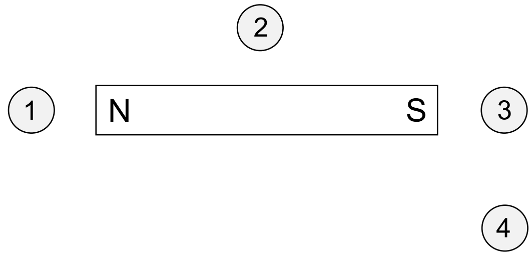
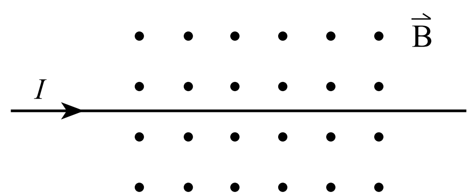
1. A compass is positioned at each of the following locations near a bar magnet.



In which location will the compass needle point to the right-hand side of the page?

A. 1
B. 2
C. 3
D. 4

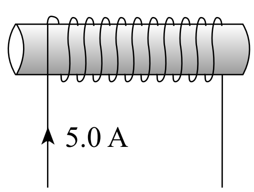
2. A current-carrying conductor is placed in a uniform magnetic field as shown.



What is the direction of the magnetic force on this conductor?

A. Into the page
B. Out of the page
C. Towards the top of the page
D. Towards the bottom of the page

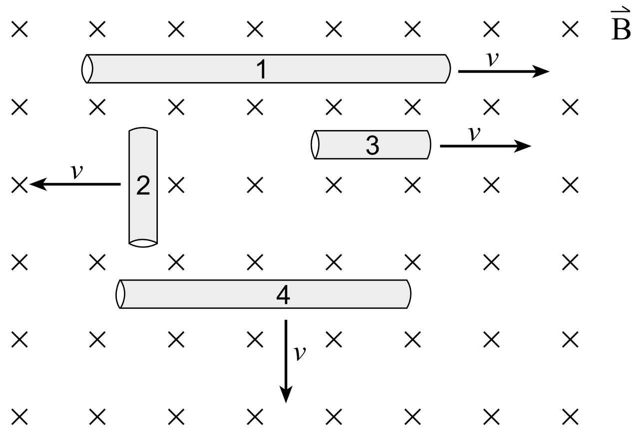
3. A $5.0\ \text{A}$ current flows through a $0.20\ \text{m}$ long solenoid that contains $1\,500$ loops.



What are the magnitude and direction of the magnetic field at the centre of the solenoid?

	MAGNITUDE	DIRECTION
A.	9.4×10^{-3} T	left
B.	9.4×10^{-3} T	right
C.	4.7×10^{-2} T	left
D.	4.7×10^{-2} T	right

4. Four conductors of different lengths are moved through a uniform magnetic field at the same speed.



Which conductor will induce the greatest emf?

A. 1
B. 2
C. 3
D. 4

5. A motor has an armature resistance of $3.5\ \Omega$ and is connected to a $12.0\ \text{V}$ source. At full speed the current through the armature is $0.18\ \text{A}$. What is the back emf at full speed?

A. $0\ \text{V}$
B. $0.63\ \text{V}$
C. $11.4\ \text{V}$
D. $12.0\ \text{V}$

6. A **step-down** transformer has a 500 turn primary that operates at 120 V ac. Which of the following sets of conditions best describes the number of secondary turns and secondary voltage of this transformer?

	SECONDARY TURNS	SECONDARY VOLTAGE
A.	40	9.6 V ac
B.	40	1 500 V ac
C.	2 000	30 V ac
D.	2 000	480 V ac

7. A flexible loop of wire of area $4.5 \times 10^{-2}\ m^2$ is positioned in a $0.17\ T$ magnetic field as shown in Figure A. The loop is then stretched until its area is zero in a time of $0.35\ s$ (Figure B). What is the average induced emf in the circuit and the direction of the current through resistor R?

Figure A

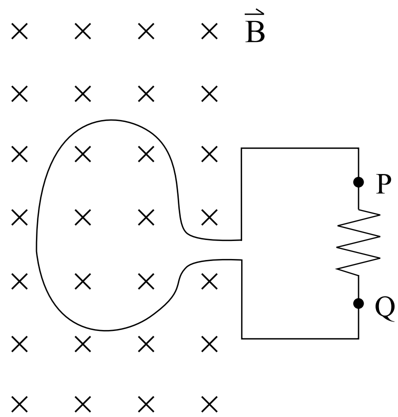
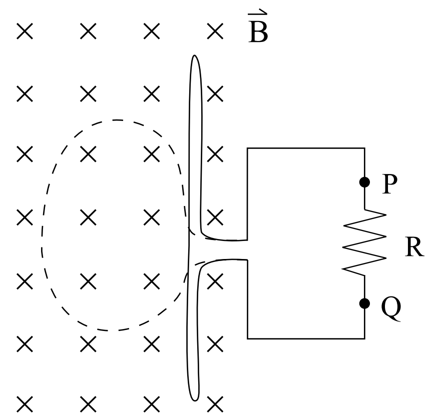


Figure B



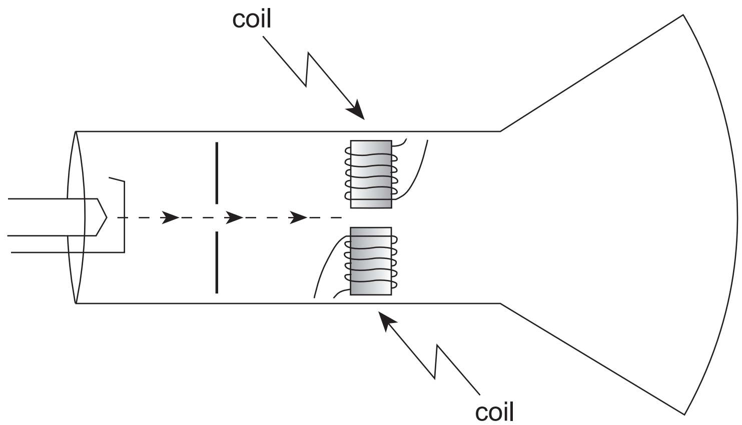
	AVERAGE EMF	DIRECTION OF CURRENT THROUGH R
A.	2.2×10^{-2} V	P to Q
B.	2.2×10^{-2} V	Q to P
C.	4.9×10^{-1} V	P to Q
D.	4.9×10^{-1} V	Q to P

8. An electron enters a uniform magnetic field as shown below.

The path of the electron upon entering the field would be

A. linear.
B. circular.
C. parabolic.
D. hyperbolic.

9. The diagram below represents a cross-sectional view from the side of a cathode ray tube. What is the purpose of the coils in a functional cathode ray tube?

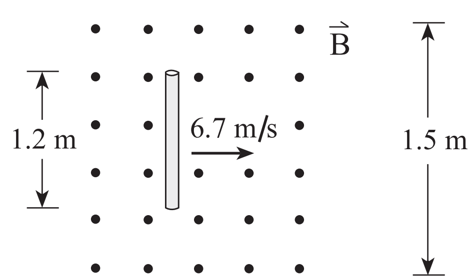


A. They increase the speed of the electrons.
B. They focus the electrons into a fine beam.
C. They deflect the electrons into or out of the page.
D. They deflect the electrons toward the top or bottom of the page.

10. A solenoid of length $0.35\ \text{m}$ and diameter $0.040\ \text{m}$ carries a current of $5.0\ \text{A}$ through its windings. If the magnetic field in the centre of the solenoid is $2.8\times10^{-2}\ \text{T}$, what is the number of turns per metre for this solenoid?

A. 1.8×10^{2} turns/m
B. 7.8×10^{2} turns/m
C. 1.6×10^{3} turns/m
D. 4.5×10^{3} turns/m

11. A $1.2\ \text{m}$ length of wire is pulled through a uniform $0.045\ \text{T}$ magnetic field at $6.7\ \text{m/s}$ as shown. What emf is generated between the ends of the wire?



