When the magnet is pulled out, the balancing arm begins to rotate in the opposite direction. When the magnet is pushed in and out of the other ring, the apparatus does not move at all.

Account for these observations using Lenz's Law and conservation of energy.

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Past HSC Questions:

2018:

4 A motor, battery and ammeter are connected in series. When the motor is turning at full speed, the ammeter has a reading of 0.1 A. While the motor is spinning, a person holds the shaft of the motor to stop it.

Which row of the table correctly identifies the change in the ammeter reading and an explanation for the change?

	Reading on ammeter	*Explanation*
A.	Decreases	Decrease in back emf
B.	Increases	Increase in back emf
C.	Decreases	Increase in back emf
D.	Increases	Decrease in back emf

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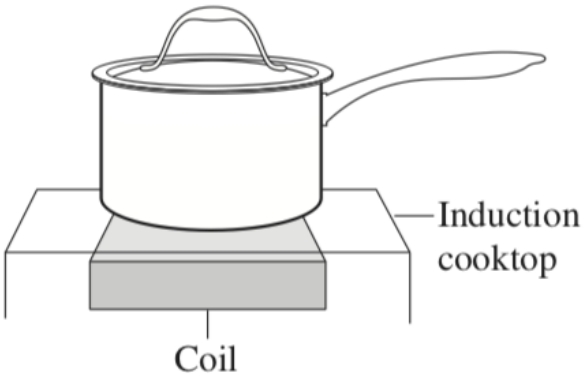
6 The diagram shows a saucepan of water on an induction cooktop.



Which row of the table correctly identifies a property of the material used to make the saucepan and the frequency of the changing magnetic field produced by the coil?

	Property of saucepan	*Frequency*
A.	Insulator	High (50 kHz)
B.	Conductor	High (50 kHz)
C.	Insulator	Low (50 Hz)
D.	Conductor	Low (50 Hz)

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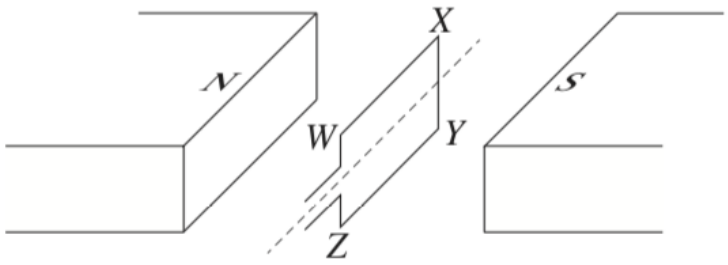
10 The diagram shows some parts of a simple DC motor.

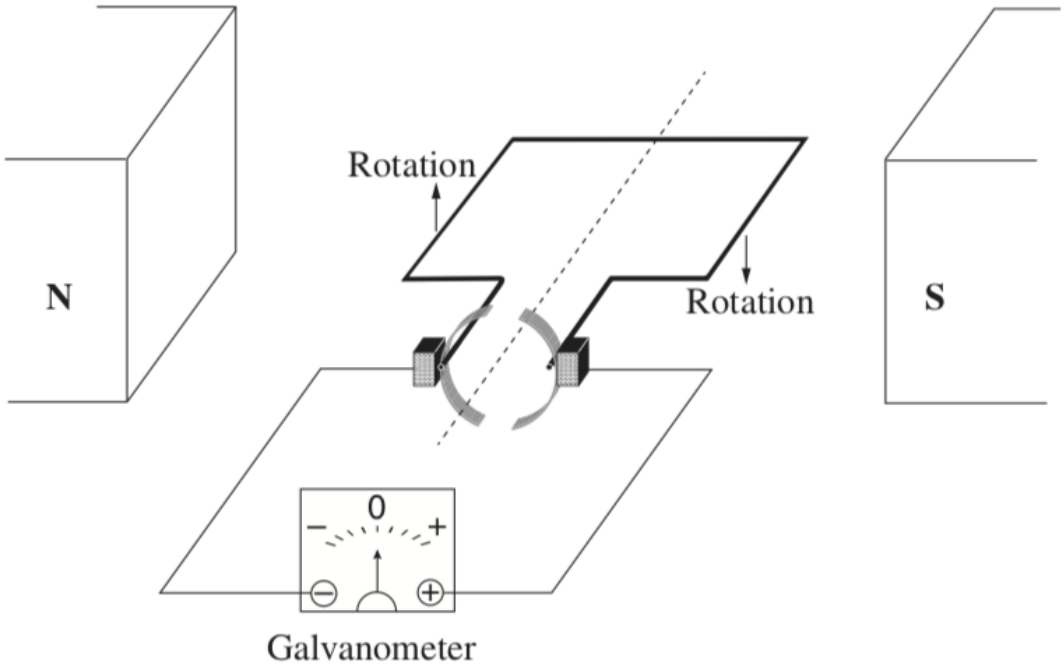


Which row of the table correctly describes the direction of force acting on side *WX* and the direction of torque this produces on the coil?

	Direction of force acting on WX	*Direction of torque produced on the coil by the force acting on WX*
A.	Remains constant	Remains constant
B.	Remains constant	Reverses every 180°
C.	Reverses every 180°	Remains constant
D.	Reverses every 180°	Reverses every 180°

2017:

10 The diagram shows a model of a generator connected to a galvanometer.

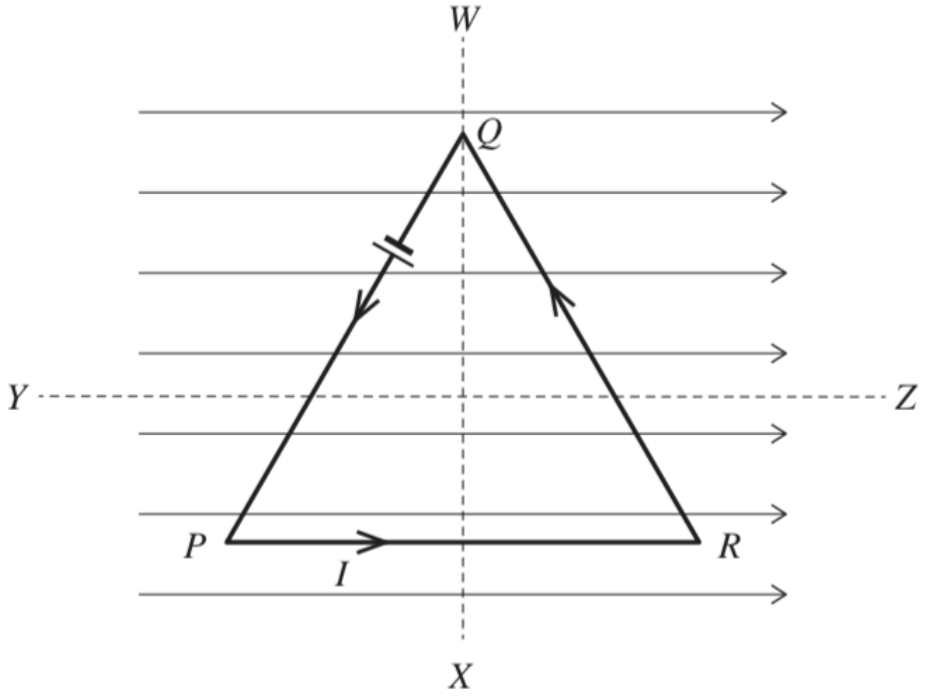


The loop is rotated continuously in a clockwise direction as viewed from the end nearest the galvanometer.

Which row of the table correctly identifies the type of generator and the movement of the needle of the galvanometer?

	Type of generator	*Movement of the needle*
A.	DC	Swings between 0 and +
B.	AC	Swings between – and 0
C.	DC	Swings between + and –
D.	AC	Swings between – and +

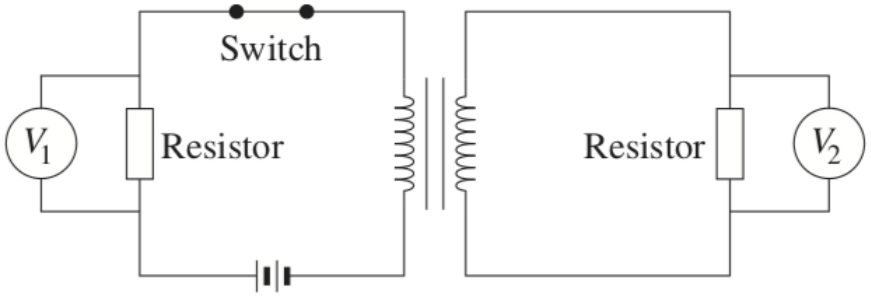
13 A triangular piece of wire is placed in a magnetic field as shown.



When current I is supplied as shown, how does the wire move?

	Axis of rotation	*Direction of movement*
A.	*YZ*	*Q* into page
B.	*YZ*	*Q* out of page
C.	*WX*	*R* into page
D.	*WX*	*R* out of page

14 The diagram shows a DC circuit containing a transformer.

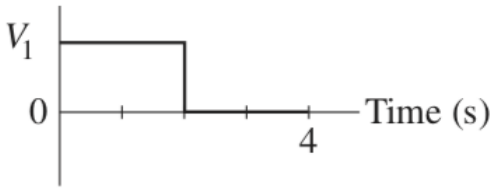


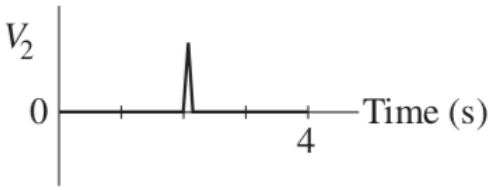
The potential differences V_1 and V_2 are measured continuously for 4 s. The switch is initially closed.

At $t = 2$ s, the switch is opened.

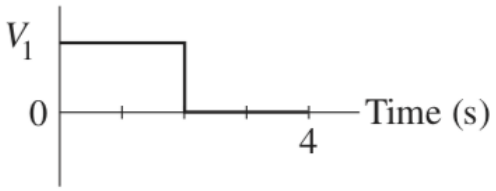
Which pair of graphs shows how the potential differences V_1 and V_2 vary with time over the 4-second interval?

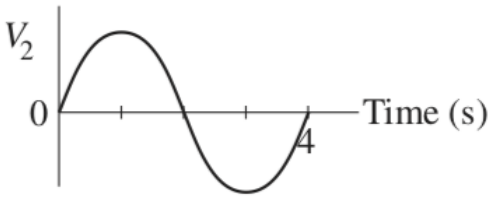
A.



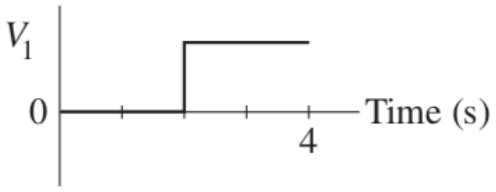


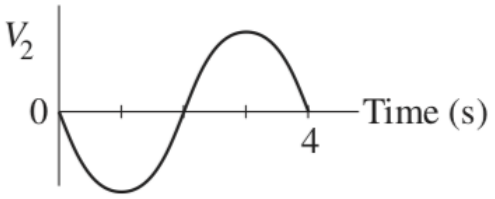
B.



