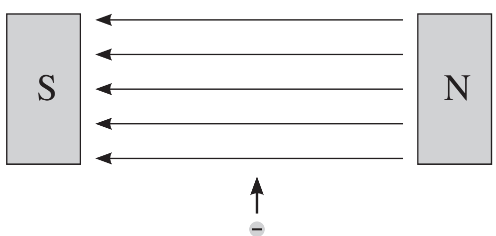
Magnetism Practice Items

1. What is the direction of the force on a negatively charged particle as it enters the magnetic field shown below?

A. to the left
B. to the right
C. into the page
D. out of the page



2. What is the magnitude and direction of a magnetic force acting on an electron (charge -1.6×10^{-19} C) moving in the opposite direction at 1000 m/s in the same plane and parallel to a 10 μT uniform magnetic field?

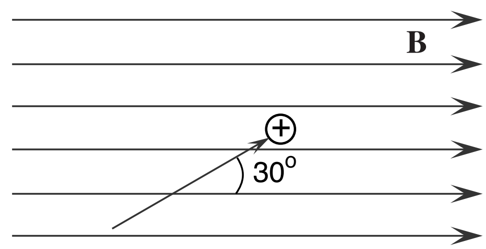
A. 0 N
B. 1.6×10^{-21} N out of the plane
C. 1.6×10^{-15} N into the plane
D. 1.6×10^{-15} N parallel to the plane

3. A positively charged particle is released from rest in a region where there is a uniform electric field and a uniform magnetic field. If the two fields are parallel to each other, the path of the particle is a

A. circle.
B. parabola.
C. helix.
D. straight line.

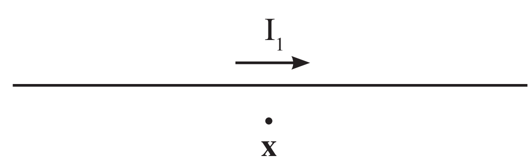
4. A proton (charge 1.6×10^{-19} C) moves at an angle to a the uniform magnetic field, **B** (300 Tesla) in the same plane as the field. The speed of the proton is 2×10^6 m/s. What is magnetic force acting upon the proton?

A. 1.6×10^{-13} N, directed into the page
B. 4.8×10^{-11} N, directed into the page
C. 4.8×10^{-11} N, directed out of the page
D. 8.3×10^{-11} N, directed out of the page



5. What is the direction of the magnetic field at the point in space **x** near the current carrying wire pictured below?

A. Out of the page
B. Into the page
C. Upward in the plane of the page
D. Downward in the plane of the page

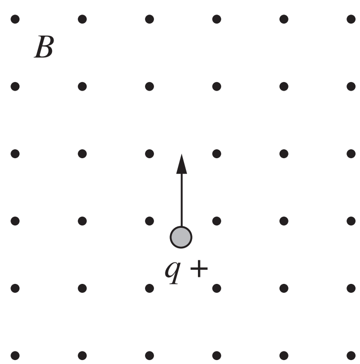


6. When electric current is flowing in the same direction through two, adjacent, parallel wires:

A. The wires attract each other.
B. The wires repel each other.
C. The wires exert no force on each others.
D. The wires oscillate.

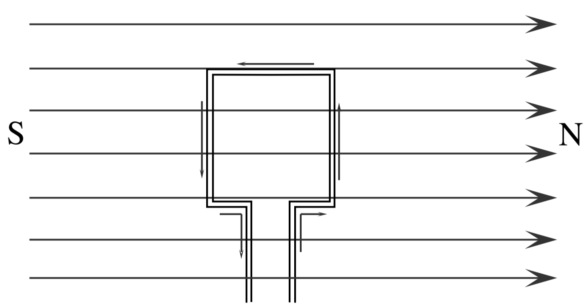
7. A positively charged particle is moving in the plane of the page in a direction perpendicular to the uniform magnetic field, ***B***, which points out of the page perpendicular to the plane of the page in the figure below. If the only force acting the particle is magnetic force, which of the following descriptions best applies to the motion of the particle?