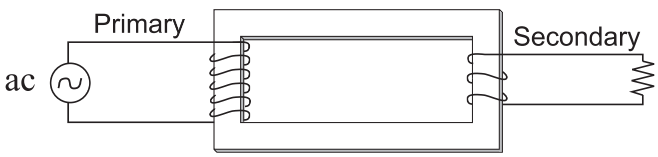
A. $0\ \text{V}$
B. $0.090\ \text{V}$
C. $0.36\ \text{V}$
D. $0.45\ \text{V}$

12. A dc motor is connected to a 12.0 V power supply. When the armature is rotating, the current through it is 0.78 A and the back emf is 10.6 V. What is the resistance of the armature?

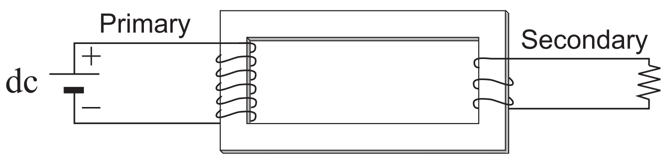
A. $1.4\ \Omega$
B. $1.8\ \Omega$
C. $14\ \Omega$
D. $15\ \Omega$

13. In which of the following diagrams is the secondary **current** greater than the primary **current**?

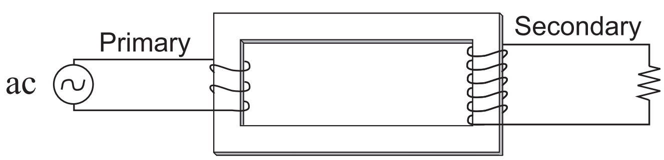
A.



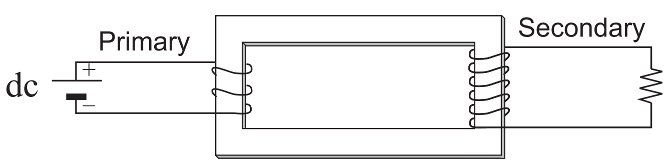
B.



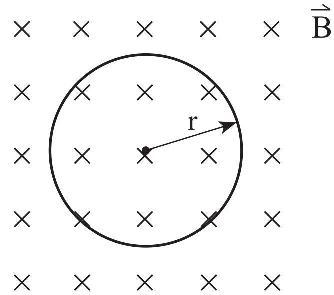
C.



D.



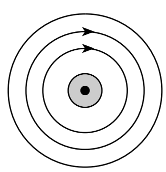
14. An electron circulates in a uniform 5.0×10^{-4} T magnetic field as shown. If the electron has 3.2×10^{-18} J of kinetic energy, what is its radius of orbit, r ?



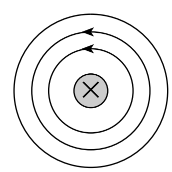
A. 2.3×10^{-7} m
B. 4.6×10^{-4} m
C. 2.5×10^{-3} m
D. 3.0×10^{-2} m

15. Which of the following diagrams shows the magnetic field produced by a long current-carrying wire?

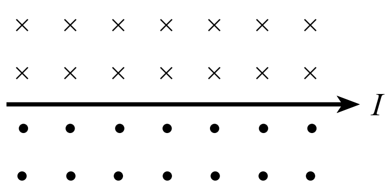
A.



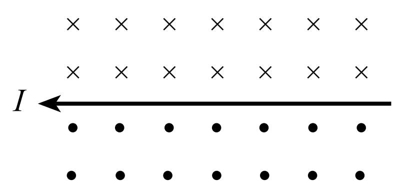
B.



C.



D.



16. Which of the following devices commonly uses a solenoid?

A. kettle
B. television
C. battery
D. incandescent bulb

17. An electric motor is connected to a constant source of potential. Considering back emf, which of the following observations is correct?

   A. At full speed the applied voltage increases.
   B. At full speed the armature resistance increases.
   C. If the motor is kept from rotating at full speed, the armature heats up.
   D. If the motor is kept from rotating at full speed, the armature temperature decreases.

18. Which of the following are correct units for magnetic flux?

   A. T
   B. Wb
   C. V/m
   D. $\mathrm{N \cdot m^2}$

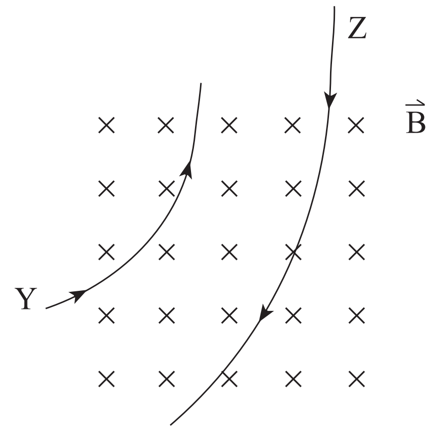
19. In a **step-up** transformer, how does the secondary voltage V_s compare with the primary voltage V_p, and the number of turns in the secondary N_s compare with the number of turns in the primary N_p ?

	VOLTAGE	NUMBER OF TURNS
A.	$V_s < V_p$	$N_s > N_p$
B.	$V_s > V_p$	$N_s > N_p$
C.	$V_s < V_p$	$N_s < N_p$
D.	$V_s > V_p$	$N_s < N_p$

20. An ideal transformer has a potential difference of 130 V ac across the primary windings and a potential difference of 780 V ac across the secondary windings. There are 390 turns in the secondary. The secondary current is

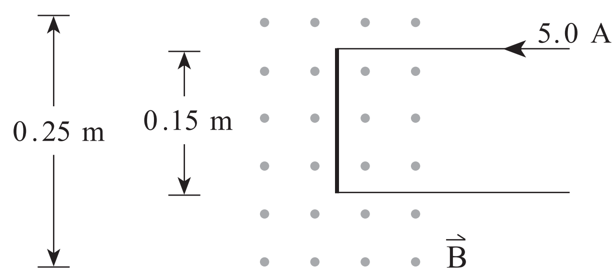
   A. twice the primary current.
   B. one half the primary current.
   C. six times the primary current.
   D. one-sixth the primary current.

21. Two particles Y and Z with equal mass and speed enter a uniform magnetic field and follow the paths as shown. How do their magnitude and polarity of charge compare?



	MAGNITUDE OF CHARGE	POLARITY
A.	Y < Z	same charge
B.	Y < Z	opposite charge
C.	Y > Z	same charge
D.	Y > Z	opposite charge

22. A wire carrying a current of $5.0\ \text{A}$ is in a uniform $3.2\times 10^{-2}\ \text{T}$ magnetic field as shown. What is the force on the $0.15\ \text{m}$ length of wire?