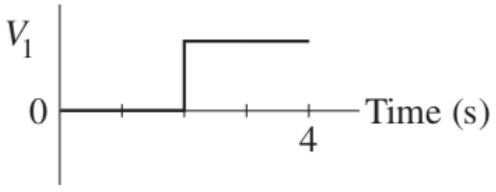


C.

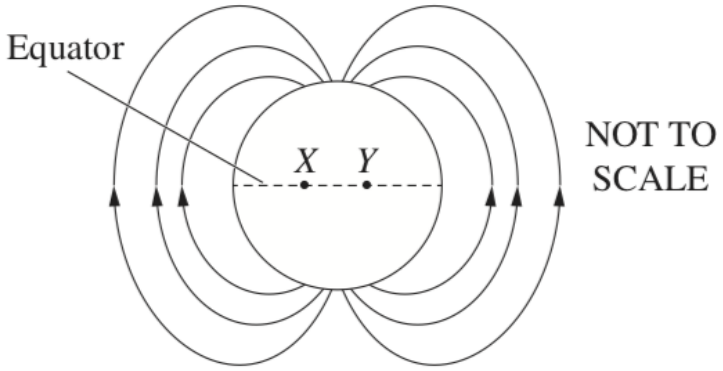




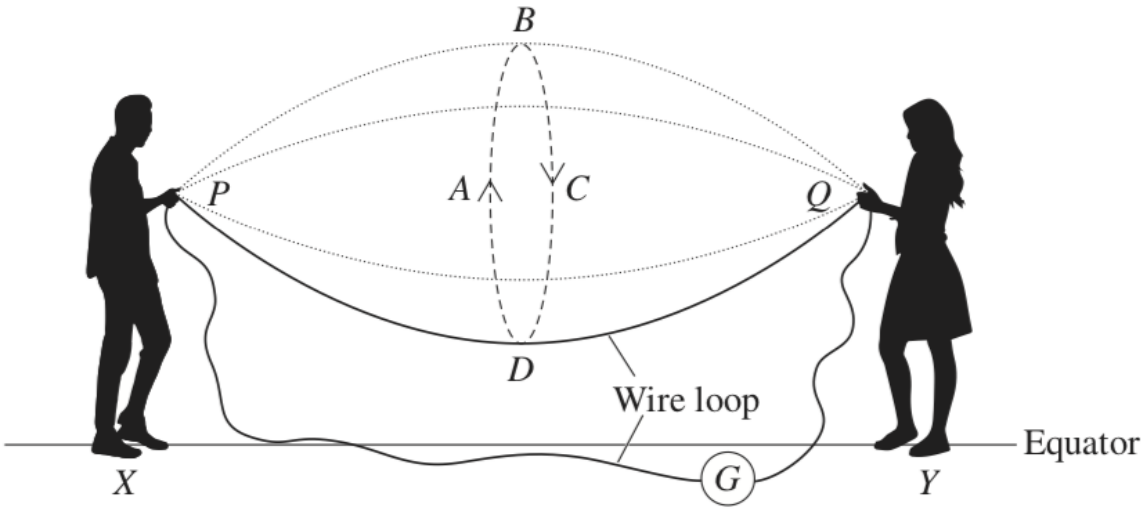
D.



19 Earth's magnetic field is shown in the following diagram.



Two students standing a few metres apart on the equator at points *X* and *Y*, where Earth's magnetic field is parallel to the ground, hold a loop of copper wire between them. Part of the loop is rotated like a skipping rope as shown, while the other part remains motionless on the ground.



At what point during the rotation of the wire does the maximum current flow in a direction from *P* to *Q* through the moving part of the wire?

A. *A*

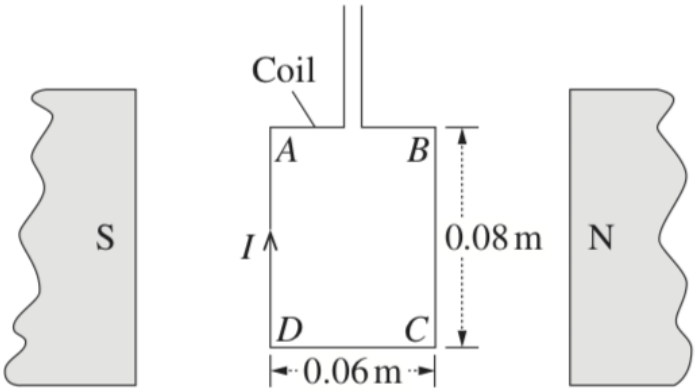
B. *B*

C. *C*

D. *D*

22)

(b) A coil consisting of 15 turns is placed in a uniform 0.2 T magnetic field between two magnets. A current of 7.0 amperes flows in the direction shown. **3**



Calculate the magnitude and direction of the torque produced by the side *BC* of the 15-turn coil.

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Question 28 (6 marks)

Contrast the design of transformers and magnetic braking systems in terms of the effects that eddy currents have in these devices. **6**

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2016:

9 How does back emf affect a DC motor?

(A) It creates heat in the iron core.

(B) It limits the speed of the motor.

(C) It reverses the current in the coil.

(D) It increases the torque of the motor.

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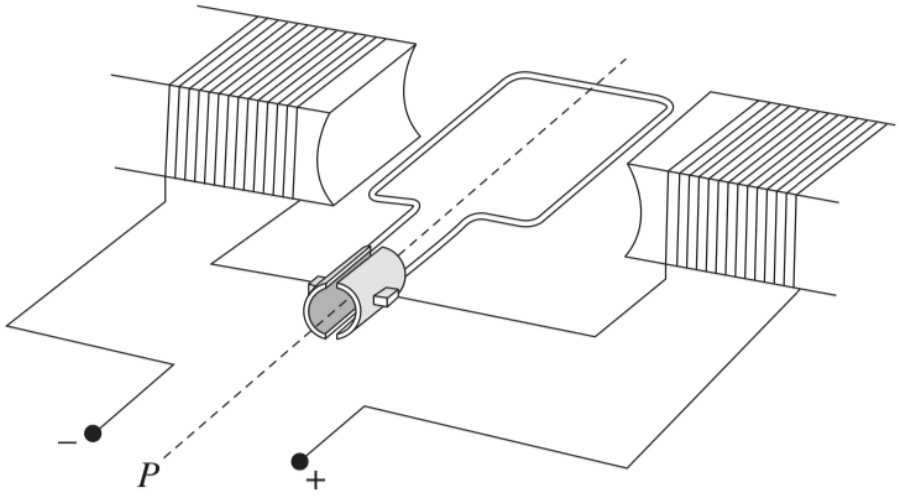
20 In the motor shown, the rotor spins clockwise, as viewed from point *P*, when connected to a DC supply.



What happens when the motor is connected to an AC supply?

(A) There is no movement of the rotor.

(B) The rotor produces clockwise movement only.

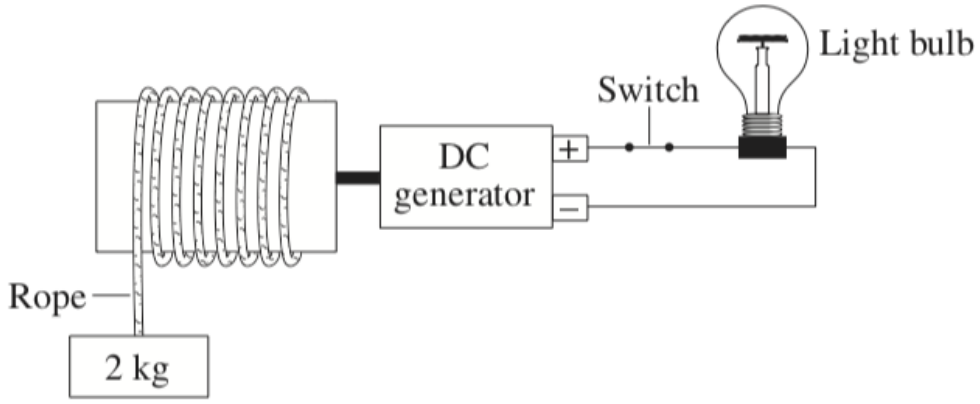
(C) The rotor vibrates at the frequency of the AC supply.

(D) The rotor continuously turns half a rotation clockwise, then half a rotation anticlockwise.

Question 30 (6 marks)

The following makeshift device was made to provide lighting for a stranded astronaut on Mars.

The mass of Mars is 6.39×10^{23} kg.



The 2 kg mass falls, turning the DC generator, which supplies energy to the light bulb. The mass falls from a point that is 3 376 204 m from the centre of Mars.

(a) Calculate the maximum possible energy released by the light bulb as the mass falls through a distance of one metre. **3**

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(b) Explain the difference in the behaviour of the falling mass when the switch is open. **3**

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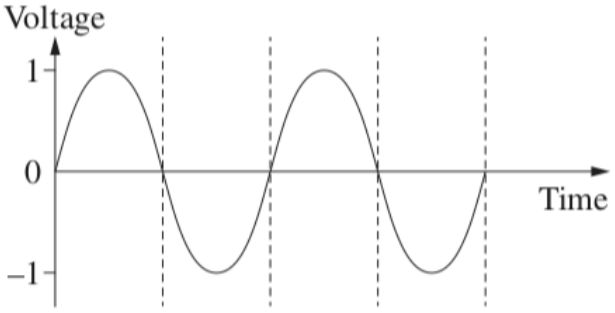
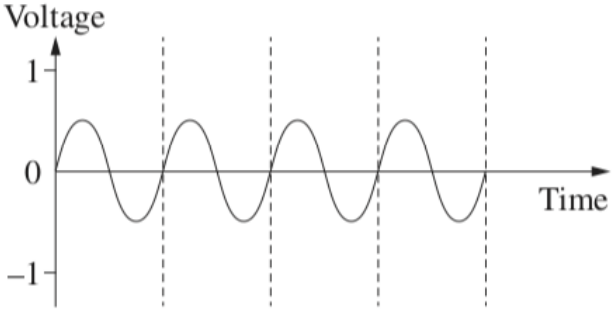
2015:

12 A simple AC generator was connected to a cathode ray oscilloscope and the coil was rotated at a constant rate. The output is shown on this graph.

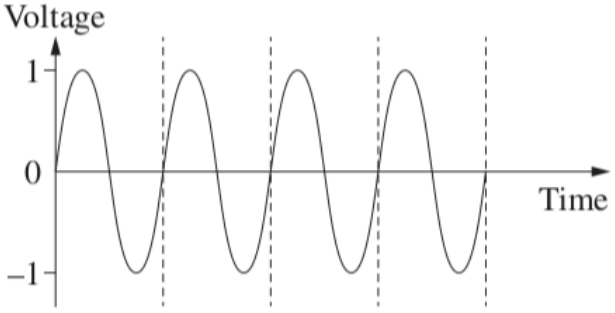


Which of the following graphs best represents the output if the rate of rotation is decreased to half of the original value?

