IB SL Physics: Magnetism NAME:

## PROBLEMS

### SECTIONS 20–3 AND 20–4

1. (I) (a) What is the force per meter on a wire carrying 0.80 A current when perpendicular to a 0.80-T magnetic field? (b) What if the angle between the wire and field is 45.0°?

2. (I) A 1.5-m length of wire carrying 6.5 A of current is oriented horizontally. At that point on the Earth's surface, the dip angle of the Earth's magnetic field makes an angle of 40° to the wire. Estimate the magnetic force on the wire due to the Earth's magnetic field of $5.5 \times 10^{-5}$ T at this point.

3. (I) How much current is flowing in a wire 4.20 m long if the maximum force on it is 0.900 N when placed in a uniform 0.0800-T field?

4. (I) The force on a wire carrying 25.0 A is a maximum of 4.14 N when placed between the pole faces of a magnet. If the pole faces are 22.0 cm in diameter, what is the approximate strength of the magnetic field?

5. (I) Determine the magnitude and direction of the force on an electron traveling $3.58 \times 10^{6}$ m/s horizontally to the west in a vertically upward magnetic field of strength 1.30 T.

6. (I) Describe the path of an electron that is projected vertically upward with a speed of $1.80 \times 10^{6}$ m/s into a uniform magnetic field of 0.250 T that is directed away from the observer.

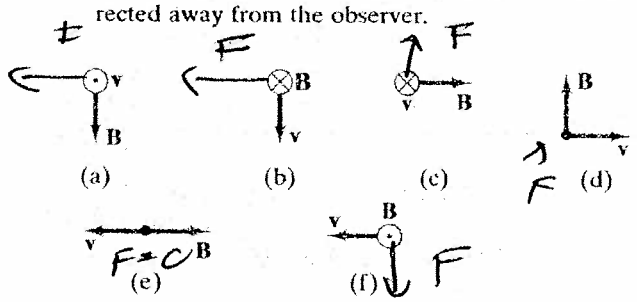



**FIGURE 20–50** Problem 7.

7. (I) Find the direction of the force on a negative charge for each diagram shown in Fig. 20–50, where **v** is the velocity of the charge and **B** is the direction of the magnetic field. (⊗ means the vector points inward. ⊙ means it points outward, toward the viewer.)

8. (I) Determine the direction of **B** for each case in Fig. 20–51, where **F** represents the force on a positively charged particle moving with velocity **v**.

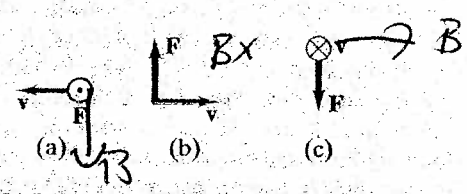



**FIGURE 20–51** Problem 8.

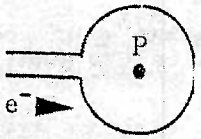
9. (I) Alpha particles of charge $q = +2e$ and mass $m = 6.6 \times 10^{-27}$ kg are emitted from a radioactive source at a speed of $1.6 \times 10^{7}$ m/s. What magnetic field strength would be required to bend these into a circular path of radius $r = 0.25$ m?

10. (II) An electron experiences the greatest force as it travels $1.8 \times 10^{6}$ m/s in a magnetic field when it is moving southward. The force is upward and of magnitude $2.2 \times 10^{-12}$ N. What is the magnitude and direction of the magnetic field?

Name _____ Electricity and Magnetism

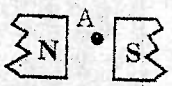
## Questions

1 The diagram represents a current-carrying loop of wire. The direction of the magnetic field at point $P$ is



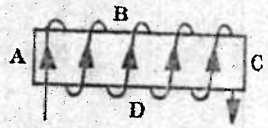

(1) toward the page
(2) to the right
(3) into the page
(4) out of the page

2 In the diagram, what is the direction of the magnetic field at point $A$?




(1) to the left
(2) to the right
(3) toward the top of the page
(4) toward the bottom of the page

3 The arrows in the diagram indicate the direction of the electron flow. The south pole of the electromagnet is located closest to point



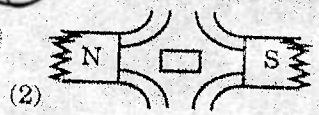

(1) $A$
(2) $B$
(3) $C$
(4) $D$

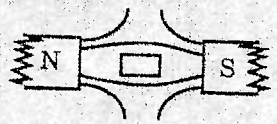
4 When the iron core is removed from the center of a direct current carrying coil, the magnetic field strength of the coil

(1) decreases (2) increases (3) remains the same

5 Which diagram best represents the magnetic field around a material of high permeability placed between unlike magnetic poles?

