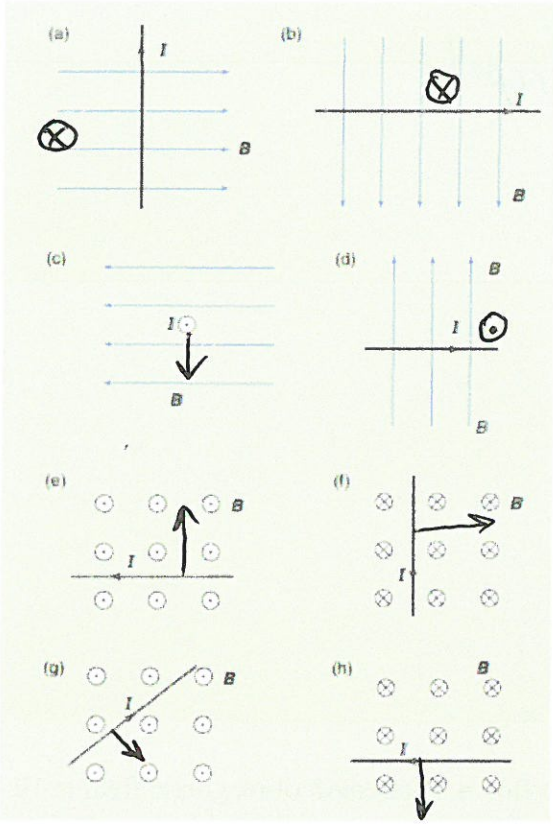
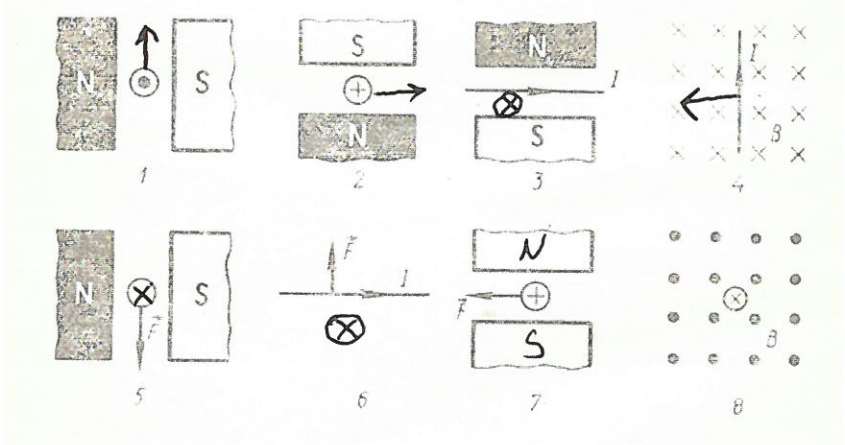
Forces in magnetic field

1. Indicate the direction of the force of the magnetic field on the current-carrying wire in diagrams (a) to (h) below.



2. Identify direction of the force acting on the wire with the current (1 – 4, 8), direction of the current (5), direction of magnetic field (6) and poles of magnets (7).

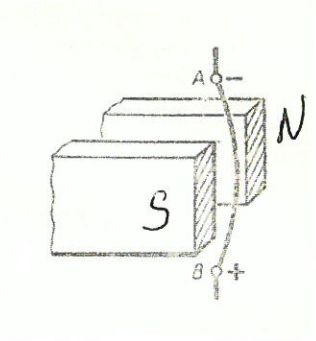


No force

3. Coil with the current as shown freely hanging on the wires facing you. What will happen if you will bring bar magnet perpendicular to the coil with south pole facing coil.

They will repel

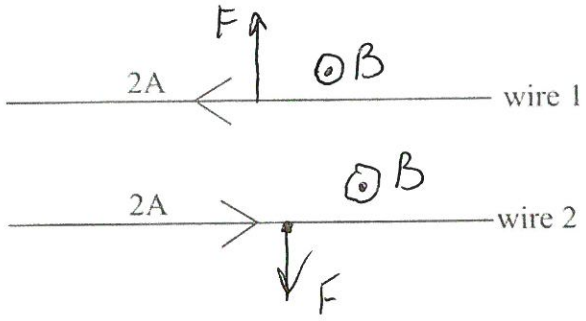
4. Identify poles of the magnet.