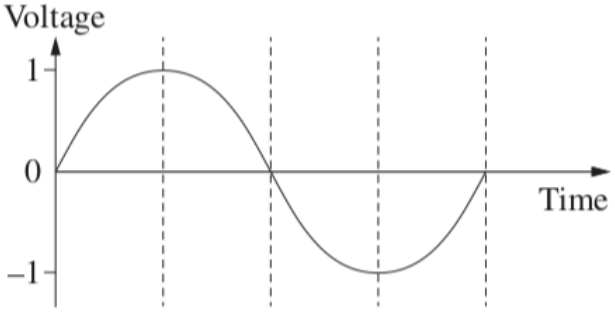
(A)



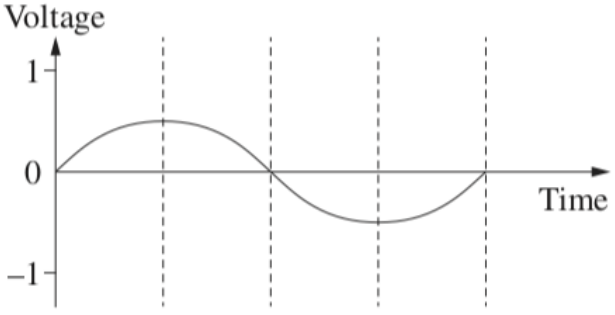
(B)



(C)

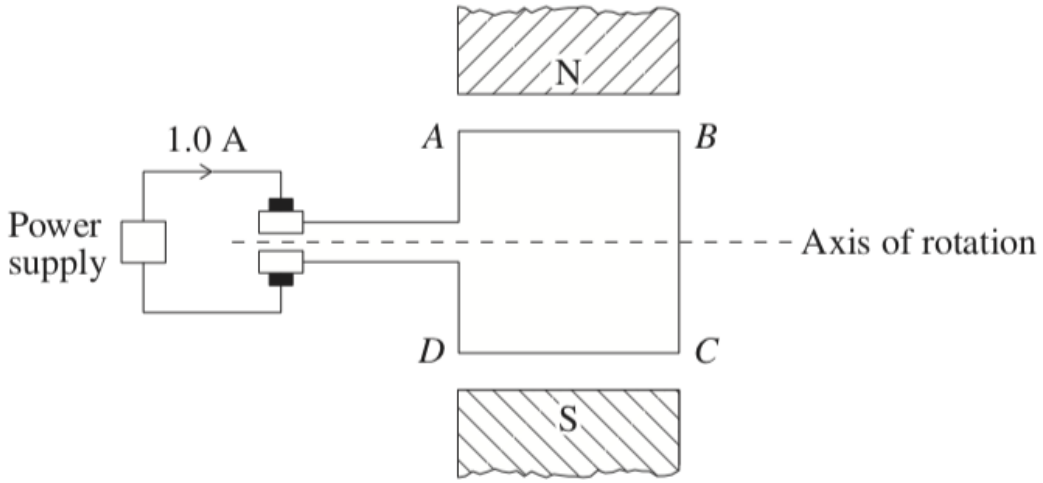


(D)



Question 22 (5 marks)

The diagram represents a simple DC motor. A current of 1.0 A flows through a square loop *ABCD* with 5 cm sides in a magnetic field of 0.01 T.



(a) Determine the force acting on section *AB* and the force acting on section *BC* due to the magnetic field, when the loop is in the position shown. **3**

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(b) How is the direction of the torque maintained as the loop rotates 360° from the position shown? **2**

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2014:

2 Wire, axle, armature, commutator and brushes can be used to build a device.

Which of the following devices requires ALL of these components?

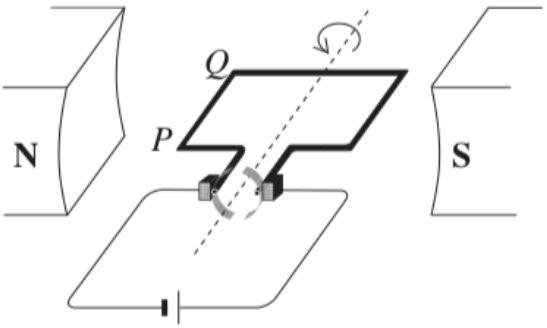
(A) Transformer

(B) DC generator

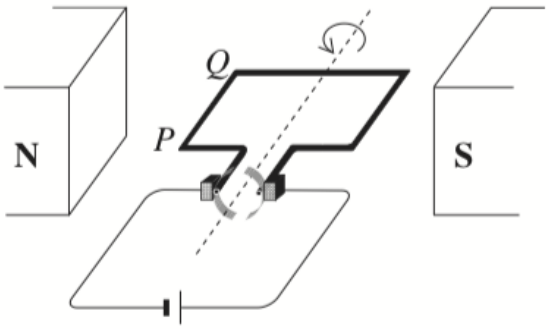
(C) Galvanometer

(D) Induction motor

12 The diagrams show a wire loop rotating anticlockwise in a radial magnetic field and in a parallel magnetic field. There is a constant current in the wire loop.

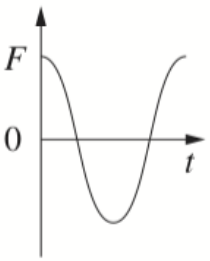
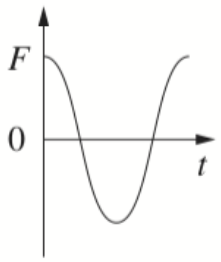
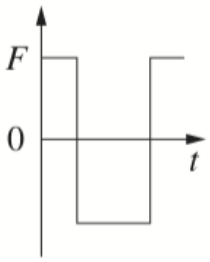
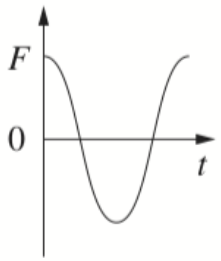
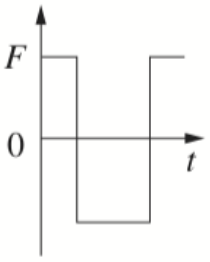
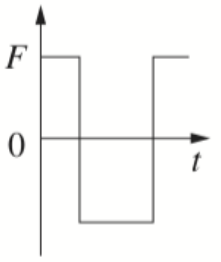
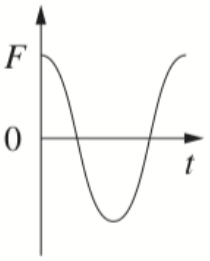
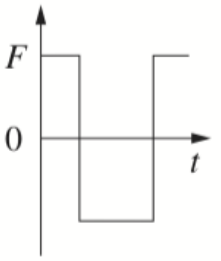


Radial magnetic field

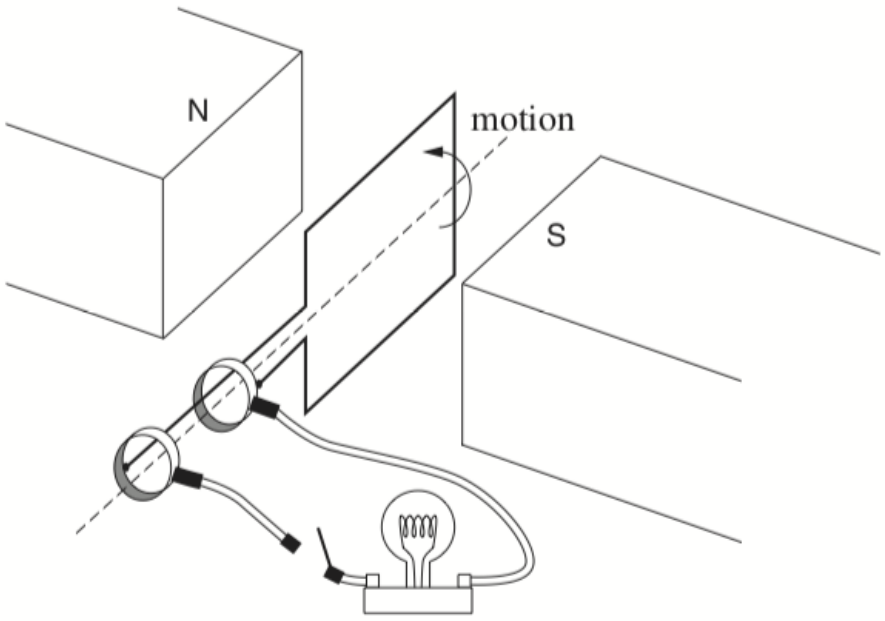


Parallel magnetic field

Which pair of graphs best describes the behaviour of the force (F) on the length of wire PQ as a function of time (t) for one revolution of the wire loop?

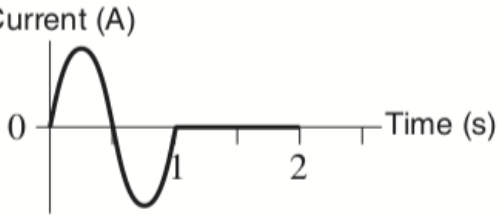
	Radial field	Parallel field
(A)		
(B)		
(C)		
(D)		

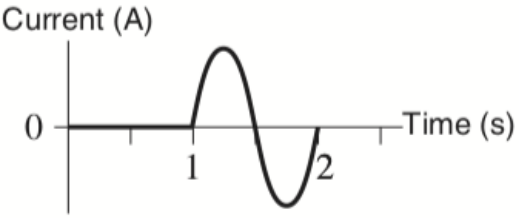
14 The diagram shows a generator circuit connected with a switch.

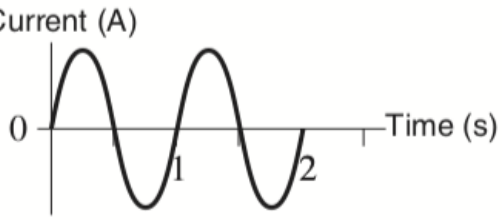


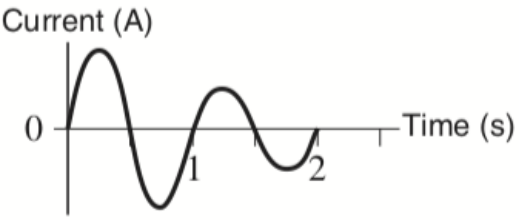
The generator is rotated by one revolution in the first second with the switch open. It is then rotated by one revolution in the next second with the switch closed.

Which graph shows the current produced by this generator for these two seconds?