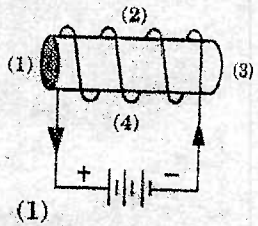
(1) 


(2) 


(3) 

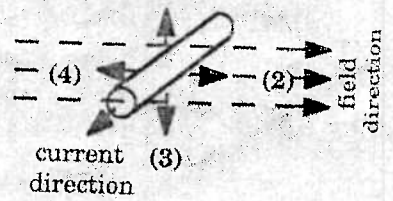

(4) 


6 An electromagnet is shown in the diagram. Its north pole will be nearest which point?



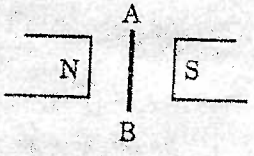

(1) 1
(2) 2
(3) 3
(4) 4

7 The diagram shows a current carrying wire in a magnetic field. If the current flows out of the page, the magnetic force on the wire will be in which direction?




(1) 1
(2) 2
(3) 3
(4) 4

8 When electrons flow from point $A$ to point $B$ in the wire shown in the diagram, there will be a force produced on the wire

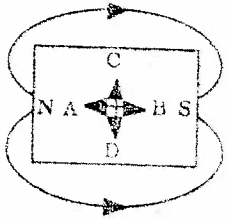



(1) toward N
(2) into the page
(3) toward S
(4) out of the page

9 The existence of a magnetic field around a current - carrying conductor can be demonstrated by placing the conductor near

(1) a pith ball (3) a battery
(2) an electroscope (4) a compass needle

10 Which arrow in the diagram represents the direction of the flux inside the bar magnet?

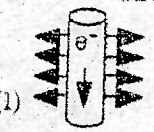


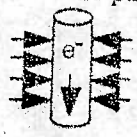

(1) $A$
(2) $B$
(3) $C$
(4) $D$

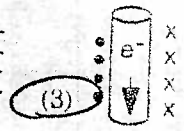
11 The field around a permanent magnet is caused by the motions of

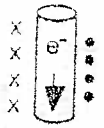
(1) nucleons (2) protons (3) neutrons (4) electrons

12 Which diagram best represents the direction of the magnetic field around a wire conductor in which the electrons are moving as indicated? (The x's indicate that the field is directed into paper and the dots indicate that the field is directed out of the page.)

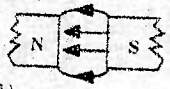
(1) 

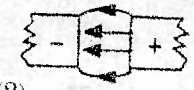

(2) 

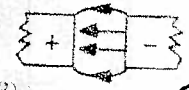

(3) 

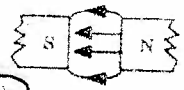

(4) 


13 Which diagram below best represents a magnetic field?

(1) 


(2) 


(3) 


(4) 

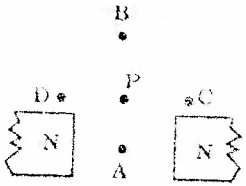

14 The accompanying diagram represents a wire carrying electrons into the page. The direction of the magnetic field above the wire is

(1) toward the left
(2) toward the right
(3) up from the page
(4) into the page

15 Magnetic fields are produced by

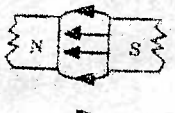
(1) motion of electric charges
(2) static electric charges
(3) photon motion
(4) gamma radiation

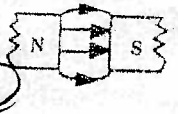
16 In the diagram, what is the direction of the magnetic field at point $P$?



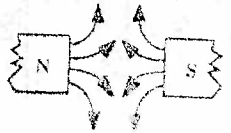

(1) toward $A$
(2) toward $B$
(3) toward $C$
(4) toward $D$

17 Which diagram best illustrates the direction of the magnetic field between the unlike poles of two bar magnets?

(1) 


(2) 


(3) 


(4) 

(1.a) $F = IlB$

$\frac{F}{l} = IB = 9.8(.8)$

$= 7.84 \frac{N}{m}$

(b) $7.84 \sin 45 = 5.54 \frac{N}{m}$

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(3) $F = IlB$

$I = 2.68A$

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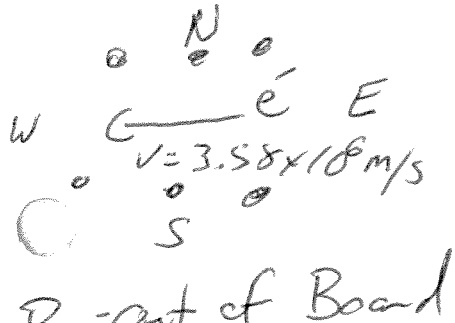
(5) Need Diagram & Direction (Page is the ground)