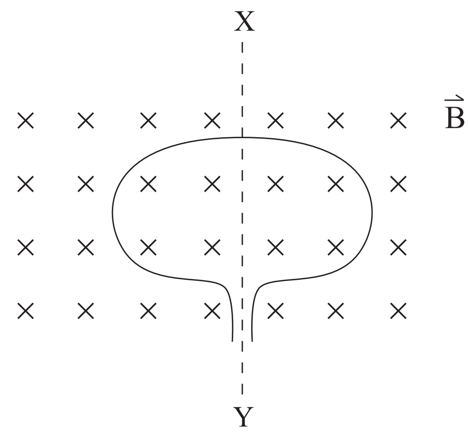
A. $0\ \text{N}$

B. $1.6\times10^{-2}\ \text{N}$

C. $2.4\times10^{-2}\ \text{N}$

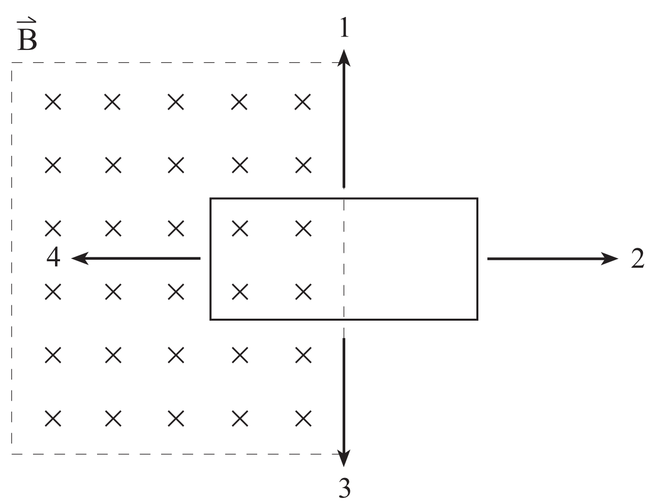
D. $4.0\times10^{-2}\ \text{N}$

23. A single coil of wire of area $6.0 \times 10^{-3}\ \text{m}^2$ is positioned in a uniform $0.18\ \text{T}$ magnetic field as shown. The coil is rotated $90°$ about axis XY in $4.2 \times 10^{-3}\ \text{s}$. What average emf is induced by the coil?



A. $0\ \text{V}$
B. $0.13\ \text{V}$
C. $0.26\ \text{V}$
D. $43\ \text{V}$

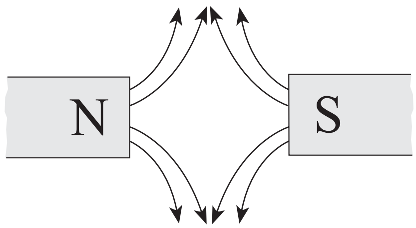
24. A part of a coil of wire is placed in a uniform magnetic field as shown. Which two directions of motion would immediately induce an emf in the coil?



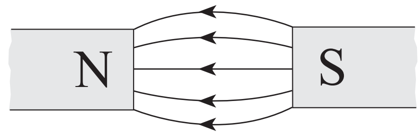
A. 1 and 2
B. 1 and 3
C. 2 and 3
D. 2 and 4

25. Which of the following diagrams best shows the magnetic field lines between the poles of two permanent magnets?

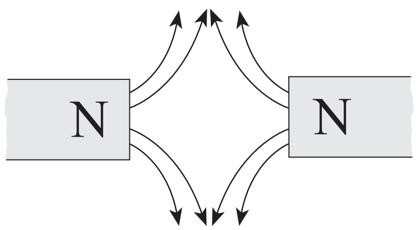
A.



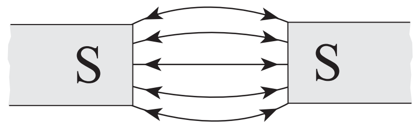
B.



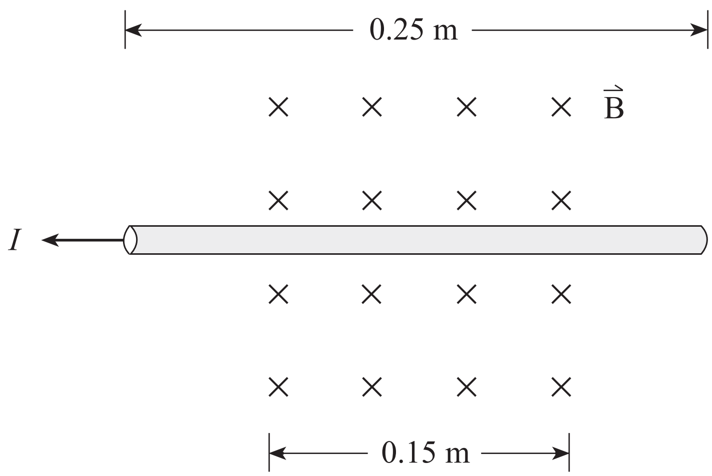
C.



D.



26. A wire carrying 12 A of current is placed in a magnetic field of strength 0.63 T.



What are the magnitude and direction of the magnetic force acting on the wire?

	FORCE	DIRECTION
A.	1.1 N	down the page
B.	1.1 N	up the page
C.	1.9 N	down the page
D.	1.9 N	up the page

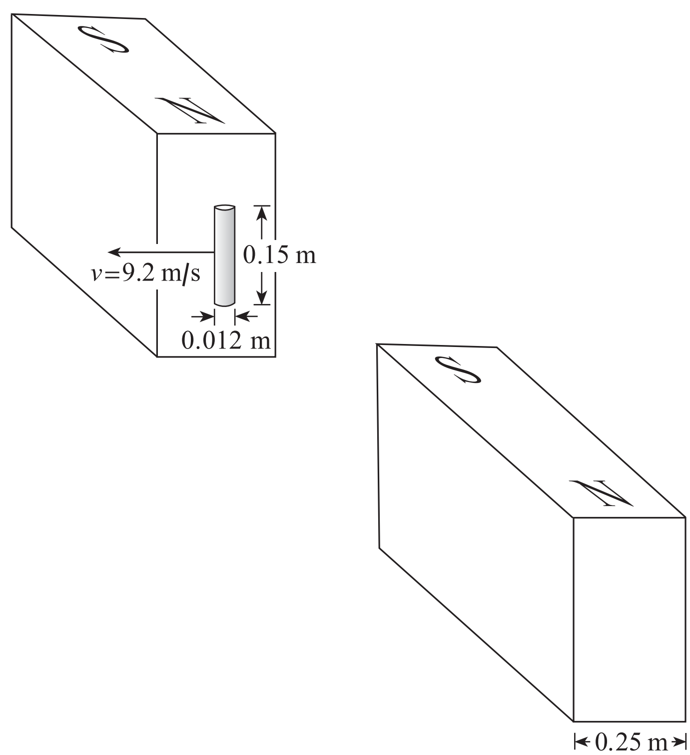
27. A particle having a charge of 3.2×10^{-19} C follows a circular path of 0.45 m radius while travelling at a speed of 1.2×10^{4} m/s in a 0.78 T magnetic field. What is the mass of the particle?

A. 7.8×10^{-28} kg
B. 9.4×10^{-24} kg
C. 1.1×10^{-19} kg
D. 3.0×10^{-15} kg

28. A 460-turn solenoid having a diameter of 0.024 m is 0.14 m long. What is the magnetic field at the centre of the solenoid when a 13 A current flows through it?

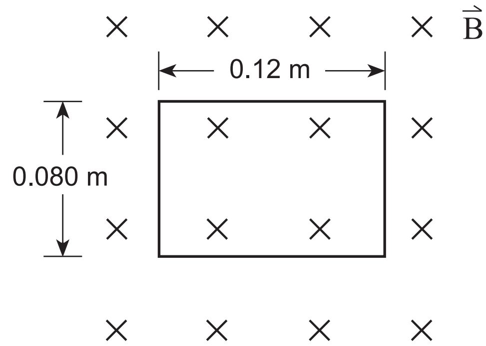
A. 0 T
B. 5.4×10^{-2} T
C. 3.1×10^{-1} T
D. 6.3×10^{-1} T

29. A conducting rod is moving perpendicular to a uniform magnetic field of 0.23 T at a velocity of 9.2 m/s. What emf is generated during this motion?



A. 0 V
B. 0.025 V
C. 0.32 V
D. 0.53 V

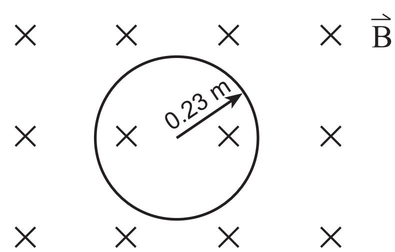
30. A rectangular coil measuring 0.12 m by 0.080 m is placed perpendicular to a 0.85 T magnetic field as shown.