A. clockwise circular motion
B. counter-clockwise circular motion
C. clockwise helical motion out of the paper
D. counter-clockwise helical motion into the paper



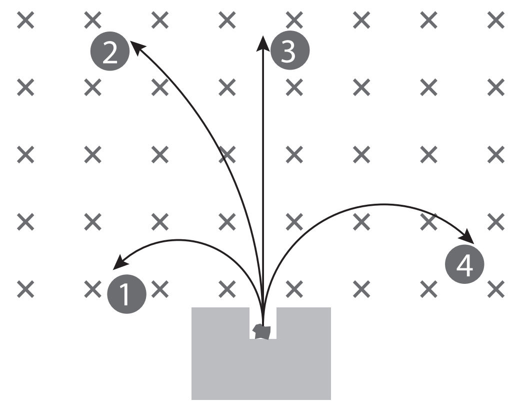
8. When current is flowing in the direction shown in the conducting loop below

A. the loop experiences a net torque.
B. the experiences a net force into the page.
C. the loop experiences compressive stress.
D. the loop is in a state of static equilibrium.



9. Radioactive emissions from an alloy in which several decay processes are occurring pass into a uniform magnetic field pointing into the page as shown in the figure below. The identity of particle 4 is most likely

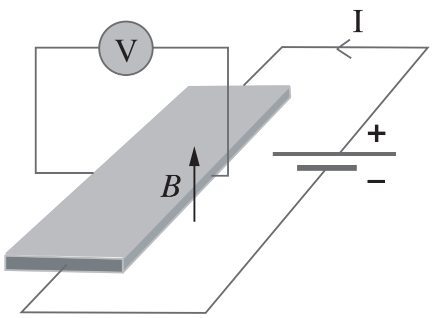
A. β^+
B. β^-
C. α
D. γ



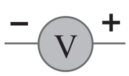
10. In a cyclotron particle accelerator, a beam of charged particles travels repeatedly round a loop. The purpose of the powerful magnets in a cyclotron is

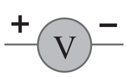
A. to record particle collisions.
B. to pull charged particles forward along the accelerator.
C. to steer and focus the particles.
D. to prevent the particles from colliding with gas molecules within the accelerator.

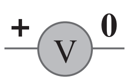
11. A voltage source is connected in series by copper wires to a steel plate, which is oriented perpendicular to the magnetic field, ***B***, as shown in the figure below.

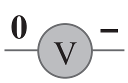


While current is flowing through the circuit, which of the following best represents the potential difference at the voltmeter pictured in the diagram above?

A. 

B. 

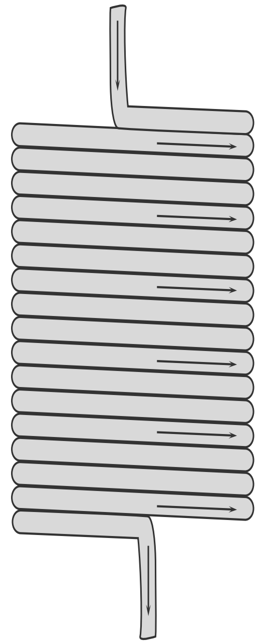
C. 

D. 

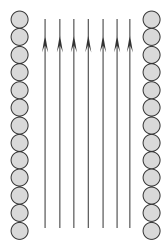
12. When subjected to an applied magnetic field, a material is magnetized in the same direction as the applied magnetic field with the induced field directly proportional to the applied field strength. This material is

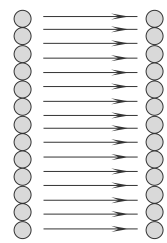
A. diamagnetic
B. paramagnetic
C. ferromagnetic
D. ferrimagnetic

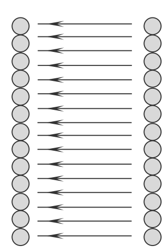
13. A coil of conducting wire is wound into a tightly packed helix. An electric current passing through the wire travels from left to right across the near face of the coil as shown in the figure below:

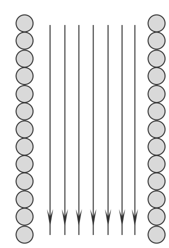


Which of the following most closely depicts the magnetic field in the volume of space within the coil?

A. 

B. 

C. 

D. 