(A)


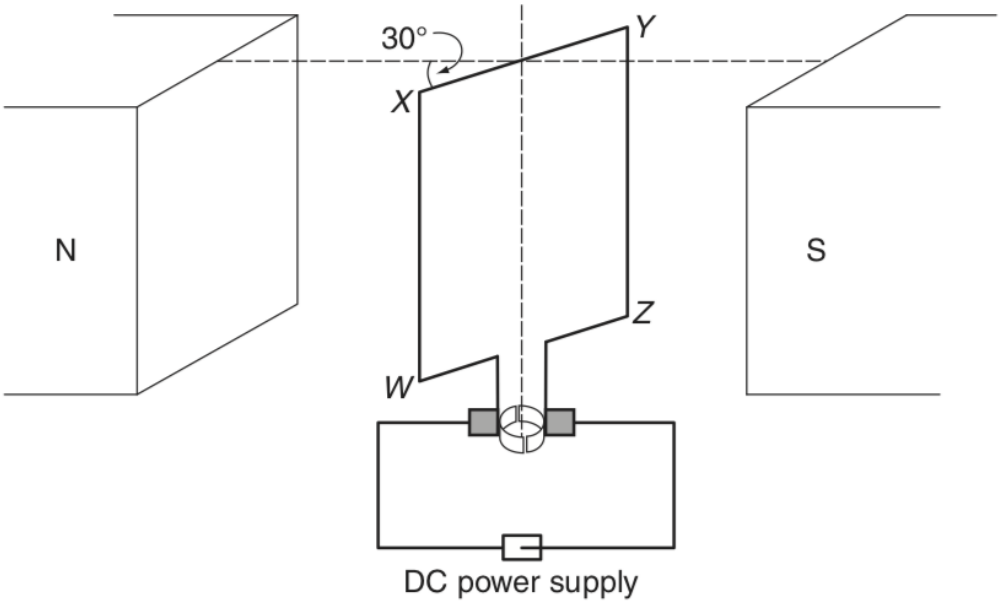
(B)


(C)


(D)


2013:

15 The diagram shows a single-loop motor.



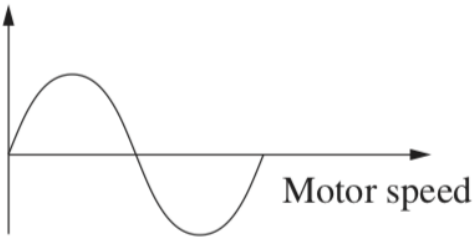
The equations $\tau = nBIA\cos\theta$ and $F = BIl\sin\omega$ can be used to calculate the torque in the motor and the force on the length of wire WX respectively.

What angles are represented by θ and ω in the above equations?

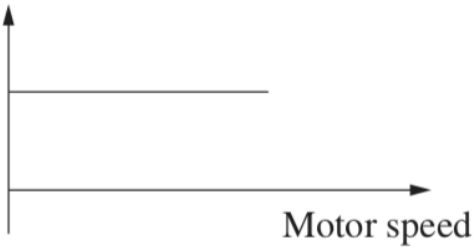
	θ	ω
(A)	30°	90°
(B)	30°	30°
(C)	60°	90°
(D)	60°	30°

17 Which graph best represents the change in torque for a DC motor, with a radial magnetic field, from start up to operating speed?

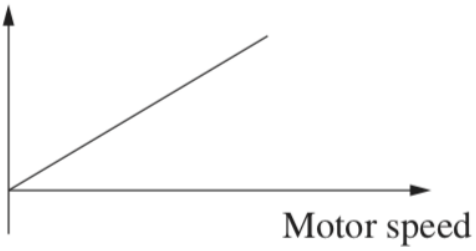
(A)



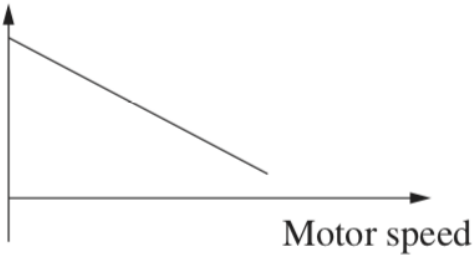
(B)



(C)

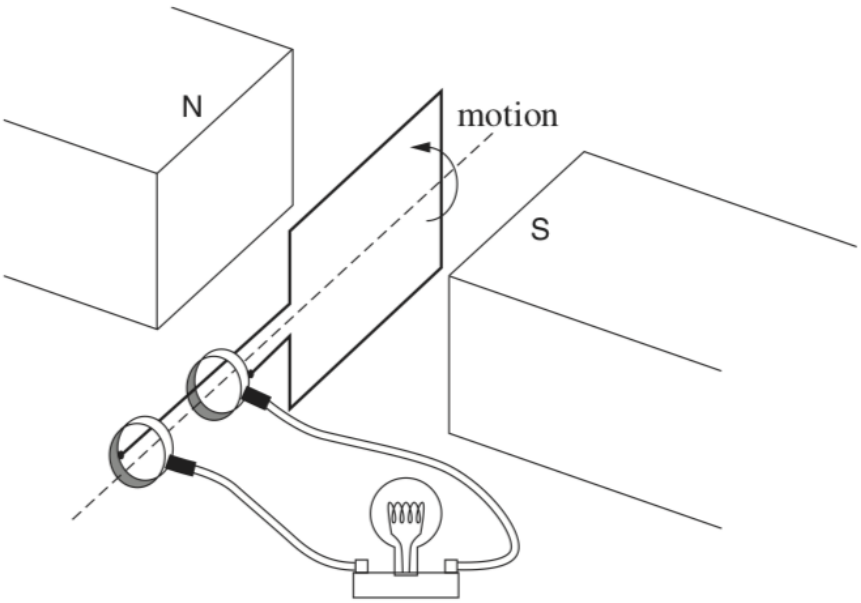


(D)

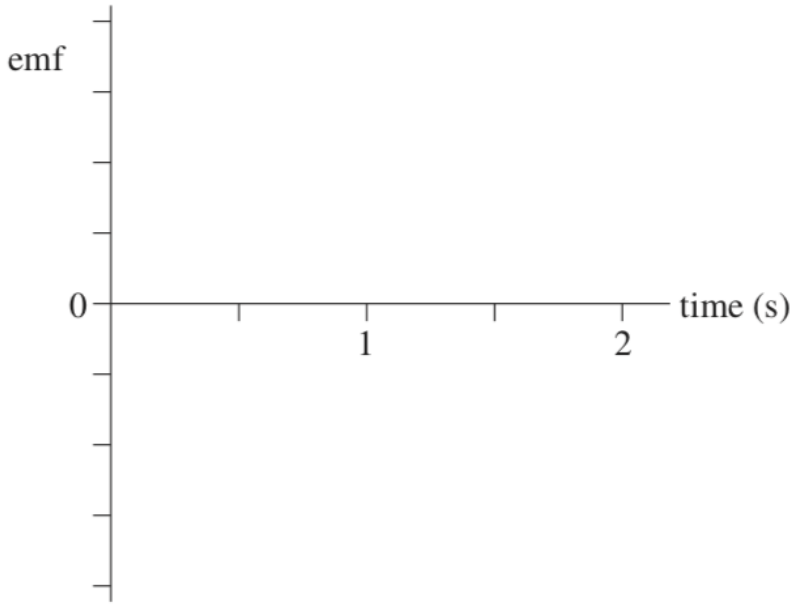


Question 27 (7 marks)

(a) A generator starts at the position shown and is rotated by one revolution in the first second. It is then rotated by two revolutions in the next second. **3**



Sketch a graph on the axes showing the electromotive force (emf) produced by this generator for these two seconds.



(b) An electric motor can be used to propel a vehicle. The electric motor can be made to operate as a generator when the vehicle is moving. This will have a braking effect on the vehicle. **4**

Explain the physics principles involved in the propelling and braking of this vehicle.

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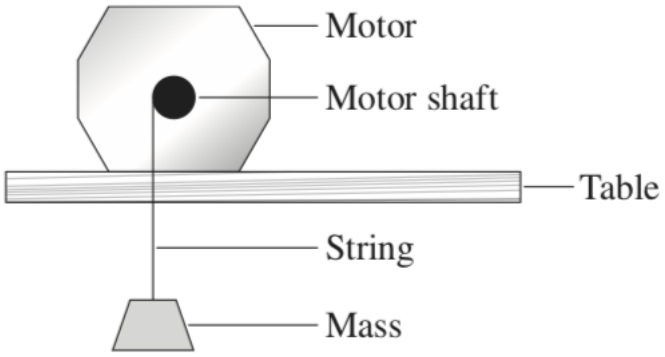
Question 29 (5 marks)

A 0.05 kg mass is lifted at a constant speed by a DC motor. The motor has a coil of 100 turns in a 0.1 T magnetic field. The area of the coil is 0.0012 m^2. The motor shaft has a radius of 0.004 m.



(a) Determine the force needed to lift the mass. **2**

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(b) Calculate the minimum current required in the coil to lift the mass. **3**

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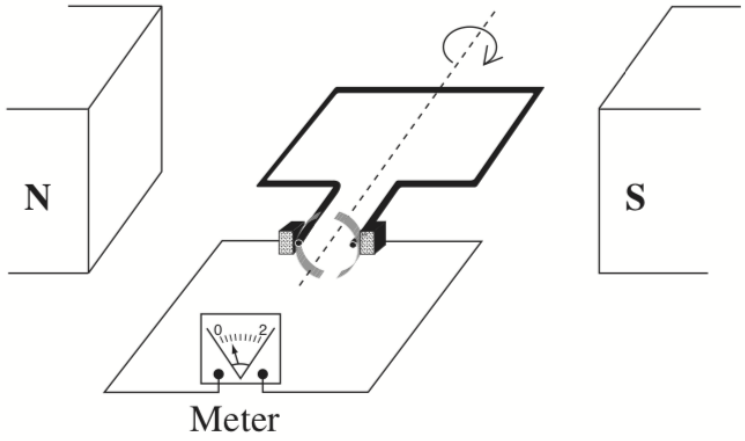
2012:

1 The diagram shows a device connected to a meter.



What device is shown in the diagram?

(A) AC motor

(B) DC motor

(C) AC generator

(D) DC generator

---

16 An ideal electric motor connected to a DC voltage source rotates at a constant rate of 200 revolutions per minute. There is no load on the motor.

Which of the following is a correct statement about the operation of the motor?

(A) The applied voltage must exceed the back emf in order to keep the motor running.

(B) There is no back emf because it is only produced in AC motors due to the changing flux.

(C) The back emf is equal to the applied voltage because no work is being done by the motor.

(D) The back emf must exceed the applied voltage to prevent the motor's speed from increasing.

2011:

6 Why is the back emf induced in a motor greater when the motor is rotating faster?

(A) A larger current is induced.

(B) It takes a greater emf to spin the motor.

(C) The rate of change of magnetic flux is greater.

(D) More magnetic field lines are being cut per rotation.