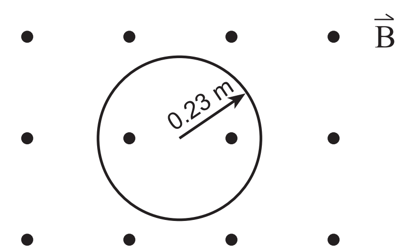
What is the magnetic flux through the coil?

A. 0 Wb
B. $8.2\times10^{-3}\text{ Wb}$
C. $6.8\times10^{-2}\text{ Wb}$
D. $1.0\times10^{-1}\text{ Wb}$

31. A single loop of wire of radius 0.23 m is placed in a 0.75 T magnetic field as shown. The magnetic field is changed to a strength of 0.50 T in the opposite direction in 0.61 s.



Before

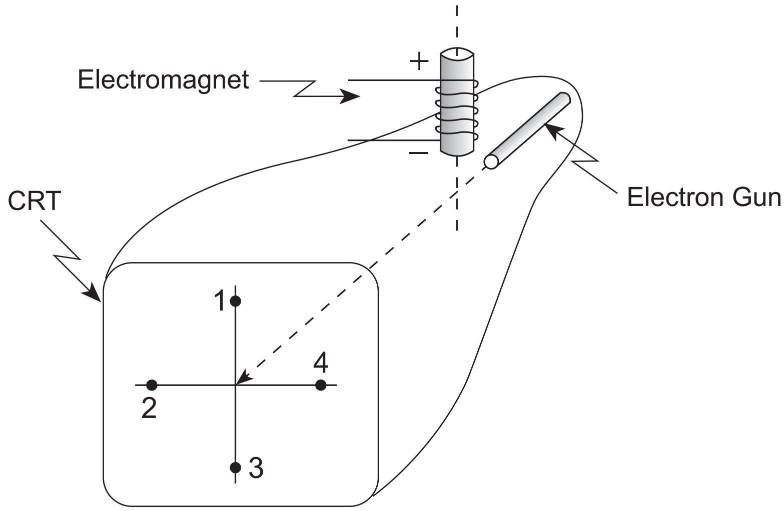


After

What is the average emf induced in the coil?

A. 0.068 V
B. 0.094 V
C. 0.34 V
D. 0.47 V

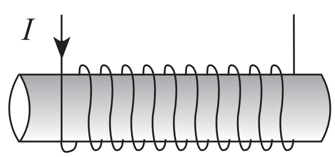
32. With the electromagnet turned off, electrons in a cathode ray tube strike the centre of the screen as shown.



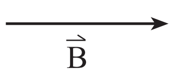
When the electromagnet is turned on, where will the electron beam now strike the screen?

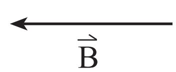
A. 1
B. 2
C. 3
D. 4

33. An electric current flows through a solenoid as shown below.

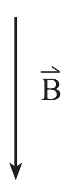


What is the direction of the magnetic field inside the solenoid?

A. 

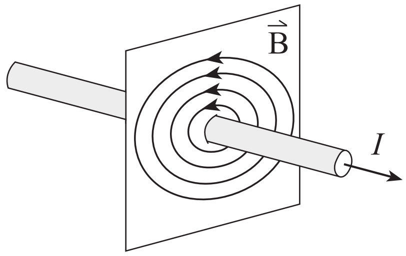
B. 

C. 

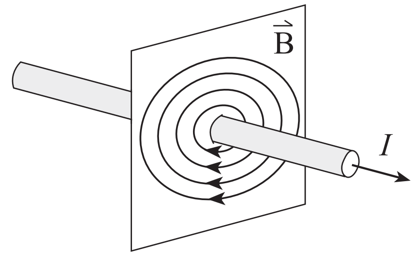
D. 

34. Which of the following diagrams best shows the magnetic field due to a long straight wire carrying a conventional current I as shown?

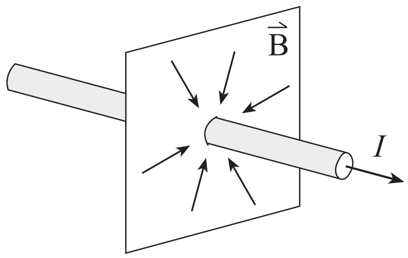
A.



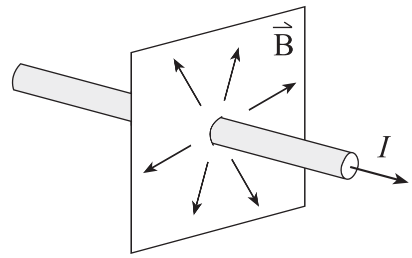
B.



C.



D.



35. A proton is travelling at 2.3×10^{6} m/s in a circular path in a 0.75 T magnetic field. What is the magnitude of the force on the proton?

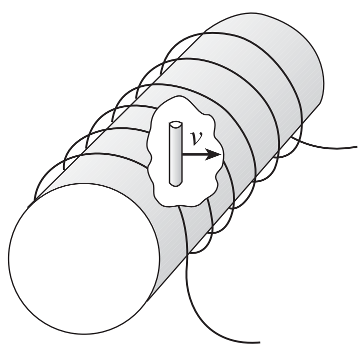
A. 1.6×10^{-24} N

B. 2.9×10^{-21} N

C. 2.8×10^{-13} N

D. 1.7 N

36. A solenoid of length 0.75 m has a radius 0.092 m. A current of 25 A flows through its 4 700 turns. Within this solenoid a 0.10 m long conductor moves at 4.3 m/s perpendicular to the field in the solenoid.



What emf is induced between the ends of the conductor?

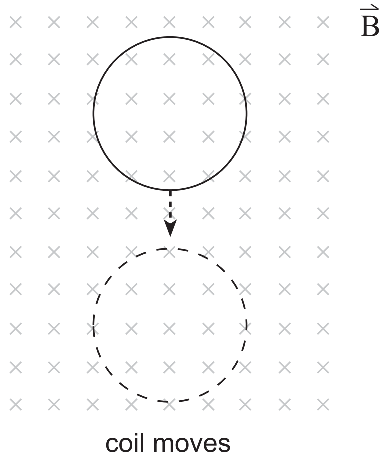
A. 0.085 V

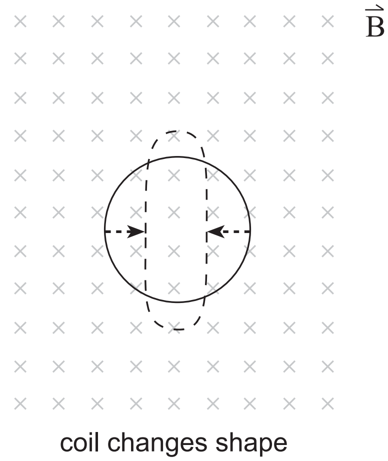
B. 0.197 V

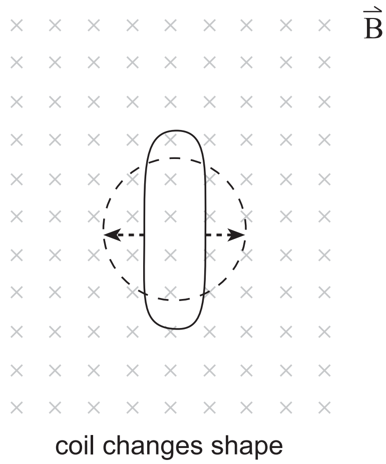
C. 0.430 V

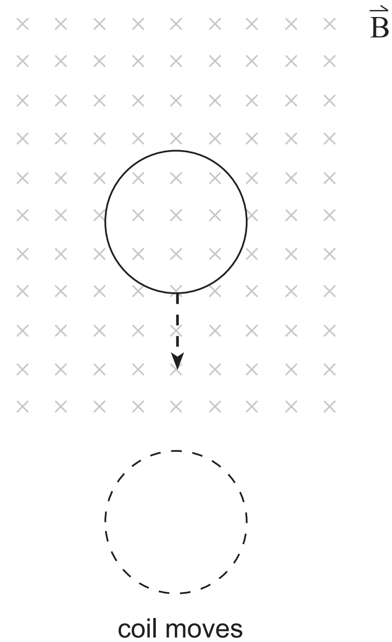
D. 4.80 V

37. In which of the following situations would the greatest emf be induced in the coil? All changes occur in the same time interval.