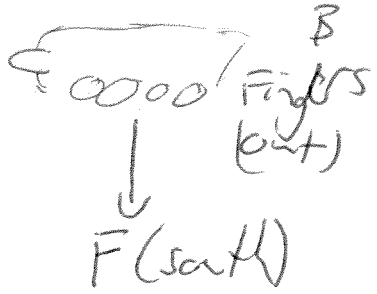
$F = qvB$

$F = (1.3T)(1.6\times10^{-11}C)(3.58\times10^{3})$

$= 7.45\times10^{-13}N$ south




B - out of Board

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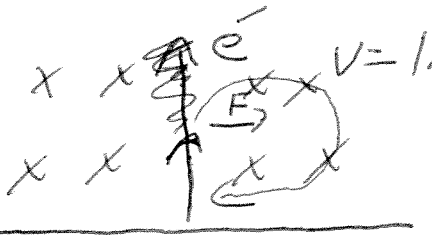
(6) Wants Path it will take (5 wants only magnitude & dir)




Electron will move into a circular path

Clockwise - Vertical Circle

Solve for r

Given $B = .25T$

Find $q =$

mass $= 9.11\times10^{-31}kg$

What causes it to move in a circle (Force of the Mag. Field)

$F_B = F_C$

$F_B = \frac{mv^2}{r}$

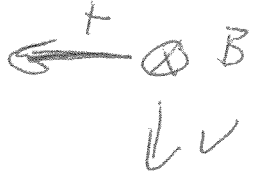
$qvB = \frac{mv^2}{r}$

$(1.6\times10^{-19}C)(1.8\times10^{6}\frac{m}{s})(.25T) = \frac{(1.8\times10^{6}\frac{m}{s})^2}{r}$

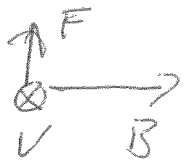
$r = 4.10\times10^{-5}m$

Draw the direction in Prob #6

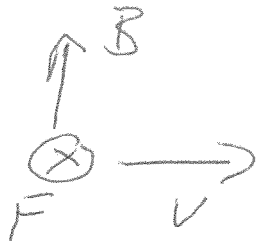

a)



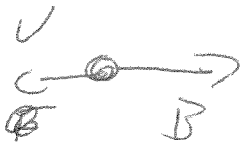

b)




c)

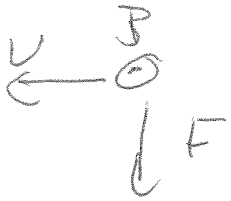



d)




$F = 0$

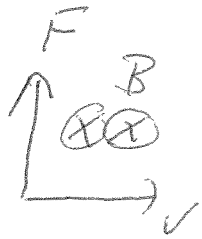
e)



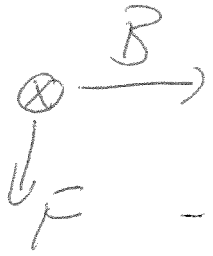

f)

8a)


8b)




8c)

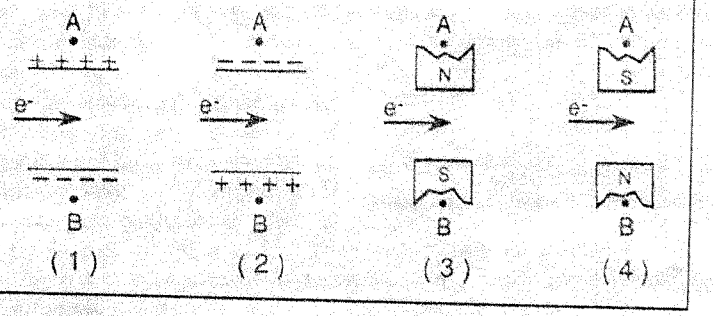



$F = ILB \sin 40$

$3.45 \times 10^{-4}$ N

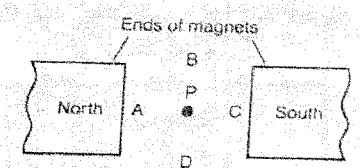
Nam _____ Electricity and M etism

84. In each diagram below, an electron travels to the right between points A and B. In which diagram would the electron be deflected toward the bottom of the page?