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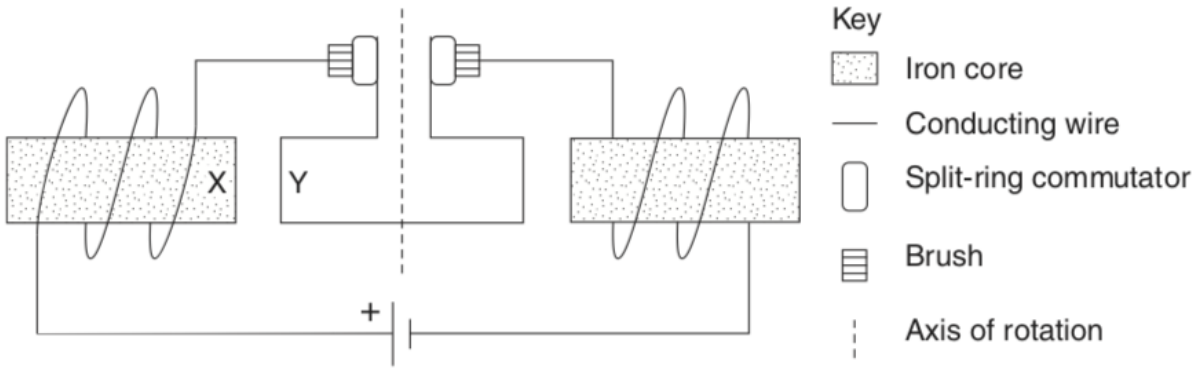
12 The diagram represents a DC electric motor.



What is the polarity of the magnetic pole at X, and the direction of the motion of wire Y?

	Polarity of magnetic pole at X	*Direction of motion of wire Y*
(A)	South	Into the page
(B)	South	Out of the page
(C)	North	Into the page
(D)	North	Out of the page

---

18 An electric motor is constructed using a square coil and a uniform magnetic field of strength 0.45 T. The coil has 3 turns and sides of 10 cm. A current of 0.5 A flows through the coil.

What is the maximum torque experienced by the coil as it rotates?

(A) 2.25×10^{-3} Nm

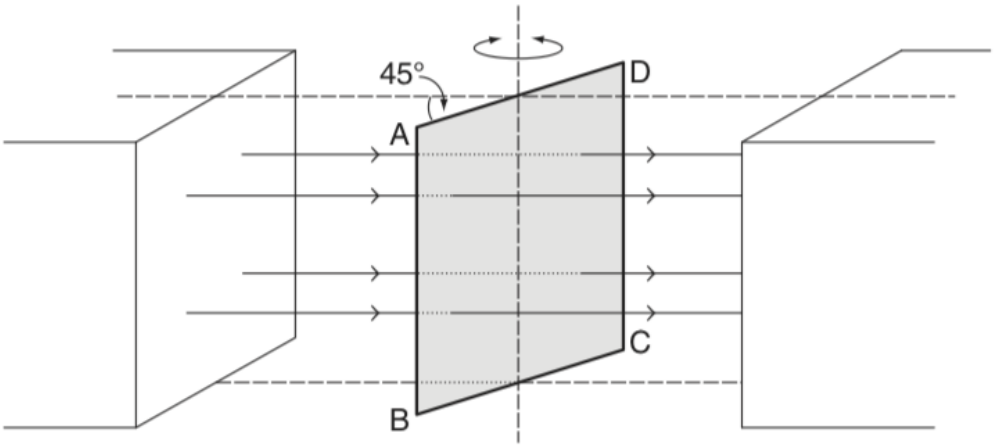
(B) 6.75×10^{-3} Nm

(C) 22.5 Nm

(D) 67.5 Nm

Question 27 (4 marks)

A single turn coil is positioned in a region of uniform magnetic field with a strength of 0.2 T. The plane of the coil is at 45° to the magnetic field. The coil is a square with 5 cm sides, and carries a current of 10.0 A.



(a) Calculate the magnitude of the force on side AB. **2**

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(b) Explain why the net force produced by the magnetic field on the coil is zero. **2**

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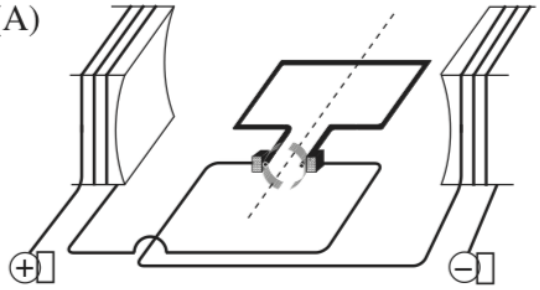
2010:

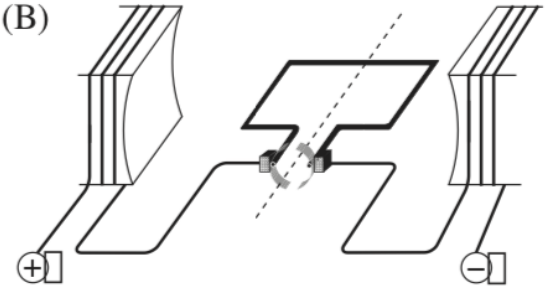
20 The diagrams show possible ways to connect the coils and rotor of a DC motor to a DC power supply.

In which circuit will the rotor turn in a clockwise direction?

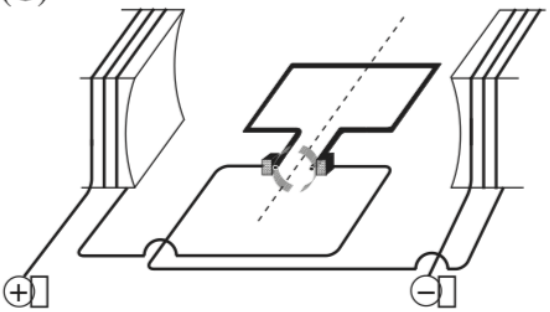
(A)



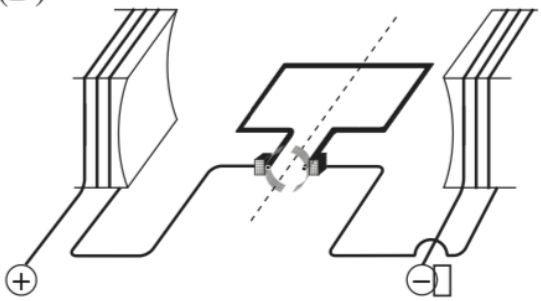
(B)



(C)



(D)



2009:

6 Which of the following would increase the output of a simple DC generator?

(A) Increasing the rotation speed of the rotor

(B) Reducing the number of windings in the coil

(C) Using slip rings instead of a split ring commutator

(D) Wrapping the windings around a laminated, aluminium core

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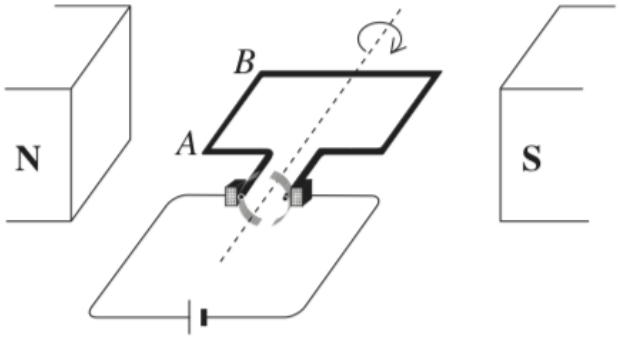
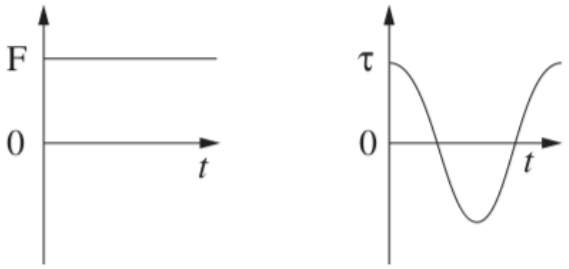
11 The diagram shows a DC motor with a constant current flowing to the rotor.

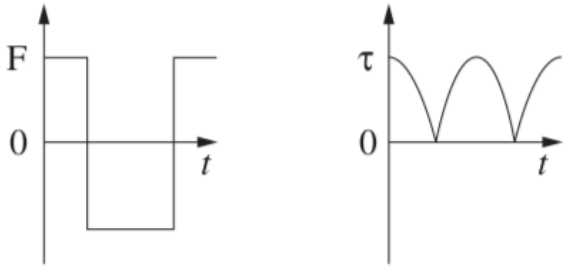


Which pair of graphs best describes the behaviour of the force F on wire AB, and the torque τ on the rotor as functions of time t?

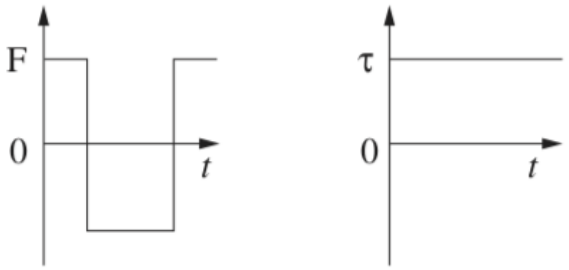
(A)



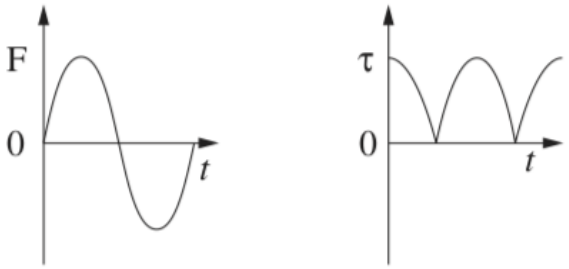
(B)



(C)



(D)



2008:

7 Which of the following is necessary for the operation of an AC induction motor?

(A) A fixed magnetic field in the rotor

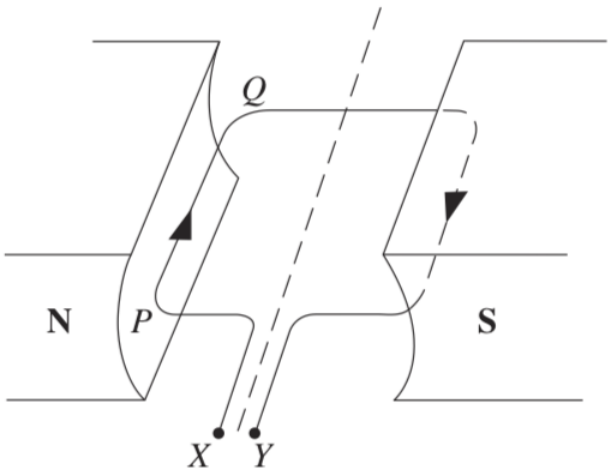
(B) A direct current supply to the rotor

(C) A changing magnetic field in the rotor

(D) Split rings conducting current to the rotor

Question 18 (4 marks)

The diagram shows a coil in a magnetic field. The coil can rotate freely.



The coil is connected to a power supply and, at the instant shown, terminal *X* is positive.

(a) In which direction will side *PQ* initially move? **1**

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(b) When the coil starts rotating, the potential difference experienced by the electrons in the wire is less than that supplied by the power supply. **3**

Describe the origin of this effect.