A. 

B. 

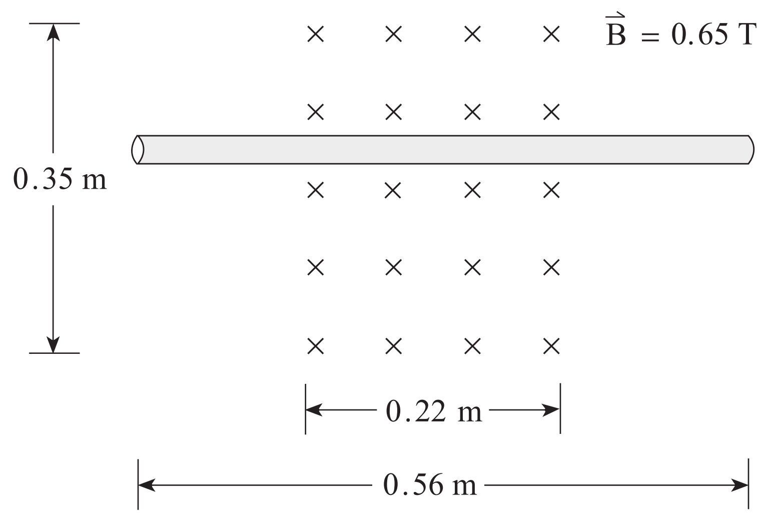
C. 

D. 

38. A motor is connected to a 12 V dc supply and draws 5.0 A when it first starts up. What will be the back emf when the motor is operating at full speed and drawing 1.2 A?

A. 7.0 V
B. 7.8 V
C. 9.1 V
D. 10.8 V

39. A long conductor is placed in a $0.65\ \text{T}$ magnetic field as shown below.



What are the magnitude and direction of the current that produces a $1.6\ \text{N}$ force on the wire directed up the page?

	MAGNITUDE OF CURRENT	DIRECTION OF CURRENT
A.	$4.4\ \text{A}$	Right
B.	$4.4\ \text{A}$	Left
C.	$11\ \text{A}$	Right
D.	$11\ \text{A}$	Left

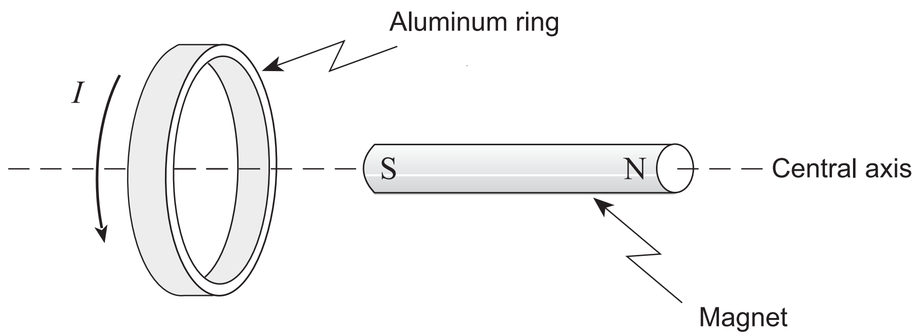
40. A proton has a speed of $5.0 \times 10^{6}\ \text{m/s}$ while travelling perpendicular to a $0.14\ \text{T}$ magnetic field. What is the magnetic force on the proton?

A. $1.6 \times 10^{-26}\ \text{N}$
B. $8.4 \times 10^{-21}\ \text{N}$
C. $2.2 \times 10^{-20}\ \text{N}$
D. $1.1 \times 10^{-13}\ \text{N}$

41. The flux through a circular coil with a radius of $0.075\ \text{m}$ is $0.013\ \text{Wb}$ when placed perpendicular to a magnetic field. What is the strength of the magnetic field?

A. $0\ \text{T}$
B. $0.17\ \text{T}$
C. $0.74\ \text{T}$
D. $2.3\ \text{T}$

42. The diagram below shows an aluminum ring and the current induced in it by the nearby magnet that is free to move along its central axis.



The magnet must be

A. stationary.
B. moving to the left.
C. moving to the right.
D. spinning about its central axis.

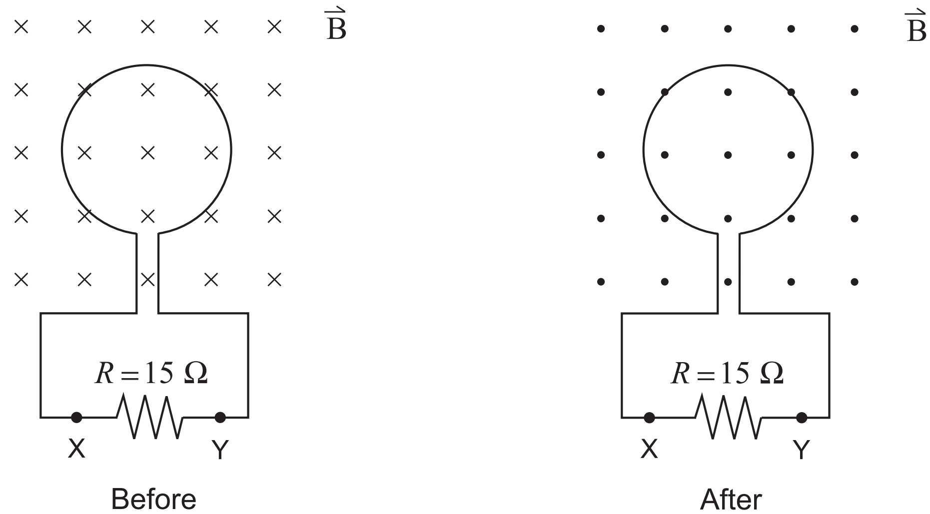
43. A computer adapter contains a transformer that converts 120 V ac across its primary windings to 24 V ac across its secondary windings. The primary current is 1.2 A. What is the secondary current and what is the type of transformer?

	MAGNITUDE OF CURRENT	DIRECTION OF CURRENT
A.	0.24 A	Step-up
B.	0.24 A	Step-down
C.	6.0 A	Step-up
D.	6.0 A	Step-down

44. A charged particle travels in a circular path in a magnetic field. What changes to the magnetic field and to the velocity of the particle would both cause the radius of its path to decrease?

	CHANGE TO THE MAGNETIC FIELD	CHANGE TO THE VELOCITY
A.	increase	increase
B.	increase	decrease
C.	decrease	increase
D.	decrease	decrease

45. A loop of wire of area $0.32\ \text{m}^2$ is placed in a $0.75\ \text{T}$ magnetic field as shown. The magnetic field is changed to $0.35\ \text{T}$ in the opposite direction in $0.45\ \text{s}$.



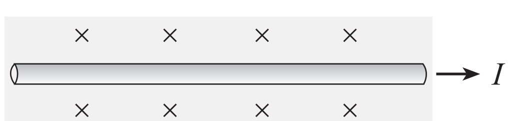
What are the magnitude and direction of the current through the $15\ \Omega$ resistor?

	MAGNITUDE OF CURRENT	DIRECTION OF CURRENT
A.	$0.019\ \text{A}$	X to Y
B.	$0.019\ \text{A}$	Y to X
C.	$0.052\ \text{A}$	X to Y
D.	$0.052\ \text{A}$	Y to X

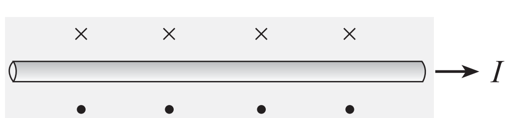
46. The direction of a magnetic field is determined to be the direction in which

A. a positive charge would tend to move.
B. a negative charge would tend to move.
C. the north end of a compass needle would point.
D. the south end of a compass needle would point.