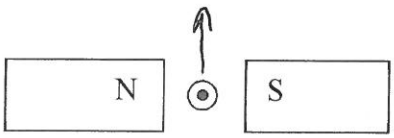
5. This question relates to the picture in question 4. If strength of magnetic field is 10 mT, current in the wire is 3 A and length of wire in magnetic field is 15 cm, calculate the size of the force acting on the wire.

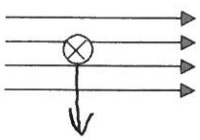
$F = BIl = 0.01 \times 3 \times 0.15 = 4.5 \times 10^{-3}\ N$

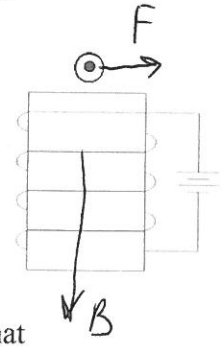
6. In the position of each wire, give the direction of the magnetic field due to other wire. Hence give the direction of the force acting on each wire.



7. Determine the direction of the force on the wire for the following 3 cases.







8. A magnetic field points down. A positive charge moves left to right. What Is the direction of the force?

Into the page

9. A magnetic field points out of the page. A positive charge moves down. What is the direction of the force?

To the left

10. The force points down. The positive charge moves from right to left. What is the direction of the magnetic field?

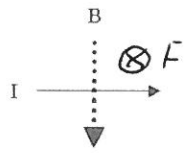
Into the page

11. The force points down. The magnetic field points from right to left. What is the direction of the velocity of the positive charge?

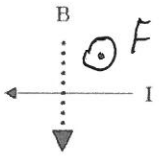
Out of the page

12. State the direction of the magnetic FORCE on these moving charges or current-carrying wires when near these external magnetic fields. Circles with a dot in them represent directions out of the page and circles with an X in them represent directions into the page. B is the letter that designates magnetic field.

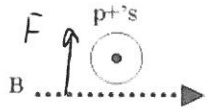
12.



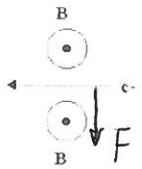
13.



14.

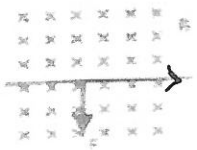


15.

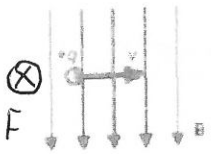


13. Using arrows, X's or dots, indicate the requested variable for each questions using the right hand rules.

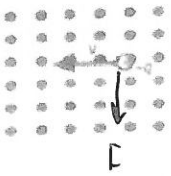
9. electron flow in the wire



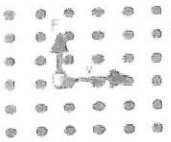
10. force on the positive charge



11. force on the negative charge



12. sign of the charge (positive or negative)



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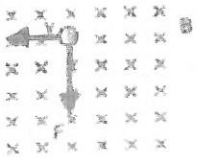
13. sign of the charge (positive or negative)

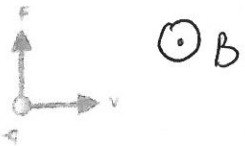


+ 0

14. magnetic field

Force is out of the page

15. magnetic field



14. An electron travels to the right of the page through a magnetic field that points into the page. Which way does the magnetic force point?

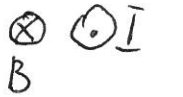
15. An electron travels into the page through a magnetic field that points to the left of the page. Which way does the magnetic force point?

16. An alpha particle travels toward the top of the page through a magnetic field that points out of the page. Which way does the magnetic force point?

17. An electron travels to the North through a magnetic field that points to the North. Which direction does the magnetic force point?

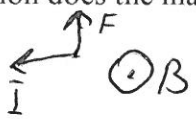
No force

18. An alpha particle travels out of the page through a magnetic field that points into the page. Which direction does the magnetic force point?

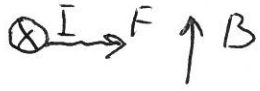


No force

19. An electron traveling to the East experiences a magnetic force to the North. In which direction does the magnetic field point?



20. An alpha particle traveling into the page experiences a magnetic force to the right of the page. In which direction does the magnetic field point?



21. Calculate the size of the force on a wire of length 0.05 m in a magnetic field of strength 0.30 T if the wire is at right angles to the field and it carries a current of 4.5 A.