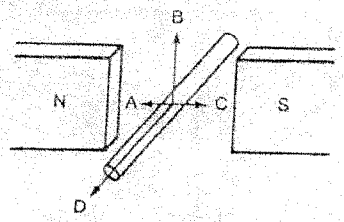



## QUESTIONS

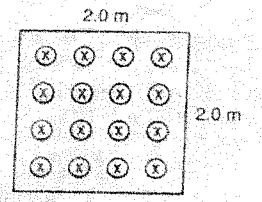
1. In the diagram, the direction of the magnetic field at point *P* is toward point
(1) *A* (3) *C*
(2) *B* (4) *D*



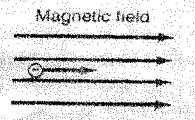

2. An electric potential difference will be induced between the ends of the conductor shown in the diagram when the conductor moves in direction
(1) *A* (3) *C*
(2) *B* (4) *D*



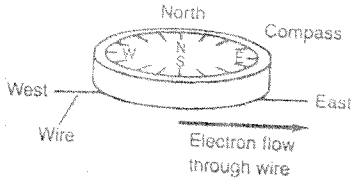

3. The diagram represents magnetic flux intersecting a plane at right angles. If the magnitude of the flux is 16 webers, the average flux density intersecting the plane is
(1) 64 T (3) 8.0 T
(2) 16 T (4) 4.0 T



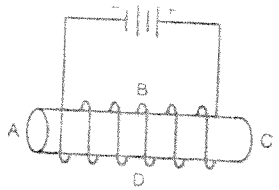

4. An electron moving parallel to a magnetic field as shown in the diagram will experience (1) no magnetic force (2) a magnetic downward force (3) a magnetic force out of the page (4) a magnetic force into the page



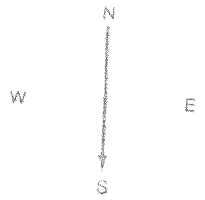

5. If the electrons in the wire shown are flowing eastward, in which direction will the needle of a compass held above the wire point?
(1) north (3) east
(2) south (4) west



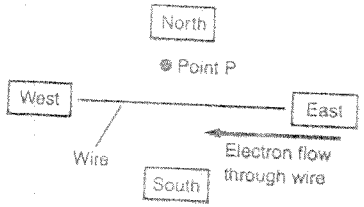

6. The north pole of the solenoid shown would be located at point
(1) *A* (3) *C*
(2) *B* (4) *D*



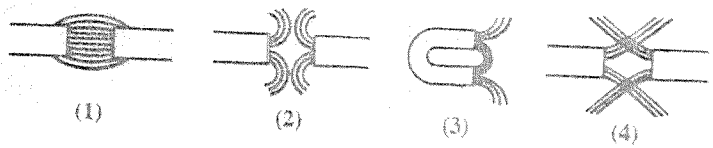

7. A beam of electrons is moving from north to south as shown. The direction of the magnetic field above the beam is toward the
(1) north (3) east
(2) south (4) west



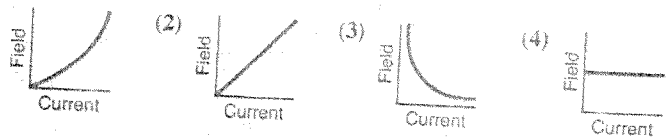

8. The direction of the electron flow in a conductor is from east to west as shown.
What is the direction of the magnetic field at point *P*?
(1) north (2) south (3) into the page (4) out of the page




9. Which magnetic-field configuration is not possible?

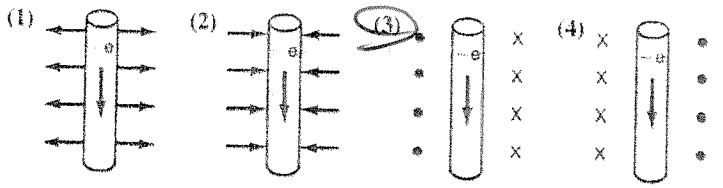



10. Which graph best represents the relationship between current in a straight conductor and magnetic field strength at a point near the conductor?



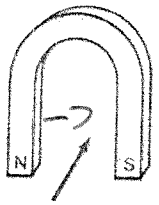
11. An iron core is placed inside a solenoid connected to a voltage source. Which of the following properties of the solenoid will change? (1) magnetic field strength (2) current (3) resistance (4) magnetic polarity

12. Which diagram best represents the magnetic field around a current-carrying conductor? (The x indicates that the field is into the page; the • indicates that the field is out of the page.)