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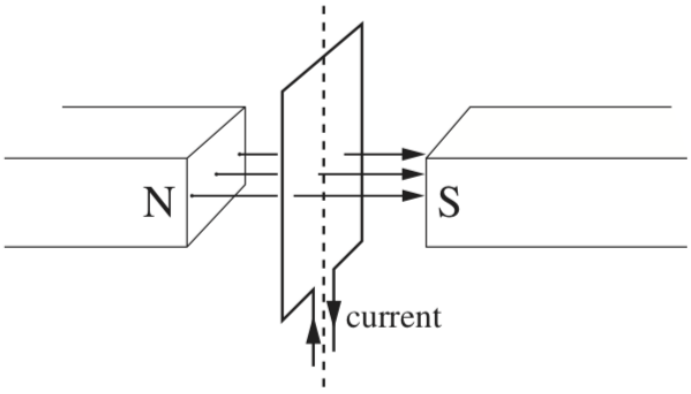
2007:

6 An electric motor is set up as shown.



When current is supplied the coil does not turn.

Which of the following is required for the coil to start turning?

(A) The magnetic field must be increased.

(B) The direction of the current must be reversed.

(C) The magnitude of the current must be increased.

(D) The starting position of the coil must be changed.

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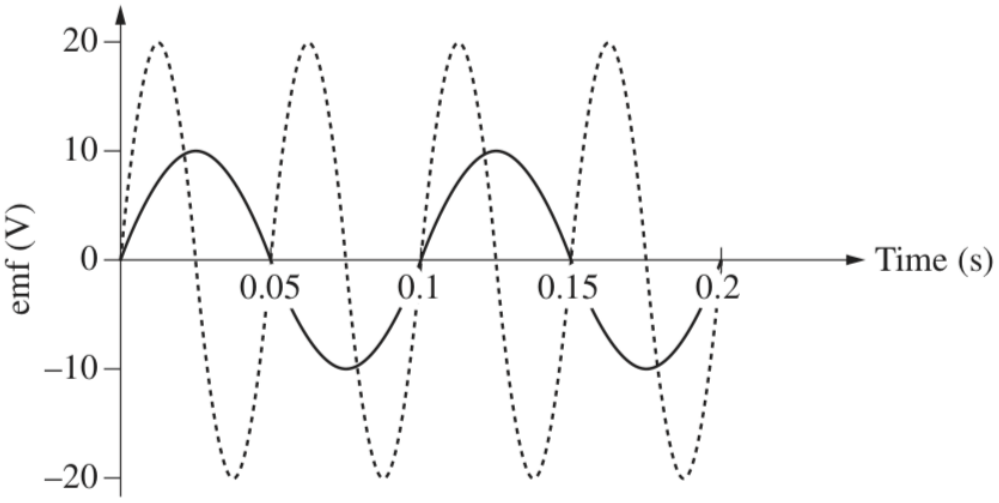
7 In the graph shown, the solid curve shows how the emf produced by a simple generator varies with time. The dashed curve is the output from the same generator after a modification has been made to the generator.



Which modification was made to produce the result shown?

(A) The area of the coil was doubled.

(B) A split-ring commutator was added.

(C) The speed of rotation of the coil was doubled.

(D) The number of turns in the coil was quadrupled.

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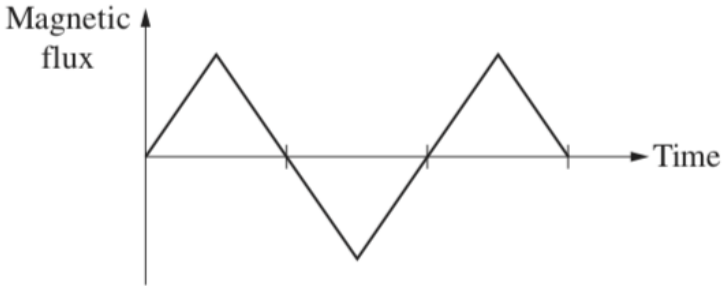
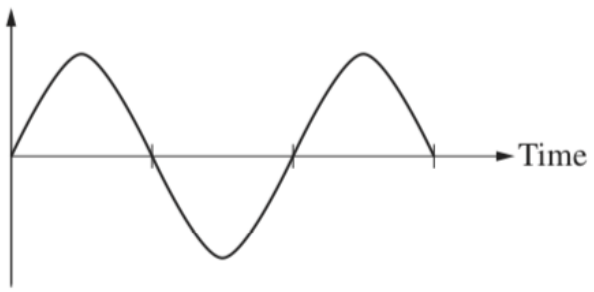
8 The variation in magnetic flux through a coil is shown below.

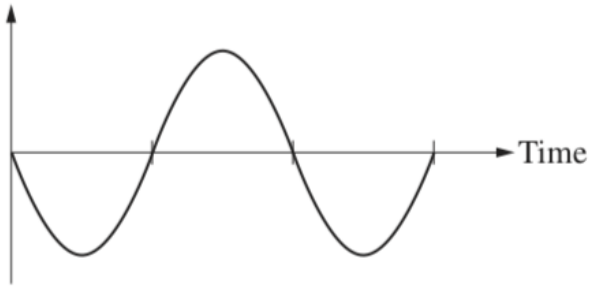


Which graph best represents the corresponding induced emf in the coil?

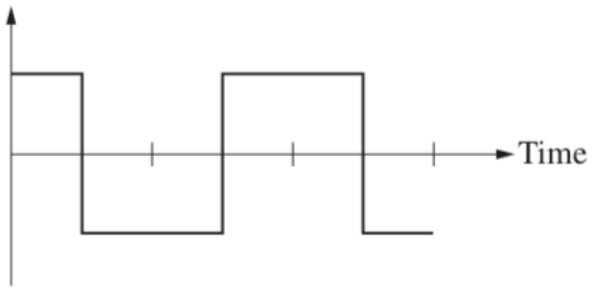
(A)



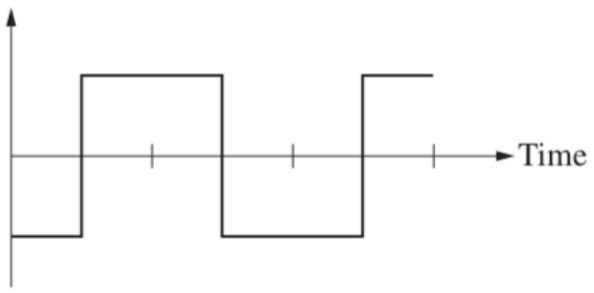
(B)



(C)



(D)



9 A stationary exercise bike has a solid metal wheel that is rotated by a chain connected to the pedals. An array of strong permanent magnets provides a magnetic field close to the face of the wheel.

The exercise level can be selected from 1 (easy) to 6 (hard) using a control panel.

When level 6 is selected, which of the following statements is correct?

(A) The current supplied to the bike is a minimum.

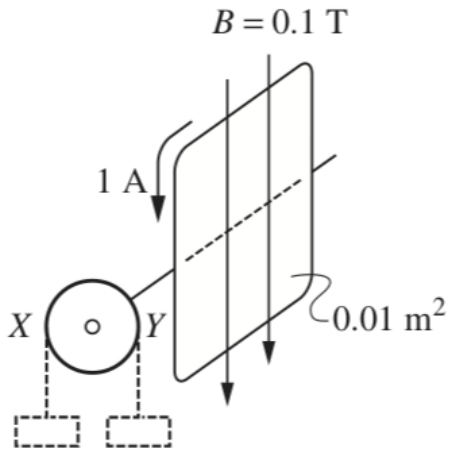
(B) The magnetic field at the wheel is a minimum.

(C) The induced current in the wheel is a maximum.

(D) The distance between the magnets and the wheel is a maximum.

Question 21 (5 marks)

A simple motor consists of a flat rectangular coil with n turns in a magnetic field B as shown.



The coil has an area of 0.01 m^2 and carries a current of 1 A. The motor drives a pulley of diameter 20 cm, and weights can be hung from either side of the pulley at point X or point Y.

(a) In order to prevent rotation, should a weight be hung at point X or at point Y? Justify your answer. **1**

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(b) What is the magnitude of the torque provided by a mass of 0.2 kg suspended from either point *X* or point *Y*? **2**

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(c) If the motor is just stopped by a mass of 0.2 kg, how many turns does the coil have? **2**

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Question 25 (4 marks)

A student claims that a DC generator is an 'electric motor in reverse'. **4**

Analyse this claim with reference to the structure and function of a simple DC generator and an electric motor.

Include diagrams in your answer.

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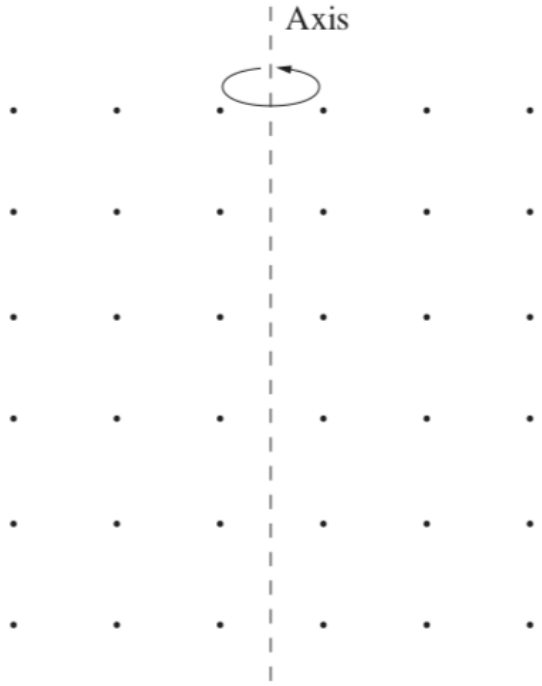
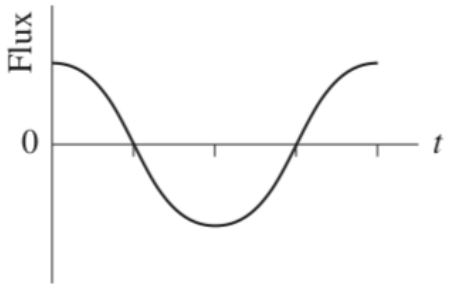
2006:

8 A square loop of wire, in a uniform magnetic field, is rotating at a constant rate about an axis as shown. The magnetic field is directed out of the plane of the page. At time $t = 0$ the plane of the loop is perpendicular to the magnetic field and side XY is moving out of the page.

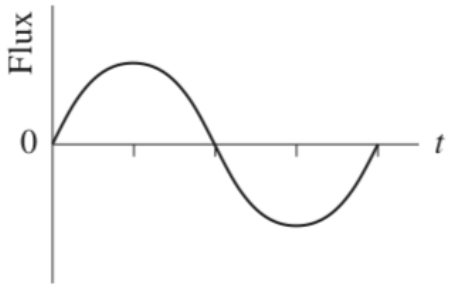


Which graph best represents the variation of the magnetic flux through the loop with time?

