Name: _____ Date: _____

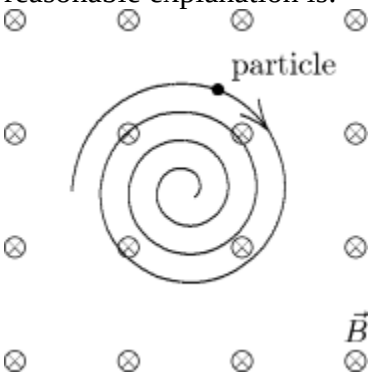
1. A loop of current-carrying wire has a magnetic dipole moment of 5×10^{-4} A · m^2. The moment initially is aligned with a 0.5-T magnetic field. To rotate the loop so its dipole moment is perpendicular to the field and hold it in that orientation, you must do work of:

A) 0
B) 2.5×10^{-4} J
C) -2.5×10^{-4} J
D) 1.0×10^{-3} J
E) -1.0×10^{-3} J

2. An electron is launched with velocity $\vec{v}$ in a uniform magnetic field $\vec{B}$. The angle θ between $\vec{v}$ and $\vec{B}$ is between 0 and 90º. As a result, the electron follows a helix, its velocity vector $\vec{v}$ returning to its initial value in a time interval of:

A) $2\pi m/eB$
B) $2\pi mv/e$B
C) $2\pi mv \sin \theta/eB$
D) $2\pi mv \cos \theta/eB$
E) none of these

3. A uniform magnetic field is directed into the page. A charged particle, moving in the plane of the page, follows a clockwise spiral of decreasing radius as shown. A reasonable explanation is:



A) the charge is positive and slowing down
B) the charge is negative and slowing down
C) the charge is positive and speeding up
D) the charge is negative and speeding up
E) none of the above

4. The units of magnetic dipole moment are:

A) ampere
B) ampere · meter
C) ampere · meter^2
D) ampere/meter
E) ampere/meter^2

5. A uniform magnetic field is in the positive *z* direction. A positively charged particle is moving in the positive *x* direction through the field. The net force on the particle can be made zero by applying an electric field in what direction?

A) Positive *y*
B) Negative *y*
C) Positive *x*
D) Negative *x*
E) Positive *z*

6. A current is clockwise around the outside edge of this page and a uniform magnetic field is directed parallel to the page, from left to right. If the magnetic force is the only force acting on the page, the page will turn so the right edge:

A) moves toward you
B) moves away from you
C) moves to your right
D) moves to your left
E) does not move

7. A charged particle is projected into a region of uniform and parallel electric and magnetic fields. The force on the particle is:

A) zero
B) at some angle $< 90^{o}$ with the field lines
C) along the field lines
D) perpendicular to the field lines
E) unknown (need to know the sign of the charge)

8. The magnetic dipole moment of a current-carrying loop of wire is in the positive *z* direction. If a uniform magnetic field is in the positive *x* direction the magnetic torque on the loop is:

A) 0
B) in the positive *y* direction
C) in the negative *y* direction
D) in the positive *z* direction
E) in the negative *z* direction

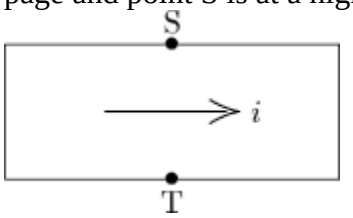
9. An electron travels due north through a vacuum in a region of uniform magnetic field $\vec{B}$ that is also directed due north. It will:

A) be unaffected by the field
B) speed up
C) slow down
D) follow a right-handed corkscrew path
E) follow a left-handed corkscrew path

10. A proton (charge e), traveling perpendicular to a magnetic field, experiences the same force as an alpha particle (charge $2e$) which is also traveling perpendicular to the same field. The ratio of their speeds, v_{proton}/v_{alpha}, is:

A) 0.5
B) 1
C) 2
D) 4
E) 8

11. The current is from left to right in the conductor shown. The magnetic field is into the page and point S is at a higher potential than point T. The charge carriers are:

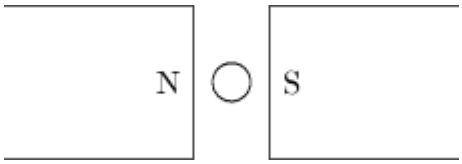


A) positive
B) negative
C) neutral
D) absent
E) moving near the speed of light

12. An electron is moving north in a region where the magnetic field is south. The magnetic force exerted on the electron is:

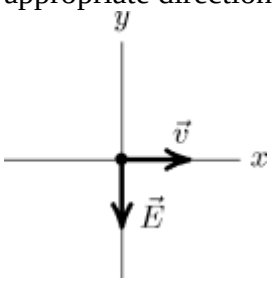
A) zero
B) up
C) down
D) east
E) west

13. The diagram shows a straight wire carrying a flow of electrons into the page. The wire is between the poles of a permanent magnet. The direction of the magnetic force exerted on the wire is:



A) ↑
B) ↓
C) ←
D) →
E) into the page

14. An electron is traveling in the positive *x* direction. A uniform electric field $\vec{E}$ is in the negative *y* direction. If a uniform magnetic field with the appropriate magnitude and direction also exists in the region, the total force on the electron will be zero. The appropriate direction for the magnetic field is:



A) the positive *y* direction
B) the negative *y* direction
C) into the page
D) out of the page
E) the negative *x* direction

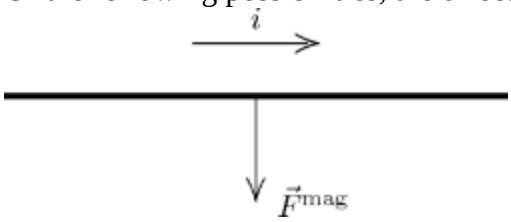
15. A magnetic field CANNOT:

A) exert a force on a charged particle
B) change the velocity of a charged particle
C) change the momentum of a charged particle
D) change the kinetic energy of a charged particle
E) change the trajectory of a charged particle

16. An electron (charge = -1.6×10^{-19} C) is moving at 3×10^5 m/s in the positive *x* direction. A magnetic field of 0.8 T is in the positive *z* direction. The magnetic force on the electron is:

A) 0
B) 4×10^{-14} N, in the positive *z* direction
C) 4×10^{-14} N, in the negative *z* direction
D) 4×10^{-14} N, in the positive *y* direction
E) 4×10^{-14} N, in the negative *y* direction

17. The diagram shows a straight wire carrying current *i* in a uniform magnetic field. The magnetic force on the wire is indicated by an arrow but the magnetic field is not shown. Of the following possibilities, the direction of the magnetic field is:

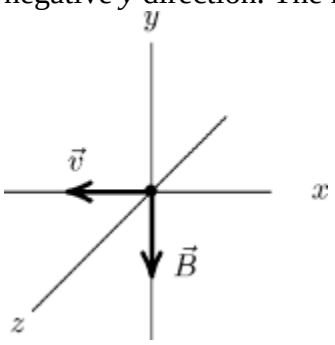


A) opposite the direction of the current
B) opposite the direction of $\vec{F}$
C) in the direction of $\vec{F}$
D) into the page
E) out of the page

18. A magnetic field exerts a force on a charged particle:

A) always
B) never
C) if the particle is moving across the field lines
D) if the particle is moving along the field lines
E) if the particle is at rest

19. An electron moves in the negative *x* direction, through a uniform magnetic field in the negative *y* direction. The magnetic force on the electron is:

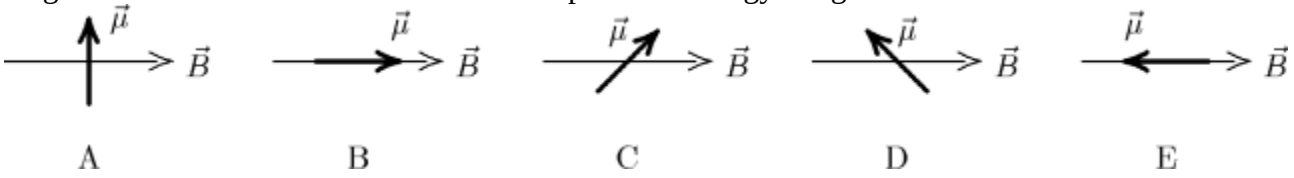


A) in the negative *x* direction
B) in the positive *y* direction
C) in the negative *y* direction
D) in the positive *z* direction
E) in the negative *z* direction

20. An ion with a charge of $+ 3.2 \times 10^{-19}$ C is in a region where a uniform electric field of magnitude 5×10^4 V/m is perpendicular to a uniform magnetic field of magnitude 0.8 T. If its acceleration is zero then its speed must be:

A) 0
B) 1.6×10^4 m/s
C) 4.0×10^4 m/s
D) 6.3×10^4 m/s
E) any value but 0

21. The diagrams show five possible orientations of a magnetic dipole $\vec{\mu}$ in a uniform magnetic field $\vec{B}$. For which of these is the potential energy the greatest?



A) A
B) B
C) C
D) D
E) E

22. An electron and a proton are both initially moving with the same speed and in the same direction at 90º to the same uniform magnetic field. They experience magnetic forces, which are initially:

A) identical
B) equal in magnitude but opposite in direction
C) in the same direction and differing in magnitude by a factor of 1840
D) in opposite directions and differing in magnitude by a factor of 1840
E) equal in magnitude but perpendicular to each other.

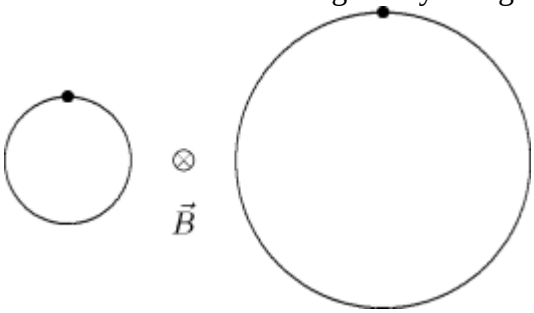
23. The magnetic force on a charged particle is in the direction of its velocity if:

A) it is moving in the direction of the field
B) it is moving opposite to the direction of the field
C) it is moving perpendicular to the field
D) it is moving in some other direction
E) never

24. The magnetic torque exerted on a flat current-carrying loop of wire by a uniform magnetic field $\vec{B}$ is:

A) maximum when the plane of the loop is perpendicular to $\vec{B}$
B) maximum when the plane of the loop is parallel to $\vec{B}$
C) dependent on the shape of the loop for a fixed loop area
D) independent of the orientation of the loop
E) such as to rotate the loop around the magnetic field lines

25. An electron and a proton each travel with equal speeds around circular orbits in the same uniform magnetic field, as shown in the diagram (not to scale). The field is into the page on the diagram. Because the electron is less massive than the proton and because the electron is negatively charged and the proton is positively charged:



A) the electron travels clockwise around the smaller circle and the proton travels counterclockwise around the larger circle
B) the electron travels counterclockwise around the smaller circle and the proton travels clockwise around the larger circle
C) the electron travels clockwise around the larger circle and the proton travels counterclockwise around the smaller circle
D) the electron travels counterclockwise around the larger circle and the proton travels clockwise around the smaller circle
E) the electron travels counterclockwise around the smaller circle and the proton travels counterclockwise around the larger circle

Answer Key

1. B
2. A
3. B
4. C
5. B
6. A
7. B
8. B
9. A
10. C
11. A
12. A
13. A
14. C
15. D
16. D
17. E
18. C
19. E
20. D
21. E
22. B
23. E
24. B
25. A