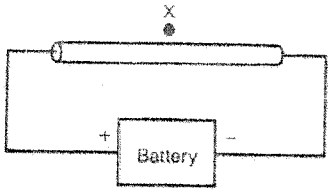



13. Magnetic flux density may be measured in (1) newtons (2) teslas (3) hertz (4) webers

14. As an electron passes between the poles of a horseshoe magnet in the direction shown by the arrow in the illustration, the direction of the magnetic force acting on the electron is (1) to the left (2) to the right (3) upward (4) downward



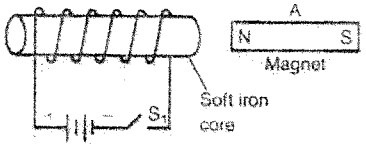

15. At point *X* above the current-carrying wire, the direction of the magnetic lines of force is (1) into the page (2) out of the page (3) to the left (4) to the right




16. As the difference in potential across the terminals of a solenoid increases, its magnetic flux density (1) decreases (2) increases (3) remains the same

17. If an iron rod is inserted into a solenoid parallel to the coil axes, the flux density (1) decreases (2) increases (3) remains the same

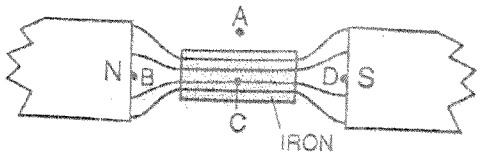
18. Given the diagram at right, at the moment when switch $S_1$ is closed, the force of the magnet on the soft iron core (1) decreases (2) increases (3) remains the same




19. As the current in a circular loop of wire increases, the magnetic field strength at the center of the loop (1) decreases (2) increases (3) remains the same

20. As the current in a conductor is increased, the strength of the magnetic field at a point near the wire (1) decreases (2) increases (3) remains the same

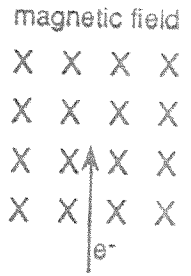
34 The diagram below shows the magnetic field that results when a piece of iron is placed between unlike magnetic poles.




At which point is the magnetic field strength greatest?

(1) *A*
(2) *B*
(3) *C*
(4) *D*

Base your answers to questions 79 and 80 on the diagram below which represents a beam of electrons moving through a uniform magnetic field. The magnetic field is directed into the page.




79 As the beam of electrons moves through the magnetic field, the electrons will be deflected

1 into the page
2 out of the page
3 toward the left
4 toward the right

80 If the speed of an electron in the magnetic field is $6.0 \times 10^6$ meters per second and a force of $5.0 \times 10^{-14}$ newton acts on the electron, what is the flux density of the magnetic field?

(1) $5.2 \times 10^{-2}$ T
(2) $8.3 \times 10^{-21}$ T
(3) $3.0 \times 10^{-7}$ T
(4) $1.9 \times 10^{1}$ T

IB Physics Ans key

3. The output voltage from a step-up transformer is greater than the input voltage. This does not contradict the law of conservation of energy because

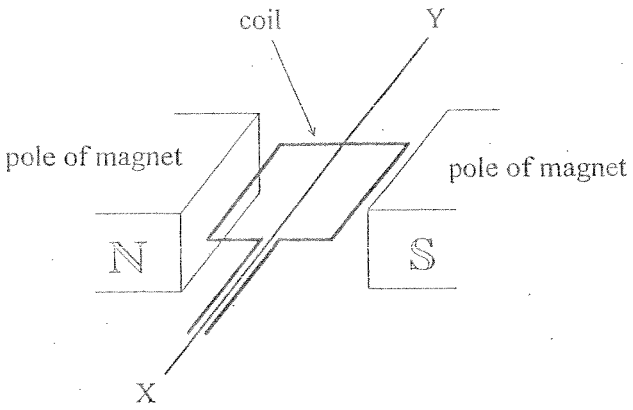
A. energy is taken from the mains supply.