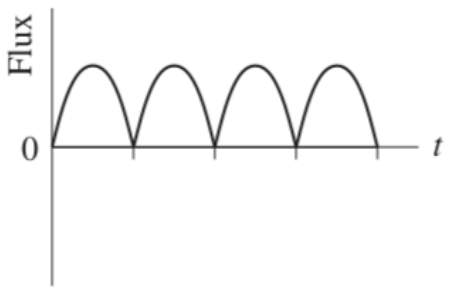
(A)



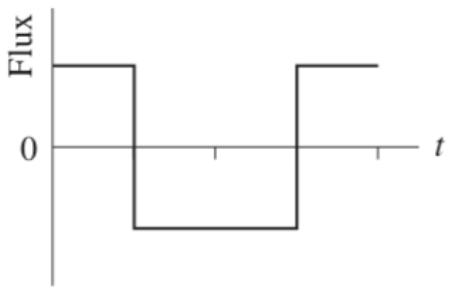
(B)



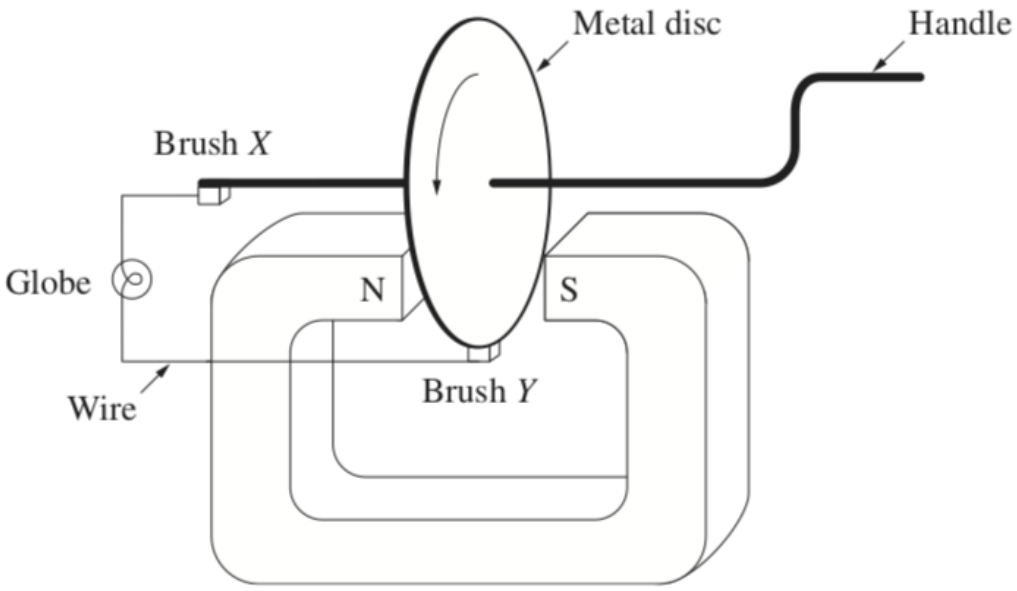
(C)



(D)



9 Early electric generators were often very simple. A hand-operated version is depicted below.



Brush *X* touches the metal axle and Brush *Y* touches the rim of the disc.

If the metal disc is rotated uniformly as shown, which statement about the current through the globe is correct?

(A) No current flows.

(B) A direct current flows from *Y* to *X*.

(C) A direct current flows from *X* to *Y*.

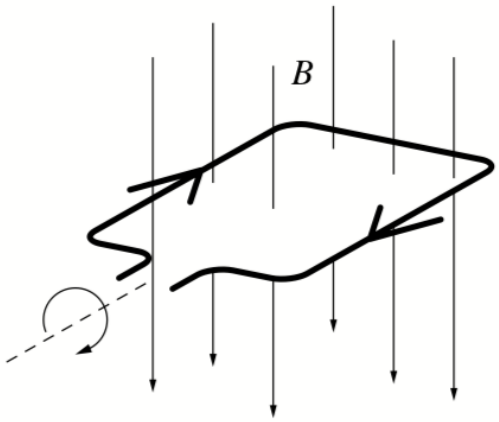
(D) An alternating current flows between *X* and *Y*.

2005:

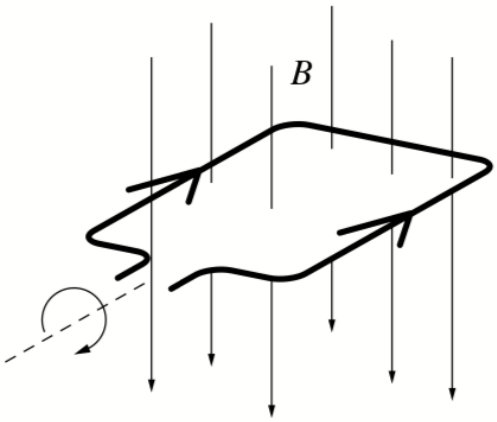
7 A single-turn coil of wire is placed in a uniform magnetic field B at right angles to the plane of the coil as shown in the diagrams. The coil is then rotated in a clockwise direction as shown.

Which of the following shows the direction of current flow in the coil as it begins to rotate?

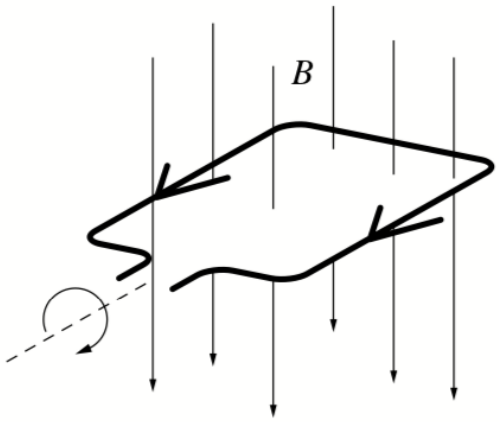
(A)



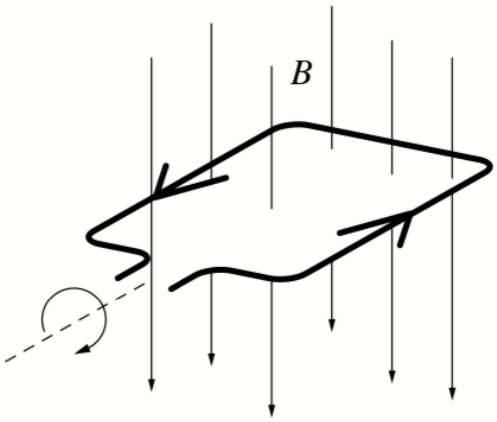
(B)



(C)



(D)



2004:

9 An electric DC motor consists of 500 turns of wire formed into a rectangular coil of dimensions $0.2\,\text{m} \times 0.1\,\text{m}$. The coil is in a magnetic field of 1.0×10^{-3} T. A current of 4.0 A flows through the coil.

What is the magnitude of the maximum torque, and the orientation of the plane of the coil relative to the magnetic field when this occurs?

(A) 0.04 N m, parallel to the field

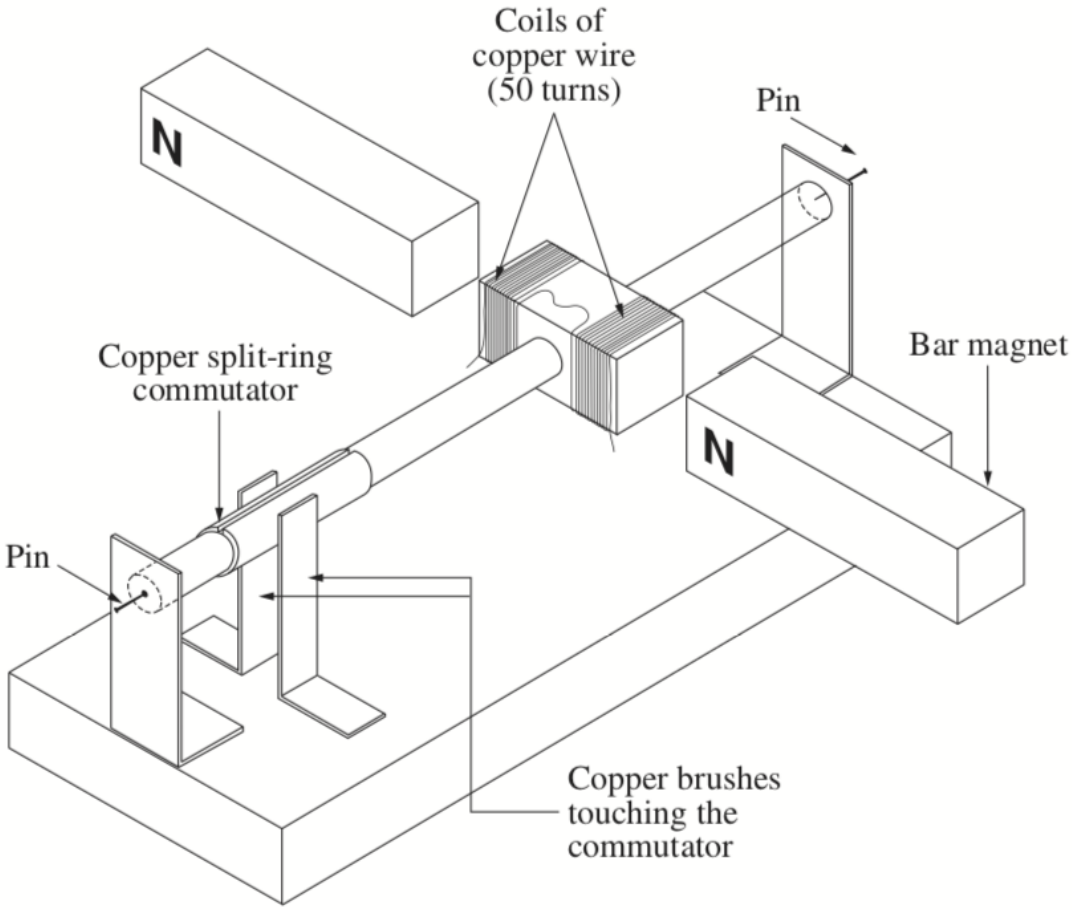
(B) 0.04 N m, perpendicular to the field

(C) 0.4 N m, parallel to the field

(D) 0.4 N m, perpendicular to the field

Question 21 (6 marks)

(a) The diagram shows a two-pole DC motor as constructed by a student. **3**



Identify THREE mistakes in the construction of this DC motor as shown in the diagram.

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(b) An ammeter was used to measure the current through a small DC motor. While it was running freely, a current of 2.09 A was recorded. While the motor was running, the axle of the motor was held firmly, preventing it from rotating, and the current was then recorded as 2.54 A. **3**

Explain this observation.

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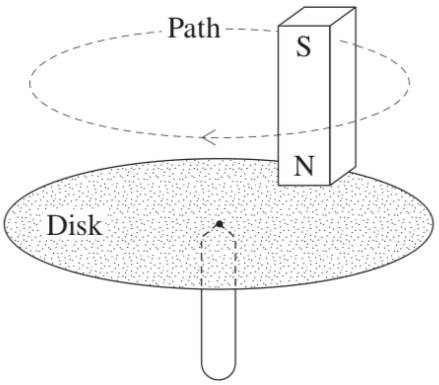
2003:

7 A non-magnetic metal disk is balanced on a support as shown in the diagram below. The disk is initially stationary. A magnet is moved in a circular path just above the surface of the disk, without touching it.



