Physics Unit 9: Magnetism Review

1. Know the fundamental properties of permanent magnets.
2. Know how to induce emf.
3. Know the RHR's, and Lenz's Law.
4. A loose proton enters a magnetic field whose direction is coming out of the page. What does its path look like? If the path is bent, what way does it bend?
5. The path of a charged particle is bent clockwise in a magnetic field that is pointed out of the page. What is sign of the charge of the particle?
6. A current goes down and the magnetic field points to the right. What is the direction of the force on the wire carrying the current?
7. A 5 cm section of wire with a 10.0 A current runs perpendicular to a 3.00-T magnetic field. What is the magnitude of the force on the wire?
8. A single circular loop of wire of radius 0.25 m carries a constant current of 10.0 A. The loop may be rotated about an axis that passes through the center and lies in the plane of the loop. When the orientation of the normal to the loop with respect to the direction of the magnetic field is 75°, the torque on the coil is 0.80 N·m. What is the magnitude of the uniform magnetic field exerting this torque on the loop?
9. A solenoid that is 2 m long and has a diameter of 0.5 m has 150 turns. Find the magnitude and direction of the magnetic field at the center of the solenoid if the current is 5 A clockwise.
10. A straight wire carries 5 A of current. If the wire is vertical and the current runs down, find the magnitude and direction of the magnetic field 2 cm from the wire.
11. A 5.00-T magnetic field is directed 15° to the plane of a circular loop of radius 0.75 m. What is the magnitude of the magnetic flux through the loop?
12. Two wires are side by side and very close to each other. One wire carries 2 A and the other 3A in the same direction. What is magnetic field 5 cm from the wires?
13. A circular loop of wire (r = 5 cm) is in a magnetic field (B = 0.5 T) with the normal of the loop parallel to the B-field. The B-field increases from 0.2 T to 0.4 T in 2 s. What is the induced emf in the loop? What direction would a current flow through the loop?
14. What is the emf between the ends of the wings of an airplane if its wings are 50.0 m long and flying at 305 m/s. as it flies perpendicular to the 4.00×10^{-5} -T earth's magnetic field?
15. A circular coil has 500 turns and a radius of 0.10 m. The coil is used as an AC generator by rotating it in a 1.0 T magnetic field, as shown in the figure. At what angular speed should the coil be rotated so that the maximum emf is 140 V?
16. An electric motor runs on 120 V and draws 15 A of current when starting. At normal operation it only draws 2.0 A of current. What is the back emf when the motor is running normally?
17. A transformer's primary coil has 160 turns and 240 V. How many turns are needed in the secondary coil to get 80 V? Is this a step-up or step-down transformer?
18. A power plant produces a voltage of 14 kV and 200 A. The voltage is stepped up to 120 kV by a transformer before it is transmitted to a substation. The resistance of the transmission line between the power plant and the substation is 200Ω. What is the current in the transmission line from the plant to the substation?

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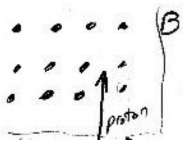
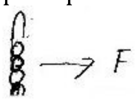
Answers

4. Since the proton is charged, the path is bent in a circle.

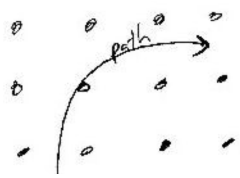


RHR – fingers
- thumb in direction of v
- palm points in direction of F

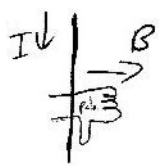


Bends to clockwise (electron would bend counterclockwise)

5. **Positive**



6. RHR – fingers B
thumb I
palm F
F is out of page

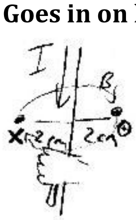


7. $F = ILB \sin \Theta$
$F = (10.0\ A)(0.05\ m)(3.00\ T) \sin 90° = \mathbf{1.5\ N}$