B. energy is taken from the magnetic field.

C. the output current is less than the input current.

D. the efficiency of the transformer is greater than 1.

4. The diagram shows a coil of wire that can rotate between the poles of a magnet about the axis XY.




A current is passed through the coil by means of a commutator connected to the ends of the coil. What is the position of the coil in the magnetic field so that its turning effect is a maximum and what is the position of the coil when the current is reversed so that the coil rotates continuously?

| | plane of coil for maximum turning effect | plane of coil for reversal of current |
|---|---|---|
| A. | parallel to direction of field | parallel to direction of field |
| B. | normal to direction of field | parallel to direction of field |
| C. | parallel to direction of field | normal to direction of field |
| D. | normal to direction of field | normal to direction of field |

5. A DC electric motor converts 75 % of the input electrical energy to mechanical energy. The remaining 25 % is

A. dissipated as heat energy.

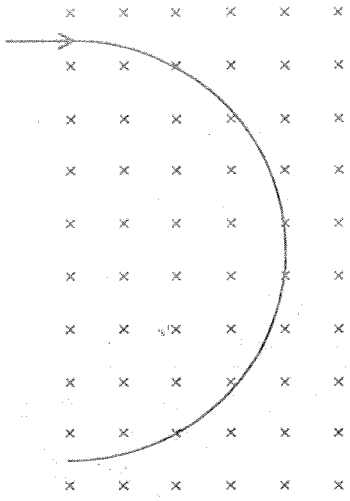
B. returned to the battery.

C. used to maintain the potential difference of the battery.

D. converted to electrical potential energy.

1.

A charged particle is injected into a region of uniform magnetic field and travels in a circular arc.

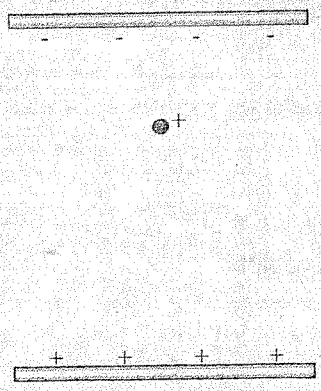


If the particle were to be injected with a **greater speed**, what would be true of the magnetic force on it and the radius of its path?

| | Force | Arc radius |
|---|---|---|
| A | greater | greater |
| B. | greater | smaller |
| C. | smaller | greater |
| D. | smaller | smaller |

2.

A positively charged oil drop is held stationary between two charged plates as shown below.



If a magnetic field *B* directed **into** the page is now applied, the charged drop would

A. move into the page.

B. move upwards.

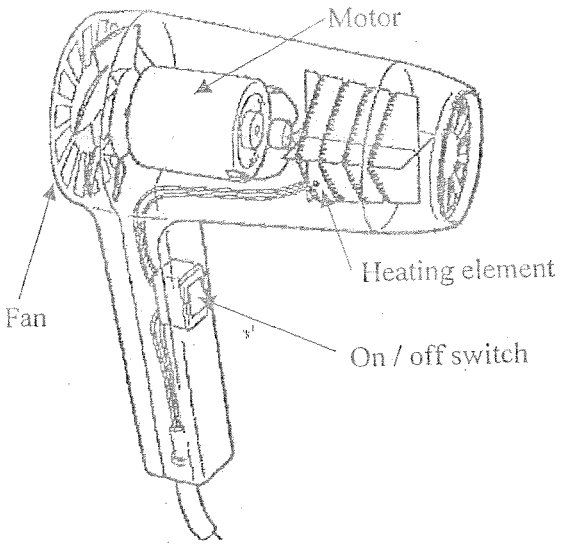
C. move to the right.

D. stay where it is.

104

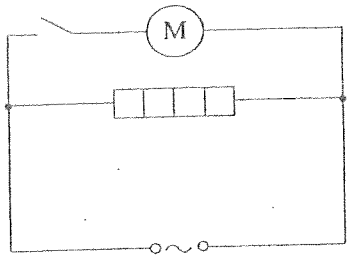
8.

A simple hairdryer that blows out hot air contains the components shown below. When it is connected to the mains and the switch is turned on, the motor and the heating element both operate together.

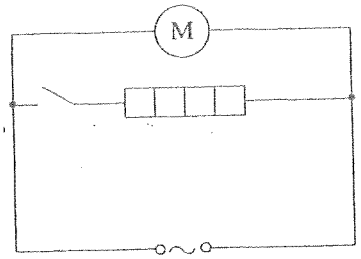



Which one of the following diagrams represents the electrical circuit in the hairdryer?

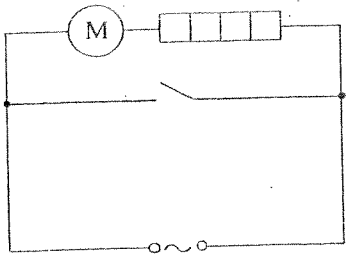
A.



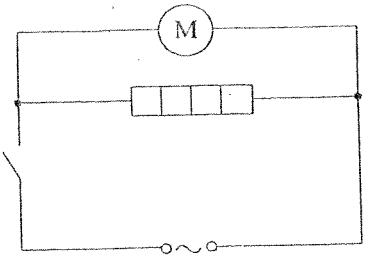

B.




