✔ Complete

In a 1.29 T magnetic field directed vertically upward, a particle having a charge of magnitude 8.20 $\mu\mathrm{C}$ and initially moving northward at 4.60 $\mathrm{km/s}$ is deflected toward the east.

You may want to review (Page) .

For related problemsolving tips and strategies, you may want to view a Video Tutor Solution of Magnetic force on a proton.

Review | Constants

Part A

What is the sign of the charge of this particle?

- The charge is negative.
- The charge is positive.

Submit Previous Answers

Correct

IDENTIFY: The force $\vec{F}$ on the particle is in the direction of the deflection of the particle. Apply the right-hand rule to the directions of $\vec{v}$ and $\vec{B}$. See if your thumb is in the direction of $\vec{F}$, or opposite to that direction. Use $F = |q|vB\ sin\ \phi$ with $\phi = 90°$ to calculate F.

SET UP: The directions of $\vec{v}$, $\vec{B}$, and $\vec{F}$ are shown in Figure 27.3.

EXECUTE: When you apply the right-hand rule to $\vec{v}$ and $\vec{B}$, your thumb points east. $\vec{F}$ is in this direction, so the charge is positive.

Part B

Find the magnetic force on the particle.

Express your answer in newtons.

F = 4.87×10^{-2} N

Submit

Previous Answers

Complete

Review | Constants

Cyclotrons are widely used in nuclear medicine for producing short-lived radioactive isotopes. These cyclotrons typically accelerate H^- (the *hydride* ion, which has one proton and two electrons) to an energy of 5 MeV to 20 MeV. This ion has a mass very close to that of a proton because the electron mass is negligible -- about $\frac{1}{2000}$ of the proton 's mass. A typical magnetic field in such cyclotrons is 1.9 T.

Part A

What is the speed of a 5.0 MeV H^-?

Express your answer with the appropriate units.

v = 3.1×10^7 $\frac{\mathrm{m}}{\mathrm{s}}$

Submit Previous Answers

Correct

Part B

If the H^- has energy 5.0 MeV and B = 1.9 T, what is the radius of this ion 's circular orbit?

Express your answer with the appropriate units.

✔ Complete

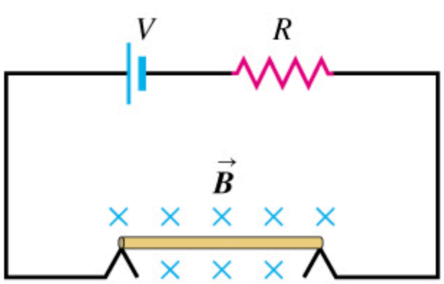
A thin, 53.0 cm long metal bar with mass 800 g rests on, but is not attached to, two metallic supports in a uniform magnetic field with a magnitude of 0.500 T, as shown in (Figure 1). A battery and a resistor of resistance 23.0 Ω are connected in series to the supports.

You may want to review (Page) .

For related problem-solving tips and strategies, you may want to view a Video Tutor Solution of Magnetic force on a straight conductor.

Figure

1 of 1



Review | Constants

Part A

What is the largest voltage the battery can have without breaking the circuit at the supports?

Express your answer in volts.

V = 680 V

Submit Previous Answers

Correct

IDENTIFY and SET UP: The magnetic force is given by $F = IlB\ \sin\phi$. $F_I = mg$ when the bar is just ready to levitate. When I becomes larger, $F_I > mg$ and $F_I - mg$ is the net force that accelerates the bar upward. Use Newton's second law to find the acceleration.

EXECUTE: $IlB = mg, I = \frac{mg}{lB} = \frac{(800\ \mathrm{g})(9.80\ \mathrm{m/s^2})}{(53.0\ \mathrm{cm})(0.500\ \mathrm{T})} = 29.6\ \mathrm{A}$.

$V = IR = (29.6\ \mathrm{A})(23.0\ \Omega) = 680\ \mathrm{V}$.

Part B

Part B

The battery voltage has the maximum value calculated in part (a). If the resistor suddenly gets partially short-circuited, decreasing its resistance to 2.00 Ω , find the initial acceleration of the bar.

Express your answer in meters per second squared.

Problem 27.54

Complete

Review | Constants

A mass spectrograph is used to measure the masses of ions, or to separate ions of different masses. In one design for such an instrument, ions with mass m and charge q are accelerated through a potential difference V. They then enter a uniform magnetic field that is perpendicular to their velocity, and are deflected in a semicircular path of radius R. A detector measures where the ions complete the semicircle and from this it is easy to calculate R.