47. Which diagram shows the magnetic field created near a conductor carrying current towards the right?

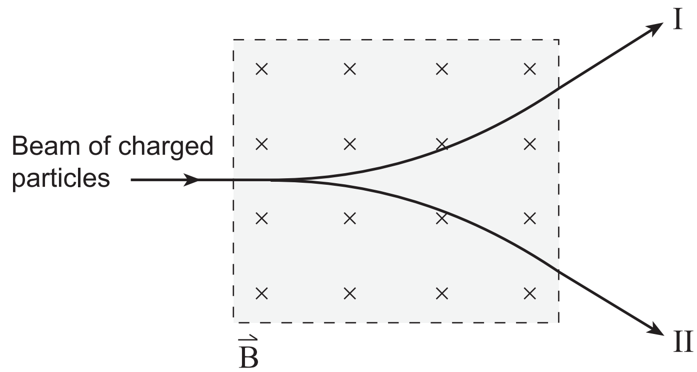
A.


B.


C.


D.


48. A beam of positively and negatively charged particles enters a magnetic field as shown. Which paths illustrate the positive and negative charges leaving the magnetic field region?



	PATH OF POSITIVE CHARGES	PATH OF NEGATIVE CHARGES
A.	I	I
B.	I	II
C.	II	I
D.	II	II

49. A solenoid has a length of $0.30\ \text{m}$, a diameter of $0.040\ \text{m}$ and 500 windings. The magnetic field at its centre is $0.045\ \text{T}$. What is the current in the windings?

A. $2.9\ \text{A}$
B. $3.0\ \text{A}$
C. $21\ \text{A}$
D. $170\ \text{A}$

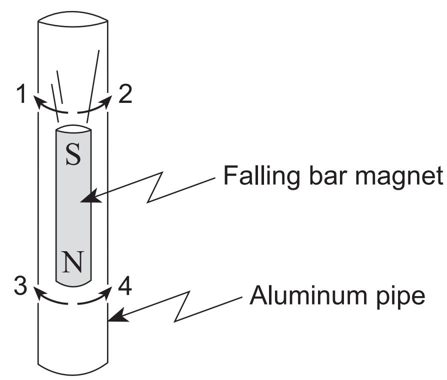
50. An aircraft with a wingspan of 24 m flies at $85\ \text{m/s}$ perpendicular to a magnetic field. An emf of $0.19\ \text{V}$ is induced across the wings of the aircraft. What is the magnitude of the magnetic field?

A. $9.3\times10^{-5}\ \text{T}$
B. $5.4\times10^{-2}\ \text{T}$
C. $6.7\times10^{-1}\ \text{T}$
D. $3.9\times10^{2}\ \text{T}$

51. As a carpenter drills into a beam, friction on the drill bit causes the armature of the drill to slow down. How will the back emf and the current through the armature change as the drill slows down?

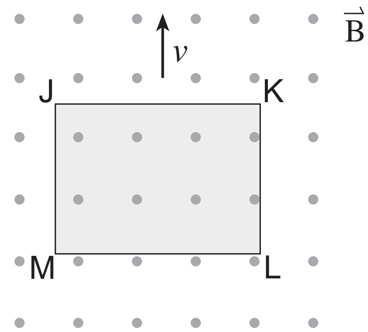
	BACK EMF	CURRENT
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

52. The diagram shows a bar magnet falling through an aluminum pipe. Electric currents are induced in the pipe immediately above and below the falling magnet. In which direction do these currents flow?



	ABOVE THE MAGNET	BELOW THE MAGNET
A.	1	3
B.	1	4
C.	2	3
D.	2	4

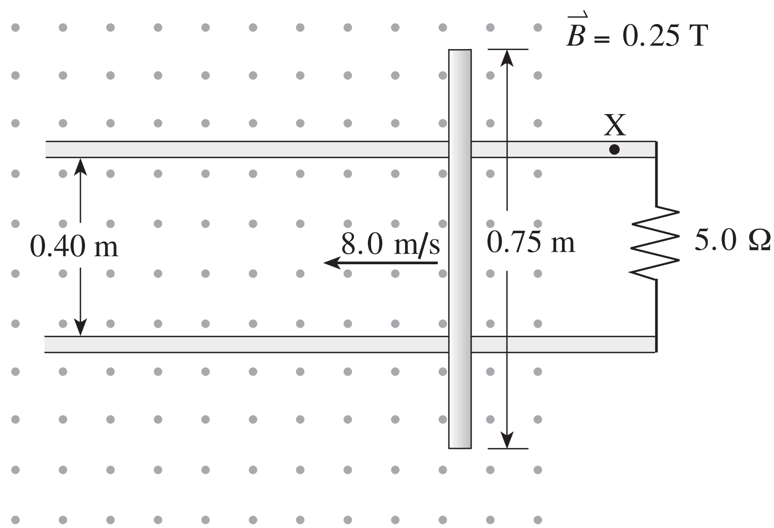
53. A metal block moves with a constant speed in a uniform magnetic field.



Which side of the block is positive?

A. JK
B. KL
C. LM
D. MJ

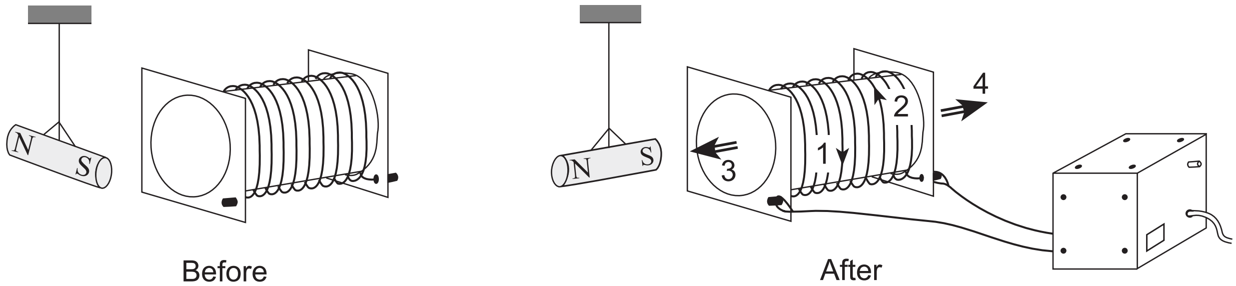
54. A 0.75 m conducting rod is moved at 8.0 m/s across a 0.25 T magnetic field along metal rails. The electrical resistance of the system is 5.0 Ω.



What are the magnitude and direction of the current through point X?

	MAGNITUDE OF CURRENT	DIRECTION OF CURRENT THROUGH X
A.	0.16 A	Left
B.	0.16 A	Right
C.	0.30 A	Left
D.	0.30 A	Right

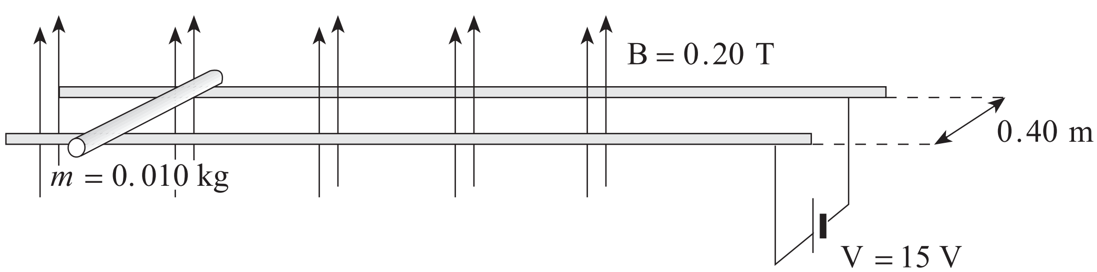
55. The diagram shows a magnet suspended near a solenoid. After the solenoid has been connected to a power supply, the magnet rotates to a new position with its south pole pointing towards the solenoid.