C.




D.




9.

An electron and a proton travelling with the same velocity are injected into a region of uniform magnetic field at 90° to the magnetic field direction. The **initial** magnetic forces on them are

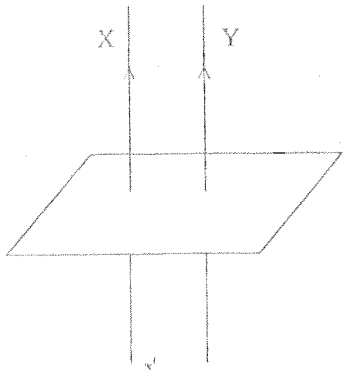
A. equal in magnitude and direction.

B. equal in magnitude and opposite in direction.

C. equal in magnitude and perpendicular to each other.

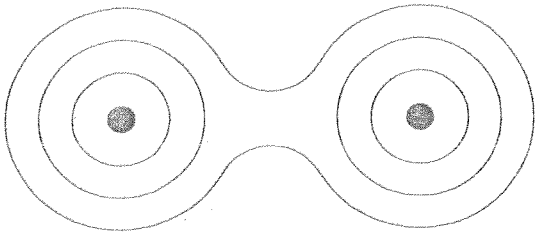
D. in opposite directions and differing in magnitude by the ratio of their masses.

6. Two long, vertical wires X and Y carry currents in the same direction and pass through a horizontal sheet of card.

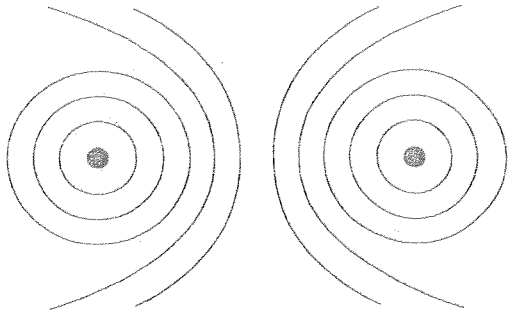



Iron filings are scattered on the card. Which **one** of the following diagrams best shows the pattern formed by the iron filings? *(The dots show where the wires X and Y enter the card.)*

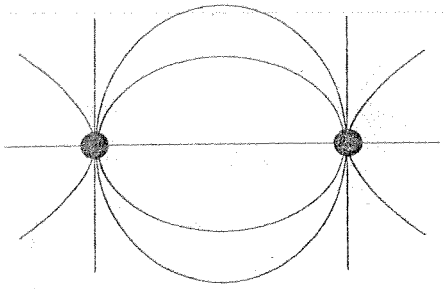
A.



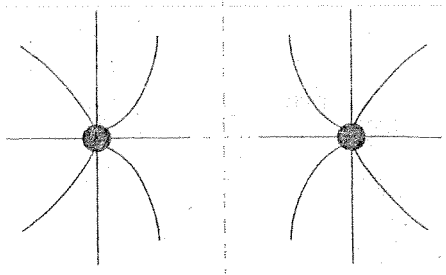
B.



C.



D.



7

The function of the commutator of a d.c. electric motor is

A. to reverse the current through the rotating coils each half turn.

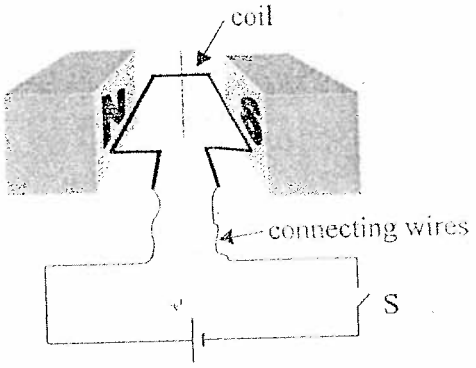
B. to step up the voltage from the electrical source.

C. to convert the motor into an a.c. motor.

D. to enable the rotational speed of the motor to be varied.

11.

Jorge builds a simple electric motor but makes a mistake. He forgets to include the commutator and brushes and connects the coil directly to the power supply. The setup is represented in the diagram below (only one turn of the coil is shown).