8. $\tau = NIAB \sin \phi$
$0.80\ N \cdot m = (1)(10.0\ A)(\pi(0.25\ m)^2)B \sin 75°$
$B = \mathbf{0.422\ T}$

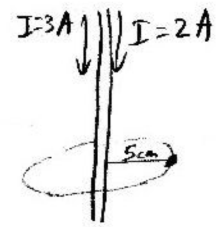
9. $L = 2\ m, d = 0.5\ m, N = 150, I = 5\ A$
$B = \mu_0 nI; n = \frac{N}{L} = \frac{150}{2\ m} = 75\ m^{-1}$
$B = \left(4\pi \times 10^{-7} \frac{Tm}{A}\right)(75\ m^{-1})(5\ A) = \mathbf{4.71 \times 10^{-4}\ T}$
RHR says points **into paper**

10. $I = 5\ A, r = 0.02\ m$
$B = \frac{\mu_0 I}{2\pi r}$
$B = \frac{\left(4\pi \times 10^{-7} \frac{Tm}{A}\right)(5\ A)}{2\pi(0.02\ m)} = \mathbf{5 \times 10^{-5}\ T}$
Goes in on left, out on right



11. The angle should be to the normal to the loop instead of the plane of the loop. $\phi = 90° - 15° = 75°$
$\Phi = BA \cos \phi$
$\Phi = (5.00\ T)(\pi(0.75\ m)^2) \cos 75° = \mathbf{2.29\ Wb}$

12. Ampere's Law



$\Sigma B \cdot \Delta \ell = \mu_0 I$
$B(2\pi r) = \mu_0 I$
$B(2\pi 0.05\ m) = \left(4\pi \times 10^{-7} \frac{Tm}{A}\right)(3\ A + 2\ A)$
$B(0.31416\ m) = 6.2832 \times 10^{-6}\ Tm$
$\mathbf{B = 2 \times 10^{-5}\ T}$

13. $N = 1, r = 0.05\ m, B = 0.5\ T, \frac{\Delta B}{\Delta t} = 0.1 \frac{T}{s}$
$emf = -N \frac{\Delta \Phi}{\Delta t}, \Phi = BA \cos \theta$
$emf = -1 \cdot \frac{B_f A \cos 0 - B_0 A \cos 0}{\Delta t}$
$emf = -\left(\frac{(0.4\ T)(\pi(0.05\ m)^2) - (0.2\ T)(\pi(0.05\ m)^2)}{2\ s}\right)$
$emf = -(\pi(0.05\ m)^2)\left(0.1 \frac{T}{s}\right) = \mathbf{-7.85 \times 10^{-4}\ V}$
Flux is getting stronger so induced B-field should cancel the original B-field.
RHR – curl your fingers through the loop in the direction of the induced B-field. Your thumb will point the direction of the current.

14. $emf = vBL$
$emf = \left(305 \frac{m}{s}\right)(4.00 \times 10^{-5}\ T)(50.0\ m)$
$= \mathbf{0.61\ V}$

15. $emf = NBA\omega \sin \omega t$
Maximum emf occurs when $\sin \omega t = 1$
$140\ V = (500)(1.0\ T)(\pi(0.10\ m)^2)\omega(1)$
$\omega = \mathbf{8.91 \frac{rad}{s}}$

16. When starting: $V = IR$
$120\ V = (15\ A)R \rightarrow R = 8\ \Omega$
When running: $V = IR$
$120\ V - emf = (2.0\ A)(8\ \Omega)$
$emf = \mathbf{104\ V}$

17. $N_p = 160, V_p = 240\ V, V_s = 80\ V$
$\frac{V_s}{V_p} = \frac{N_s}{N_p} \rightarrow \frac{80\ V}{240\ V} = \frac{N_s}{160}$
$N_s = 53.3$
54 turns; Step-down since V decreases.

18. $\frac{V_S}{V_P} = \frac{I_P}{I_S} \rightarrow \frac{120\ kV}{14\ kV} = \frac{200\ A}{I_S} \rightarrow I_S = \mathbf{23.3\ A}$