Which arrows show the direction of the current in the solenoid and the direction of the magnetic field caused by this current?

	DIRECTION OF CURRENT	DIRECTION OF MAGNETIC FIELD
A.	1	3
B.	1	4
C.	2	3
D.	2	4

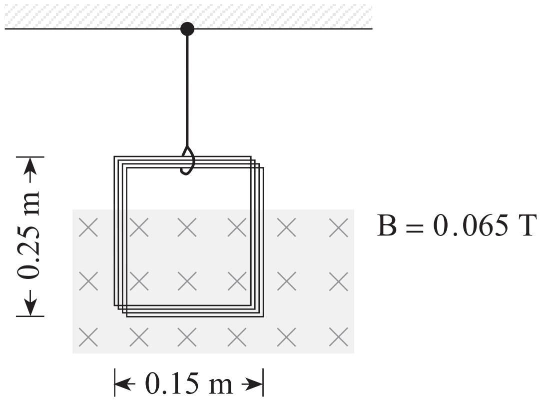
56. The diagram shows a 0.010 kg metal rod resting on two long horizontal frictionless rails which remain 0.40 m apart. The circuit has a resistance of $3.0\ \Omega$ and is located in a uniform 0.20 T magnetic field.



Find the initial acceleration and maximum velocity for the rod.

	INITIAL ACCELERATION	MAXIMUM VELOCITY
A.	$40\ m/s^2$	190 m/s
B.	$40\ m/s^2$	300 m/s
C.	$120\ m/s^2$	190 m/s
D.	$120\ m/s^2$	300 m/s

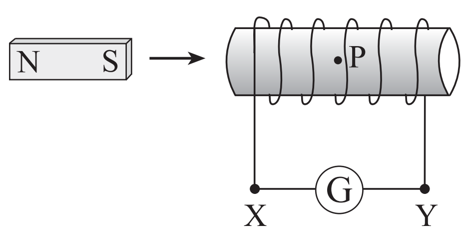
57. A coil of 25 turns of wire is suspended by a thread. When a current flows through the coil, the tension in the thread is reduced by 4.0×10^{-2} N.



What are the magnitude and direction of the current?

	MAGNITUDE OF CURRENT	DIRECTION OF CURRENT
A.	0.16 A	clockwise
B.	0.16 A	counter-clockwise
C.	4.1 A	clockwise
D.	4.1 A	counter-clockwise

58. A bar magnet is moving toward a solenoid.



What is the direction of the current through the galvanometer and what is the direction of the magnetic field produced by this current at location P inside the solenoid?

	DIRECTION OF THE CURRENT THROUGH THE GALVANOMETER	DIRECTION OF THE MAGNETIC FIELD AT P
A.	From X to Y	Right
B.	From X to Y	Left
C.	From Y to X	Right
D.	From Y to X	Left

1. A single loop of wire of area 5.0×10^{-3} m^2 and resistance $1.8\ \Omega$ is perpendicular to a uniform magnetic field B. The field then decreases to zero in 1.2×10^{-3} s inducing an average current of 8.3×10^{-2} A in the loop. What was the initial value of the magnetic field B? **(7 marks)**

2. An electron is accelerated from rest through a potential difference of 750 V. It then enters a uniform 2.3×10^{-3} T magnetic field at right angles to the field.

a) What is the speed of the electron? **(3 marks)**

b) What is the radius of its path in the magnetic field? **(4 marks)**

3. An electric device operates on $9.0\ \text{V ac}$ and has a total resistance of $21\ \Omega$. An ideal transformer is used to change the incoming line voltage of $120\ \text{V ac}$ to the operating voltage of $9.0\ \text{V ac}$.

   a) Is the transformer a step-up or step-down transformer? **(1 mark)**

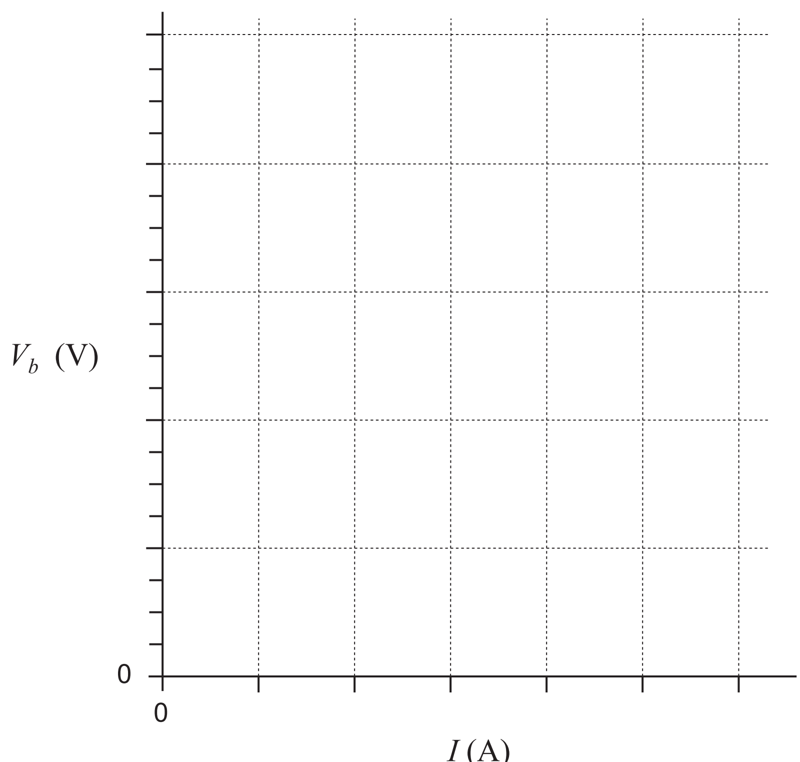
   ____

   b) What is the current in the primary side? **(6 marks)**

4. An electric motor is connected to a 9.0 V power supply. The data table below shows how the back emf of the motor, V_{back}, varies with the current through the armature, I, as the mechanical load changes.

Back emf V_{back} (V)	7.5	6.0	4.5	3.0	1.5	0
Current I (A)	1.0	2.0	3.0	4.0	5.0	6.0

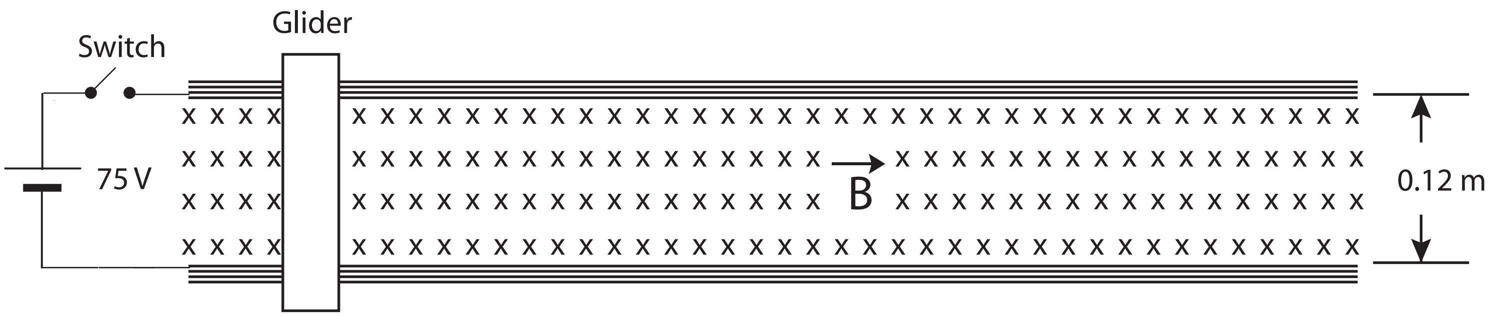
a) Plot this data on the graph below. **(2 marks)**



b) Determine the slope of this graph. **(2 marks)**

c) What property of the motor does the slope of this graph represent? **(1 mark)**