Part A

Derive the equation for calculating the mass of the ion from measurements of B, V, R, and q.

Express your answer in terms of the given quantities and appropriate constants.

$m = \frac{R^2 q B^2}{2V}$

Submit Previous Answers

Correct

Part B

What potential difference V is needed so that singly ionized $^{12}\mathrm{C}$ atoms (mass $1.99 \times 10^{-26}\ \mathrm{kg}$) will have $R = 50.0\ \mathrm{cm}$ in a 0.150 T magnetic field?

Express your answer with the appropriate units.

Part C

Suppose the beam consists of a mixture of $^{12}\mathrm{C}$ and $^{14}\mathrm{C}$ ions. If v and B have the same values as in part B, calculate the separation of these two isotopes at the detector.

Express your answer with the appropriate units.

ΔD = 8.01×10^{-2} m

Submit [Previous Answers]

Correct

Part D

Do you think that this beam separation is sufficient for the two ions to be distinguished?

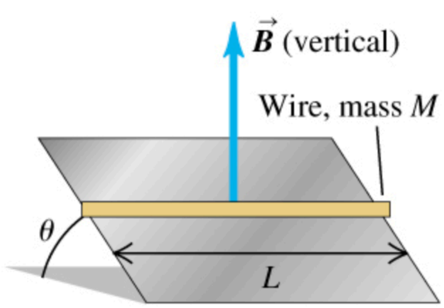
- easily distinguishible
- hardly distinguishible

Submit [Previous Answers]

Review I Constants

A straight piece of conducting wire with mass M and length L is placed on a frictionless incline tilted at an angle θ from the horizontal (the figure (Figure 1)). There is a uniform, vertical magnetic field $\vec{B}$ at all points (produced by an arrangement of magnets not shown in the figure). To keep the wire from sliding down the incline, a voltage source is attached to the ends of the wire. When just the right amount of current flows through the wire, the wire remains at rest.

Figure



Part A

Determine the magnitude of the current in the wire that will cause the wire to remain at rest.

Express your answer in terms of the variables M, θ, L, B, and acceleration due to gravity g.

I =

Submit Request Answer

Part B

Determine the direction of the current in the wire that will cause the wire to remain at rest.

- The current in the wire must be directed from right to left.
- The current in the wire must be directed from left to right.

Submit Request Answer

Part C

In addition viewing the wire from its left-hand end, show in a free-body diagram all the forces that act on the wire.

Draw the force vectors with their tails at the dot. The orientation of your vectors will be graded. The exact length of your vectors will not be graded but the relative length of one to the other will be graded.

Problem 27.57

Review | Constants

One method for determining the amount of corn in early Native American diets is the stable isotope ratio analysis (SIRA) technique. As corn photosynthesizes, it concentrates the isotope carbon-13, whereas most other plants concentrate carbon-12. Overreliance on corn consumption can then be correlated with certain diseases, because corn lacks the essential amino acid lysine. Archaeologists use a mass spectrometer to separate the $^{12}\mathrm{C}$ and $^{13}\mathrm{C}$ isotopes in samples of human remains. Suppose you use a velocity selector to obtain singly ionized (missing one electron) atoms of speed 8.50$\mathrm{km/s}$, and you want to bend them within a uniform magnetic field in a semicircle of diameter 25.0cm for the $^{12}\mathrm{C}$. The measured masses of these isotopes are $1.99 \times 10^{-26}\ \mathrm{kg}$ ($^{12}\mathrm{C}$) and $2.16 \times 10^{-26}\ \mathrm{kg}$ ($^{13}\mathrm{C}$).

Part A

What strength of magnetic field is required?

Express your answer in teslas.

ΑΣφ ?

B = T

Submit Request Answer

Part B

What is the diameter of the $^{13}\mathrm{C}$ semicircle?

Express your answer in centimeters.

ΑΣφ ?

D = cm

Part C

What is the separation of the $^{12}\mathrm{C}$ and $^{13}\mathrm{C}$ ions at the detector at the end of the semicircle?

Express your answer in centimeters.

$s =$ cm

Submit Request Answer

Part D

Is the distance found in part C large enough to be easily observed?

Please Choose

Submit Request Answer

A plastic circular loop of radius R and a positive charge q is distributed uniformly around the circumference of the loop. The loop is then rotated around its central axis, perpendicular to the plane of the loop, with angular speed ω.

Review | Constants

Part A

If the loop is in a region where there is a uniform magnetic field $\vec{B}$ directed parallel to the plane of the loop, calculate the magnitude of the magnetic torque on the loop.

Express your answer in terms of the variables q, ω, R, and B.