With the coil in the position shown, when the switch S is closed the coil will

A. rotate normally – but the wires would tangle.

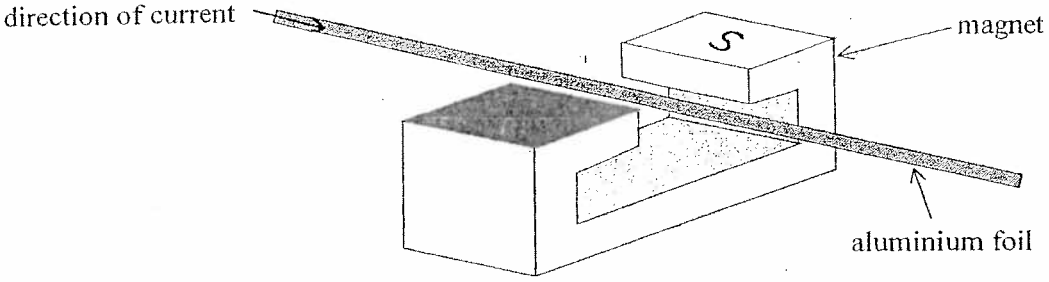
B. stop after half a revolution.

C. stop after a quarter of a revolution.

D. not move.

12

A strip of aluminium foil is held between the poles of a strong magnet, as shown below.




When a current is passed through the aluminium foil in the direction shown, the foil is deflected. In which direction is this deflection?

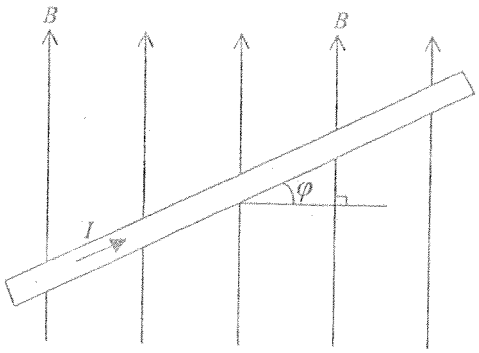
A. Vertically downwards

B. Vertically upwards

C. Towards the North pole of the magnet

D. Towards the South pole of the magnet

The diagram below shows a current $I$ in a wire placed at an angle $\varphi$ inside a uniform magnetic field of field strength $B$.




The magnetic force per unit of length of wire is $M$. The magnetic field strength $B$ is given by

A. $\dfrac{M}{I\sin\varphi}$.

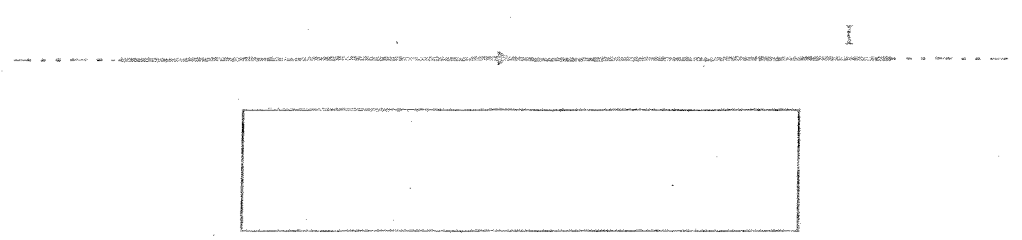
B. $\dfrac{M}{I\cos\varphi}$.

C. $\dfrac{M\cos\varphi}{I}$.

D. $\dfrac{M\sin\varphi}{I}$.

13

A long straight wire is in the plane of a rectangular conducting loop of wire. The straight wire carries a constant current I as shown in the figure below and is moved towards the rectangular loop.




While the wire is being moved towards the rectangular loop, the current in the loop

A. is always zero.

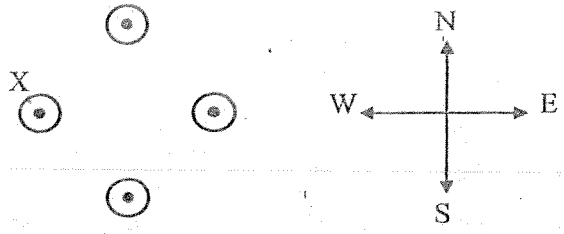
B. flows clockwise around the loop.

C. flows counterclockwise around the loop.

D. alternates, first one way then the opposite way around the loop.

14

Four long straight parallel wires carry equal currents directed vertically out of the page. They are arranged on the corners of a square as shown in the figure below.




The direction of the resultant magnetic force exerted on the wire labelled X is

A. south.

B. north.

C. west.

D. east.

15

A charged particle of mass $m$ and charge $q$ is travelling in a uniform magnetic field with speed $v$ such that the magnetic force on the particle is $F$. The magnetic force on a particle of mass $2m$, charge $q$ and speed $2v$ travelling in the same direction in the magnetic field is

A. $4F$.

B. $2F$.

C. $F$.

D. $\frac{1}{2}F$.