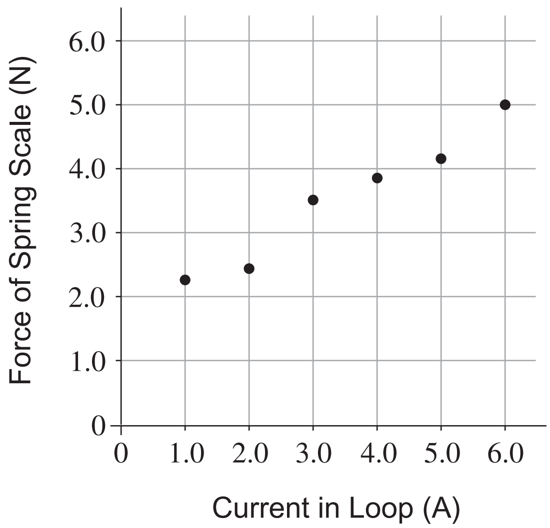
5. The diagram below shows a pair of horizontal parallel rails 0.12 m apart with a uniform magnetic field of 0.055 T directed vertically downward between the rails. There is a glider of mass 9.5×10^{-2} kg across the rails. the internal resistance of the 75 V power supply is 0.30 ohms and the electrical resistance of the rails and the glider is negligible. Assume friction is also negligible.

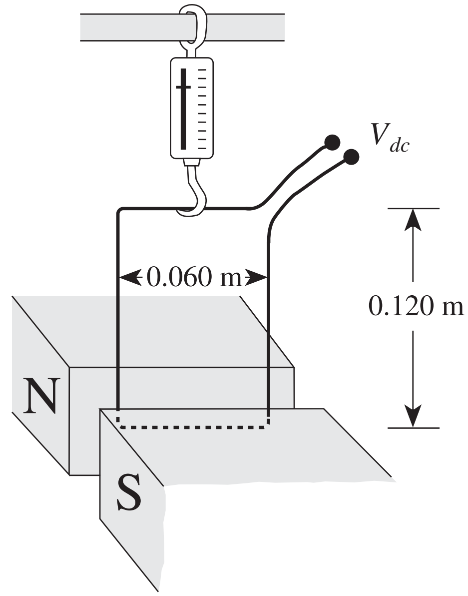


(a) When the switch is closed, what is the initial accleration of the glider? **(5 marks)**

(b) What is the value of the terminal velocity as limited by the back emf produced by the moving glider? **(4 marks)**

6. A rectangular loop is suspended by a spring scale between magnetic poles. The loop is 0.060 m wide by 0.120 m high. As the current in the loop is varied, the readings of the spring scale and current are plotted on a graph.



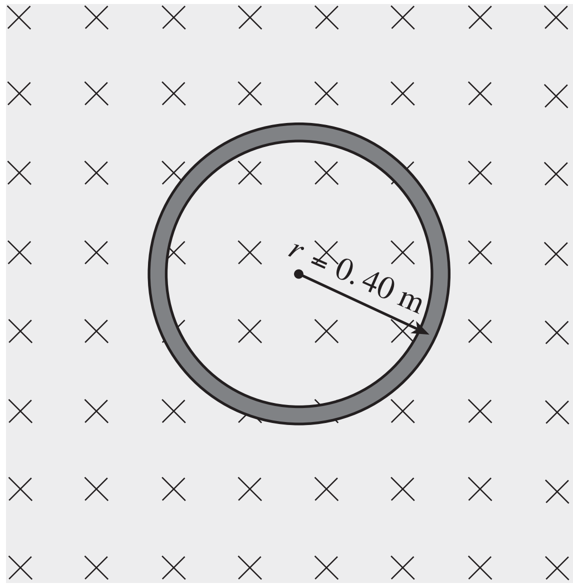


a) What is the weight, in newtons, of the loop? **(1 mark)**

b) What is the slope of the best fit line? **(2 marks)**

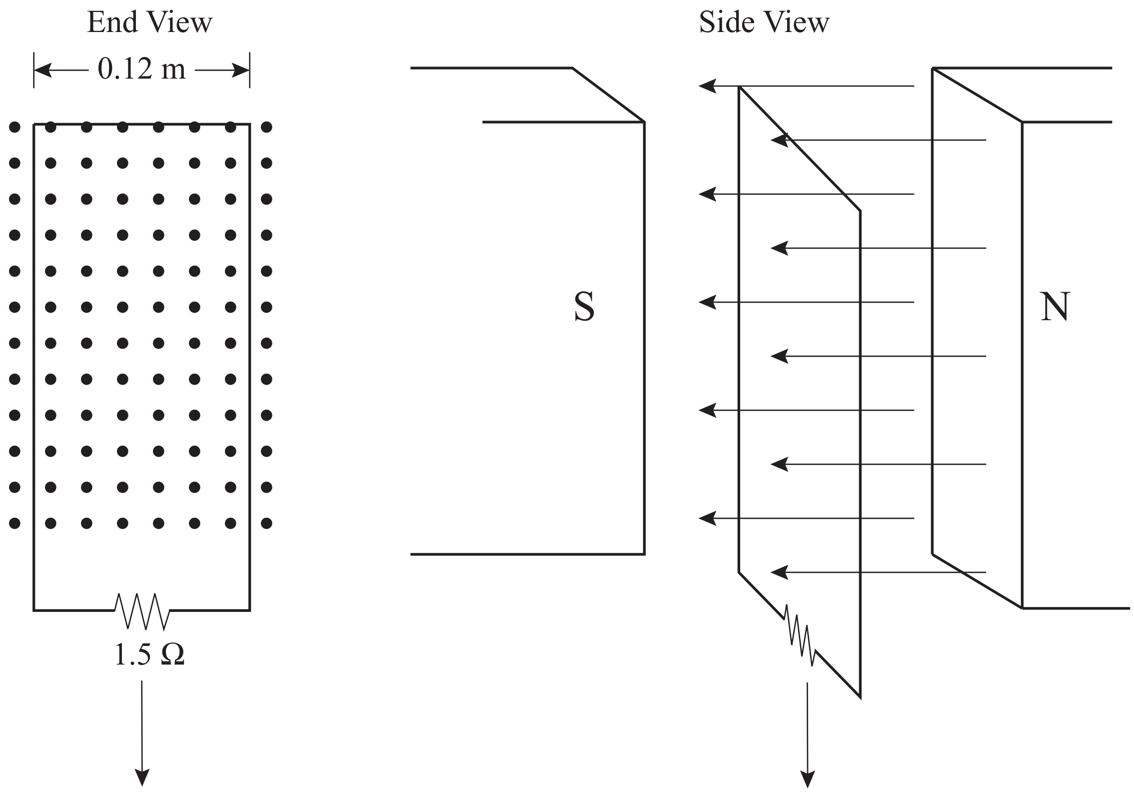
c) What is the magnitude of the magnetic field? **(2 marks)**

7. A coil of wire containing 50 loops is lying on a flat surface in a 0.60 T magnetic field pointing directly into the surface.



The magnetic field then changes to a value of 0.10 T in the opposite direction in 2.10 s. What is the average emf induced in the coil during the time that the magnetic field was changing? **(7 marks)**

8. A rectangular conducting loop of mass 4.5×10^{-2} kg and resistance 1.5 Ω is dropped in the direction shown through a uniform horizontal magnetic field of 1.8 T.



At what speed will this loop be falling through the magnetic field when it stops accelerating? **(7 marks)**