$F = BIl = 0.3 \times 4.5 \times 0.05 = 0.0675\ N$

22. Calculate the size of the force exerted on a loudspeaker coil of radius 1.5 cm and 500 turns which carries a current of 15 mA in a radial magnetic field of 2.0 T.

$F = nB\bar{I}\ell$

$= nB\bar{I} \times 2\pi\hat{r}$

$= 500 \times 2 \times 0.015 \times 2\pi \times 0.015 = 1.4\,N$

23. How could a moving electron remain undeflected in a magnetic field?

If its velocity parallel to magnetic field

24. Can a magnetic field move a stationary electron?

No $F = qvB$ $v = 0$ $F = 0$

25. An alpha particle is traveling at 5.00 x 10^5 m/s through a perpendicular magnetic field of value 20 T. Calculate the magnetic force acting on the alpha particle.

$F = qvB$

$= 2 \times 1.6 \times 10^{-19} \times 5 \times 10^{5} \times 20$

$= 3.2 \times 10^{-12}\,N$

26. An electron is traveling at 6.00 x 10^5 m/s through a perpendicular magnetic field of value 0.5 T. Calculate the magnetic force acting on the electron. Calculate the initial acceleration of the electron.

$F = qvB = 1.6 \times 10^{-19} \times 6 \times 10^{5} \times 0.5 = 4.8 \times 10^{-14}\,N$

$a = \frac{F}{m} = \frac{4.8 \times 10^{-14}}{9.1 \times 10^{-31}} = 5.3 \times 10^{16}\,m/s^2$

27. An electron is traveling through a perpendicular magnetic field of value 3.00 x 10-1 T. If the magnetic force that it experiences is 4.50 x 10-14 N, how fast is the electron moving?

$F = qvB \quad v = \frac{F}{qB}$

$v = \frac{4.5 \times 10^{-14}}{1.6 \times 10^{-19} \times 0.3} = 9.4 \times 10^{5}\,m/s$

28. How fast must an electron be traveling through a magnetic field of strength 3.0 x 10^-3 T if it follows a circular path of radius 6.5 x 10^-2 m?

$r = \frac{mv}{qB}$ $v = \frac{qBr}{m}$ $v = \frac{1.6\times10^{-19}\times3\times10^{-3}\times6.5\times10^{-2}}{9.1\times10^{-31}}$

$= 3.4\times10^{7}$ m/s

29. What is the magnetic field strength required to make a proton with a speed of 5.0 x 10^5 m/s follow a circular path of radius 2.0 x 10^-2 m?

$r = \frac{mv}{qB}$ $B = \frac{mv}{qr}$ $B = \frac{1.67\times10^{-27}\times5\times10^{5}}{1.6\times10^{-19}\times2\times10^{-2}} = 0.26$ T

30. What is the kinetic energy, in Joules and electronvolts, of an alpha particle that moves through a magnetic field of strength 1.0 x 10-1 T and follows a circular path of radius 0.025 m?

$v = \frac{qBr}{m}$ $v = \frac{2\times1.6\times10^{-19}\times0.1\times0.025}{6.7\times10^{-27}} = 1.2\times10^{5}$ m/s

$E_k = \frac{mv^2}{2} = \frac{6.7\times10^{-27}\times(1.2\times10^{5})^2}{2} = 4.8\times10^{-17}$ J $= 300$ eV

31. How does the radius of curvature of an electron compare to the radius of curvature of an alpha particle moving through the same magnetic field at the same speed?

$\frac{r_e}{r_\alpha} = \frac{m_e q_\alpha}{m_\alpha q_e} = \frac{9.1\times10^{-31}\times4}{6.7\times10^{-27}\times1} = 5.4\times10^{-4}$

32. A 10.0 cm long wire carries a current of 0.500 A through a magnetic field of strength 0.100 T. Calculate the strength of the magnetic force acting on the wire.

$F = BIl$ $F = 0.1\times0.5\times0.1 = 0.005$ N

33. The magnetic force acting on a wire is 0.0300 N. If the wire has a current of 1.00 A and a length of 20.0 cm, what is the strength of the magnetic field?

$F = BIl$

$B = \frac{F}{Il} = \frac{0.03}{1\times0.2} = 0.15$ T