The following passage pertains to questions 14 - 19.

Assigning oxygenated hemoglobin's oxidation state is difficult because oxyhemoglobin ($Hb\text{-}O_2$), by experimental measurement, is diamagnetic, yet the low-energy electron configurations in both oxygen and iron are paramagnetic.

Triplet oxygen, O_2, the lowest-energy molecular oxygen species, has two unpaired electrons in anti-bonding π^* molecular orbitals. Iron(II) tends to exist in a high-spin configuration with unpaired electrons spread out among its d orbitals in accord with Hund's rule. Iron(III) has an odd number of electrons, and thus must have one or more unpaired electrons, in any energy state. Thus, a non-intuitive distribution of electrons in the combination of iron and oxygen must exist, in order to explain the observed diamagnetism and no unpaired electrons.

The three logical possibilities to produce diamagnetic (no net spin) $Hb\text{-}O_2$ are as follows. One possibility is that low-spin Fe^{2+} binds to singlet oxygen. Both low-spin iron and singlet oxygen are diamagnetic. However, the singlet form of oxygen is the higher-energy form of the molecule. Another possibility is for low-spin Fe^{3+} to be bound to O^{2-} (the superoxide ion) and the two unpaired electrons couple antiferromagnetically, giving diamagnetic properties. The third possibility is that low-spin Fe^{4+} binds to peroxide, O_2^{2-}. Both are diamagnetic.

Compelling evidence from X-ray photoelectron spectroscopy and IR spectroscopy point to the second choice as the one that is correct of the three logical possibilities for diamagnetic oxyhemoglobin. This is not surprising because singlet oxygen (possibility #1) and large separations of charge (possibility #3) are both unfavorably high-energy states. Iron's shift to a higher oxidation state in $Hb\text{-}O_2$ decreases the atom's size, and allows it into the plane of the porphyrin ring, pulling on the coordinated histidine residue and initiating the allosteric changes seen in the globulins. All three models for diamagnetic $Hb\text{-}O_2$ may contribute to some small degree (by resonance) to the actual electronic configuration of $Hb\text{-}O_2$. However, the model of iron in $Hb\text{-}O_2$ being Fe(III) is more correct than the classical idea that it remains Fe(II).

14. As described in the passage which trait do triplet oxygen, high spin iron II, and iron III all have in common?

A. They are paramagnetic.
B. They have an even number of electrons.
C. They contribute to the structure of oxyhemoglobin by resonance.
D. They represent unfavorably high energy states.

15. Which medical imaging technique might be used to detect the relative abundance of the oxygenated and deoxygenated forms of hemoglobin in living tissue?

A. functional magnetic resonance imaging (fMRI)
B. electroencephalography (EEG)
C. positron emission tomography (PET)
D. computed tomography (CT)

16. Ferritin is a ubiquitous intracellular protein that stores iron and releases it in a controlled fashion. Based on information presented in the passage, ferritin is most likely

A. diamagnetic.
B. paramagnetic.
C. ferromagnetic.
D. anti-ferromagnetic.

17. According to the information presented in the passage, which value for bond order would most likely correspond to the O-O bond in $Hb\text{-}O_2$?

A. 1
B. 1.5
C. 2
D. 3

18. Which of the following information in the passage supports the determination that low-spin iron(III) bound to superoxide represents the iron-oxygen binding state in Hb-O_2.

A. Both Fe^{3+} and O^{2-} are diamagnetic.
B. Spectroscopic evidence that Hb-O_2 is paramagnetic.
C. Infrared vibrational frequencies of the O-O bond suggests a bond length consistent with singlet oxygen.
D. Fe^{3+} has a smaller radius than Fe^{2+}.

19. Which of the following is suggested in the passage to explain the diamagnetic properties of Hb-O_2 given that neither iron(III) and superoxide are diamagnetic?

A. Neighboring singlet electrons may align with spins pointing in opposite directions.
B. Electron sharing between O^{2-} and high-spin Fe^{3+} produces a hybrid orbital.
C. A decrease in the size of the iron atoms allows it into the plane of the porphyrin ring.
D. Binding with superoxide forces the iron(III) *d* orbitals into a spherical arrangement in which they are degenerate.