As a result of this movement the disk begins to rotate in the same direction as the magnet.

The observed effect demonstrates the principle *most* applicable to the operation of the

(A) DC motor.

(B) galvanometer.

(C) generator.

(D) induction motor.

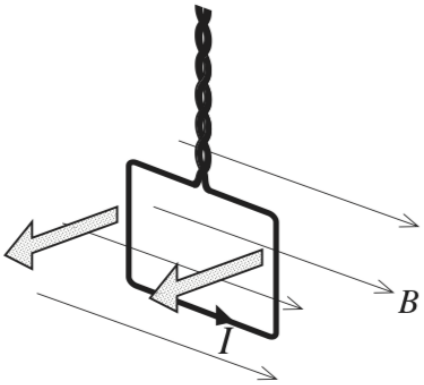
2002:

8 A single-turn coil of wire is placed in a uniform magnetic field B, so that the plane of the coil is parallel to the field, as shown in the diagrams. The coil can move freely.

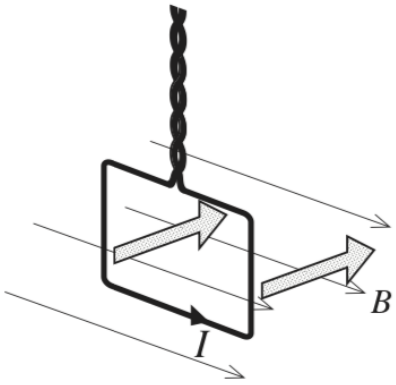
An electric current I flows around the coil in the direction shown.

In which direction does the coil begin to move as a consequence of the interaction between the external magnetic field and the current?

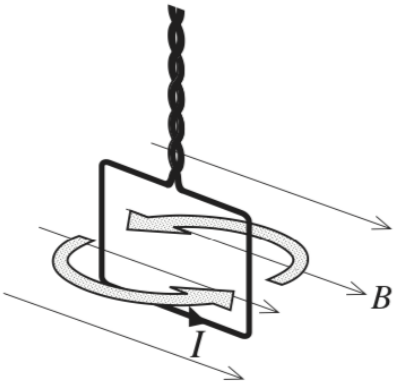
(A)



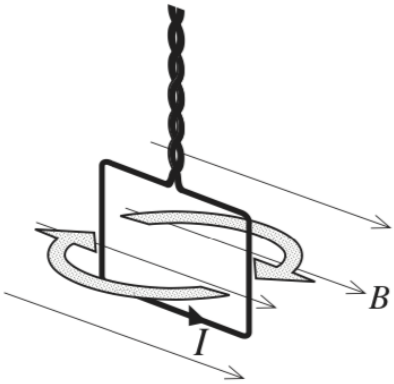
(B)



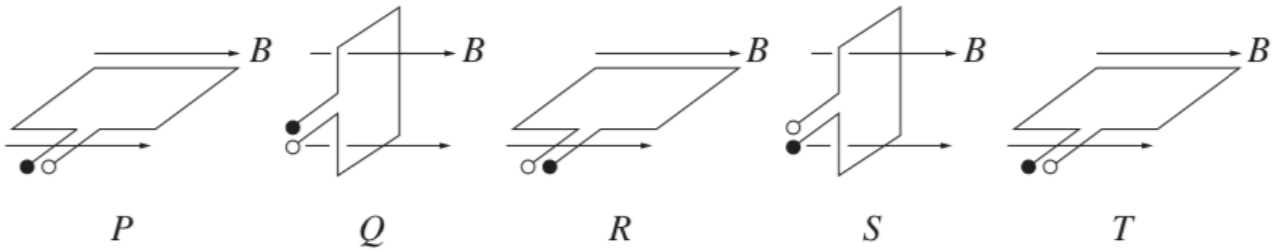
(C)



(D)

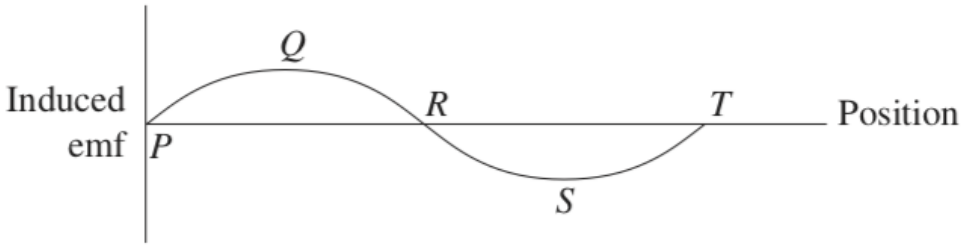


10 The coil of an AC generator rotates at a constant rate in a magnetic field as shown.

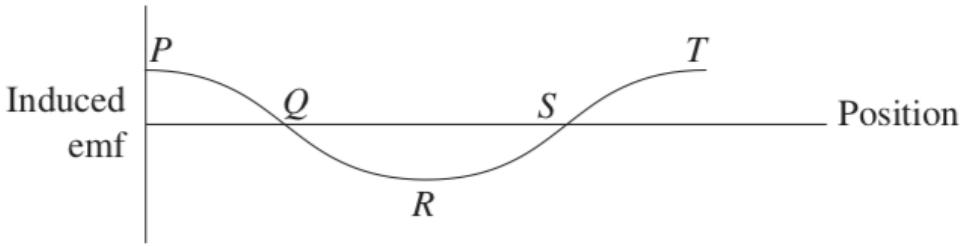


Which of the following diagrams represents the curve of induced emf against position?

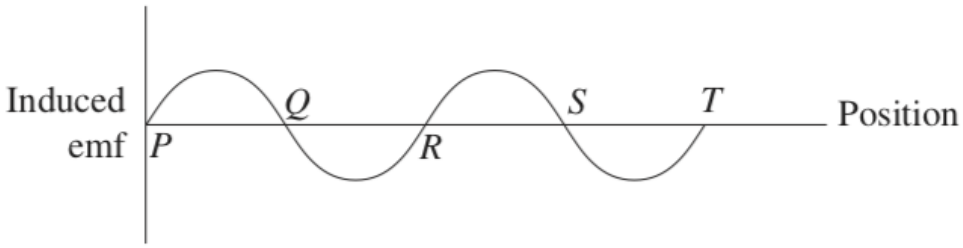
(A)



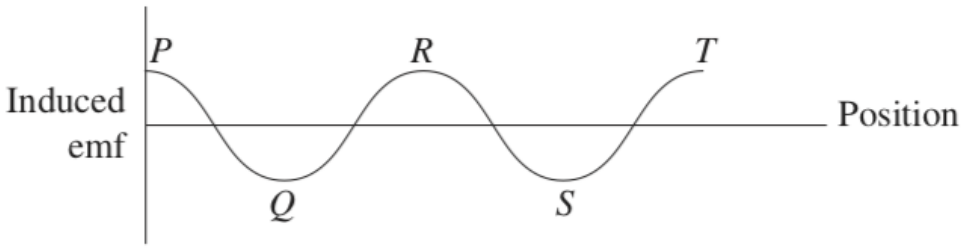
(B)



(C)

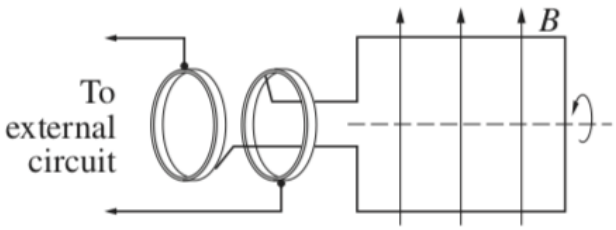


(D)

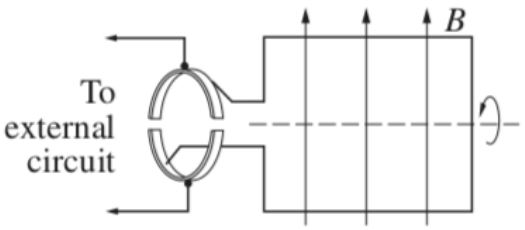


Question 22 (6 marks)

Two types of generator are shown in the diagram.



Generator *P*



Generator *Q*

(a) What is the function of the brush in a generator? **1**

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(b) Which of these generators is a DC generator? Justify your choice. **3**

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(c) Outline why AC generators are used in large-scale electrical power production. **2**

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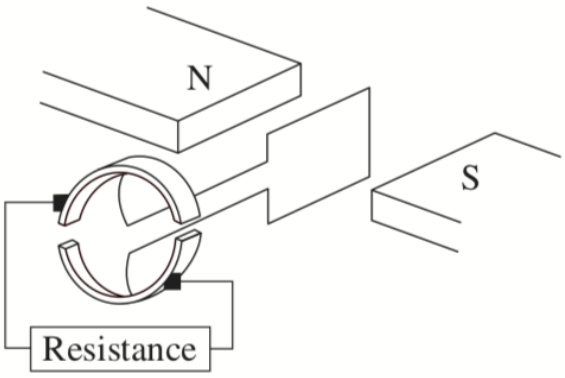
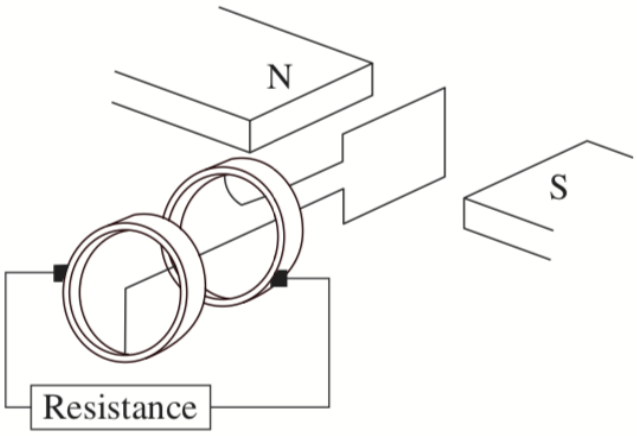
2001:

4 Two types of generator are shown.



Generator 1



Generator 2

What type of current is produced by each generator when connected to an external resistance?

(A) Both produce d.c.

(B) Both produce a.c.

(C) Generator 1 produces d.c. and Generator 2 produces a.c.

(D) Generator 1 produces a.c. and Generator 2 produces d.c.

Question 21 (3 marks)

A fan that ventilates an underground mine is run by a very large d.c. electric motor. This motor is connected in series with a variable resistor to protect the windings in the coil. **3**

When the motor is starting up, the variable resistor is adjusted to have a large resistance. The resistance is then lowered slowly as the motor increases to its operating speed.

Explain why no resistance is required when the motor is running at high speed, but a substantial resistance is needed when the motor is starting up.

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