ΑΣφ ?

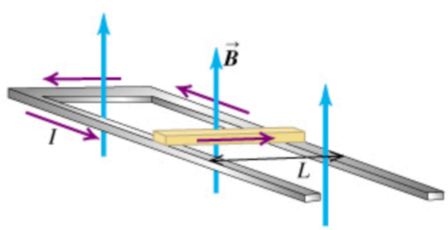
τ =

Review | Constants

A conducting bar with mass m and length L slides over horizontal rails that are connected to a voltage source. The voltage source maintains a constant current I in the rails and bar, and a constant, uniform, vertical magnetic field B fills the region between the rails (see the figure (Figure 1)).

Figure

1 of 1



Part A

Find the magnitude of the net force on the conducting bar. Ignore friction, air resistance, and electrical resistance.

Express your answer in terms of the variables I, L, and B.

ΑΣφ ?

F =

Submit Request Answer

Part B

What is the direction of the net force?

- to the left
- to the right

Submit Request Answer

Part C

If the bar has mass m, find the distance d that the bar must move along the rails from rest to attain speed v.

Express your answer in terms of the variables I, L, v, m, and B.

d =

Submit Request Answer

Part D

It has been suggested that rail guns based on this principle could accelerate payloads into earth orbit or beyond. Find the distance the bar must travel along the rails if it is to reach the escape speed for the earth (11.2 $\mathrm{km/s}$).

Let $B0$ = 0.72 T, $I0$ = 2500 A, $m0$ = 30 kg, and $L0$ = 51 cm. For simplicity, assume the net force on the object is equal to the magnetic force, as in parts A and B, even though gravity plays an important role in an actual launch into space.

Express your answer in meters.

Review | Constants

Point a is on the $+y$-axis at $y = +0.200\ \mathrm{m}$ and point b is on the $+x$-axis at $x = +0.200\ \mathrm{m}$. A wire in the shape of a circular arc of radius $0.200\ \mathrm{m}$ and centered on the origin goes from a to b and carries current $I = 5.50\ \mathrm{A}$ in the direction from a to b.

Part A

If the wire is in a uniform magnetic field $B = 0.800\ \mathrm{T}$ in the $+z$-dirction, what is the magnitude of the net force that the magnetic field exerts on the wire segment?

Express your answer with the appropriate units.

F_1 = Value Units

Submit Request Answer

Part B

What is the direction of the net force that the magnetic field exerts on the wire segment?

- The direction of the force is in the $+x$-axis.
- The direction of the force is toward the origin.
- The direction of the force is in the $+z$-axis.
- The direction of the force is in the $+y$-axis.

Part C

What is the magnitude of the net force on the wire if the field is $B = 0.800\ \mathrm{T}$ in the $+x$-direction?

Express your answer with the appropriate units.

F_2 = Value Units

Submit Request Answer

Part D

What is the direction of the net force on the wire if the field is $B = 0.800\ \mathrm{T}$ in the $+x$-direction?

- The direction of the force is in the $+z$-axis.
- The direction of the force is in the $+y$-axis.
- The direction of the force is toward the origin.
- The direction of the force is in the $+x$-axis.

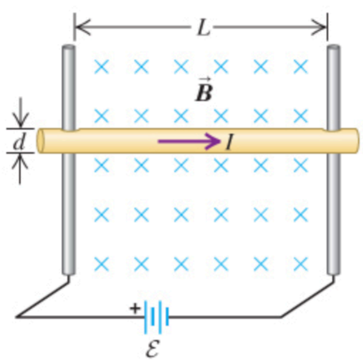
Submit Request Answer

Review | Constants

Earth's magnetic field near the ground is typically 0.50 G (0.50 gauss), where $1\ \mathrm{G} = 10^{-4}$ tesla. In temperate northern latitudes, this field is inclined downward at an angle of approximately 45°. Consider the feasibility of using the earth's magnetic field to enable the levitation device shown in (Figure 1).

Figure

1 of 1



Part A

Estimate the current needed to lift a copper bar with diameter d = 5.0 mm using the horizontal component of the earth's magnetic field. The density of copper is 8900 $\mathrm{kg/m^3}$.

Express your answer to two significant figures and include the appropriate units.

I = 4.8×10^4 A

Submit Previous Answers

Correct

Part B

A copper bar with diameter 5.0 mm will melt if it carries a current greater than the fusing current of 900 A. Is it feasible for our device?

- feasible
- not feasible

Submit Request Answer

Part C

Estimate the minimum strength of the magnetic field needed to levitate our copper bar.

Express your answer to two significant figures and include the appropriate units.

$B_{\min}$ = $1.9 \times 10^{-3}\ \mathrm{T}$

Submit Previous Answers

Correct

Part D

Suppose we use easily obtainable 1.0 T permanent magnets to supply the horizontal magnetic field and suppose our bar has length 10 cm. Estimate how much extra weight we could levitate with our device using a current of 10 A.

Express your answer to two significant figures and include the appropriate units.

w = $0.83\ \mathrm{N}$

Submit Previous Answers

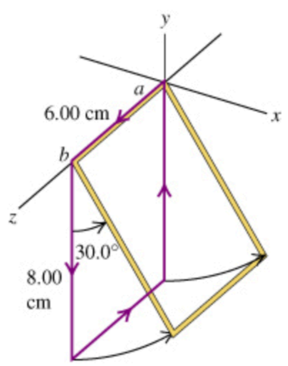
Problem 27.65

Review | Constants

The rectangular loop of wire shown in the figure (Figure 1) has a mass of 0.13 g per centimeter of length and is pivoted about side **ab** on a frictionless axis. The current in the wire is 8.9 A in the direction shown.

Figure

1 of 1



Part A

Find the magnitude of the magnetic field parallel to the y-axis that will cause the loop to swing up until its plane makes an angle of 30.0 $^\circ$ with the yz-plane.

Express your answer in teslas.

B = T

Submit Request Answer

Part B

Find the direction of the magnetic field parallel to the y-axis that will cause the loop to swing up until its plane makes an angle of 30.0 $^\circ$ with the yz-plane.

- $-y$-direction
- $+y$-direction

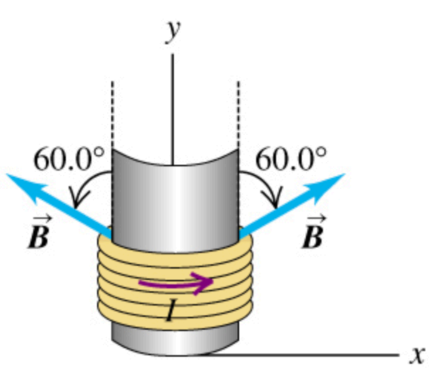
Submit Request Answer

Review | Constants

The net force on a current loop in a *uniform* magnetic field is zero. The magnetic force on the voice coil of a loudspeaker is nonzero because the magnetic field at the coil is not uniform. A voice coil in a loudspeaker has 51 turns of wire and a diameter of 1.40 cm , and the current in the coil is 0.920 A . Assume that the magnetic field at each point of the coil has a constant magnitude of 0.210 T and is directed at an angle of 60.0 $^\circ$ outward from the normal to the plane of the coil (the figure (Figure 1)). Let the axis of the coil be in the y-direction. The current in the coil is in the direction shown (counterclockwise as viewed from a point above the coil on the y-axis).

Figure

1 of 1



Part A

Calculate the magnitude of the net magnetic force on the coil.

Express your answer in newtons.

F = N

Submit Request Answer

Part B

Calculate the direction of the net magnetic force on the coil.

- $+x$-diraction
- $-x$-diraction
- $+y$-diraction
- $-y$-diraction

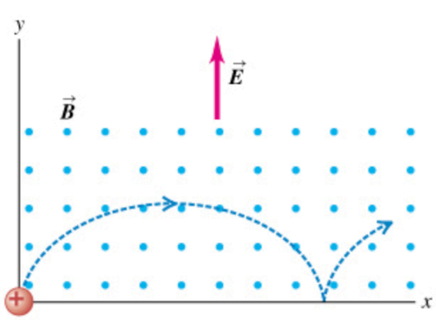
Submit Previous Answers

✔ Complete

A particle with mass m and positive charge q starts from rest at the origin shown in the figure (Figure 1). There is a uniform electric field $\vec{E}$ in the $+y$-direction and a uniform magnetic field $\vec{B}$ directed out of the page. It is shown in more advanced books that the path is a *cycloid* whose radius of curvature at the top points is twice the y-coordinate at that level.

Figure

1 of 1



Review | Constants

Part B

Find the speed at any point. (*Hint:* Use energy conservation.)

Express your answer in terms of some or all of the variables q, E, y, and m.

$v = \sqrt{\dfrac{2qEy}{m}}$

Submit Previous Answers

✔ **Correct**

Part C

Applying Newton's second law at the top point and taking as given that the radius of curvature here equals $2y$, find the speed at this point.

Express your answer in terms of some or all of the variables q, E, y, and m.

$v = \dfrac{2E}{B}$

Submit Previous Answers